Suricata User Guide

Release 7.0.14

OISF

Jan 09, 2026

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This is the documentation for Suricata 7.0.14.

CHAPTER

ONE

WHAT IS SURICATA

Suricata is a high performance Network IDS, IPS and Network Security Monitoring engine. It is open source and owned by a community-run non-profit foundation, the Open Information Security Foundation (OISF). Suricata is developed by the OISF.

1.1 About the Open Information Security Foundation

The Open Information Security Foundation is a non-profit foundation organized to build community and to support open-source security technologies like Suricata, the world-class IDS/IPS engine.

1.1.1 License

The Suricata source code is licensed under version 2 of the *GNU General Public License*.

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CHAPTER

TWO

QUICKSTART GUIDE

This guide will give you a quick start to run Suricata and will focus only on the basics. For more details, read through the more specific chapters.

2.1 Installation

It's assumed that you run a recent Ubuntu release as the official PPA can then be used for the installation. To install the latest stable Suricata version, follow the steps:

```
sudo apt-get install software-properties-common
sudo add-apt-repository ppa:oisf/suricata-stable
sudo apt update
sudo apt install suricata jq
```

The dedicated PPA repository is added, and after updating the index, Suricata can be installed. We recommend installing the `jq` tool at this time as it will help with displaying information from Suricata's EVE JSON output (described later in this guide).

For the installation on other systems or to use specific compile options see *Installation*.

After installing Suricata, you can check which version of Suricata you have running and with what options, as well as the service state:

```
sudo suricata --build-info
sudo systemctl status suricata
```

2.2 Basic setup

First, determine the interface(s) and IP address(es) on which Suricata should be inspecting network packets:

```
$ ip addr

2: enp1s0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group␣
↪default qlen 1000
link/ether 00:11:22:33:44:55 brd ff:ff:ff:ff:ff:ff
inet 10.0.0.23/24 brd 10.23.0.255 scope global noprefixroute enp1s0
```

Use that information to configure Suricata:

```
sudo vim /etc/suricata/suricata.yaml
```

There are many possible configuration options, we focus on the setup of the `HOME_NET` variable and the network interface configuration. The `HOME_NET` variable should include, in most scenarios, the IP address of the monitored interface and all the local networks in use. The default already includes the RFC 1918 networks. In this example `10.0.0.23` is already included within `10.0.0.0/8`. If no other networks are used the other predefined values can be removed.

In this example the interface name is `enp1s0` so the interface name in the `af-packet` section needs to match. An example interface config might look like this:

Capture settings:

```
af-packet:
    - interface: enp1s0
      cluster-id: 99
      cluster-type: cluster_flow
      defrag: yes
      use-mmap: yes
      tpacket-v3: yes
```

This configuration uses the most recent recommended settings for the IDS runmode for basic setups. There are many of possible configuration options which are described in dedicated chapters and are especially relevant for high performance setups.

2.3 Signatures

Suricata uses Signatures to trigger alerts so it's necessary to install those and keep them updated. Signatures are also called rules, thus the name *rule-files*. With the tool `suricata-update` rules can be fetched, updated and managed to be provided for Suricata.

In this guide we just run the default mode which fetches the ET Open ruleset:

```
sudo suricata-update
```

Afterwards the rules are installed at `/var/lib/suricata/rules` which is also the default at the config and uses the sole `suricata.rules` file.

2.4 Running Suricata

With the rules installed, Suricata can run properly and thus we restart it:

```
sudo systemctl restart suricata
```

To make sure Suricata is running check the Suricata log:

```
sudo tail /var/log/suricata/suricata.log
```

The last line will be similar to this:

```
<Notice> - all 4 packet processing threads, 4 management threads initialized, engine␣
↪started.
```

The actual thread count will depend on the system and the configuration.

To see statistics, check the `stats.log` file:

```
sudo tail -f /var/log/suricata/stats.log
```

By default, it is updated every 8 seconds to show updated values with the current state, like how many packets have been processed and what type of traffic was decoded.

2.5 Alerting

To test the IDS functionality of Suricata it's best to test with a signature. The signature with ID `2100498` from the ET Open ruleset is written specific for such test cases.

2100498:

```
alert ip any any -> any any (msg:"GPL ATTACK_RESPONSE id check returned root"; content:
↪"uid=0|28|root|29|"; classtype:bad-unknown; sid:2100498; rev:7; metadata:created_at␣
↪2010_09_23, updated_at 2010_09_23;)
```

The syntax and logic behind those signatures is covered in other chapters. This will alert on any IP traffic that has the content within its payload. This rule can be triggered quite easy. Before we trigger it, start `tail` to see updates to `fast.log`.

Rule trigger:

```
sudo tail -f /var/log/suricata/fast.log
curl http://testmynids.org/uid/index.html
```

The following output should now be seen in the log:

```
[1:2100498:7] GPL ATTACK_RESPONSE id check returned root [**] [Classification:␣
↪Potentially Bad Traffic] [Priority: 2] {TCP} 217.160.0.187:80 -> 10.0.0.23:41618
```

This should include the timestamp and the IP of your system.

2.6 EVE Json

The more advanced output is the EVE JSON output which is explained in detail in *Eve JSON Output*. To see what this looks like it's recommended to use `jq` to parse the JSON output.

Alerts:

```
sudo tail -f /var/log/suricata/eve.json | jq 'select(.event_type=="alert")'
```

This will display more detail about each alert, including meta-data.

Stats:

```
sudo tail -f /var/log/suricata/eve.json | jq 'select(.event_type=="stats")|.stats.
↪capture.kernel_packets'
sudo tail -f /var/log/suricata/eve.json | jq 'select(.event_type=="stats")'
```

The first example displays the number of packets captured by the kernel; the second examples shows all of the statistics.

CHAPTER

THREE

INSTALLATION

Before Suricata can be used it has to be installed. Suricata can be installed on various distributions using binary packages: *Binary packages*.

For people familiar with compiling their own software, the *Source method* is recommended.

Advanced users can check the advanced guides, see *Arch Based*.

3.1 Source

Installing from the source distribution files gives the most control over the Suricata installation.

The Suricata source distribution files should be verified before building the source, see *Verifying Suricata Source Distribution Files*.

Basic steps:

```
tar xzvf suricata-7.0.5.tar.gz
cd suricata-7.0.5
./configure
make
make install
```

This will install Suricata into `/usr/local/bin/`, use the default configuration in `/usr/local/etc/suricata/` and will output to `/usr/local/var/log/suricata`

3.1.1 Common configure options

`--disable-gccmarch-native`

Do not optimize the binary for the hardware it is built on. Add this flag if the binary is meant to be portable or if Suricata is to be used in a VM.

`--prefix``=/usr/`

Installs the Suricata binary into /usr/bin/. Default `/usr/local/`

`--sysconfdir``=/etc`

Installs the Suricata configuration files into /etc/suricata/. Default `/usr/local/etc/`

`--localstatedir``=/var`

Setups Suricata for logging into /var/log/suricata/. Default `/usr/local/var/log/suricata`

--enable-lua
Enables Lua support for detection and output.

--enable-geoip
Enables GeoIP support for detection.

--enable-dpdk
Enables DPDK packet capture method.

3.1.2 Dependencies and compilation

Ubuntu/Debian

Note: The following instructions require sudo to be installed.

Listing 1: Minimal dependencies for Ubuntu/Debian

```
sudo apt -y install autoconf automake build-essential cargo \
    cbindgen libjansson-dev libpcap-dev libpcre2-dev libtool \
    libyaml-dev make pkg-config rustc zlib1g-dev
```

CentOS, AlmaLinux, RockyLinux, Fedora, etc

Note: The following instructions require sudo to be installed.

To install all minimal dependencies, it is required to enable extra package repository in most distros. You can enable it possibly by one of the following ways:

```
sudo dnf -y update
sudo dnf -y install epel-release dnf-plugins-core
# AlmaLinux 8 / RockyLinux 8
sudo dnf config-manager --set-enabled powertools
# AlmaLinux 9 / RockyLinux 9
sudo dnf config-manager --set-enable crb
# Oracle Linux 8
sudo dnf config-manager --set-enable ol8_codeready_builder
# Oracle Linux 9
sudo dnf config-manager --set-enable ol9_codeready_builder
```

Listing 2: Minimal dependencies for RPM-based distributions

```
sudo dnf install -y rustc cargo cbindgen
sudo dnf install -y gcc gcc-c++ jansson-devel libpcap-devel \
    libyaml-devel make pcre2-devel zlib-devel
```

Compilation

Follow these steps from your Suricata directory:

```
./configure # you may want to add additional parameters here
# ./configure --help to get all available parameters
# j is for adding concurrency to make; the number indicates how much
# concurrency so choose a number that is suitable for your build system
make -j8
make install # to install your Suricata compiled binary
# make install-full - installs configuration and rulesets as well
```

Rust support

Rust packages can be found in package managers but some distributions don't provide Rust or provide outdated Rust packages. In case of insufficient version you can install Rust directly from the Rust project itself:

```
1) Install Rust https://www.rust-lang.org/en-US/install.html
2) Install cbindgen - if the cbindgen is not found in the repository
   or the cbindgen version is lower than required, it can be
   alternatively installed as: cargo install --force cbindgen
3) Make sure the cargo path is within your PATH environment
   echo 'export PATH="~/.cargo/bin:${PATH}"' >> ~/.bashrc
   export PATH="~/.cargo/bin:${PATH}"
```

3.1.3 Auto-Setup

You can also use the available auto-setup features of Suricata:

```
./configure && make && sudo make install-conf
```

make install-conf would do the regular "make install" and then it would automatically create/setup all the necessary directories and `suricata.yaml` for you.

```
./configure && make && sudo make install-rules
```

make install-rules would do the regular "make install" and then it would automatically download and set up the latest ruleset from Emerging Threats available for Suricata.

```
./configure && make && sudo make install-full
```

make install-full would combine everything mentioned above (install-conf and install-rules) and will present you with a ready-to-run (configured and set-up) Suricata.

3.2 Binary packages

3.2.1 Ubuntu from Personal Package Archives (PPA)

For Ubuntu, OISF maintains a PPA `suricata-stable` that always contains the latest stable release.

Note: The following instructions require `sudo` to be installed.

Setup to install the latest stable Suricata:

```
sudo apt-get install software-properties-common
sudo add-apt-repository ppa:oisf/suricata-stable
sudo apt-get update
```

Then, you can install the latest stable with:

```
sudo apt-get install suricata
```

After installing you can proceed to the *Basic setup*.

OISF launchpad: suricata-stable.

Upgrading

To upgrade:

```
sudo apt-get update
sudo apt-get upgrade suricata
```

Remove

To remove Suricata from your system:

```
sudo apt-get remove suricata
```

Getting Debug or Pre-release Versions

Note: The following instructions require `sudo` to be installed.

If you want Suricata with built-in (enabled) debugging, you can install the debug package:

```
sudo apt-get install suricata-dbg
```

If you would like to help test the Release Candidate (RC) packages, the same procedures apply, just using another PPA: `suricata-beta`:

```
sudo add-apt-repository ppa:oisf/suricata-beta
sudo apt-get update
sudo apt-get upgrade
```

You can use both the suricata-stable and suricata-beta repositories together. Suricata will then always be the latest release, stable or beta.

OISF launchpad: suricata-beta.

Daily Releases

Note: The following instructions require `sudo` to be installed.

If you would like to help test the daily build packages from our latest git(dev) repository, the same procedures as above apply, just using another PPA, `suricata-daily`:

```
sudo add-apt-repository ppa:oisf/suricata-daily-allarch
sudo apt-get update
sudo apt-get upgrade
```

Note: Please have in mind that this is packaged from our latest development git main and is therefore potentially unstable.

We do our best to make others aware of continuing development and items within the engine that are not yet complete or optimal. With this in mind, please refer to Suricata's issue tracker on Redmine for an up-to-date list of what we are working on, planned roadmap, and to report issues.

OISF launchpad: suricata-daily.

3.2.2 Debian

Note: The following instructions require `sudo` to be installed.

In Debian 9 (stretch) and later do:

```
sudo apt-get install suricata
```

In the "stable" version of Debian, Suricata is usually not available in the latest version. A more recent version is often available from Debian backports, if it can be built there.

To use backports, the backports repository for the current stable distribution needs to be added to the system-wide sources list. For Debian 10 (buster), for instance, run the following as `root`:

```
echo "deb http://http.debian.net/debian buster-backports main" > \
    /etc/apt/sources.list.d/backports.list
apt-get update
apt-get install suricata -t buster-backports
```

3.2.3 CentOS, AlmaLinux, RockyLinux, Fedora, etc

RPMs are provided for the latest release of *Enterprise Linux*. This includes CentOS Linux and rebuilds such as AlmaLinux and RockyLinux. Additionally, RPMs are provided for the latest supported versions of Fedora.

RPMs specifically for CentOS Stream are not provided, however the RPMs for their related version may work fine.

Installing From Package Repositories

CentOS, RHEL, AlmaLinux, RockyLinux, etc Version 8+

Note: The following instructions require `sudo` to be installed.

```
sudo dnf install epel-release dnf-plugins-core
sudo dnf copr enable @oisf/suricata-7.0
sudo dnf install suricata
```

CentOS 7

```
sudo yum install epel-release yum-plugin-copr
sudo yum copr enable @oisf/suricata-7.0
sudo yum install suricata
```

Fedora

```
sudo dnf install dnf-plugins-core
sudo dnf copr enable @oisf/suricata-7.0
sudo dnf install suricata
```

Additional Notes for RPM Installations

- Suricata is pre-configured to run as the `suricata` user.
- Command line parameters such as providing the interface names can be configured in `/etc/sysconfig/suricata`.
- Users can run `suricata-update` without being root provided they are added to the `suricata` group.
- Directories:
  - `/etc/suricata`: Configuration directory
  - `/var/log/suricata`: Log directory
  - `/var/lib/suricata`: State directory rules, datasets.

Starting Suricata On-Boot

The Suricata RPMs are configured to run from Systemd.

Note: The following instructions require `sudo` to be installed.

To start Suricata:

```
sudo systemctl start suricata
```

To stop Suricata:

```
sudo systemctl stop suricata
```

To have Suricata start on-boot:

```
sudo systemctl enable suricata
```

To reload rules:

```
sudo systemctl reload suricata
```

3.2.4 Arch Based

The ArchLinux AUR contains Suricata and suricata-nfqueue packages, with commonly used configurations for compilation (may also be edited to your liking). You may use makepkg, yay (sample below), or other AUR helpers to compile and build Suricata packages.

```
yay -S suricata
```

3.3 Advanced Installation

If you are using Ubuntu, you can follow *Installation from GIT*.

For other various installation guides for installing from GIT and for other operating systems, please check (bear in mind that those may be somewhat outdated): https://redmine.openinfosecfoundation.org/projects/suricata/wiki/Suricata_Installation

CHAPTER

FOUR

UPGRADING

4.1 General instructions

Suricata can be upgraded by simply installing the new version to the same locations as the already installed version. When installing from source, this means passing the same `--prefix`, `--sysconfdir`, `--localstatedir` and `--datadir` options to `configure`.

```
$ suricata --build-info|grep -A 3 '\-\-prefix'
    --prefix                                /usr
    --sysconfdir                            /etc
    --localstatedir                         /var
    --datarootdir                           /usr/share
```

4.1.1 Configuration Updates

New versions of Suricata will occasionally include updated config files: `classification.config` and `reference.config`. Since the Suricata installation will not overwrite these if they exist, they must be manually updated. If there are no local modifications they can simply be overwritten by the ones Suricata supplies.

Major updates include new features, new default settings and often also remove features. This upgrade guide covers the changes that might have an impact of migrating from an older version and keeping the config. We encourage you to also check all the new features that have been added but are not covered by this guide. Those features are either not enabled by default or require dedicated new configuration.

4.2 Upgrading to 7.0.14

4.2.1 Other Changes

- `dnp3` has reduced the maximum number of open transactions from 500 down to 32, the maximum number of points per message from unbounded to 16384, and the maximum number of objects per message from unbounded to 2048. Configuration options, `max-tx`, `max-points`, and `max-objects` have been added for users who may need to change these defaults.

4.3 Upgrading to 7.0.12

- Various expected PPP packet types will no longer be marked as Unsupported Protocol when in a PPPOE packet.
- Added Cisco Discovery Protocol Control Protocol as a valid PPP packet.

4.4 Upgrading to 7.0.9

- The AF_PACKET default block size for both TPACKET_V2 and TPACKET_V3 has been increased from 32k to 128k. This is to allow for full size defragmented packets. For TPACKET_V3 the existing `block-size` parameter can be used to change this back to the old default of 32768 if needed. For TPACKET_V2 a new configuration parameter has been added, `v2-block-size` which can be used to tune this value for TPACKET_V2. Due to the increased block size, memory usage has been increased, but should not be an issue in most cases.
- Datasets specifying a custom *hashsize* will now be limited to 262144 by default. Additionally, the cumulative hash sizes for all datasets in use should not exceed 67108864. These settings can be changed with the following settings.

```
datasets:
  # Limits for per rule dataset instances to avoid rules using too many
  # resources.
  # Note: in Suricata 8 the built-in default will be set to lower values.
  limits:
    # Max value for per dataset `hashsize` setting
    #single-hashsize: 262144
    # Max combined hashsize values for all datasets.
    #total-hashsizes: 67108864
```

- For detect inspection recursion limits, if no value is provided, the default is 3000 now.

4.5 Upgrading to 7.0.8

- Unknown requirements in the `requires` keyword will now be treated as unsatisfied requirements, causing the rule to not be loaded. See *requires*. To opt out of this change and to ignore unknown requirements, effectively treating them as satisfied the `ignore-unknown-requirements` configuration option can be used.

  Command line example:

```
--set ignore-unknown-requirements=true
```

  Or as a top-level configuration option in `suricata.yaml`:

```
default-rule-path: /var/lib/suricata/rules
rule-files:
  - suricata.rules
ignore-unknown-requirements: true
```

  Note: This option will only exist in Suricata 7.0.8 and future 7.0 releases. It will not be provided in Suricata 8. Please fix any rules that depend on this behavior.

- Application layer metadata is logged with alerts by default **only for rules that use application layer keywords**. For other rules, the configuration parameter `detect.guess-applayer-tx` can be used to force the detect engine to guess a transaction, which is not guaranteed to be the one you expect. **In this case, the engine will NOT log any transaction metadata if there is more than one live transaction, to reduce the chances of logging unrelated data.** This may lead to what looks like a regression in behavior, but it is a considered choice.
- The configuration setting controlling stream checksum checks no longer affects checksum keyword validation. In previous Suricata versions, when `stream.checksum-validation` was set to `no`, the checksum keywords (e.g., `ipv4-csum`, `tcpv4-csum`, etc) will always consider it valid; e.g., `tcpv4-csum: invalid` will never match. Now, `stream.checksum-validation` no longer affects the checksum rule keywords. E.g., `ipv4-csum: valid` will only match if the check sum is valid, even when engine checksum validations are disabled.

4.6 Upgrading 6.0 to 7.0

4.6.1 Major changes

- Upgrade of PCRE1 to PCRE2. See *Changes from PCRE1 to PCRE2* for more details.
- IPS users: by default various new "exception policies" are set to DROP traffic. Please see *Exception Policies* for details on the settings and their scope. For trouble shooting, please check My traffic gets blocked after upgrading to Suricata 7.
- New protocols enabled by default: bittorrent-dht, quic, http2.
- The telnet protocol is also enabled by default, but only for the `app-layer`.

4.6.2 Security changes

- suricata.yaml now prevents process creation by Suricata by default with *security.limit-noproc*. The suricata.yaml configuration file needs to be updated to enable this feature. For more info, see *Configuration hardening*.
- Absolute filenames and filenames containing parent directory traversal are no longer allowed by default for datasets when the filename is specified as part of a rule. See *Datasets Security* and *Datasets File Locations* for more information.
- Lua rules are now disabled by default (change also introduced in 6.0.13), see *Lua Scripting for Detection*.
- Support for JA4 has been added. JA4 hashes will be computed when explicitly enabled or a rule uses *ja4.hash*. JA4 hashes are output under a restricted set of conditions (see below):

4.6.3 Removals

- The libprelude output plugin has been removed.
- EVE DNS v1 logging support has been removed. If still using EVE DNS v1 logging, see the manual section on DNS logging configuration for the current configuration options: *DNS EVE Configuration*

4.6.4 Logging changes

- IKEv2 Eve logging changed, the event_type has become `ike` which covers both protocol versions. The fields `errors` and `notify` have moved to `ike.ikev2.errors` and `ike.ikev2.notify`.
- FTP DATA metadata for alerts are now logged in `ftp_data` instead of root.
- Alert `xff` field is now logged as `alert.xff` for alerts instead of at the root.
- Protocol values and their names are built into Suricata instead of using the system's `/etc/protocols` file. Some names and casing may have changed in the values `proto` in `eve.json` log entries and other logs containing protocol names and values. See https://redmine.openinfosecfoundation.org/issues/4267 for more information.
- Logging of additional HTTP headers configured through the EVE `http.custom` option will now be logged in the `request_headers` and/or `response_headers` respectively instead of merged into the existing `http` object. In Suricata 6.0, a configuration like:

```
http:
  custom: [Server]
```

would result in a log entry like:

```
"http": {
  "hostname": "suricata.io",
  "http_method": "GET",
  "protocol": "HTTP/1/1",
  "server": "nginx",
  ...
}
```

This merging of custom headers in the `http` object could result in custom headers overwriting standard fields in the `http` object, or a response header overwriting request header.

To prevent the possibility of fields being overwritten, **all** custom headers are now logged into the `request_headers` and `response_headers` arrays to avoid any chance of collision. This also facilitates the logging of headers that may appear multiple times, with each occurrence being logged in future releases (see note below).

While these arrays are not new in Suricata 7.0, they had previously been used exclusively for the `dump-all-headers` option.

As of Suricata 7.0, the above configuration example will now be logged like:

```
"http": {
  "hostname": "suricata.io",
  "http_method": "GET",
  "protocol": "HTTP/1/1",
  "response_headers": [
    { "name": "Server", "value": "nginx" }
  ]
}
```

Effectively making the `custom` option a subset of the `dump-all-headers` option.

If you've been using the `custom` option, this may represent a breaking change. However, if you haven't used it, there will be no change in the output.

Note: Currently, if the same HTTP header is seen multiple times, the values are concatenated into a comma-separated value.

For more information, refer to: https://redmine.openinfosecfoundation.org/issues/1275.

- JA4 hashes are output under a restricted set of conditions when JA4 is dynamically or explicitly enabled:
  - Alerts: The signature causing the alert contains the *ja4.hash* keyword
  - Logs: With QUIC logs iff outputs.quic.ja4 is enabled (default off)
  - Logs: With TLS logs iff outputs.tls.ja4 is enabled (default off)

4.6.5 Deprecations

- Multiple "include" fields in the configuration file will now issue a warning and in Suricata 8.0 will not be supported. See *Includes* for documentation on including multiple files.
- For AF-Packet, the *cluster_rollover* setting is no longer supported. Configuration settings using `cluster_rollover` will cause a warning message and act as though *cluster_flow* ` was specified. Please update your configuration settings.

4.6.6 Other changes

- Experimental keyword *http2.header* is removed. *http.header*, *http.request_header*, and *http.response_header* are to be used.
- NSS is no longer required. File hashing and JA3 can now be used without the NSS compile time dependency.
- If installing Suricata without the bundled Suricata-Update, the `default-rule-path` has been changed from `/etc/suricata/rules` to `/var/lib/suricata/rules` to be consistent with Suricata when installed with Suricata-Update.
- FTP has been updated with a maximum command request and response line length of 4096 bytes. To change the default see *FTP*.
- SWF decompression in http has been disabled by default. To change the default see *Configure HTTP (libhtp)*. Users with configurations from previous releases may want to modify their config to match the new default. See https://redmine.openinfosecfoundation.org/issues/5632 for more information.
- The new option *livedev* is enabled by default with *use-for-tracking* being set to *true*. This should be disabled if multiple live devices are used to capture traffic from the same network.

4.7 Upgrading 5.0 to 6.0

- SIP now enabled by default
- RDP now enabled by default
- ERSPAN Type I enabled by default.

4.7.1 Major changes

- New protocols enabled by default: mqtt, rfb
- SSH Client fingerprinting for SSH clients
- Conditional logging
- Initial HTTP/2 support
- DCERPC logging
- Improved EVE logging performance

4.7.2 Removals

- File-store v1 has been removed. If using file extraction, the file-store configuration will need to be updated to version 2. See *Update File-store v1 Configuration to V2*.
- Individual Eve (JSON) loggers have been removed. For example, `stats-json`, `dns-json`, etc. Use multiple Eve logger instances if this behavior is still required. See *Multiple Logger Instances*.
- Unified2 has been removed. See unified2-removed.

4.7.3 Performance

- In YAML files w/o a *flow-timeouts.tcp.closed* setting, the default went from 0 to 10 seconds. This may lead to higher than expected TCP memory use: https://redmine.openinfosecfoundation.org/issues/6552

4.8 Upgrading 4.1 to 5.0

4.8.1 Major changes

- New protocols enabled by default: snmp (new config only)
- New protocols disabled by default: rdp, sip
- New defaults for protocols: nfs, smb, tftp, krb5 ntp are all enabled by default (new config only)
- VXLAN decoder enabled by default. To disable, set `decoder.vxlan.enabled` to `false`.
- HTTP LZMA support enabled by default. To disable, set `lzma-enabled` to `false` in each of the `libhtp` configurations in use.
- classification.config updated. ET 5.0 ruleset will use this.
- decoder event counters use 'decoder.event' as prefix now. This can be controlled using the `stats.decoder-events-prefix` setting.

4.8.2 Removals

- `dns-log`, the text dns log. Use EVE.dns instead.
- `file-log`, the non-EVE JSON file log. Use EVE.files instead.
- `drop-log`, the non-EVE JSON drop log.

See https://suricata.io/about/deprecation-policy/

CHAPTER

FIVE

SECURITY CONSIDERATIONS

Suricata is a security tool that processes untrusted network data, as well as requiring elevated system privileges to acquire that data. This combination deserves extra security precautions that we discuss below.

Additionally, supply chain attacks, particularly around rule distribution, could potentially target Suricata installations.

5.1 Running as a User Other Than Root

Note: If using the Suricata RPMs, either from the OISF COPR repo, or the EPEL repo, the following is already configured for you. The only thing you might want to do is add your management user to the `suricata` group.

Many Suricata examples and guides will show Suricata running as the *root* user, particularly when running on live traffic. As Suricata generally needs low level read (and in IPS write) access to network traffic, it is required that Suricata starts as root, however Suricata does have the ability to drop down to a non-root user after startup, which could limit the impact of a security vulnerability in Suricata itself.

Note: Currently the ability to drop root privileges after startup is only available on Linux systems.

5.1.1 Create User

Before running as a non-root user, you need to choose and possibly create the user and group that will Suricata will run as. Typically this user would be a sytem user with the name `suricata`. Such a user can be created with the following command:

```
useradd --no-create-home --system --shell /sbin/nologin suricata
```

This will create a user and group with the name `suricata`.

5.1.2 File System Permissions

Before running Suricata as the user `suricata`, some directory permissions will need to be updated to allow the `suricata` read and write access.

Assuming your Suricata was installed from source using the recommended configuration of:

```
./configure --prefix=/usr/ --sysconfdir=/etc/ --localstatedir=/var/
```

the following directories will need their permissions updated:

Directory	Permissions
/etc/suricata	Read
/var/log/suricata	Read, Write
/var/lib/suricata	Read, Write
/var/run/suricata	Read, Write

The following commands will setup the correct permissions:

- `/etc/suricata`:

```
chgrp -R suricata /etc/suricata
chmod -R g+r /etc/suricata
```

- `/var/log/suricata`:

```
chgrp -R suricata /var/log/suricata
chmod -R g+rw /var/log/suricata
```

- `/var/lib/suricata`:

```
chgrp -R suricata /var/lib/suricata
chmod -R g+srw /var/lib/suricata
```

- `/var/lib/suricata`:

```
chgrp -R suricata /var/run/suricata
chmod -R g+srw /var/run/suricata
```

5.1.3 Configure Suricata to Run as `Suricata`

Suricata can be configured to run as an alternate user by updating the configuration file or using command line arguments.

- Using the configuration file, update the `run-as` section to look like:

```
run-as:
  user: suricata
  group: suricata
```

- Or if using command line arguments, add the following to your command:

```
--user suricata --group suricata
```

5.1.4 Starting Suricata

It is important to note that Suricata still needs to be started with **root** permissions in most cases. Starting as *root* allows Suricata to get access to the network interfaces and set the *capabilities* required during runtime before it switches down to the configured user.

5.1.5 Other Commands: Suricata-Update, SuricataSC

With the previous permissions setup, `suricata-update` and `suricatasc` can also be run without root or sudo. To allow a user to access these commands, add them to the `suricata` group.

5.2 Containers

Containers such as Docker and Podman are other methods to provide isolation between Suricata and the host machine running Suricata. However, we still recommend running as a non-root user, even in containers.

5.2.1 Capabilities

For both Docker and Podman the following capabilities should be provided to the container running Suricata for proper operation:

```
--cap-add=net_admin --cap-add=net_raw --cap-add=sys_nice
```

5.2.2 Podman

Unfortunately Suricata will not work with *rootless* Podman, this is due to Suricata's requirement to start with root privileges to gain access to the network interfaces. However, if started with the above capabilities, and configured to run as a non-root user, it will drop root privileges before processing network data.

CHAPTER

SIX

SUPPORT STATUS

6.1 Levels of Support

The support tiers detailed below do not represent a binding commitment. Instead, they serve as a framework that the OISF employs to prioritize features and functionality.

6.1.1 Tier 1

Tier 1 supported items are developed and supported by the Suricata team. These items receive full CI (continuous integration) coverage, and functional failures block git merges and releases. Tier 1 features are enabled by default on platforms that support the feature.

6.1.2 Tier 2

Tier 2 supported items are developed and supported by the Suricata team, sometimes with help from community members. Major functional failures block git merges and releases, however less major issues may be documented as "known issues" and may go into a release. Tier 2 features and functionality may be disabled by default.

6.1.3 Community

When a feature of Suricata is community supported, it means the OISF/Suricata development team won't directly support it. This is to avoid overloading the team.

When accepting a feature into the code base anyway, it will come with a number of limits and conditions:

- submitter must commit to maintaining it:
  - make sure code compiles and correctly functions after Suricata and/or external (e.g. library) changes.
  - support users when they encounter problems on forum and redmine tickets.
- the code will be disabled by default and will not become part of the QA setup. This means it will be enabled only by an `--enable` configure flag.
- the code may not have CI coverage by the OISF infrastructure.

If the feature gets lots of traction, and/or if the team just considers it very useful, it may get 'promoted' to being officially supported.

On the other hand, the feature will be removed if the submitter stops maintaining it and no-one steps up to take over.

6.1.4 Vendor

Vendor supported features are features specific to a certain vendor and usually require software and/or hardware from that vendor. While these features may exist in the main Suricata code, they rely on support from the vendor to keep the feature in a functional state.

Vendor supported functionality will generally not have CI or QA coverage by the OISF.

6.1.5 Unmaintained

When a feature is unmaintained it is very likely broken and may be (partially) removed during cleanups and code refactoring. No end-user support is done by the core team. If someone wants to help maintain and support such a feature, we recommend talking to the core team before spending a lot of time on it.

Please see *Contributing to Suricata* for more information if you wish to contribute.

6.2 Distributions

6.2.1 Tier 1

These tier 1 supported Linux distributions and operating systems receive full CI and QA, as well as documentation.

Distribution	Version	Support	QA	Notes
RHEL/CentOS	7	OISF		
RHEL/Alma/Rocky	8	OISF		
RHEL/Alma/Rocky	9	OISF		
Ubuntu	20.04	OISF		
Ubuntu	22.04	OISF		
Debian	10 (Buster)	OISF		
Debian	11 (Bullseye)	OISF		Foundation of SELKS
Debian	12 (Bookworm)	OISF		
FreeBSD	12	OISF		Foundation of OPNsense, pfSense
FreeBSD	13	OISF		Foundation of OPNSense

6.2.2 Tier 2

These tier 2 supported Linux distributions and operating systems receive CI but not full QA (functional testing).

Distribution	Version	Support	QA	Notes
CentOS	Stream	OISF		
Fedora	Active	OISF		
OpenBSD	7.2	OISF		
OpenBSD	7.1	OISF		
OSX/macOS	??	OISF		
Windows/MinGW64		OISF		

6.3 Architecture Support

6.3.1 Tier 1

Architecture	Support	QA	Notes
x86_64	OISF		
ARM8-64bit	OISF		

6.3.2 Tier 2

Architecture	Support	QA	Notes
ARM7-32bit	OISF		
i386	OISF		

6.3.3 Community

Architecture	Support	QA	Notes
PPC64el		Part of Fedora automated QA	Access can be arranged through IBM dev cloud
PPC64			No access to working hardware
PPC32			No access to working hardware
RISC-V			

6.3.4 High Level Features

Capture support

Tier 1

Capture Type	Maintainer	QA	Notes
AF_PACKET	OISF		Used by Security Onion, SELKS
NETMAP (FreeBSD)	OISF		Used by OPNsense, PFsense
NFQUEUE	OISF		
libpcap	OISF		

Tier 2

Capture Type	Maintainer	QA	Notes
PF_RING	OISF		
NETMAP (Linux)	OISF		
DPDK	OISF		
AF_PACKET (eBPF/XDP)	OISF		

Community

Capture Type	Maintainer	QA	Notes
NFLOG	Community		
AF_XDP	Community		

Vendor

Capture Type	Maintainer	QA	Notes
Napatech	Napatech / Community		

Unmaintained

Capture Type	Maintainer	QA	Notes
IPFW			
Endace/DAG			

Operation modes

Tier 1

Mode	Maintainer	QA	Notes
IDS (passive)	OISF		
IPS (active)	OISF		
Offline pcap file	OISF		

Tier 2

Mode	Maintainer	QA	Notes
Unix socket mode	OISF		
IDS (active)	OISF		Active responses, reject keyword

CHAPTER

SEVEN

COMMAND LINE OPTIONS

Suricata's command line options:

-h

Display a brief usage overview.

-V

Displays the version of Suricata.

-c <path>

Path to configuration file.

--include <path>

Additional configuration files to include. Multiple additional configuration files can be provided and will be included in the order specified on the command line. These additional configuration files are loaded as if they existed at the end of the main configuration file.

Example including one additional file:

```
--include /etc/suricata/other.yaml
```

Example including more than one additional file:

```
--include /etc/suricata/other.yaml --include /etc/suricata/extra.yaml
```

-T

Test configuration.

-v

Increase the verbosity of the Suricata application logging by increasing the log level from the default. This option can be passed multiple times to further increase the verbosity.

- -v: INFO
- -vv: PERF
- -vvv: CONFIG
- -vvvv: DEBUG

This option will not decrease the log level set in the configuration file if it is already more verbose than the level requested with this option.

-r <path>

Run in pcap offline mode (replay mode) reading files from pcap file. If <path> specifies a directory, all files in that directory will be processed in order of modified time maintaining flow state between files.

--pcap-file-continuous

Used with the -r option to indicate that the mode should stay alive until interrupted. This is useful with directories to add new files and not reset flow state between files.

--pcap-file-recursive

Used with the -r option when the path provided is a directory. This option enables recursive traversal into subdirectories to a maximum depth of 255. This option cannot be combined with --pcap-file-continuous. Symlinks are ignored.

--pcap-file-delete

Used with the -r option to indicate that the mode should delete pcap files after they have been processed. This is useful with pcap-file-continuous to continuously feed files to a directory and have them cleaned up when done. If this option is not set, pcap files will not be deleted after processing.

-i <interface>

After the -i option you can enter the interface card you would like to use to sniff packets from. This option will try to use the best capture method available. Can be used several times to sniff packets from several interfaces.

--pcap[=<device>]

Run in PCAP mode. If no device is provided the interfaces provided in the *pcap* section of the configuration file will be used.

--af-packet[=<device>]

Enable capture of packet using AF_PACKET on Linux. If no device is supplied, the list of devices from the af-packet section in the yaml is used.

--af-xdp[=<device>]

Enable capture of packet using AF_XDP on Linux. If no device is supplied, the list of devices from the af-xdp section in the yaml is used.

-q <queue id>

Run inline of the NFQUEUE queue ID provided. May be provided multiple times.

-s <filename.rules>

With the -s option you can set a file with signatures, which will be loaded together with the rules set in the yaml.

It is possible to use globbing when specifying rules files. For example, `-s '/path/to/rules/*.rules'`

-S <filename.rules>

With the -S option you can set a file with signatures, which will be loaded exclusively, regardless of the rules set in the yaml.

It is possible to use globbing when specifying rules files. For example, `-S '/path/to/rules/*.rules'`

-l <directory>

With the -l option you can set the default log directory. If you already have the default-log-dir set in yaml, it will not be used by Suricata if you use the -l option. It will use the log dir that is set with the -l option. If you do not set a directory with the -l option, Suricata will use the directory that is set in yaml.

-D

Normally if you run Suricata on your console, it keeps your console occupied. You can not use it for other purposes, and when you close the window, Suricata stops running. If you run Suricata as daemon (using the -D option), it runs at the background and you will be able to use the console for other tasks without disturbing the engine running.

--runmode <runmode>

With the *--runmode* option you can set the runmode that you would like to use. This command line option can override the yaml runmode option.

Runmodes are: *workers*, *autofp* and *single*.

For more information about runmodes see *Runmodes* in the user guide.

-F <bpf filter file>

Use BPF filter from file.

-k [all|none]

Force (all) the checksum check or disable (none) all checksum checks.

--user=<user>

Set the process user after initialization. Overrides the user provided in the *run-as* section of the configuration file.

--group=<group>

Set the process group to group after initialization. Overrides the group provided in the *run-as* section of the configuration file.

--pidfile <file>

Write the process ID to file. Overrides the *pid-file* option in the configuration file and forces the file to be written when not running as a daemon.

--init-errors-fatal

Exit with a failure when errors are encountered loading signatures.

--strict-rule-keywords[=all|<keyword>|<keywords(csv)]

Applies to: classtype, reference and app-layer-event.

By default missing reference or classtype values are warnings and not errors. Additionally, loading outdated app-layer-event events are also not treated as errors, but as warnings instead.

If this option is enabled these warnings are considered errors.

If no value, or the value 'all', is specified, the option applies to all of the keywords above. Alternatively, a comma separated list can be supplied with the keyword names it should apply to.

--disable-detection

Disable the detection engine.

--disable-hashing

Disable support for hash algorithms such as md5, sha1 and sha256.

By default hashing is enabled. Disabling hashing will also disable some Suricata features such as the filestore, ja3, and rule keywords that use hash algorithms.

--dump-config

Dump the configuration loaded from the configuration file to the terminal and exit.

--dump-features

Dump the features provided by Suricata modules and exit. Features list (a subset of) the configuration values and are intended to assist with comparing provided features with those required by one or more rules.

--build-info

Display the build information the Suricata was built with.

--list-app-layer-protos

List all supported application layer protocols.

--list-keywords=[all|csv|<kword>]

List all supported rule keywords.

--list-runmodes

List all supported run modes.

--set <key>=<value>

Set a configuration value. Useful for overriding basic configuration parameters. For example, to change the default log directory:

```
--set default-log-dir=/var/tmp
```

This option cannot be used to add new entries to a list in the configuration file, such as a new output. It can only be used to modify a value in a list that already exists.

For example, to disable the `eve-log` in the default configuration file:

```
--set outputs.1.eve-log.enabled=no
```

Also note that the index values may change as the `suricata.yaml` is updated.

See the output of `--dump-config` for existing values that could be modified with their index.

--engine-analysis

Print reports on analysis of different sections in the engine and exit. Please have a look at the conf parameter engine-analysis on what reports can be printed

--unix-socket=<file>

Use file as the Suricata unix control socket. Overrides the *filename* provided in the *unix-command* section of the configuration file.

--reject-dev=<device>

Use *device* to send out RST / ICMP error packets with the *reject* keyword.

--pcap-buffer-size=<size>

Set the size of the PCAP buffer (0 - 2147483647).

--netmap[=<device>]

Enable capture of packet using NETMAP on FreeBSD or Linux. If no device is supplied, the list of devices from the netmap section in the yaml is used.

--pfring[=<device>]

Enable PF_RING packet capture. If no device provided, the devices in the Suricata configuration will be used.

--pfring-cluster-id <id>

Set the PF_RING cluster ID.

--pfring-cluster-type <type>

Set the PF_RING cluster type (cluster_round_robin, cluster_flow).

-d <divert-port>

Run inline using IPFW divert mode.

--dag <device>

Enable packet capture off a DAG card. If capturing off a specific stream the stream can be select using a device name like "dag0:4". This option may be provided multiple times read off multiple devices and/or streams.

--napatech

Enable packet capture using the Napatech Streams API.

--erf-in=<file>

Run in offline mode reading the specific ERF file (Endace extensible record format).

--simulate-ips

Simulate IPS mode when running in a non-IPS mode.

7.1 Unit Tests

The builtin unittests are only available when Suricata has been configured and built with `--enable-unittests`.

Running unittests does not require a configuration file. Use -l to supply an output directory.:

```
sudo suricata -u
```

-u

Run the unit tests and exit. Requires that Suricata be configured with *--enable-unittests*.

-U, --unittest-filter=REGEX

With the -U option you can select which of the unit tests you want to run. This option uses REGEX. Example of use: suricata -u -U http

--list-unittests

Lists available unit tests.

--fatal-unittests

Enables fatal failure on a unit test error. Suricata will exit instead of continuing more tests.

--unittests-coverage

Display unit test coverage report.

CHAPTER

EIGHT

SURICATA RULES

8.1 Rules Format

Signatures play a very important role in Suricata. In most occasions people are using existing rulesets.

The official way to install rulesets is described in *Rule Management with Suricata-Update*.

There are a number of free rulesets that can be used via suricata-update. To aid in learning about writing rules, the Emerging Threats Open ruleset is free and a good reference that has a wide range of signature examples.

This Suricata Rules document explains all about signatures; how to read, adjust and create them.

A rule/signature consists of the following:

- The **action**, determining what happens when the rule matches.
- The **header**, defining the protocol, IP addresses, ports and direction of the rule.
- The **rule options**, defining the specifics of the rule.

An example of a rule is as follows:

alert http $HOME_NET any -> $EXTERNAL_NET any (msg:"HTTP GET Request Containing Rule in URI"; flow:established,to_server; http.method; content:"GET"; http.uri; content:"rule"; fast_pattern; classtype:bad-unknown; sid:123; rev:1;)

In this example, red is the action, green is the header and blue are the options.

We will be using the above signature as an example throughout this section, highlighting the different parts of the signature.

8.1.1 Action

alert http $HOME_NET any -> $EXTERNAL_NET any (msg:"HTTP GET Request Containing Rule in URI"; flow:established,to_server; http.method; content:"GET"; http.uri; content:"rule"; fast_pattern; classtype:bad-unknown; sid:123; rev:1;)

Valid actions are:

- alert - generate an alert.
- pass - stop further inspection of the packet.
- drop - drop packet and generate alert.
- reject - send RST/ICMP unreach error to the sender of the matching packet.
- rejectsrc - same as just *reject*.

- rejectdst - send RST/ICMP error packet to receiver of the matching packet.
- rejectboth - send RST/ICMP error packets to both sides of the conversation.

Note: In IPS mode, using any of the *reject* actions also enables *drop*.

For more information see *Action-order*.

8.1.2 Protocol

alert http $HOME_NET any -> $EXTERNAL_NET any (msg:"HTTP GET Request Containing Rule in URI"; flow:established,to_server; http.method; content:"GET"; http.uri; content:"rule"; fast_pattern; classtype:bad-unknown; sid:123; rev:1;)

This keyword in a signature tells Suricata which protocol it concerns. You can choose between four basic protocols:

- tcp (for tcp-traffic)
- udp
- icmp
- ip (ip stands for 'all' or 'any')

There are a couple of additional TCP related protocol options:

- tcp-pkt (for matching content in individual tcp packets)
- tcp-stream (for matching content only in a reassembled tcp stream)

There are also a few so-called application layer protocols, or layer 7 protocols you can pick from. These are:

- http (either HTTP1 or HTTP2)
- http1
- http2
- ftp
- tls (this includes ssl)
- smb
- dns
- dcerpc
- dhcp
- ssh
- smtp
- imap
- modbus (disabled by default)
- dnp3 (disabled by default)
- enip (disabled by default)
- nfs
- ike

- krb5
- bittorrent-dht
- ntp
- dhcp
- rfb
- rdp
- snmp
- tftp
- sip

The availability of these protocols depends on whether the protocol is enabled in the configuration file, suricata.yaml.

If you have a signature with the protocol declared as 'http', Suricata makes sure the signature will only match if the TCP stream contains http traffic.

8.1.3 Source and destination

alert http $HOME_NET any -> $EXTERNAL_NET any (msg:"HTTP GET Request Containing Rule in URI"; flow:established,to_server; http.method; content:"GET"; http.uri; content:"rule"; fast_pattern; classtype:bad-unknown; sid:123; rev:1;)

The first emphasized part is the traffic source, the second is the traffic destination (note the direction of the directional arrow).

With the source and destination, you specify the source of the traffic and the destination of the traffic, respectively. You can assign IP addresses, (both IPv4 and IPv6 are supported) and IP ranges. These can be combined with operators:

Operator	Description
../..	IP ranges (CIDR notation)
!	exception/negation
[.., ..]	grouping

Normally, you would also make use of variables, such as `$HOME_NET` and `$EXTERNAL_NET`. The suricata.yaml configuration file specifies the IP addresses these concern. The respective `$HOME_NET` and `$EXTERNAL_NET` settings will be used in place of the variables in your rules.

See *Rule-vars* for more information.

Rule usage examples:

Example	Meaning
!1.1.1.1	Every IP address but 1.1.1.1
![1.1.1.1, 1.1.1.2]	Every IP address but 1.1.1.1 and 1.1.1.2
$HOME_NET	Your setting of HOME_NET in yaml
[$EXTERNAL_NET, !$HOME_NET]	EXTERNAL_NET and not HOME_NET
[10.0.0.0/24, !10.0.0.5]	10.0.0.0/24 except for 10.0.0.5
[..., [....]]	
[..., ![.....]]	

Warning: If you set your configuration to something like this:

```
HOME_NET: any
EXTERNAL_NET: !$HOME_NET
```

You cannot write a signature using `$EXTERNAL_NET` because it evaluates to 'not any', which is an invalid value.

Note: Please note that the source and destination address can also be matched via the `ip.src` and `ip.dst` keywords (See *IP Addresses Match*). These keywords are mostly used in conjunction with the dataset feature (*Datasets*).

8.1.4 Ports (source and destination)

alert http $HOME_NET any -> $EXTERNAL_NET any (msg:"HTTP GET Request Containing Rule in URI"; flow:established,to_server; http.method; content:"GET"; http.uri; content:"rule"; fast_pattern; classtype:bad-unknown; sid:123; rev:1;)

The first emphasized part is the source port, the second is the destination port (note the direction of the directional arrow).

Traffic comes in and goes out through ports. Different protocols have different port numbers. For example, the default port for HTTP is 80 while 443 is typically the port for HTTPS. Note, however, that the port does not dictate which protocol is used in the communication. Rather, it determines which application is receiving the data.

The ports mentioned above are typically the destination ports. Source ports, i.e. the application that sent the packet, typically get assigned a random port by the operating system. When writing a rule for your own HTTP service, you would typically write `any -> 80`, since that would mean any packet from any source port to your HTTP application (running on port 80) is matched.

In setting ports you can make use of special operators as well. Operators such as:

Operator	Description
:	port ranges
!	exception/negation
[.., ..]	grouping

Rule usage examples:

Example	Meaning
[80, 81, 82]	port 80, 81 and 82
[80: 82]	Range from 80 till 82
[1024:]	From 1024 till the highest port-number
!80	Every port but 80
[80:100,!99]	Range from 80 till 100 but 99 excluded
[1:80,![2,4]]	Range from 1-80, except ports 2 and 4
[.., [..,..]]	

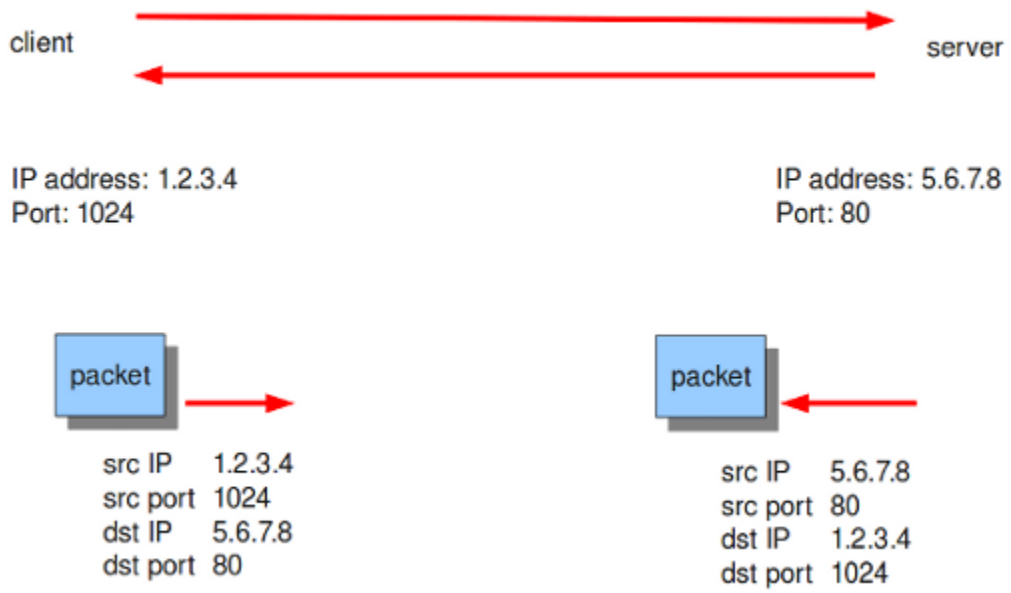
8.1.5 Direction

alert http $HOME_NET any -> $EXTERNAL_NET any (msg:"HTTP GET Request Containing Rule in URI"; flow:established,to_server; http.method; content:"GET"; http.uri; content:"rule"; fast_pattern; classtype:bad-unknown; sid:123; rev:1;)

The directional arrow indicates which way the signature will be evaluated. In most signatures an arrow to the right (->) is used. This means that only packets with the same direction can match. However, it is also possible to have a rule match both directions (<>):

```
source -> destination
source <> destination  (both directions)
```

The following example illustrates direction. In this example there is a client with IP address 1.2.3.4 using port 1024. A server with IP address 5.6.7.8, listening on port 80 (typically HTTP). The client sends a message to the server and the server replies with its answer.



Now, let's say we have a rule with the following header:

```
alert tcp 1.2.3.4 1024 -> 5.6.7.8 80
```

Only the traffic from the client to the server will be matched by this rule, as the direction specifies that we do not want to evaluate the response packet.

Warning: There is no 'reverse' style direction, i.e. there is no <-.

8.1.6 Rule options

The rest of the rule consists of options. These are enclosed by parenthesis and separated by semicolons. Some options have settings (such as `msg`), which are specified by the keyword of the option, followed by a colon, followed by the settings. Others have no settings; they are simply the keyword (such as `nocase`):

```
<keyword>: <settings>;
<keyword>;
```

Rule options have a specific ordering and changing their order would change the meaning of the rule.

Note: The characters `;` and `"` have special meaning in the Suricata rule language and must be escaped when used in a rule option value. For example:

```
msg:"Message with semicolon\;";
```

As a consequence, you must also escape the backslash, as it functions as an escape character.

The rest of this chapter in the documentation documents the use of the various keywords.

Some generic details about keywords follow.

Modifier Keywords

Some keywords function act as modifiers. There are two types of modifiers.

- The older style **'content modifiers'** look back in the rule, e.g.:

  ```
  alert http any any -> any any (content:"index.php"; http_uri; sid:1;)
  ```

  In the above example the pattern 'index.php' is modified to inspect the HTTP uri buffer.

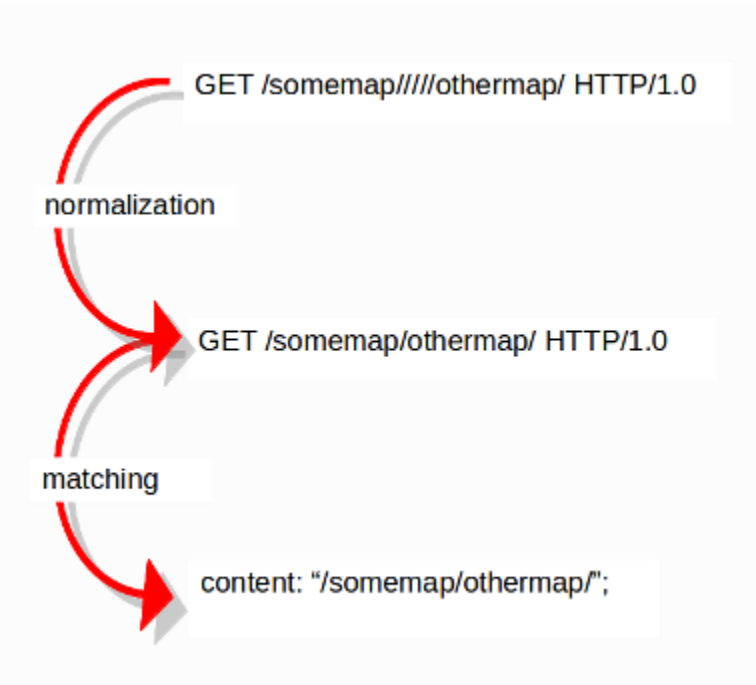
- The more recent type is called the **'sticky buffer'**. It places the buffer name first and all keywords following it apply to that buffer, for instance:

  ```
  alert http any any -> any any (http_response_line; content:"403 Forbidden"; sid:1;)
  ```

  In the above example the pattern '403 Forbidden' is inspected against the HTTP response line because it follows the `http_response_line` keyword.

Normalized Buffers

A packet consists of raw data. HTTP and reassembly make a copy of those kinds of packets data. They erase anomalous content, combine packets etcetera. What remains is a called the 'normalized buffer':



Because the data is being normalized, it is not what it used to be; it is an interpretation. Normalized buffers are: all HTTP-keywords, reassembled streams, TLS-, SSL-, SSH-, FTP- and dcerpc-buffers.

Note that there are some exceptions, e.g. the `http_raw_uri` keyword. See *http.uri and http.uri.raw* for more information.

8.2 Meta Keywords

Meta keywords have no effect on Suricata's inspection of network traffic; they do have an effect on the way Suricata reports events/alerts.

8.2.1 msg (message)

The keyword msg gives contextual information about the signature and the possible alert.

The format of msg is:

```
msg: "some description";
```

Examples:

```
msg:"ET MALWARE Win32/RecordBreaker CnC Checkin";
msg:"ET EXPLOIT SMB-DS DCERPC PnP bind attempt";
```

To continue the example from the previous chapter, the msg component of the signature is emphasized below:

alert http $HOME_NET any -> $EXTERNAL_NET any (msg:"HTTP GET Request Containing Rule in URI"; flow:established,to_server; http.method; content:"GET"; http.uri; content:"rule"; fast_pattern; classtype:bad-unknown; sid:123; rev:1;)

Tip: It is a standard practice in rule writing to make the first part of the signature msg uppercase and to indicate the class of the signature.

It is also standard practice that `msg` is the first keyword in the signature.

Note: The following characters must be escaped inside the msg: `;` `\` `"`

8.2.2 sid (signature ID)

The keyword sid gives every signature its own id. This id is stated with a number greater than zero. The format of sid is:

```
sid:123;
```

Example of sid in a signature:

alert http $HOME_NET any -> $EXTERNAL_NET any (msg:"HTTP GET Request Containing Rule in URI"; flow:established,to_server; http.method; content:"GET"; http.uri; content:"rule"; fast_pattern; classtype:bad-unknown; sid:123; rev:1;)

Tip: It is a standard practice in rule writing that the signature `sid` is provided as the last keyword (or second-to-last if there is a `rev`) of the signature.

There are reserved ranges of sids, the reservations are recorded at https://sidallocation.org/ .

Note: This value must be unique for all rules within the same *rule group* (`gid`).

As Suricata-update currently considers the rule's `sid` only (cf. Bug#5447), it is advisable to opt for a completely unique `sid` altogether.

8.2.3 rev (revision)

The sid keyword is commonly accompanied by the rev keyword. Rev represents the version of the signature. If a signature is modified, the number of rev will be incremented by the signature writers. The format of rev is:

```
rev:123;
```

Example of rev in a signature:

alert http $HOME_NET any -> $EXTERNAL_NET any (msg:"HTTP GET Request Containing Rule in URI"; flow:established,to_server; http.method; content:"GET"; http.uri; content:"rule"; fast_pattern; classtype:bad-unknown; sid:123; rev:1;)

Tip: It is a standard practice in rule writing that the rev keyword is expressed after the sid keyword. The sid and rev keywords are commonly put as the last two keywords in a signature.

8.2.4 gid (group ID)

The gid keyword can be used to give different groups of signatures another id value (like in sid). Suricata by default uses gid 1. It is possible to modify the default value. In most cases, it will be unnecessary to change the default gid value. Changing the gid value has no technical implications, the value is only noted in alert data.

Example of the gid value in an alert entry in the fast.log file. In the part [1:123], the first 1 is the gid (123 is the sid and 1 is the rev).

07/12/2022-21:59:26.713297 [**] [1:123:1] HTTP GET Request Containing Rule in URI [**] [Classification: Potentially Bad Traffic] [Priority: 2] {TCP} 192.168.225.121:12407 -> 172.16.105.84:80

8.2.5 classtype

The classtype keyword gives information about the classification of rules and alerts. It consists of a short name, a long name and a priority. It can tell for example whether a rule is just informational or is about a CVE. For each classtype, the classification.config has a priority that will be used in the rule.

Example classtype definition:

```
config classification: web-application-attack,Web Application Attack,1
config classification: not-suspicious,Not Suspicious Traffic,3
```

Once we have defined the classification in the configuration file, we can use the classtypes in our rules. A rule with classtype web-application-attack will be assigned a priority of 1 and the alert will contain 'Web Application Attack' in the Suricata logs:

classtype	Alert	Priority
web-application-attack	Web Application Attack	1
not-suspicious	Not Suspicious Traffic	3

Our continuing example also has a classtype: bad-unknown:

alert http $HOME_NET any -> $EXTERNAL_NET any (msg:"HTTP GET Request Containing Rule in URI"; flow:established,to_server; http.method; content:"GET"; http.uri; content:"rule"; fast_pattern; classtype:bad-unknown; sid:123; rev:1;)

Tip: It is a standard practice in rule writing that the classtype keyword comes before the sid and rev keywords (as shown in the example rule).

8.2.6 reference

The reference keyword is used to document where information about the signature and about the problem the signature tries to address can be found. The reference keyword can appear multiple times in a signature. This keyword is meant for signature-writers and analysts who investigate why a signature has matched. It has the following format:

```
reference:type,reference
```

A typical reference to www.info.com would be:

```
reference:url,www.info.com
```

There are several systems that can be used as a reference. A commonly known example is the CVE-database, which assigns numbers to vulnerabilities, to prevent having to type the same URL over and over again. An example reference of a CVE:

```
reference:cve,CVE-2014-1234
```

This would make a reference to http://cve.mitre.org/cgi-bin/cvename.cgi?name=CVE-2014-1234.

All the reference types are defined in the reference.config configuration file.

8.2.7 priority

The priority keyword comes with a mandatory numeric value which can range from 1 to 255. The values 1 through 4 are commonly used. The highest priority is 1. Signatures with a higher priority will be examined first. Normally signatures have a priority determined through a classtype definition. The classtype definition can be overridden by defining the priority keyword in the signature. The format of priority is:

```
priority:1;
```

8.2.8 metadata

The metadata keyword allows additional, non-functional, information to be added to the signature. While the format is free-form, it is recommended to stick to *[key, value]* pairs as Suricata can include these in eve alerts. The format is:

```
metadata: key value;
metadata: key value, key value;
```

8.2.9 target

The target keyword allows the rules writer to specify which side of the alert is the target of the attack. If specified, the alert event is enhanced to contain information about source and target.

The format is:

```
target:[src_ip|dest_ip]
```

If the value is src_ip then the source IP in the generated event (src_ip field in JSON) is the target of the attack. If target is set to dest_ip then the target is the destination IP in the generated event.

8.2.10 requires

The `requires` keyword allows a rule to require specific Suricata features to be enabled, or the Suricata version to match an expression. Rules that do not meet the requirements will by ignored, and Suricata will not treat them as errors.

Requirements that follow the valid format of `<keyword> <expression>` but are not known to Suricata are allowed for future compatiblity, however unknown requirement expressions will lead to the requirement not being met, skipping the rule.

When parsing rules, the parser attempts to process the `requires` keywords before others. This allows it to occur after keywords that may only be present in specific versions of Suricata, as specified by the `requires` statement. However, the keywords preceding it must still adhere to the basic known formats of Suricata rules.

The format is:

```
requires: feature geoip, version >= 7.0.0
```

To require multiple features, the feature sub-keyword must be specified multiple times:

```
requires: feature geoip, feature lua
```

Alternatively, *and* expressions may be expressed like:

```
requires: version >= 7.0.4 < 8
```

and *or* expressions may expressed with `|` like:

```
requires: version >= 7.0.4 < 8 | >= 8.0.3
```

to express that a rules requires version 7.0.4 or greater, but less than 8, **OR** greater than or equal to 8.0.3. Which could be useful if a keyword wasn't added until 7.0.4 and the 8.0.3 patch releases, as it would not exist in 8.0.1.

This can be extended to multiple release branches:

```
requires: version >= 7.0.10 < 8 | >= 8.0.5 < 9 | >= 9.0.3
```

If no *minor* or *patch* version component is provided, it will default to 0.

The `version` may only be specified once, if specified more than once the rule will log an error and not be loaded.

The `requires` keyword was introduced in Suricata 7.0.3 and 8.0.0.

8.3 IP Keywords

8.3.1 ttl

The ttl keyword is used to check for a specific IP time-to-live value in the header of a packet. The format is:

```
ttl:<number>;
```

For example:

```
ttl:10;
```

At the end of the ttl keyword you can enter the value on which you want to match. The Time-to-live value determines the maximal amount of time a packet can be in the Internet-system. If this field is set to 0, then the packet has to be

destroyed. The time-to-live is based on hop count. Each hop/router the packet passes subtracts one from the packet TTL counter. The purpose of this mechanism is to limit the existence of packets so that packets can not end up in infinite routing loops.

Example of the ttl keyword in a rule:

alert ip $EXTERNAL_NET any -> $HOME_NET any (msg:"IP Packet With TTL 0"; ttl:0; classtype:misc-activity; sid:1; rev:1;)

8.3.2 ipopts

With the ipopts keyword you can check if a specific IP option is set. Ipopts has to be used at the beginning of a rule. You can only match on one option per rule. There are several options on which can be matched. These are:

IP Option	Description
rr	Record Route
eol	End of List
nop	No Op
ts	Time Stamp
sec	IP Security
esec	IP Extended Security
lsrr	Loose Source Routing
ssrr	Strict Source Routing
satid	Stream Identifier
any	any IP options are set

Format of the ipopts keyword:

```
ipopts: <name>;
```

For example:

```
ipopts: ts;
```

Example of ipopts in a rule:

alert ip $EXTERNAL_NET any -> $HOME_NET any (msg:"IP Packet with timestamp option"; ipopts:ts; classtype:misc-activity; sid:2; rev:1;)

8.3.3 sameip

Every packet has a source IP-address and a destination IP-address. It can be that the source IP is the same as the destination IP. With the sameip keyword you can check if the IP address of the source is the same as the IP address of the destination. The format of the sameip keyword is:

```
sameip;
```

Example of sameip in a rule:

alert ip any any -> any any (msg:"IP Packet with the same source and destination IP"; sameip; classtype:bad-unknown; sid:3; rev:1;)

8.3.4 ip_proto

With the ip_proto keyword you can match on the IP protocol in the packet-header. You can use the name or the number of the protocol. You can match for example on the following protocols:

```
 1     ICMP        Internet Control Message
 6     TCP         Transmission Control Protocol
17     UDP         User Datagram
47     GRE         General Routing Encapsulation
50     ESP         Encap Security Payload for IPv6
51     AH          Authentication Header for Ipv6
58     IPv6-ICMP   ICMP for Ipv6
```

For the complete list of protocols and their numbers see http://en.wikipedia.org/wiki/List_of_IP_protocol_numbers

Example of ip_proto in a rule:

alert ip any any -> any any (msg:"IP Packet with protocol 1"; ip_proto:1; classtype:bad-unknown; sid:5; rev:1;)

The named variant of that example would be:

```
ip_proto:ICMP;
```

8.3.5 ipv4.hdr

Sticky buffer to match on content contained within an IPv4 header.

Example rule:

alert ip any any -> any any (msg:"IPv4 header keyword example"; ipv4.hdr; content:"|06|"; offset:9; depth:1; sid:1; rev:1;)

This example looks if byte 10 of IPv4 header has value 06, which indicates that the IPv4 protocol is TCP.

8.3.6 ipv6.hdr

Sticky buffer to match on content contained within an IPv6 header.

Example rule:

alert ip any any -> any any (msg:"IPv6 header keyword example"; ipv6.hdr; content:"|06|"; offset:6; depth:1; sid:1; rev:1;)

This example looks if byte 7 of IP64 header has value 06, which indicates that the IPv6 protocol is TCP.

8.3.7 id

With the id keyword, you can match on a specific IP ID value. The ID identifies each packet sent by a host and increments usually with one with each packet that is being send. The IP ID is used as a fragment identification number. Each packet has an IP ID, and when the packet becomes fragmented, all fragments of this packet have the same ID. In this way, the receiver of the packet knows which fragments belong to the same packet. (IP ID does not take care of the order, in that case offset is used. It clarifies the order of the fragments.)

Format of id:

```
id:<number>;
```

Example of id in a rule:

alert tcp $EXTERNAL_NET any -> $HOME_NET any (msg:"id keyword example"; id:1; content:"content|3a 20|"; fast_pattern; classtype:misc-activity; sid:12; rev:1;)

8.3.8 geoip

The geoip keyword enables matching on the source, destination or source and destination IPv4 addresses of network traffic, and to see to which country it belongs. To be able to do this, Suricata uses the GeoIP2 API of MaxMind.

The syntax of geoip:

```
geoip: src,RU;
geoip: both,CN,RU;
geoip: dst,CN,RU,IR;
geoip: both,US,CA,UK;
geoip: any,CN,IR;
```

Option	Description
both	Both source and destination have to match with the given geoip(s)
any	Either the source or the destination has to match with the given geoip(s).
dest	The destination matches with the given geoip.
src	The source matches with the given geoip.

geoip currently only supports IPv4. As it uses the GeoIP2 API of MaxMind, libmaxminddb must be compiled in. You must download and install the GeoIP2 or GeoLite2 database editions desired. Visit the MaxMind site at https://dev.maxmind.com/geoip/geolite2-free-geolocation-data for details.

You must also supply the location of the GeoIP2 or GeoLite2 database file on the local system in the YAML-file configuration (for example):

```
geoip-database: /usr/local/share/GeoIP/GeoLite2-Country.mmdb
```

8.3.9 fragbits (IP fragmentation)

With the fragbits keyword, you can check if the fragmentation and reserved bits are set in the IP header. The fragbits keyword should be placed at the beginning of a rule. Fragbits is used to modify the fragmentation mechanism. During routing of messages from one Internet module to the other, it can occur that a packet is bigger than the maximal packet size a network can process. In that case, a packet can be send in fragments. This maximum of the packet size is called Maximal Transmit Unit (MTU).

You can match on the following bits:

```
M - More Fragments
D - Do not Fragment
R - Reserved Bit
```

Matching on this bits can be more specified with the following modifiers:

```
+         match on the specified bits, plus any others
*         match if any of the specified bits are set
!         match if the specified bits are not set
```

Format:

```
fragbits:[*+!]<[MDR]>;
```

Example of fragbits in a rule:

alert tcp $EXTERNAL_NET any -> $HOME_NET any (msg:"fragbits keyword example non-fragmented packet with fragment offset>0"; fragbits:M; fragoffset:>0; classtype:bad-unknown; sid:123; rev:1;)

8.3.10 fragoffset

With the fragoffset keyword you can match on specific decimal values of the IP fragment offset field. If you would like to check the first fragments of a session, you have to combine fragoffset 0 with the More Fragment option. The fragmentation offset field is convenient for reassembly. The id is used to determine which fragments belong to which packet and the fragmentation offset field clarifies the order of the fragments.

You can use the following modifiers:

```
<       match if the value is smaller than the specified value
>       match if the value is greater than the specified value
!       match if the specified value is not present
```

Format of fragoffset:

```
fragoffset:[!|<|>]<number>;
```

Example of fragoffset in a rule:

alert tcp $EXTERNAL_NET any -> $HOME_NET any (msg:"fragoffset keyword example invalid non-fragmented packet with fragment offset>0"; fragbits:M; fragoffset:>0; classtype:bad-unknown; sid:13; rev:1;)

8.3.11 tos

The tos keyword can match on specific decimal values of the IP header TOS field. The tos keyword can have a value from 0 - 255. This field of the IP header has been updated by rfc2474 to include functionality for Differentiated services. Note that the value of the field has been defined with the right-most 2 bits having the value 0. When specifying a value for tos, ensure that the value follows this.

E.g, instead of specifying the decimal value 34 (hex 22), right shift twice and use decimal 136 (hex 88).

You can specify hexadecimal values with a leading *x*, e.g, *x88*.

Format of tos:

```
tos:[!]<number>;
```

Example of tos in a rule:

alert ip any any -> any any (msg:"tos keyword example tos value 8"; flow:established; tos:8; classtype:not-suspicious; sid:123; rev:1;)

Example of tos with a negated value:

alert ip any any -> any any (msg:"tos keyword example with negated content"; flow:established,to_server; tos:!8; classtype:bad-unknown; sid:14; rev:1;)

8.4 TCP keywords

8.4.1 tcp.flags

The tcp.flags keyword checks for specific TCP flag bits.

The following flag bits may be checked:

Flag	Description
F	FIN - Finish
S	SYN - Synchronize sequence numbers
R	RST - Reset
P	PSH - Push
A	ACK - Acknowledgment
U	URG - Urgent
C	CWR - Congestion Window Reduced
E	ECE - ECN-Echo
0	No TCP Flags Set

The following modifiers can be set to change the match criteria:

Modifier	Description
+	match on the bits, plus any others
*	match if any of the bits are set
!	match if the bits are not set

To handle writing rules for session initiation packets such as ECN where a SYN packet is sent with CWR and ECE flags set, an option mask may be used by appending a comma and masked values. For example, a rule that checks for a SYN flag, regardless of the values of the reserved bits is `tcp.flags:S,CE;`

Format of tcp.flags:

```
tcp.flags:[modifier]<test flags>[,<ignore flags>];
tcp.flags:[!|*|+]<FSRPAUCE0>[,<FSRPAUCE>];
```

Example:

```
 alert tcp $EXTERNAL_NET any -> $HOME_NET any (msg:"Example tcp.flags sig"; \
:example-rule-emphasis:`tcp.flags:FPU,CE;` classtype:misc-activity; sid:1; rev:1;)
```

It is also possible to use the *tcp.flags* content as a fast_pattern by using the *prefilter* keyword. For more information on *prefilter* usage see *Prefiltering Keywords*

Example:

```
 alert tcp $EXTERNAL_NET any -> $HOME_NET any (msg:"Example tcp.flags sig"; \
:example-rule-emphasis:`tcp.flags:FPU,CE; prefilter;` classtype:misc-activity; sid:1;␣
↪rev:1;)
```

8.4.2 seq

The seq keyword can be used in a signature to check for a specific TCP sequence number. A sequence number is a number that is generated practically at random by both endpoints of a TCP-connection. The client and the server both create a sequence number, which increases with one with every byte that they send. So this sequence number is different for both sides. This sequence number has to be acknowledged by both sides of the connection. Through sequence numbers, TCP handles acknowledgement, order and retransmission. Its number increases with every data-byte the sender has send. The seq helps keeping track of to what place in a data-stream a byte belongs. If the SYN flag is set at 1, than the sequence number of the first byte of the data is this number plus 1 (so, 2).

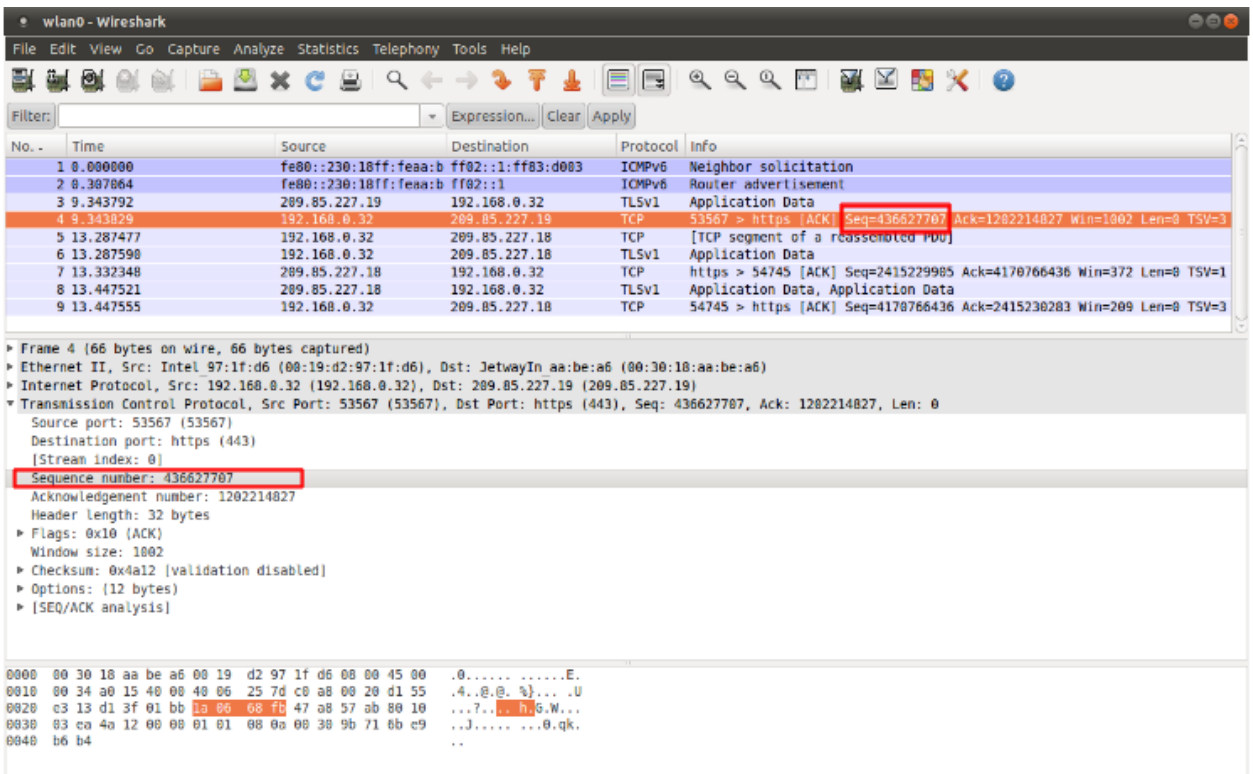
Example:

```
seq:0;
```

Example of seq in a signature:

alert tcp $EXTERNAL_NET any -> $HOME_NET any (msg:"GPL SCAN NULL"; flow:stateless; ack:0; flags:0; seq:0; reference:arachnids,4; classtype:attempted-recon; sid:2100623; rev:7;)

Example of seq in a packet (Wireshark):



8.4.3 ack

The ack is the acknowledgement of the receipt of all previous (data)-bytes send by the other side of the TCP-connection. In most occasions every packet of a TCP connection has an ACK flag after the first SYN and a ack-number which increases with the receipt of every new data-byte. The ack keyword can be used in a signature to check for a specific TCP acknowledgement number.

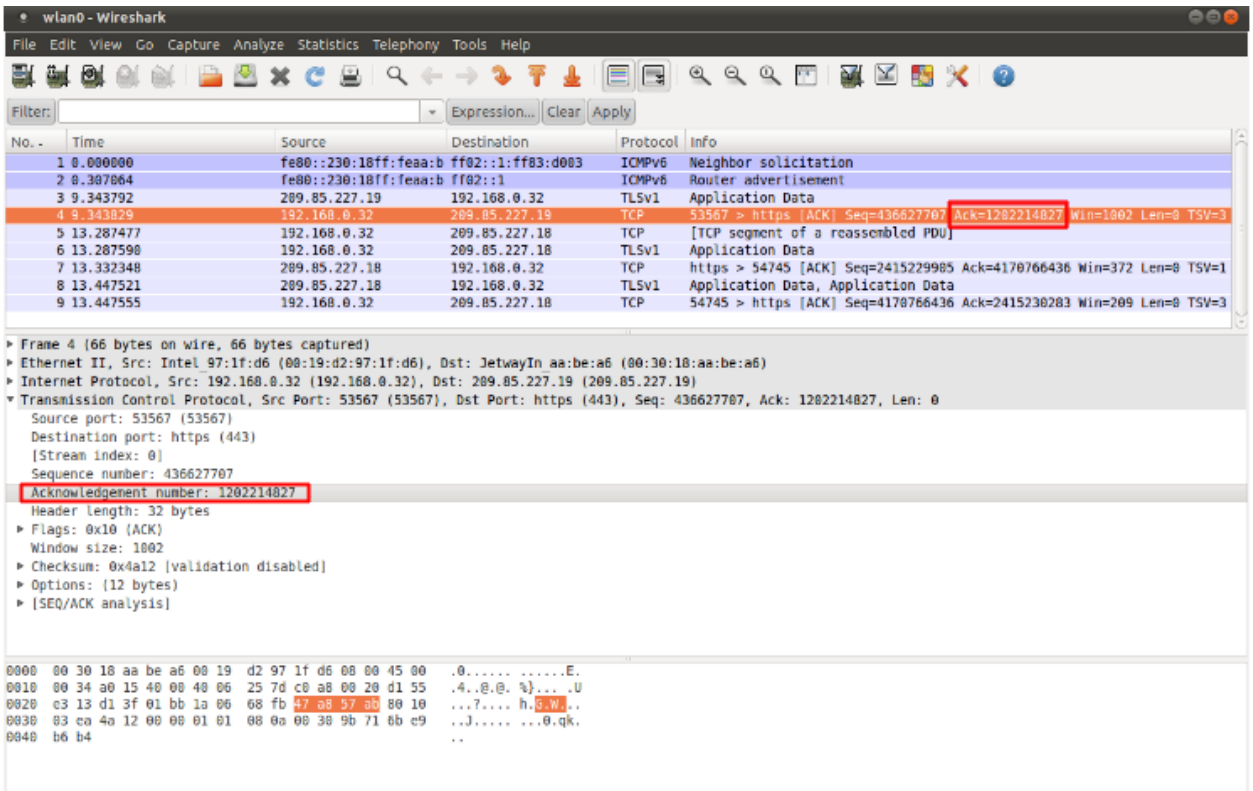
Format of ack:

```
ack:1;
```

Example of ack in a signature:

alert tcp $EXTERNAL_NET any -> $HOME_NET any (msg:"GPL SCAN NULL"; flow:stateless; ack:0; flags:0; seq:0; reference:arachnids,4; classtype:attempted-recon; sid:2100623; rev:7;)

Example of ack in a packet (Wireshark):



8.4.4 window

The window keyword is used to check for a specific TCP window size. The TCP window size is a mechanism that has control of the data-flow. The window is set by the receiver (receiver advertised window size) and indicates the amount of bytes that can be received. This amount of data has to be acknowledged by the receiver first, before the sender can send the same amount of new data. This mechanism is used to prevent the receiver from being overflowed by data. The value of the window size is limited and can be 2 to 65.535 bytes. To make more use of your bandwidth you can use a bigger TCP-window.

The format of the window keyword:

```
window:[!]<number>;
```

Example of window in a rule:

alert tcp $EXTERNAL_NET any -> $HOME_NET any (msg:"GPL DELETED typot trojan traffic"; flow:stateless; flags:S,12; window:55808; reference:mcafee,100406; classtype:trojan-activity; sid:2182; rev:8;)

8.4.5 tcp.mss

Match on the TCP MSS option value. Will not match if the option is not present.

The format of the keyword:

```
tcp.mss:<min>-<max>;
tcp.mss:[<|>]<number>;
tcp.mss:<value>;
```

Example rule:

alert tcp $EXTERNAL_NET any -> $HOME_NET any (flow:stateless; flags:S,12; tcp.mss:<536; sid:1234; rev:5;)

8.4.6 tcp.hdr

Sticky buffer to match on the whole TCP header.

Example rule:

alert tcp $EXTERNAL_NET any -> $HOME_NET any (flags:S,12; tcp.hdr; content:"|02 04|"; offset:20; byte_test:2,<,536,0,big,relative; sid:1234; rev:5;)

This example starts looking after the fixed portion of the header, so into the variable sized options. There it will look for the MSS option (type 2, option len 4) and using a byte_test determine if the value of the option is lower than 536. The *tcp.mss* option will be more efficient, so this keyword is meant to be used in cases where no specific keyword is available.

8.5 UDP keywords

8.5.1 udp.hdr

Sticky buffer to match on the whole UDP header.

Example rule:

alert udp any any -> any any (udp.hdr; content:"|00 08|"; offset:4; depth:2; sid:1234; rev:5;)

This example matches on the length field of the UDP header. In this case the length of 8 means that there is no payload. This can also be matched using *dsize:0;*.

8.6 ICMP keywords

ICMP (Internet Control Message Protocol) is a part of IP. IP at itself is not reliable when it comes to delivering data (datagram). ICMP gives feedback in case problems occur. It does not prevent problems from happening, but helps in understanding what went wrong and where. If reliability is necessary, protocols that use IP have to take care of reliability themselves. In different situations ICMP messages will be send. For instance when the destination is unreachable, if there is not enough buffer-capacity to forward the data, or when a datagram is send fragmented when it should not be, etcetera. More can be found in the list with message-types.

There are four important contents of a ICMP message on which can be matched with corresponding ICMP-keywords. These are: the type, the code, the id and the sequence of a message.

8.6.1 itype

The itype keyword is for matching on a specific ICMP type (number). ICMP has several kinds of messages and uses codes to clarify those messages. The different messages are distinct by different names, but more important by numeric values. For more information see the table with message-types and codes.

The format of the itype keyword:

```
itype:min<>max;
itype:[<|>]<number>;
```

Example This example looks for an ICMP type greater than 10:

```
itype:>10;
```

Example of the itype keyword in a signature:

alert icmp $EXTERNAL_NET any -> $HOME_NET any (msg:"GPL SCAN Broadscan Smurf Scanner"; dsize:4; icmp_id:0; icmp_seq:0; itype:8; classtype:attempted-recon; sid:2100478; rev:4;)

The following lists all ICMP types known at the time of writing. A recent table can be found at the website of IANA

ICMP Type	Name
0	Echo Reply
3	Destination Unreachable
4	Source Quench
5	Redirect
6	Alternate Host Address
8	Echo
9	Router Advertisement
10	Router Solicitation
11	Time Exceeded
12	Parameter Problem
13	Timestamp
14	Timestamp Reply
15	Information Request
16	Information Reply
17	Address Mask Request
18	Address Mask Reply
30	Traceroute
31	Datagram Conversion Error
32	Mobile Host Redirect
33	IPv6 Where-Are-You
34	IPv6 I-Am-Here
35	Mobile Registration Request
36	Mobile Registration Reply
37	Domain Name Request
38	Domain Name Reply
39	SKIP
40	Photuris
41	Experimental mobility protocols such as Seamoby

8.6.2 icode

With the icode keyword you can match on a specific ICMP code. The code of a ICMP message clarifies the message. Together with the ICMP-type it indicates with what kind of problem you are dealing with. A code has a different purpose with every ICMP-type.

The format of the icode keyword:

```
icode:min<>max;
icode:[<|>]<number>;
```

Example: This example looks for an ICMP code greater than 5:

```
icode:>5;
```

Example of the icode keyword in a rule:

alert icmp $HOME_NET any -> $EXTERNAL_NET any (msg:"GPL MISC Time-To-Live Exceeded in Transit"; icode:0; itype:11; classtype:misc-activity; sid:2100449; rev:7;)

The following lists the meaning of all ICMP types. When a code is not listed, only type 0 is defined and has the meaning of the ICMP code, in the table above. A recent table can be found at the website of IANA

ICMP Code	ICMP Type	Description
3	0	Net Unreachable
	1	Host Unreachable
	2	Protocol Unreachable
	3	Port Unreachable
	4	Fragmentation Needed and Don't Fragment was Set
	5	Source Route Failed
	6	Destination Network Unknown
	7	Destination Host Unknown
	8	Source Host Isolated
	9	Communication with Destination Network is Administratively Prohibited
	10	Communication with Destination Host is Administratively Prohibited
	11	Destination Network Unreachable for Type of Service
	12	Destination Host Unreachable for Type of Service
	13	Communication Administratively Prohibited
	14	Host Precedence Violation
	15	Precedence cutoff in effect
5	0	Redirect Datagram for the Network (or subnet)
	1	Redirect Datagram for the Host
	2	Redirect Datagram for the Type of Service and Network
	3	Redirect Datagram for the Type of Service and Host
9	0	Normal router advertisement
	16	Doesn't route common traffic
11	0	Time to Live exceeded in Transit
	1	Fragment Reassembly Time Exceeded
12	0	Pointer indicates the error
	1	Missing a Required Option
	2	Bad Length
40	0	Bad SPI
	1	Authentication Failed
	2	Decompression Failed
	3	Decryption Failed
	4	Need Authentication
	5	Need Authorization

8.6.3 icmp_id

With the icmp_id keyword you can match on specific ICMP id-values. Every ICMP-packet gets an id when it is being send. At the moment the receiver has received the packet, it will send a reply using the same id so the sender will recognize it and connects it with the correct ICMP-request.

Format of the icmp_id keyword:

```
icmp_id:<number>;
```

Example: This example looks for an ICMP ID of 0:

```
icmp_id:0;
```

Example of the icmp_id keyword in a rule:

alert icmp $EXTERNAL_NET any -> $HOME_NET any (msg:"GPL SCAN Broadscan Smurf Scanner"; dsize:4; icmp_id:0; icmp_seq:0; itype:8; classtype:attempted-recon; sid:2100478; rev:4;)

8.6.4 icmp_seq

You can use the icmp_seq keyword to check for a ICMP sequence number. ICMP messages all have sequence numbers. This can be useful (together with the id) for checking which reply message belongs to which request message.

Format of the icmp_seq keyword:

```
icmp_seq:<number>;
```

Example: This example looks for an ICMP Sequence of 0:

```
icmp_seq:0;
```

Example of icmp_seq in a rule:

alert icmp $EXTERNAL_NET any -> $HOME_NET any (msg:"GPL SCAN Broadscan Smurf Scanner"; dsize:4; icmp_id:0; icmp_seq:0; itype:8; classtype:attempted-recon; sid:2100478; rev:4;)

8.6.5 icmpv4.hdr

Sticky buffer to match on the whole ICMPv4 header.

8.6.6 icmpv6.hdr

Sticky buffer to match on the whole ICMPv6 header.

8.6.7 icmpv6.mtu

Match on the ICMPv6 MTU optional value. Will not match if the MTU is not present.

The format of the keyword:

```
icmpv6.mtu:<min>-<max>;
icmpv6.mtu:[<|>]<number>;
icmpv6.mtu:<value>;
```

Example rule:

alert ip $EXTERNAL_NET any -> $HOME_NET any (icmpv6.mtu:<1280; sid:1234; rev:5;)

8.7 Payload Keywords

Payload keywords inspect the content of the payload of a packet or stream.

8.7.1 content

The content keyword is very important in signatures. Between the quotation marks you can write on what you would like the signature to match. The most simple format of content is:

```
content: "............";
```

It is possible to use several contents in a signature.

Contents match on bytes. There are 256 different values of a byte (0-255). You can match on all characters; from a till z, upper case and lower case and also on all special signs. But not all of the bytes are printable characters. For these bytes heximal notations are used. Many programming languages use 0x00 as a notation, where 0x means it concerns a binary value, however the rule language uses `|00|` as a notation. This kind of notation can also be used for printable characters.

Example:

```
|61| is a
|61 61| is aa
|41| is A
|21| is !
|0D| is carriage return
|0A| is line feed
```

There are characters you can not use in the content because they are already important in the signature. For matching on these characters you should use the heximal notation. These are:

```
"     |22|
;     |3B|
:     |3A|
|     |7C|
```

It is a convention to write the heximal notation in upper case characters.

To write for instance `http://` in the content of a signature, you should write it like this: `content: "http|3A|//";` If you use a heximal notation in a signature, make sure you always place it between pipes. Otherwise the notation will be taken literally as part of the content.

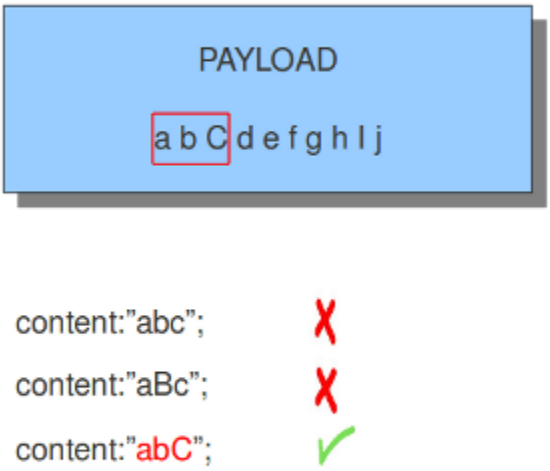
A few examples:

```
content:"a|0D|bc";
content:"|61 0D 62 63|";
content:"a|0D|b|63|";
```

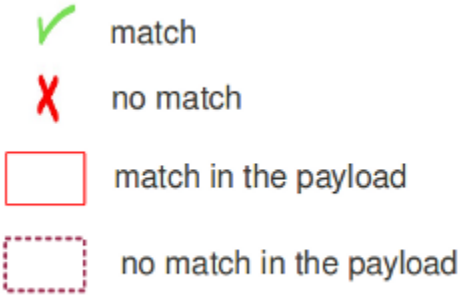
It is possible to let a signature check the whole payload for a match with the content or to let it check specific parts of the payload. We come to that later. If you add nothing special to the signature, it will try to find a match in all the bytes of the payload.

drop tcp $HOME_NET any -> $EXTERNAL_NET any (msg:"ET TROJAN Likely Bot Nick in IRC (USA +..)"; flow:established,to_server; flowbits:isset,is_proto_irc; content:"NICK "; pcre:"/NICK .*USA.*[0-9]{3,}/i"; reference:url,doc.emergingthreats.net/2008124; classtype:trojan-activity; sid:2008124; rev:2;)

By default the pattern-matching is case sensitive. The content has to be accurate, otherwise there will not be a match.



Legend:



It is possible to use the ! for exceptions in contents as well.

For example:

```
alert http $HOME_NET any -> $EXTERNAL_NET any (msg:"Outdated Firefox on
Windows"; content:"User-Agent|3A| Mozilla/5.0 |28|Windows|3B| ";
content:"Firefox/3."; distance:0; content:!"Firefox/3.6.13";
distance:-10; sid:9000000; rev:1;)
```

You see `content:!"Firefox/3.6.13";`. This means an alert will be generated if the used version of Firefox is not 3.6.13.

Note: The following characters must be escaped inside the content: `;` `\` `"`

8.7.2 nocase

If you do not want to make a distinction between uppercase and lowercase characters, you can use nocase. The keyword nocase is a content modifier.

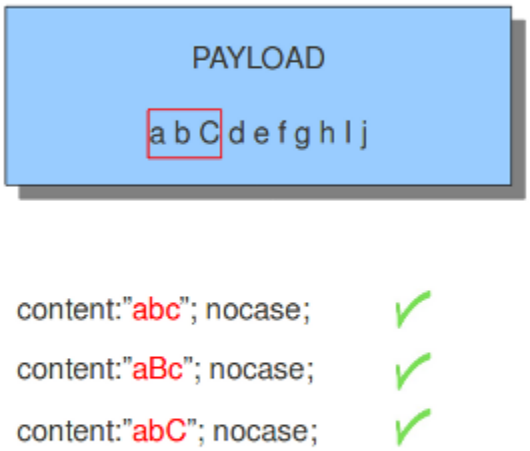
The format of this keyword is:

```
nocase;
```

You have to place it after the content you want to modify, like:

```
content: "abc"; nocase;
```

Example nocase:



It has no influence on other contents in the signature.

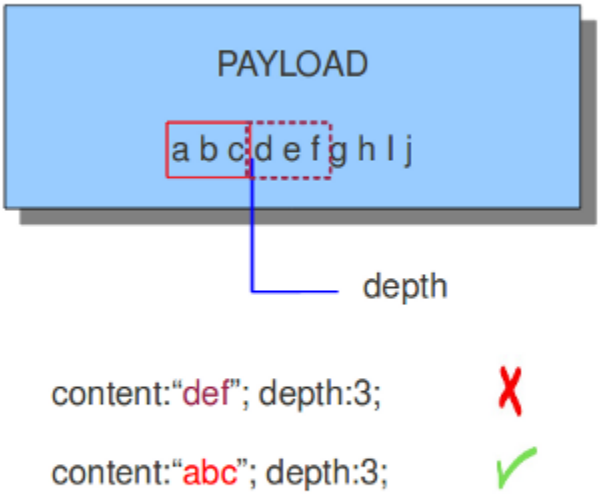
8.7.3 depth

The depth keyword is a absolute content modifier. It comes after the content. The depth content modifier comes with a mandatory numeric value, like:

```
depth:12;
```

The number after depth designates how many bytes from the beginning of the payload will be checked.

Example:



8.7.4 startswith

The `startswith` keyword is similar to `depth`. It takes no arguments and must follow a `content` keyword. It modifies the `content` to match exactly at the start of a buffer.

Example:

```
content:"GET|20|"; startswith;
```

`startswith` is a short hand notation for:

```
content:"GET|20|"; depth:4; offset:0;
```

`startswith` cannot be mixed with `depth`, `offset`, `within` or `distance` for the same pattern.

8.7.5 endswith

The `endswith` keyword is similar to `isdataat:!1,relative;`. It takes no arguments and must follow a `content` keyword. It modifies the `content` to match exactly at the end of a buffer.

Example:

```
content:".php"; endswith;
```

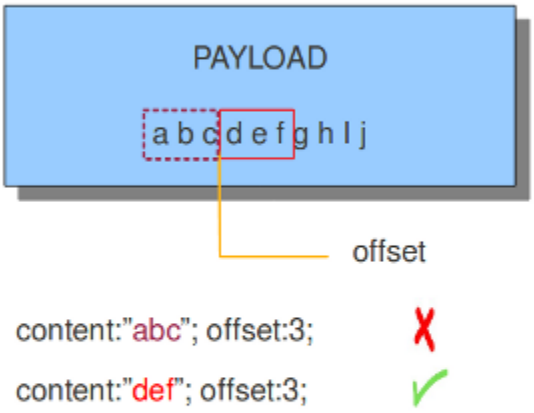
`endswith` is a short hand notation for:

```
content:".php"; isdataat:!1,relative;
```

`endswith` cannot be mixed with `offset`, `within` or `distance` for the same pattern.

8.7.6 offset

The offset keyword designates from which byte in the payload will be checked to find a match. For instance offset:3; checks the fourth byte and further.

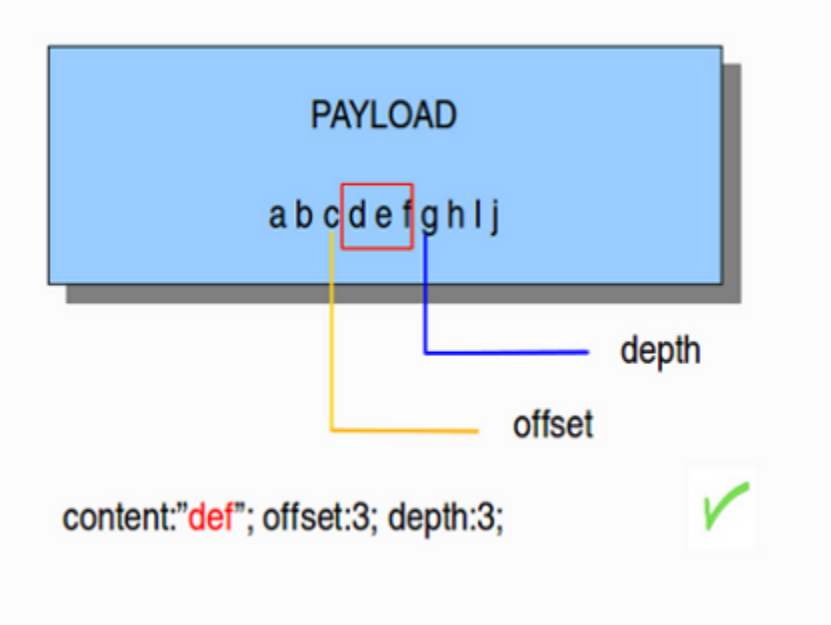


The keywords offset and depth can be combined and are often used together.

For example:

```
content:"def"; offset:3; depth:3;
```

If this was used in a signature, it would check the payload from the third byte till the sixth byte.

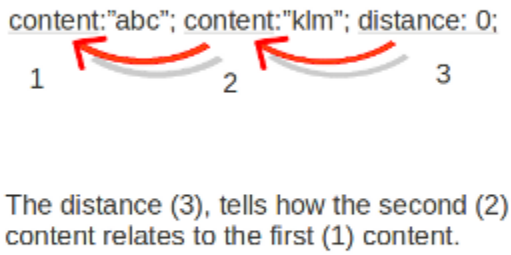


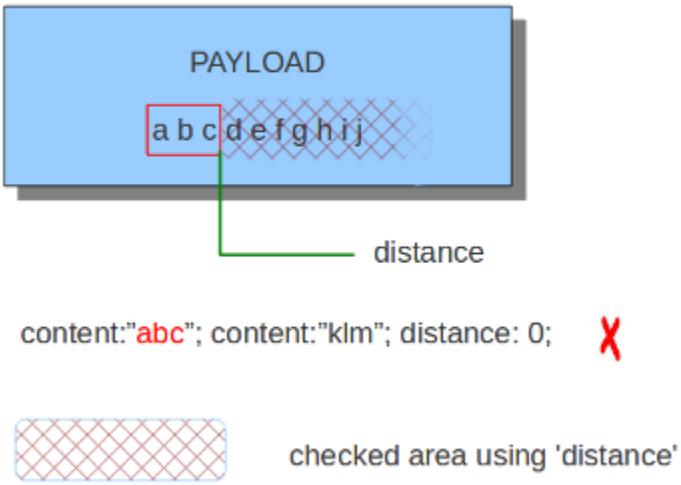
8.7.7 distance

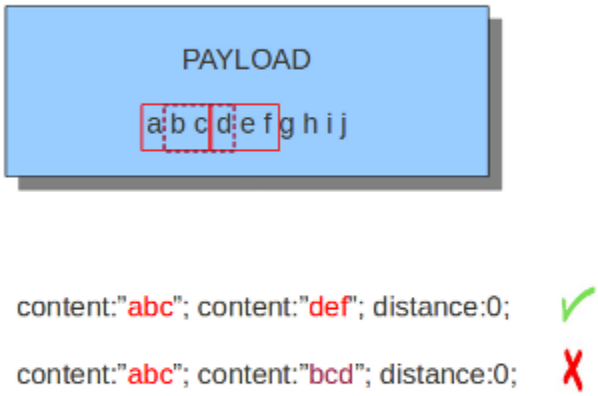
The keyword distance is a relative content modifier. This means it indicates a relation between this content keyword and the content preceding it. Distance has its influence after the preceding match. The keyword distance comes with a mandatory numeric value. The value you give distance, determines the byte in the payload from which will be checked for a match relative to the previous match. Distance only determines where Suricata will start looking for a pattern. So, distance:5; means the pattern can be anywhere after the previous match + 5 bytes. For limiting how far after the last match Suricata needs to look, use 'within'.

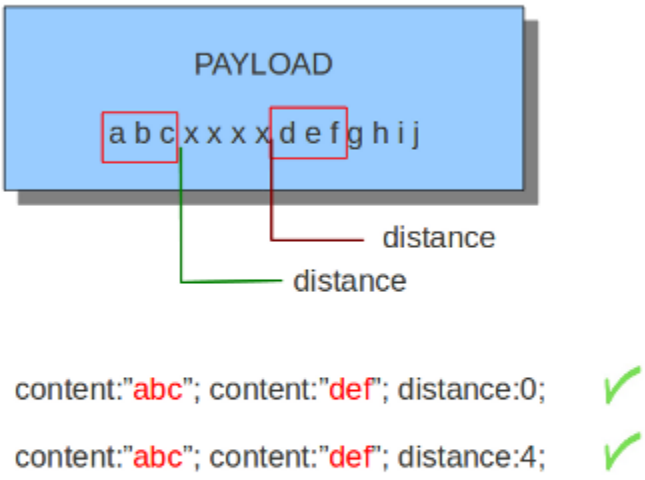
The absolute value for distance must be less than or equal to 1MB (1048576).

Examples of distance:

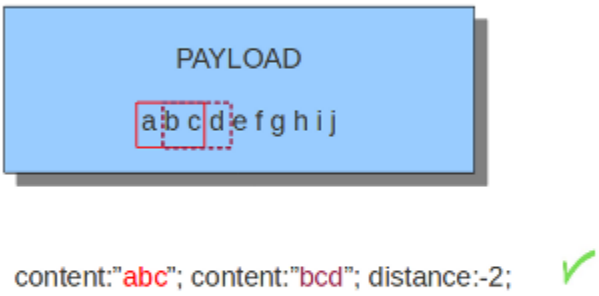



PAYLOAD
a b c d e f g h i j
distance
content:"abc"; content:"klm"; distance: 0;
checked area using 'distance'


PAYLOAD
a b c d e f g h i j
content:"abc"; content:"def"; distance:0;
content:"abc"; content:"bcd"; distance:0;



Distance can also be a negative number. It can be used to check for matches with partly the same content (see example) or for a content even completely before it. This is not very often used though. It is possible to attain the same results with other keywords.

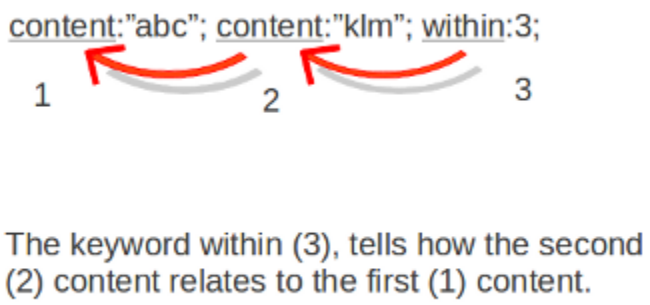


8.7.8 within

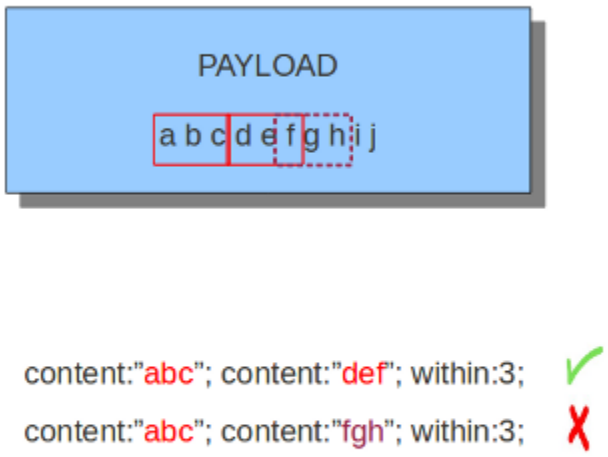
The keyword within is relative to the preceding match. The keyword within comes with a mandatory numeric value. Using within makes sure there will only be a match if the content matches with the payload within the set amount of bytes. Within can not be 0 (zero)

The absolute value for within must be less than or equal to 1MB (1048576).

Example:

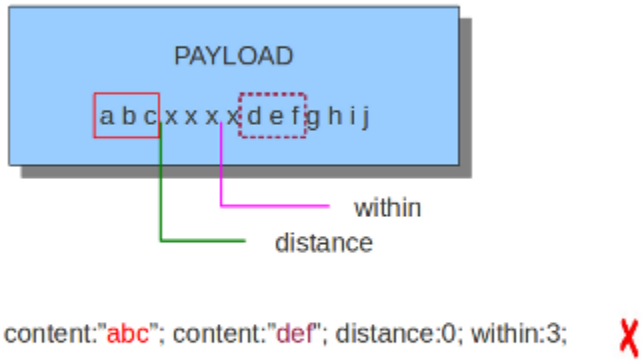


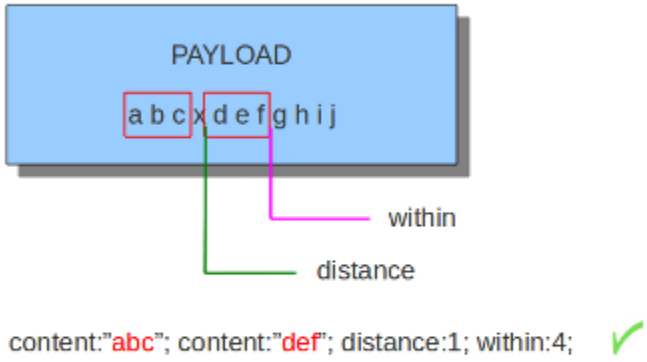
Example of matching with within:



The second content has to fall/come 'within 3 ' from the first content.

As mentioned before, distance and within can be very well combined in a signature. If you want Suricata to check a specific part of the payload for a match, use within.





8.7.9 rawbytes

The rawbytes keyword has no effect but is included to be compatible with signatures that use it, for example signatures used with Snort.

8.7.10 isdataat

The purpose of the isdataat keyword is to look if there is still data at a specific part of the payload. The keyword starts with a number (the position) and then optional followed by 'relative' separated by a comma and the option rawbytes. You use the word 'relative' to know if there is still data at a specific part of the payload relative to the last match.

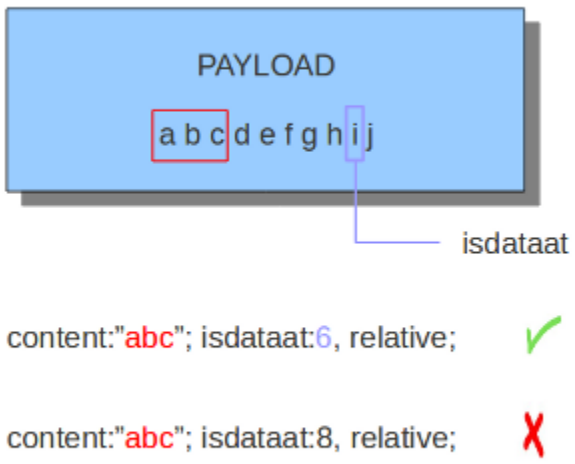
So you can use both examples:

```
isdataat:512;

isdataat:50, relative;
```

The first example illustrates a signature which searches for byte 512 of the payload. The second example illustrates a signature searching for byte 50 after the last match.

You can also use the negation (!) before isdataat.



8.7.11 bsize

With the `bsize` keyword, you can match on the length of the buffer. This adds precision to the content match, previously this could have been done with `isdataat`.

An optional operator can be specified; if no operator is present, the operator will default to '='. When a relational operator is used, e.g., '<', '>' or '<>' (range), the bsize value will be compared using the relational operator. Ranges are exclusive.

If one or more `content` keywords precedes `bsize`, each occurrence of `content` will be inspected and an error will be raised if the content length and the bsize value prevent a match.

Format:

```
bsize:<number>;
bsize:=<number>;
bsize:<<number>;
```

(continues on next page)

(continued from previous page)

```
bsize:><number>;
bsize:<lo-number><><hi-number>;
```

Examples of `bsize` in a rule:

alert dns any any -> any any (msg:"bsize exact buffer size"; dns.query; content:"google.com"; bsize:10; sid:1; rev:1;)

alert dns any any -> any any (msg:"bsize less than value"; dns.query; content:"google.com"; bsize:<25; sid:2; rev:1;)

alert dns any any -> any any (msg:"bsize buffer less than or equal value"; dns.query; content:"google.com"; bsize:<=20; sid:3; rev:1;)

alert dns any any -> any any (msg:"bsize buffer greater than value"; dns.query; content:"google.com"; bsize:>8; sid:4; rev:1;)

alert dns any any -> any any (msg:"bsize buffer greater than or equal value"; dns.query; content:"google.com"; bsize:>=8; sid:5; rev:1;)

alert dns any any -> any any (msg:"bsize buffer range value"; dns.query; content:"google.com"; bsize:8<>20; sid:6; rev:1;)

alert dns any any -> any any (msg:"test bsize rule"; dns.query; content:"short"; bsize:<10; sid:124; rev:1;)

alert dns any any -> any any (msg:"test bsize rule"; dns.query; content:"longer string"; bsize:>10; sid:125; rev:1;)

alert dns any any -> any any (msg:"test bsize rule"; dns.query; content:"middle"; bsize:6<>15; sid:126; rev:1;)

To emphasize how range works: in the example above, a match will occur if `bsize` is greater than 6 and less than 15.

8.7.12 dsize

With the dsize keyword, you can match on the size of the packet payload/data. You can use the keyword for example to look for abnormal sizes of payloads which are equal to some n i.e. 'dsize:n' not equal 'dsize:!n' less than 'dsize:<n' or greater than 'dsize:>n' This may be convenient in detecting buffer overflows.

dsize cannot be used when using app/streamlayer protocol keywords (i.e. http.uri)

Format:

```
dsize:[<>!]number; || dsize:min<>max;
```

Examples of dsize values:

alert tcp any any -> any any (msg:"dsize exact size"; dsize:10; sid:1; rev:1;)

alert tcp any any -> any any (msg:"dsize less than value"; dsize:<10; sid:2; rev:1;)

alert tcp any any -> any any (msg:"dsize less than or equal value"; dsize:<=10; sid:3; rev:1;)

alert tcp any any -> any any (msg:"dsize greater than value"; dsize:>8; sid:4; rev:1;)

alert tcp any any -> any any (msg:"dsize greater than or equal value"; dsize:>=10; sid:5; rev:1;)

alert tcp any any -> any any (msg:"dsize range value"; dsize:8<>20; sid:6; rev:1;)

alert tcp any any -> any any (msg:"dsize not equal value"; dsize:!9; sid:7; rev:1;)

8.7.13 byte_test

The `byte_test` keyword extracts `<num of bytes>` and performs an operation selected with `<operator>` against the value in `<test value>` at a particular `<offset>`. The `<bitmask value>` is applied to the extracted bytes (before the operator is applied), and the final result will be right shifted one bit for each trailing `0` in the `<bitmask value>`.

Format:

```
byte_test:<num of bytes> | <variable_name>, [!]<operator>, <test value>, <offset> [,
↪relative] \
[,<endian>][, string, <num type>][, dce][, bitmask <bitmask value>];
```

<num of bytes>	The number of bytes selected from the packet to be converted or the name of a byte_extract/byte_math variable.
<operator>	• [!] Negation can prefix other operators • < less than • > greater than • = equal • <= less than or equal • >= greater than or equal • & bitwise AND • ^ bitwise OR
<value>	Value to test the converted value against [hex or decimal accepted]
<offset>	Number of bytes into the payload
[relative]	Offset relative to last content match
[endian]	Type of number being read: - big (Most significant byte at lowest address) - little (Most significant byte at the highest address)
[string] <num>	• hex - Converted string represented in hex • dec - Converted string represented in decimal • oct - Converted string represented in octal
[dce]	Allow the DCE module to determine the byte order
[bitmask]	Applies the AND operator on the bytes converted

Example:

```
alert tcp any any -> any any \
       (msg:"Byte_Test Example - Num = Value"; \
       content:"|00 01 00 02|"; byte_test:2,=,0x01,0;)

alert tcp any any -> any any \
       (msg:"Byte_Test Example - Num = Value relative to content"; \
       content:"|00 01 00 02|"; byte_test:2,=,0x03,2,relative;)

alert tcp any any -> any any \
       (msg:"Byte_Test Example - Num != Value"; content:"|00 01 00 02|"; \
       byte_test:2,!=,0x06,0;)

alert tcp any any -> any any \
```

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```
        (msg:"Byte_Test Example - Detect Large Values"; content:"|00 01 00 02|"; \
        byte_test:2,>,1000,1,relative;)

alert tcp any any -> any any \
        (msg:"Byte_Test Example - Lowest bit is set"; \
        content:"|00 01 00 02|"; byte_test:2,&,0x01,12,relative;)

alert tcp any any -> any any (msg:"Byte_Test Example - Compare to String"; \
        content:"foobar"; byte_test:4,=,1337,1,relative,string,dec;)
```

8.7.14 byte_math

The `byte_math` keyword adds the capability to perform mathematical operations on extracted values with an existing variable or a specified value.

When `relative` is included, there must be a previous `content` or `pcre` match.

Note: if `oper` is `/` and the divisor is 0, there will never be a match on the `byte_math` keyword.

The result can be stored in a result variable and referenced by other rule options later in the rule.

Keyword	Modifier
content	offset,depth,distance,within
byte_test	offset,value
byte_jump	offset
isdataat	offset

Format:

```
byte_math:bytes <num of bytes> | <variable-name> , offset <offset>, oper <operator>,␣
↪rvalue <rvalue>, \
      result <result_var> [, relative] [, endian <endian>] [, string <number-type>] \
      [, dce] [, bitmask <value>];
```

<num of bytes>	The number of bytes selected from the packet or the name of a byte_extract variable.
<offset>	Number of bytes into the payload
oper <operator>	Mathematical operation to perform: +, -, *, /, <<, >>
rvalue <rvalue>	Value to perform the math operation with
result <result-var>	Where to store the computed value
[relative]	Offset relative to last content match
[endian <type>]	• big (Most significant byte at lowest address) • little (Most significant byte at the highest address) • dce (Allow the DCE module to determine the byte order)
[string <num_type>]	• hex Converted data is represented in hex • dec Converted data is represented in decimal • oct Converted data is represented as octal
[dce]	Allow the DCE module to determine the byte order
[bitmask] <value>	The AND operator will be applied to the extracted value The result will be right shifted by the number of bits equal to the number of trailing zeros in the mask

Example:

```
alert tcp any any -> any any \
  (msg:"Testing bytemath_body"; \
  content:"|00 04 93 F3|"; \
  content:"|00 00 00 07|"; distance:4; within:4; \
  byte_math:bytes 4, offset 0, oper +, rvalue \
  248, result var, relative;)

alert udp any any -> any any \
  (byte_extract: 1, 0, extracted_val, relative; \
  byte_math: bytes 1, offset 1, oper +, rvalue extracted_val, result var; \
  byte_test: 2, =, var, 13; \
  msg:"Byte extract and byte math with byte test verification";)
```

8.7.15 byte_jump

The `byte_jump` keyword allows for the ability to select a `<num of bytes>` from an `<offset>` and moves the detection pointer to that position. Content matches will then be based off the new position.

Format:

```
byte_jump:<num of bytes> | <variable-name>, <offset> [, relative][, multiplier <mult_
↪value>] \
      [, <endian>][, string, <num_type>][, align][, from_beginning][, from_end] \
      [, post_offset <value>][, dce][, bitmask <value>];
```

<num of bytes>	The number of bytes selected from the packet to be converted or the name of a byte_extract/byte_math variable.
<offset>	Number of bytes into the payload
[relative]	Offset relative to last content match
[multiplier] <value>	Multiple the converted byte by the <value>
[endian]	• big (Most significant byte at lowest address) • little (Most significant byte at the highest address)
[string] <num_type>	• hex Converted data is represented in hex • dec Converted data is represented in decimal • oct Converted data is represented as octal
[align]	Rounds the number up to the next 32bit boundary
[from_beginning]	Jumps forward from the beginning of the packet, instead of where the detection pointer is set
[from_end]	Jump will begin at the end of the payload, instead of where the detection point is set
[post_offset] <value>	After the jump operation has been performed, it will jump an additional number of bytes specified by <value>
[dce]	Allow the DCE module to determine the byte order
[bitmask] <value>	The AND operator will be applied by <value> and the converted bytes, then jump operation is performed

Example:

```
alert tcp any any -> any any \
      (msg:"Byte_Jump Example"; \
      content:"Alice"; byte_jump:2,0; content:"Bob";)

alert tcp any any -> any any \
      (msg:"Byte_Jump Multiple Jumps"; \
      byte_jump:2,0; byte_jump:2,0,relative; content:"foobar"; distance:0; within:6;)

alert tcp any any -> any any \
      (msg:"Byte_Jump From the End -8 Bytes"; \
      byte_jump:0,0, from_end, post_offset -8; \
      content:"|6c 33 33 74|"; distance:0 within:4;)
```

8.7.16 byte_extract

The `byte_extract` keyword extracts `<num of bytes>` at a particular `<offset>` and stores it in `<var_name>`. The value in `<var_name>` can be used in any modifier that takes a number as an option and in the case of `byte_test` it can be used as a value.

Format:

```
byte_extract:<num of bytes>, <offset>, <var_name>, [,relative] [,multiplier <mult-value>
↪] \
      [,<endian>] [, dce] [, string [, <num_type>] [, align <align-value];
```

<num of bytes>	The number of bytes selected from the packet to be extracted
<offset>	Number of bytes into the payload
<var_name>	The name of the variable in which to store the value
[relative]	Offset relative to last content match
multiplier <value>	multiply the extracted bytes by <mult-value> before storing
[endian]	Type of number being read: - big (Most significant byte at lowest address) - little (Most significant byte at the highest address)
[string] <num>	• hex - Converted string represented in hex • dec - Converted string represented in decimal • oct - Converted string represented in octal
[dce]	Allow the DCE module to determine the byte order
align <align-value>	Round the extracted value up to the next <align-value> byte boundary post-multiplication (if any) ; <align-value> may be 2 or 4

Keyword	Modifier
content	offset,depth,distance,within
byte_test	offset,value
byte_math	rvalue
byte_jump	offset
isdataat	offset

Example:

```
alert tcp any any -> any any \
       (msg:"Byte_Extract Example Using distance"; \
       content:"Alice"; byte_extract:2,0,size; content:"Bob"; distance:size; within:3;␣
↪sid:1;)
alert tcp any any -> any any \
       (msg:"Byte_Extract Example Using within"; \
       flow:established,to_server; content:"|00 FF|"; \
       byte_extract:1,0,len,relative; content:"|5c 00|"; distance:2; within:len; sid:2;)
alert tcp any any -> any any \
       (msg:"Byte_Extract Example Comparing Bytes"; \
       flow:established,to_server; content:"|00 FF|"; \
       byte_extract:2,0,cmp_ver,relative; content:"FooBar"; distance:0; byte_test:2,=,
↪cmp_ver,0; sid:3;)
```

8.7.17 rpc

The rpc keyword can be used to match in the SUNRPC CALL on the RPC procedure numbers and the RPC version.

You can modify the keyword by using a wild-card, defined with * With this wild-card you can match on all version and/or procedure numbers.

RPC (Remote Procedure Call) is an application that allows a computer program to execute a procedure on another computer (or address space). It is used for inter-process communication. See http://en.wikipedia.org/wiki/Inter-process_communication

Format:

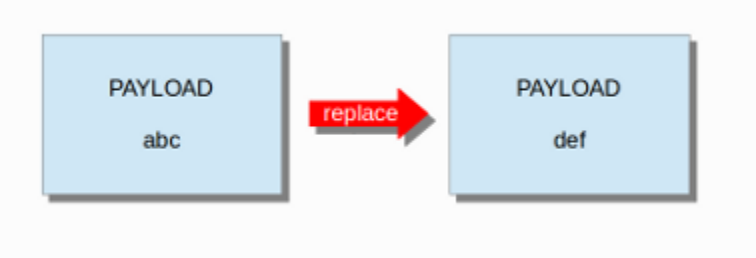
```
rpc:<application number>, [<version number>|*], [<procedure number>|*]>;
```

Example of the rpc keyword in a rule:

alert udp $EXTERNAL_NET any -> $HOME_NET 111 (msg:"RPC portmap request yppasswdd"; rpc:100009,*,*; reference:bugtraq,2763; classtype:rpc-portmap-decode; sid:1296; rev:4;)

8.7.18 replace

The replace content modifier can only be used in ips. It adjusts network traffic. It changes the content it follows ('abc') into another ('def'), see example:



The replace modifier has to contain as many characters as the content it replaces. It can only be used with individual packets. It will not work for *Normalized Buffers* like HTTP uri or a content match in the reassembled stream.

The checksums will be recalculated by Suricata and changed after the replace keyword is being used.

8.7.19 pcre (Perl Compatible Regular Expressions)

The keyword pcre matches specific on regular expressions. More information about regular expressions can be found here http://en.wikipedia.org/wiki/Regular_expression.

The complexity of pcre comes with a high price though: it has a negative influence on performance. So, to mitigate Suricata from having to check pcre often, pcre is mostly combined with 'content'. In that case, the content has to match first, before pcre will be checked.

Format of pcre:

```
pcre:"/<regex>/opts";
```

Example of pcre. In this example there will be a match if the payload contains six numbers following:

```
pcre:"/[0-9]{6}/";
```

Example of pcre in a signature:

drop tcp $HOME_NET any -> $EXTERNAL_NET any (msg:"ET TROJAN Likely Bot Nick in IRC (USA +..)"; flow:established,to_server; flowbits:isset,is_proto_irc; content:"NICK "; pcre:"/NICK .*USA.*[0-9]{3,}/i"; reference:url,doc.emergingthreats.net/2008124; classtype:trojan-activity; sid:2008124; rev:2;)

There are a few qualities of pcre which can be modified:

- By default pcre is case-sensitive.
- The . (dot) is a part of regex. It matches on every byte except for newline characters.
- By default the payload will be inspected as one line.

These qualities can be modified with the following characters:

```
i    pcre is case insensitive
s    pcre does check newline characters
m    can make one line (of the payload) count as two lines
```

These options are perl compatible modifiers. To use these modifiers, you should add them to pcre, behind regex. Like this:

```
pcre: "/<regex>/i";
```

Pcre compatible modifiers

There are a few pcre compatible modifiers which can change the qualities of pcre as well. These are:

- `A`: A pattern has to match at the beginning of a buffer. (In pcre ^ is similar to A.)
- `E`: Ignores newline characters at the end of the buffer/payload.
- `G`: Inverts the greediness.

Note: The following characters must be escaped inside the content: `;` `\` `"`

Suricata's modifiers

Suricata has its own specific pcre modifiers. These are:

- `R`: Match relative to the last pattern match. It is similar to distance:0;
- `U`: Makes pcre match on the normalized uri. It matches on the uri_buffer just like uricontent and content combined with http_uri.U can be combined with /R. Note that R is relative to the previous match so both matches have to be in the HTTP-uri buffer. Read more about *HTTP URI Normalization*.

PAYLOAD

/index.html

content:"/index."; http_uri; content:"htm"; http_uri; distance:0; ✓

content:"index."; http_uri; pcre:"/html?$/UR"; ✓

content:"index."; http_uri; pcre:"/^/index\.html?/$/U"; ✓

PAYLOAD

/index.htm

content:"/index."; http_uri; content:"htm"; http_uri; distance:0; ✓

content:"index."; http_uri; pcre:"/html?$/UR"; ✓

content:"index."; http_uri; pcre:"/^/index\.html?/$/U"; ✓

PAYLOAD

/index.htmo

content:"/index."; http_uri; content:"htm"; http_uri; distance:0; ✓

content:"index."; http_uri; pcre:"/html?$/UR"; ✗

content:"index."; http_uri; pcre:"/^/index\.html?/$/U"; ✗

- `I`: Makes pcre match on the HTTP-raw-uri. It matches on the same buffer as http_raw_uri. I can be combined with /R. Note that R is relative to the previous match so both matches have to be in the HTTP-raw-uri buffer. Read more about *HTTP URI Normalization*.
- `P`: Makes pcre match on the HTTP- request-body. So, it matches on the same buffer as http_client_body. P can be combined with /R. Note that R is relative to the previous match so both matches have to be in the HTTP-request body.
- `Q`: Makes pcre match on the HTTP- response-body. So, it matches on the same buffer as http_server_body. Q can be combined with /R. Note that R is relative to the previous match so both matches have to be in the HTTP-response body.
- `H`: Makes pcre match on the HTTP-header. H can be combined with /R. Note that R is relative to the previous match so both matches have to be in the HTTP-header body.
- `D`: Makes pcre match on the unnormalized header. So, it matches on the same buffer as http_raw_header. D can be combined with /R. Note that R is relative to the previous match so both matches have to be in the HTTP-raw-header.
- `M`: Makes pcre match on the request-method. So, it matches on the same buffer as http_method. M can be combined with /R. Note that R is relative to the previous match so both matches have to be in the HTTP-method buffer.
- `C`: Makes pcre match on the HTTP-cookie. So, it matches on the same buffer as http_cookie. C can be combined with /R. Note that R is relative to the previous match so both matches have to be in the HTTP-cookie buffer.
- `S`: Makes pcre match on the HTTP-stat-code. So, it matches on the same buffer as http_stat_code. S can be combined with /R. Note that R is relative to the previous match so both matches have to be in the HTTP-stat-code buffer.
- `Y`: Makes pcre match on the HTTP-stat-msg. So, it matches on the same buffer as http_stat_msg. Y can be combined with /R. Note that R is relative to the previous match so both matches have to be in the HTTP-stat-msg buffer.
- `B`: You can encounter B in signatures but this is just for compatibility. So, Suricata does not use B but supports it so it does not cause errors.
- `O`: Overrides the configures pcre match limit.
- `V`: Makes pcre match on the HTTP-User-Agent. So, it matches on the same buffer as http_user_agent. V can be combined with /R. Note that R is relative to the previous match so both matches have to be in the HTTP-User-Agent buffer.

- `W`: Makes pcre match on the HTTP-Host. So, it matches on the same buffer as http_host. W can be combined with /R. Note that R is relative to the previous match so both matches have to be in the HTTP-Host buffer.

Changes from PCRE1 to PCRE2

The upgrade from PCRE1 to PCRE2 changes the behavior for some PCRE expressions.

- `\I` is a valid pcre in PCRE1, with a useless escape, so equivalent to `I`, but it is no longer the case in PCRE2. There are other characters than I exhibiting this pattern
- `[\d-a]` is a valid pcre in PCRE1, with either a digit, a dash or the character `a`, but the dash must now be escaped with PCRE2 as `[\d\-a]` to get the same behavior
- `pcre2_substring_copy_bynumber` now returns an error `PCRE2_ERROR_UNSET` instead of `pcre_copy_substring` returning no error and giving an empty string. If the behavior of some use case is no longer the expected one, please let us know.

8.8 Transformations

Transformation keywords turn the data at a sticky buffer into something else. Some transformations support options for greater control over the transformation process

Example:

```
alert http any any -> any any (file_data; strip_whitespace; \
    content:"window.navigate("; sid:1;)
```

This example will match on traffic even if there are one or more spaces between the `navigate` and `(`.

The transforms can be chained. They are processed in the order in which they appear in a rule. Each transform's output acts as input for the next one.

Example:

```
alert http any any -> any any (http_request_line; compress_whitespace; to_sha256; \
    content:"|54A9 7A8A B09C 1B81 3725 2214 51D3 F997 F015 9DD7 049E E5AD CED3 945A FC79␣
↪7401|"; sid:1;)
```

Note: not all sticky buffers support transformations yet

8.8.1 dotprefix

Takes the buffer, and prepends a `.` character to help facilitate concise domain checks. For example, an input string of `hello.google.com` would be modified and become `.hello.google.com`. Additionally, adding the dot allows `google.com` to match against `content:".google.com"`

Example:

```
alert dns any any -> any any (dns.query; dotprefix; \
    content:".microsoft.com"; sid:1;)
```

This example will match on `windows.update.microsoft.com` and `maps.microsoft.com.au` but not `windows.update.fakemicrosoft.com`.

This rule can be used to match on the domain only; example:

```
alert dns any any -> any any (dns.query; dotprefix; \
    content:".microsoft.com"; endswith; sid:1;)
```

This example will match on `windows.update.microsoft.com` but not `windows.update.microsoft.com.au`.

Finally, this rule can be used to match on the TLD only; example:

```
alert dns any any -> any any (dns.query; dotprefix; \
    content:".co.uk"; endswith; sid:1;)
```

This example will match on `maps.google.co.uk` but not `maps.google.co.nl`.

8.8.2 strip_whitespace

Strips all whitespace as considered by the `isspace()` call in C.

Example:

```
alert http any any -> any any (file_data; strip_whitespace; \
    content:"window.navigate("; sid:1;)
```

8.8.3 compress_whitespace

Compresses all consecutive whitespace into a single space.

8.8.4 to_lowercase

Converts the buffer to lowercase and passes the value on.

This example alerts if `http.uri` contains `this text has been converted to lowercase`

Example:

```
alert http any any -> any any (http.uri; to_lowercase; \
    content:"this text has been converted to lowercase"; sid:1;)
```

8.8.5 to_md5

Takes the buffer, calculates the MD5 hash and passes the raw hash value on.

Example:

```
alert http any any -> any any (http_request_line; to_md5; \
    content:"|54 A9 7A 8A B0 9C 1B 81 37 25 22 14 51 D3 F9 97|"; sid:1;)
```

8.8.6 to_uppercase

Converts the buffer to uppercase and passes the value on.

This example alerts if `http.uri` contains `THIS TEXT HAS BEEN CONVERTED TO LOWERCASE`

Example:

```
alert http any any -> any any (http.uri; to_uppercase; \
    content:"THIS TEXT HAS BEEN CONVERTED TO UPPERCASE"; sid:1;)
```

8.8.7 to_sha1

Takes the buffer, calculates the SHA-1 hash and passes the raw hash value on.

Example:

```
alert http any any -> any any (http_request_line; to_sha1; \
    content:"|54A9 7A8A B09C 1B81 3725 2214 51D3 F997 F015 9DD7|"; sid:1;)
```

8.8.8 to_sha256

Takes the buffer, calculates the SHA-256 hash and passes the raw hash value on.

Example:

```
alert http any any -> any any (http_request_line; to_sha256; \
    content:"|54A9 7A8A B09C 1B81 3725 2214 51D3 F997 F015 9DD7 049E E5AD CED3 945A FC79␣
↪7401|"; sid:1;)
```

8.8.9 pcrexform

Takes the buffer, applies the required regular expression, and outputs the *first captured expression*.

Note: this transform requires a mandatory option string containing a regular expression.

This example alerts if `http.request_line` contains `/dropper.php` Example:

```
alert http any any -> any any (msg:"HTTP with pcrexform"; http.request_line; \
    pcrexform:"[a-zA-Z]+\s+(.*)\s+HTTP"; content:"/dropper.php"; sid:1;)
```

8.8.10 url_decode

Decodes url-encoded data, ie replacing '+' with space and '%HH' with its value. This does not decode unicode '%uZZZZ' encoding

8.8.11 xor

Takes the buffer, applies xor decoding.

Note: this transform requires a mandatory option which is the hexadecimal encoded xor key.

This example alerts if `http.uri` contains `password=` xored with 4-bytes key `0d0ac8ff` Example:

```
alert http any any -> any any (msg:"HTTP with xor"; http.uri; \
    xor:"0d0ac8ff"; content:"password="; sid:1;)
```

8.8.12 header_lowercase

This transform is meant for HTTP/1 HTTP/2 header names normalization. It lowercases the header names, while keeping untouched the header values.

The implementation uses a state machine : - it lowercases until it finds `:` - it does not change until it finds a new line and switch back to first state

This example alerts for both HTTP/1 and HTTP/2 with a authorization header Example:

```
alert http any any -> any any (msg:"HTTP authorization"; http.header_names; \
    header_lowercase; content:"authorization:"; sid:1;)
```

8.8.13 strip_pseudo_headers

This transform is meant for HTTP/1 HTTP/2 header names normalization. It strips HTTP2 pseudo-headers (names and values).

The implementation just strips every line beginning by `:`.

This example alerts for both HTTP/1 and HTTP/2 with only a user agent Example:

```
alert http any any -> any any (msg:"HTTP ua only"; http.header_names; \
   bsize:16; content:"|0d 0a|User-Agent|0d 0a 0d 0a|"; nocase; sid:1;)
```

8.9 Prefiltering Keywords

8.9.1 fast_pattern

Suricata Fast Pattern Determination Explained

If the 'fast_pattern' keyword is explicitly set in a rule, Suricata will use that as the fast pattern match. The 'fast_pattern' keyword can only be set once per rule. If 'fast_pattern' is not set, Suricata automatically determines the content to use as the fast pattern match.

The following explains the logic Suricata uses to automatically determine the fast pattern match to use.

Be aware that if there are positive (i.e. non-negated) content matches, then negated content matches are ignored for fast pattern determination. Otherwise, negated content matches are considered.

The fast_pattern selection criteria are as follows:

1. Suricata first identifies all content matches that have the highest "priority" that are used in the signature. The priority is based off of the buffer being matched on and generally application layer buffers have a higher priority (lower number is higher priority). The buffer *http_method* is an exception and has lower priority than the general *content* buffer.
2. Within the content matches identified in step 1 (the highest priority content matches), the longest (in terms of character/byte length) content match is used as the fast pattern match.
3. If multiple content matches have the same highest priority and qualify for the longest length, the one with the highest character/byte diversity score ("Pattern Strength") is used as the fast pattern match. See *Appendix A* for details on the algorithm used to determine Pattern Strength.
4. If multiple content matches have the same highest priority, qualify for the longest length, and the same highest Pattern Strength, the buffer ("list_id") that was *registered last* is used as the fast pattern match.
5. If multiple content matches have the same highest priority, qualify for the longest length, the same highest Pattern Strength, and have the same list_id (i.e. are looking in the same buffer), then the one that comes first (from left-to-right) in the rule is used as the fast pattern match.

It is worth noting that for content matches that have the same priority, length, and Pattern Strength, 'http_stat_msg', 'http_stat_code', and 'http_method' take precedence over regular 'content' matches.

Appendices

Appendix A - Pattern Strength Algorithm

From detect-engine-mpm.c. Basically the Pattern Strength "score" starts at zero and looks at each character/byte in the passed in byte array from left to right. If the character/byte has not been seen before in the array, it adds 3 to the score if it is an alpha character; else it adds 4 to the score if it is a printable character, 0x00, 0x01, or 0xFF; else it adds 6 to the score. If the character/byte has been seen before it adds 1 to the score. The final score is returned.

```
/** \brief Predict a strength value for patterns
 *
 *  Patterns with high character diversity score higher.
 *  Alpha chars score not so high
 *  Other printable + a few common codes a little higher
 *  Everything else highest.
 *  Longer patterns score better than short patters.
 *
 *  \param pat pattern
 *  \param patlen length of the pattern
 *
 *  \retval s pattern score
 */
uint32_t PatternStrength(uint8_t *pat, uint16_t patlen) {
    uint8_t a[256];
    memset(&a, 0 ,sizeof(a));
    uint32_t s = 0;
    uint16_t u = 0;
    for (u = 0; u < patlen; u++) {
        if (a[pat[u]] == 0) {
            if (isalpha(pat[u]))
                s += 3;
            else if (isprint(pat[u]) || pat[u] == 0x00 || pat[u] == 0x01 || pat[u] ==␣
```

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```
↪0xFF)
                s += 4;
            else
                s += 6;
            a[pat[u]] = 1;
        } else {
            s++;
        }
    }
    return s;
}
```

Only one content of a signature will be used in the Multi Pattern Matcher (MPM). If there are multiple contents, then Suricata uses the 'strongest' content. This means a combination of length, how varied a content is, and what buffer it is looking in. Generally, the longer and more varied the better. For full details on how Suricata determines the fast pattern match, see *Suricata Fast Pattern Determination Explained*.

Sometimes a signature writer concludes he wants Suricata to use another content than it does by default.

For instance:

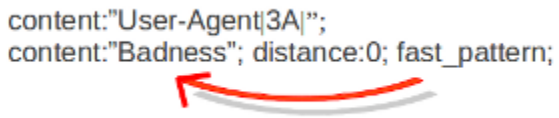
```
User-agent: Mozilla/5.0 Badness;

content:"User-Agent|3A|";
content:"Badness"; distance:0;
```

In this example you see the first content is longer and more varied than the second one, so you know Suricata will use this content for the MPM. Because 'User-Agent:' will be a match very often, and 'Badness' appears less often in network traffic, you can make Suricata use the second content by using 'fast_pattern'.

```
content:"User-Agent|3A|";
content:"Badness"; distance:0; fast_pattern;
```

The keyword fast_pattern modifies the content previous to it.



Fast-pattern can also be combined with all previous mentioned keywords, and all mentioned HTTP-modifiers.

fast_pattern:only

Sometimes a signature contains only one content. In that case it is not necessary Suricata will check it any further after a match has been found in MPM. If there is only one content, the whole signature matches. Suricata notices this automatically. In some signatures this is still indicated with 'fast_pattern:only;'. Although Suricata does not need fast_pattern:only, it does support it.

fast_pattern:'chop'

If you do not want the MPM to use the whole content, you can use fast_pattern 'chop'.

For example:

```
content: "aaaaaaaaabc"; fast_pattern:8,4;
```

This way, MPM uses only the last four characters.

8.9.2 prefilter

The prefilter engines for other non-MPM keywords can be enabled in specific rules by using the 'prefilter' keyword.

In the following rule the TTL test will be used in prefiltering instead of the single byte pattern:

```
alert ip any any -> any any (ttl:123; prefilter; content:"a"; sid:1;)
```

For more information on how to configure the prefilter engines, see *Prefilter Engines*

8.10 Flow Keywords

8.10.1 flowbits

Flowbits consists of two parts. The first part describes the action it is going to perform, the second part is the name of the flowbit.

There are multiple packets that belong to one flow. Suricata keeps those flows in memory. For more information see *Flow Settings*. Flowbits can make sure an alert will be generated when for example two different packets match. An alert will only be generated when both packets match. So, when the second packet matches, Suricata has to know if the first packet was a match too. Flowbits marks the flow if a packet matches so Suricata 'knows' it should generate an alert when the second packet matches as well.

Flowbits have different actions. These are:

flowbits: set, name
: Will set the condition/'name', if present, in the flow.

flowbits: isset, name
: Can be used in the rule to make sure it generates an alert when the rule matches and the condition is set in the flow.

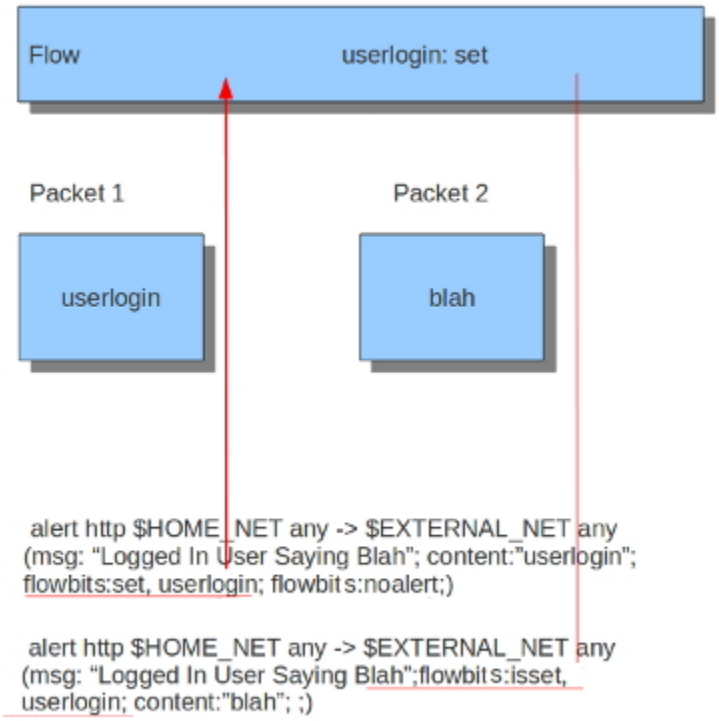
flowbits: toggle, name
: Reverses the present setting. So for example if a condition is set, it will be unset and vice-versa.

flowbits: unset, name
: Can be used to unset the condition in the flow.

flowbits: isnotset, name
Can be used in the rule to make sure it generates an alert when it matches and the condition is not set in the flow.

flowbits: noalert
No alert will be generated by this rule.

Example:



When you take a look at the first rule you will notice it would generate an alert if it would match, if it were not for the 'flowbits: noalert' at the end of that rule. The purpose of this rule is to check for a match on 'userlogin' and mark that in the flow. So, there is no need for generating an alert. The second rule has no effect without the first rule. If the first rule matches, the flowbits sets that specific condition to be present in the flow. Now with the second rule there can be checked whether or not the previous packet fulfills the first condition. If at that point the second rule matches, an alert will be generated.

It is possible to use flowbits several times in a rule and combine the different functions.

It is also possible to perform an *OR* operation with flowbits with | op.

Example::
alert http any any -> any any (msg: "User1 or User2 logged in"; content:"login"; flowbits:isset,user1|user2; sid:1;)

This can be used with either *isset* or *isnotset* action.

8.10.2 flow

The flow keyword can be used to match on direction of the flow, so to/from client or to/from server. It can also match if the flow is established or not. The flow keyword can also be used to say the signature has to match on stream only (only_stream) or on packet only (no_stream).

So with the flow keyword you can match on:

to_client
Match on packets from server to client.

to_server
Match on packets from client to server.

from_client
Match on packets from client to server (same as to_server).

from_server
Match on packets from server to client (same as to_client).

established
Match on established connections.

not_established
Match on packets that are not part of an established connection.

stateless
Match on packets that are and are not part of an established connection.

only_stream
Match on packets that have been reassembled by the stream engine.

no_stream
Match on packets that have not been reassembled by the stream engine. Will not match packets that have been reassembled.

only_frag
Match packets that have been reassembled from fragments.

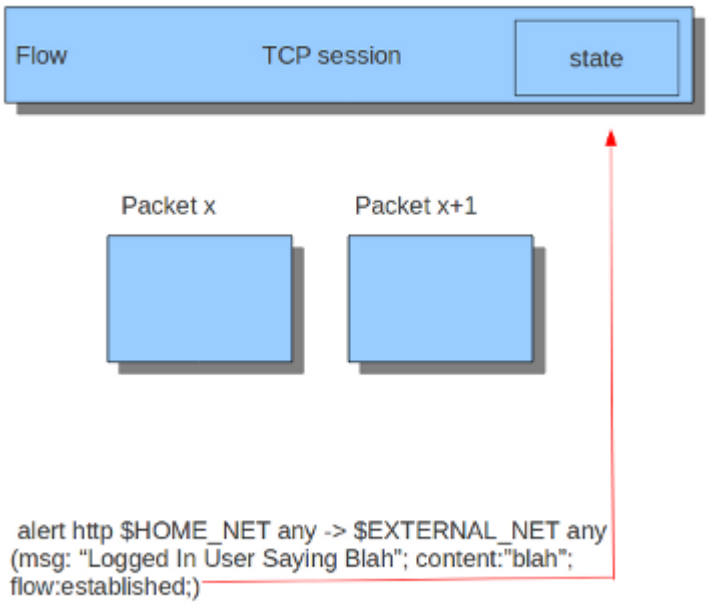
no_frag
Match packets that have not been reassembled from fragments.

Multiple flow options can be combined, for example:

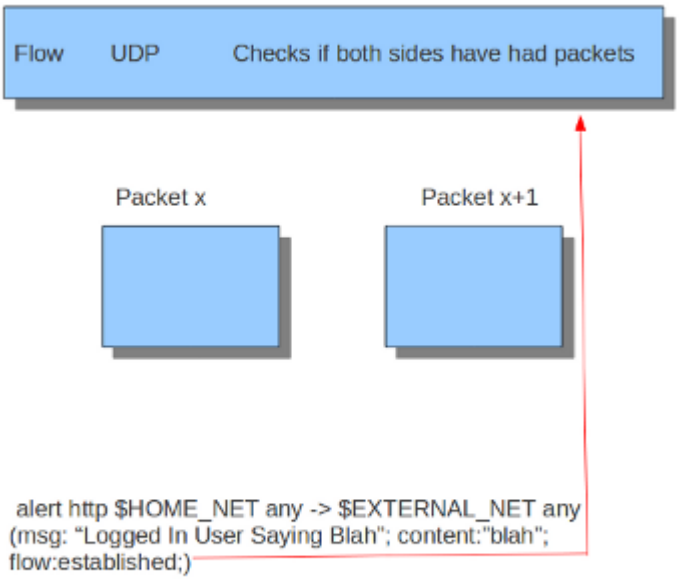
```
flow:to_client, established
flow:to_server, established, only_stream
flow:to_server, not_established, no_frag
```

The determination of *established* depends on the protocol:

- For TCP a connection will be established after a three way handshake.



- For other protocols (for example UDP), the connection will be considered established after seeing traffic from both sides of the connection.



8.10.3 flowint

Flowint allows storage and mathematical operations using variables. It operates much like flowbits but with the addition of mathematical capabilities and the fact that an integer can be stored and manipulated, not just a flag set. We can use this for a number of very useful things, such as counting occurrences, adding or subtracting occurrences, or doing thresholding within a stream in relation to multiple factors. This will be expanded to a global context very soon, so users can perform these operations between streams.

The syntax is as follows:

```
flowint: name, modifier[, value];
```

Define a var (not required), or check that one is set or not set.

```
flowint: name, < +,-,=,>,<,>=,<=,==, != >, value;
flowint: name, (isset|notset|isnotset);
```

Compare or alter a var. Add, subtract, compare greater than or less than, greater than or equal to, and less than or equal to are available. The item to compare with can be an integer or another variable.

For example, if you want to count how many times a username is seen in a particular stream and alert if it is over 5.

```
alert tcp any any -> any any (msg:"Counting Usernames"; content:"jonkman"; \
      flowint: usernamecount, +, 1; noalert;)
```

This will count each occurrence and increment the var usernamecount and not generate an alert for each.

Now say we want to generate an alert if there are more than five hits in the stream.

```
alert tcp any any -> any any (msg:"More than Five Usernames!"; content:"jonkman"; \
      flowint: usernamecount, +, 1; flowint:usernamecount, >, 5;)
```

So we'll get an alert ONLY if usernamecount is over five.

So now let's say we want to get an alert as above but NOT if there have been more occurrences of that username logging out. Assuming this particular protocol indicates a log out with "jonkman logout", let's try:

```
alert tcp any any -> any any (msg:"Username Logged out"; content:"logout jonkman"; \
      flowint: usernamecount, -, 1; flowint:usernamecount, >, 5;)
```

So now we'll get an alert ONLY if there are more than five active logins for this particular username.

This is a rather simplistic example, but I believe it shows the power of what such a simple function can do for rule writing. I see a lot of applications in things like login tracking, IRC state machines, malware tracking, and brute force login detection.

Let's say we're tracking a protocol that normally allows five login fails per connection, but we have vulnerability where an attacker can continue to login after that five attempts and we need to know about it.

```
alert tcp any any -> any any (msg:"Start a login count"; content:"login failed"; \
      flowint:loginfail, notset; flowint:loginfail, =, 1; noalert;)
```

So we detect the initial fail if the variable is not yet set and set it to 1 if so. Our first hit.

```
alert tcp any any -> any any (msg:"Counting Logins"; content:"login failed"; \
      flowint:loginfail, isset; flowint:loginfail, +, 1; noalert;)
```

We are now incrementing the counter if it's set.

```
alert tcp any any -> any any (msg:"More than Five login fails in a Stream"; \
      content:"login failed"; flowint:loginfail, isset; flowint:loginfail, >, 5;)
```

Now we'll generate an alert if we cross five login fails in the same stream.

But let's also say we also need alert if there are two successful logins and a failed login after that.

```
alert tcp any any -> any any (msg:"Counting Good Logins";             \
      content:"login successful"; flowint:loginsuccess, +, 1; noalert;)
```

Here we're counting good logins, so now we'll count good logins relevant to fails:

```
alert tcp any any -> any any (msg:"Login fail after two successes";   \
      content:"login failed"; flowint:loginsuccess, isset;            \
      flowint:loginsuccess, =, 2;)
```

Here are some other general examples:

```
alert tcp any any -> any any (msg:"Setting a flowint counter"; content:"GET"; \
      flowint:myvar, notset; flowint:maxvar,notset;                           \
      flowint:myvar,=,1; flowint: maxvar,=,6;)
```

```
alert tcp any any -> any any (msg:"Adding to flowint counter";                \
      content:"Unauthorized"; flowint:myvar,isset; flowint: myvar,+,2;)
```

```
alert tcp any any -> any any (msg:"when flowint counter is 3 create new counter"; \
      content:"Unauthorized"; flowint:myvar, isset; flowint:myvar,==,3; \
      flowint:cntpackets,notset; flowint:cntpackets, =, 0;)
```

```
alert tcp any any -> any any (msg:"count the rest without generating alerts"; \
      flowint:cntpackets,isset; flowint:cntpackets, +, 1; noalert;)
```

```
alert tcp any any -> any any (msg:"fire this when it reach 6";                \
      flowint: cntpackets, isset;                                             \
      flowint: maxvar,isset; flowint: cntpackets, ==, maxvar;)
```

8.10.4 stream_size

The stream size option matches on traffic according to the registered amount of bytes by the sequence numbers. There are several modifiers to this keyword:

```
>      greater than
<      less than
=      equal
!=     not equal
>=    greater than or equal
<=    less than or equal
```

Format

```
stream_size:<server|client|both|either>, <modifier>, <number>;
```

Example of the stream-size keyword in a rule:

```
alert tcp any any -> any any (stream_size:both, >, 5000; sid:1;)
```

8.10.5 flow.age

Flow age in seconds (integer)

Syntax:

```
flow.age: [op]<number>
```

The time can be matched exactly, or compared using the _op_ setting:

```
flow.age:3    # exactly 3
flow.age:<3   # smaller than 3 seconds
flow.age:>=2  # greater or equal than 2 seconds
```

Signature example:

```
alert tcp any any -> any any (msg:"Flow longer than one hour"; flow.age:>3600; flowbits:␣
↪isnotset, onehourflow; flowbits: onehourflow, name; sid:1; rev:1;)
```

In this example, we combine *flow.age* and *flowbits* to get an alert on the first packet after the flow's age is older than one hour.

8.11 Bypass Keyword

Suricata has a `bypass` keyword that can be used in signatures to exclude traffic from further evaluation.

The `bypass` keyword is useful in cases where there is a large flow expected (e.g. Netflix, Spotify, YouTube).

The `bypass` keyword is considered a post-match keyword.

8.11.1 bypass

Bypass a flow on matching http traffic.

Example:

```
alert http any any -> any any (content:"suricata.io"; \
    http_host; bypass; sid:10001; rev:1;)
```

8.12 HTTP Keywords

Using the HTTP specific sticky buffers provides a way to efficiently inspect specific fields of the HTTP protocol. After specifying a sticky buffer in a rule it should be followed by one or more *Payload Keywords*.

Many of the sticky buffers have legacy variants in the older "content modifier" notation. See *Modifier Keywords* for more information. As a refresher:

- **'sticky buffers'** are placed first and all keywords following it apply to that buffer, for instance:

```
alert http any any -> any any (http.response_line; content:"403 Forbidden"; sid:1;)
```

  Sticky buffers apply to all "payload" keywords following it. E.g. *content*, *isdataat*, *byte_test*, *pcre*.

- **'content modifiers'** look back in the rule, e.g.:

```
alert http any any -> any any (content:"index.php"; http_uri; sid:1;)
```

  Content modifiers only apply to the preceding *content* keyword.

The following **request** keywords are available:

Keyword	Legacy Content Modifier	Direction
http.uri	http_uri	Request
http.uri.raw	http_raw_uri	Request
http.method	http_method	Request
http.request_line	http_request_line (*)	Request
http.request_body	http_client_body	Request
http.header	http_header	Both
http.header.raw	http_raw_header	Both
http.cookie	http_cookie	Both
http.user_agent	http_user_agent	Request
http.host	http_host	Request
http.host.raw	http_raw_host	Request
http.accept	http_accept (*)	Request
http.accept_lang	http_accept_lang (*)	Request
http.accept_enc	http_accept_enc (*)	Request
http.referer	http_referer (*)	Request
http.connection	http_connection (*)	Both
file.data	file_data (*)	Both
http.content_type	http_content_type (*)	Both
http.content_len	http_content_len (*)	Both
http.start	http_start (*)	Both
http.protocol	http_protocol (*)	Both
http.header_names	http_header_names (*)	Both

*) sticky buffer

The following **response** keywords are available:

Keyword	Legacy Content Modifier	Direction
http.stat_msg	http_stat_msg	Response
http.stat_code	http_stat_code	Response
http.response_line	http_response_line (*)	Response
http.header	http_header	Both
http.header.raw	http_raw_header	Both
http.cookie	http_cookie	Both
http.response_body	http_server_body	Response
http.server	N/A	Response
http.location	N/A	Response
file.data	file_data (*)	Both
http.content_type	http_content_type (*)	Both
http.content_len	http_content_len (*)	Both
http.start	http_start (*)	Both
http.protocol	http_protocol (*)	Both
http.header_names	http_header_names (*)	Both

*) sticky buffer

8.12.1 HTTP Primer

It is important to understand the structure of HTTP requests and responses. A simple example of a HTTP request and response follows:

HTTP request

```
GET /index.html HTTP/1.0\r\n
```

GET is the request **method**. Examples of methods are: GET, POST, PUT, HEAD, etc. The URI path is `/index.html` and the HTTP version is `HTTP/1.0`. Several HTTP versions have been used over the years; of the versions 0.9, 1.0 and 1.1, 1.0 and 1.1 are the most commonly used today.

Example request with keywords:

HTTP	Keyword
GET /index.html HTTP/1.1\r\n	http.request_line
Host: www.oisf.net\r\n	http.header
Cookie: **<cookie data>**	http.cookie

Example request with finer grained keywords:

HTTP	Keyword
GET */index.html* **HTTP/1.1**\r\n	**http.method** *http.uri* **http.protocol**
Host: **www.oisf.net**\r\n	**http.host**
User-Agent: **Mozilla/5.0**\r\n	**http.user_agent**
Cookie: **<cookie data>**	**http.cookie**

HTTP response

```
HTTP/1.0 200 OK\r\n
<html>
```

(continues on next page)

(continued from previous page)

```
<title> some page </title>
</HTML>
```

In this example, HTTP/1.0 is the HTTP version, 200 the response status code and OK the response status message.

Although cookies are sent in an HTTP header, you can not match on them with the `http.header` keyword. Cookies are matched with their own keyword, namely `http.cookie`.

Each part of the table belongs to a so-called *buffer*. The HTTP method belongs to the method buffer, HTTP headers to the header buffer etc. A buffer is a specific portion of the request or response that Suricata extracts in memory for inspection.

All previous described keywords can be used in combination with a buffer in a signature. The keywords `distance` and `within` are relative modifiers, so they may only be used within the same buffer. You can not relate content matches against different buffers with relative modifiers.

8.12.2 http.method

With the `http.method` sticky buffer, it is possible to match specifically and only on the HTTP method buffer. The keyword can be used in combination with all previously mentioned content modifiers such as: `depth`, `distance`, `offset`, `nocase` and `within`.

Examples of methods are: **GET**, **POST**, **PUT**, **HEAD**, **DELETE**, **TRACE**, **OPTIONS**, **CONNECT** and **PATCH**.

Example of a method in a HTTP request:

```
GET / HTTP/1.1
Host: www.google.com
Connection: keep-alive
Accept:
application/xml,application/xhtml+xml,text/html;q=0.9,text/
plain;q=0.8,image/png,*/*;q=0.5
```

Example of the purpose of method:

PAYLOAD
GET /index.html HTTP/1.0\r\n
content:"GET";
content:"GET"; http_method
match
no match
match in the payload
no match in the payload

8.12.3 http.uri and http.uri.raw

With the `http.uri` and the `http.uri.raw` sticky buffers, it is possible to match specifically and only on the request URI buffer. The keyword can be used in combination with all previously mentioned content modifiers like `depth`, `distance`, `offset`, `nocase` and `within`.

The uri has two appearances in Suricata: the uri.raw and the normalized uri. The space for example can be indicated with the heximal notation %20. To convert this notation in a space, means normalizing it. It is possible though to match specific on the characters %20 in a uri. This means matching on the uri.raw. The uri.raw and the normalized uri are separate buffers. So, the uri.raw inspects the uri.raw buffer and can not inspect the normalized buffer.

Note: uri.raw never has any spaces in it. With this request line `GET /uid=0(root) gid=0(root) HTTP/1.1`, the `http.uri.raw` will match `/uid=0(root)` and `http.protocol` will match `gid=0(root) HTTP/1.1` Reference: https://redmine.openinfosecfoundation.org/issues/2881

Example of the URI in a HTTP request:

```
GET /index.html HTTP/1.0\r\n
```

Example of the purpose of `http.uri`:

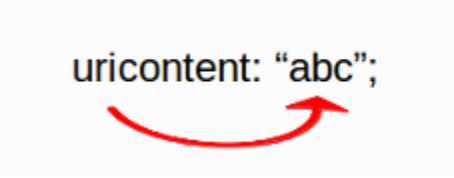
8.12.4 uricontent

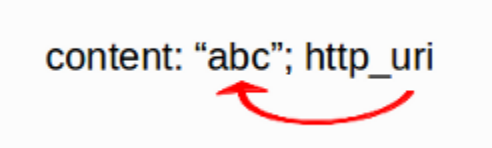
The `uricontent` keyword has the exact same effect as the `http.uri` sticky buffer. `uricontent` is a deprecated (although still supported) way to match specifically and only on the request URI buffer.

Example of `uricontent`:

alert tcp $HOME_NET any -> $EXTERNAL_NET $HTTP_PORTS (msg:"ET TROJAN Possible Vundo Trojan Variant reporting to Controller"; flow:established,to_server; content:"POST "; depth:5; uricontent:"/frame.html?"; urilen: > 80; classtype:trojan-activity; reference:url,doc.emergingthreats.net/2009173; reference:url,www.emergingthreats.net/cgi-bin/cvsweb.cgi/sigs/VIRUS/TROJAN_Vundo; sid:2009173; rev:2;)

The difference between `http.uri` and `uricontent` is the syntax:





When authoring new rules, it is recommended that the `http.uri` content sticky buffer be used rather than the deprecated `uricontent` keyword.

8.12.5 urilen

The `urilen` keyword is used to match on the length of the request URI. It is possible to use the < and > operators, which indicate respectively *smaller than* and *larger than*.

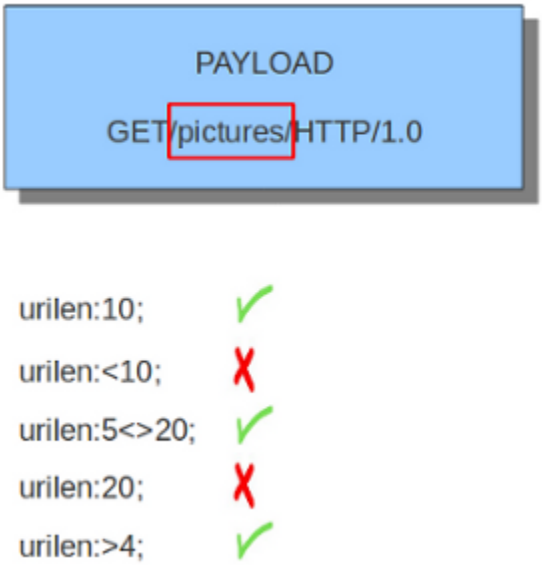
The format of `urilen` is:

```
urilen:3;
```

Other possibilities are:

```
urilen:1;
urilen:>1;
urilen:<10;
urilen:10<>20;        (bigger than 10, smaller than 20)
```

Example:



Example of `urilen` in a signature:

alert tcp $HOME_NET any -> $EXTERNAL_NET $HTTP_PORTS (msg:"ET TROJAN Possible Vundo Trojan Variant reporting to Controller"; flow:established,to_server; content:"POST "; depth:5; uricontent:"/frame.html?"; urilen: > 80; classtype:trojan-activity; reference:url,doc.emergingthreats.net/2009173; reference:url,www.emergingthreats.net/cgi-bin/cvsweb.cgi/sigs/VIRUS/TROJAN_Vundo; sid:2009173; rev:2;)

You can also append `norm` or `raw` to define what sort of buffer you want to use (normalized or raw buffer).

8.12.6 http.protocol

The `http.protocol` inspects the protocol field from the HTTP request or response line. If the request line is 'GET / HTTP/1.0rn', then this buffer will contain 'HTTP/1.0'.

Example:

```
alert http any any -> any any (flow:to_server; http.protocol; content:"HTTP/1.0"; sid:1;)
```

`http.protocol` replaces the previous keyword name: `http_protocol`. You may continue to use the previous name, but it's recommended that rules be converted to use the new name.

Example:

```
alert http any any -> any any (flow:to_server; http.protocol; content:"HTTP/1.0"; sid:1;)
```

8.12.7 http.request_line

The `http.request_line` forces the whole HTTP request line to be inspected.

Example:

```
alert http any any -> any any (http.request_line; content:"GET / HTTP/1.0"; sid:1;)
```

8.12.8 http.header and http.header.raw

With the `http.header` sticky buffer, it is possible to match specifically and only on the HTTP header buffer. This contains all of the extracted headers in a single buffer, except for those indicated in the documentation that are not able to match by this buffer and have their own sticky buffer (e.g. `http.cookie`). The sticky buffer can be used in combination with all previously mentioned content modifiers, like `depth`, `distance`, `offset`, `nocase` and `within`.

> **Note**: the header buffer is *normalized*. Any trailing whitespace and tab characters are removed. See: https://lists.openinfosecfoundation.org/pipermail/oisf-users/2011-October/000935.html. If there are multiple values for the same header name, they are concatenated with a comma and space (", ") between each of them. See RFC 2616 4.2 Message Headers. To avoid that, use the `http.header.raw` keyword.

Example of a header in a HTTP request:

```
GET / HTTP/1.1
Host: www.google.com
Connection: keep-alive
Accept:
application/xml,application/xhtml+xml,text/html;q=0.9,
text/plain;q=0.8,image/png,*/*;q=0.5
```

Example of the purpose of `http.header`:

8.12.9 http.cookie

With the `http.cookie` sticky buffer it is possible to match specifically on the HTTP cookie contents. Keywords like `depth`, `distance`, `offset`, `nocase` and `within` can be used with `http.cookie`.

Note that cookies are passed in HTTP headers but Suricata extracts the cookie data to `http.cookie` and will not match cookie content put in the `http.header` sticky buffer.

Example of a cookie in a HTTP request:

Examples:

```
GET / HTTP/1.1
User-Agent: Mozilla/5.0
Host: www.example.com
Cookie: PHPSESSIONID=1234
Connection: close
```

Example `http.cookie` keyword in a signature:

alert http $HOME_NET any -> $EXTERNAL_NET any (msg:"HTTP Request with Cookie"; flow:established,to_server; http.method; content:"GET"; http.uri; content:"/"; fast_pattern; http.cookie; content:"PHPSESSIONID="; startswith; classtype:bad-unknown; sid:123; rev:1;)

8.12.10 http.user_agent

The `http.user_agent` sticky buffer is part of the HTTP request header. It makes it possible to match specifically on the value of the User-Agent header. It is normalized in the sense that it does not include the _"User-Agent: "_ header name and separator, nor does it contain the trailing carriage return and line feed (CRLF). The keyword can be used in combination with all previously mentioned content modifiers like `depth`, `distance`, `offset`, `nocase` and `within`. Note that the `pcre` keyword can also inspect this buffer when using the `/V` modifier.

Normalization: leading spaces **are not** part of this buffer. So "User-Agent: rn" will result in an empty `http.user_agent` buffer.

Example of the User-Agent header in a HTTP request:

```
GET / HTTP/1.1
Host: www.google.com
Connection: keep-alive
User-Agent: Mozilla/5.0 (X11; U; Linux i686; en-US)
AppleWebKit/534.16
(KHTML, like Gecko) Ubuntu/10.10
Chromium/10.0.618.0 Chrome/10.0.618.0
Safari/534.16
```

Example of the purpose of `http.user_agent`:

Notes

- The `http.user_agent` buffer will NOT include the header name, colon, or leading whitespace. i.e. it will not include "User-Agent: ".
- The `http.user_agent` buffer does not include a CRLF (0x0D 0x0A) at the end. If you want to match the end of the buffer, use a relative `isdataat` or a PCRE (although PCRE will be worse on performance).
- If a request contains multiple "User-Agent" headers, the values will be concatenated in the `http.user_agent` buffer, in the order seen from top to bottom, with a comma and space (", ") between each of them.

  Example request:

  ```
  GET /test.html HTTP/1.1
  User-Agent: SuriTester/0.8
  User-Agent: GGGG
  ```

`http.user_agent` buffer contents:

```
SuriTester/0.8, GGGG
```

- Corresponding PCRE modifier: `V`
- Using the `http.user_agent` buffer is more efficient when it comes to performance than using the `http.header` buffer (~10% better).
- https://blog.inliniac.net/2012/07/09/suricata-http_user_agent-vs-http_header/

8.12.11 http.accept

Sticky buffer to match on the HTTP Accept header. Only contains the header value. The \r\n after the header are not part of the buffer.

Example:

```
alert http any any -> any any (http.accept; content:"image/gif"; sid:1;)
```

8.12.12 http.accept_enc

Sticky buffer to match on the HTTP Accept-Encoding header. Only contains the header value. The \r\n after the header are not part of the buffer.

Example:

```
alert http any any -> any any (http.accept_enc; content:"gzip"; sid:1;)
```

8.12.13 http.accept_lang

Sticky buffer to match on the HTTP Accept-Language header. Only contains the header value. The \r\n after the header are not part of the buffer.

Example:

```
alert http any any -> any any (http.accept_lang; content:"en-us"; sid:1;)
```

8.12.14 http.connection

Sticky buffer to match on the HTTP Connection header. Only contains the header value. The \r\n after the header are not part of the buffer.

Example:

```
alert http any any -> any any (http.connection; content:"keep-alive"; sid:1;)
```

8.12.15 http.content_type

Sticky buffer to match on the HTTP Content-Type headers. Only contains the header value. The \r\n after the header are not part of the buffer.

Use flow:to_server or flow:to_client to force inspection of request or response.

Examples:

```
alert http any any -> any any (flow:to_server; \
        http.content_type; content:"x-www-form-urlencoded"; sid:1;)

alert http any any -> any any (flow:to_client; \
        http.content_type; content:"text/javascript"; sid:2;)
```

8.12.16 http.content_len

Sticky buffer to match on the HTTP Content-Length headers. Only contains the header value. The \r\n after the header are not part of the buffer.

Use flow:to_server or flow:to_client to force inspection of request or response.

Examples:

```
alert http any any -> any any (flow:to_server; \
        http.content_len; content:"666"; sid:1;)

alert http any any -> any any (flow:to_client; \
        http.content_len; content:"555"; sid:2;)
```

To do a numeric inspection of the content length, `byte_test` can be used.

Example, match if C-L is equal to or bigger than 8079:

```
alert http any any -> any any (flow:to_client; \
        http.content_len; byte_test:0,>=,8079,0,string,dec; sid:3;)
```

8.12.17 http.referer

Sticky buffer to match on the HTTP Referer header. Only contains the header value. The \r\n after the header are not part of the buffer.

Example:

```
alert http any any -> any any (http.referer; content:".php"; sid:1;)
```

8.12.18 http.start

Inspect the start of a HTTP request or response. This will contain the request/response line plus the request/response headers. Use flow:to_server or flow:to_client to force inspection of request or response.

Example:

```
alert http any any -> any any (http.start; content:"HTTP/1.1|0d 0a|User-Agent"; sid:1;)
```

The buffer contains the normalized headers and is terminated by an extra \r\n to indicate the end of the headers.

8.12.19 http.header_names

Inspect a buffer only containing the names of the HTTP headers. Useful for making sure a header is not present or testing for a certain order of headers.

Buffer starts with a \r\n and ends with an extra \r\n.

Example buffer:

```
\\r\\nHost\\r\\n\\r\\n
```

Example rule:

```
alert http any any -> any any (http.header_names; content:"|0d 0a|Host|0d 0a|"; sid:1;)
```

Example to make sure *only* Host is present:

```
alert http any any -> any any (http.header_names; \
        content:"|0d 0a|Host|0d 0a 0d 0a|"; sid:1;)
```

Example to make sure *User-Agent* is directly after *Host*:

```
alert http any any -> any any (http.header_names; \
        content:"|0d 0a|Host|0d 0a|User-Agent|0d 0a|"; sid:1;)
```

Example to make sure *User-Agent* is after *Host*, but not necessarily directly after:

```
alert http any any -> any any (http.header_names; \
        content:"|0d 0a|Host|0d 0a|"; content:"|0a 0d|User-Agent|0d 0a|"; \
        distance:-2; sid:1;)
```

8.12.20 http.request_body

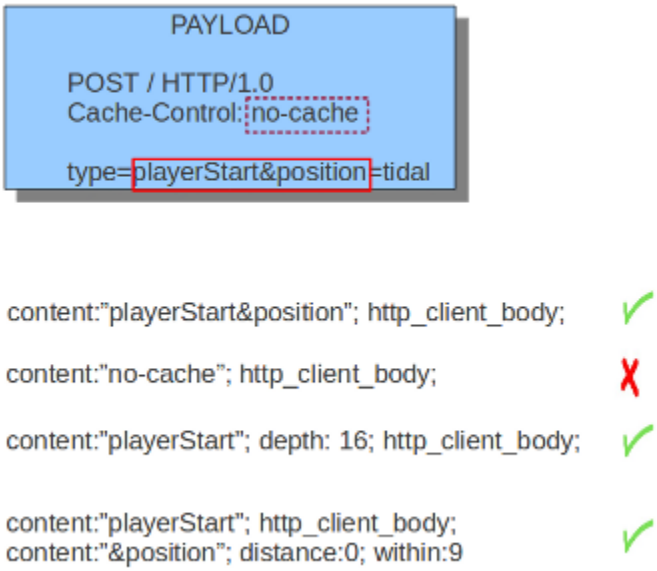
With the `http.request_body` sticky buffer, it is possible to match specifically and only on the HTTP request body. The keyword can be used in combination with all previously mentioned content modifiers like `distance`, `offset`, `nocase`, `within`, etc.

Example of `http.request_body` in a HTTP request:

```
Host: nowhereasdfasdf.com
Connection: Keep-Alive
Cache-Control: no-cache

type=playerStart&position=tidal
```

Example of the purpose of `http.client_body`:



Note: how much of the request/client body is inspected is controlled in the *libhtp configuration section* via the `request-body-limit` setting.

`http.request_body` replaces the previous keyword name: `` `http_client_body ``. You may continue +to use the previous name, but it's recommended that rules be converted to use +the new name.

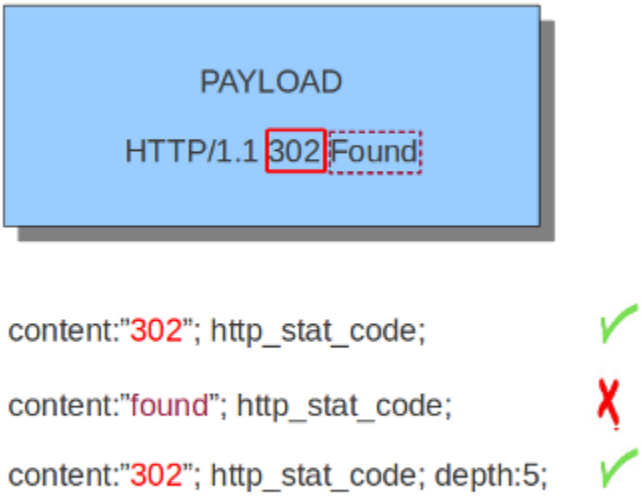
8.12.21 http.stat_code

With the `http.stat_code` sticky buffer, it is possible to match specifically and only on the HTTP status code buffer. The keyword can be used in combination with all previously mentioned content modifiers like `distance`, `offset`, `nocase`, `within`, etc.

Example of `http.stat_code` in a HTTP response:

```
HTTP/1.1 302 Found
```

Example of the purpose of `http.stat_code`:



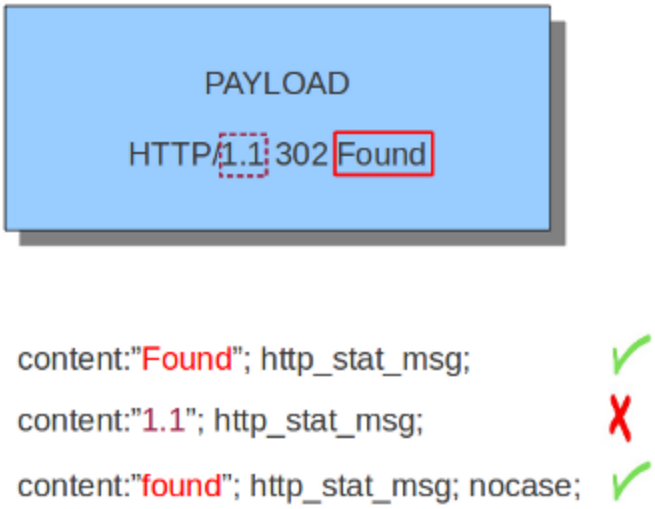
8.12.22 http.stat_msg

With the `http.stat_msg` sticky buffer, it is possible to match specifically and only on the HTTP status message buffer. The keyword can be used in combination with all previously mentioned content modifiers like `depth`, `distance`, `offset`, `nocase` and `within`.

Example of `http.stat_msg` in a HTTP response:

```
HTTP/1.1 302 Found
```

Example of the purpose of `http.stat_msg`:



8.12.23 http.response_line

The `http.response_line` forces the whole HTTP response line to be inspected.

Example:

```
alert http any any -> any any (http.response_line; content:"HTTP/1.0 200 OK"; sid:1;)
```

8.12.24 http.response_body

With the `http.response_body` sticky buffer, it is possible to match specifically and only on the HTTP response body. The keyword can be used in combination with all previously mentioned content modifiers like `distance`, `offset`, `nocase`, `within`, etc.

Note: how much of the response/server body is inspected is controlled in your *libhtp configuration section* via the `response-body-limit` setting.

Notes

- Using `http.response_body` is similar to having content matches that come after `file.data` except that it doesn't permanently (unless reset) set the detection pointer to the beginning of the server response body. i.e. it is not a sticky buffer.
- `http.response_body` will match on gzip decoded data just like `file.data` does.
- Since `http.response_body` matches on a server response, it can't be used with the `to_server` or `from_client` flow directives.
- Corresponding PCRE modifier: `Q`
- further notes at the `file.data` section below.

`http.response_body` replaces the previous keyword name: `` `http_server_body`. You may continue +to use the previous name, but it's recommended that rules be converted to use +the new name.

8.12.25 http.server

Sticky buffer to match on the HTTP Server headers. Only contains the header value. The \r\n after the header are not part of the buffer.

Example:

```
alert http any any -> any any (flow:to_client; \
        http.server; content:"Microsoft-IIS/6.0"; sid:1;)
```

8.12.26 http.location

Sticky buffer to match on the HTTP Location headers. Only contains the header value. The \r\n after the header are not part of the buffer.

Example:

```
alert http any any -> any any (flow:to_client; \
        http.location; content:"http://www.google.com"; sid:1;)
```

8.12.27 http.host and http.host.raw

With the `http.host` sticky buffer, it is possible to match specifically and only the normalized hostname. The `http.host.raw` inspects the raw hostname.

The keyword can be used in combination with most of the content modifiers like `distance`, `offset`, `within`, etc.

The `nocase` keyword is not allowed anymore. Keep in mind that you need to specify a lowercase pattern.

8.12.28 http.request_header

Match on the name and value of a HTTP request header (HTTP1 or HTTP2).

For HTTP2, name and value get concatenated by ": ", colon and space. To detect if a http2 header name contains ':', the keyword `http2.header_name` can be used.

Examples:

```
http.request_header; content:"agent: nghttp2";
http.request_header; content:"custom-header: I love::colons";
```

`http.request_header` is a 'sticky buffer'.

`http.request_header` can be used as `fast_pattern`.

8.12.29 http.response_header

Match on the name and value of a HTTP response header (HTTP1 or HTTP2).

For HTTP2, name and value get concatenated by ": ", colon and space. To detect if a http2 header name contains ':', the keyword `http2.header_name` can be used.

Examples:

```
http.response_header; content:"server: nghttp2";
http.response_header; content:"custom-header: I love::colons";
```

`http.response_header` is a 'sticky buffer'.

`http.response_header` can be used as `fast_pattern`.

Notes

- `http.host` does not contain the port associated with the host (i.e. abc.com:1234). To match on the host and port or negate a host and port use `http.host.raw`.
- The `http.host` and `http.host.raw` buffers are populated from either the URI (if the full URI is present in the request like in a proxy request) or the HTTP Host header. If both are present, the URI is used.
- The `http.host` and `http.host.raw` buffers will NOT include the header name, colon, or leading whitespace if populated from the Host header. i.e. they will not include "Host: ".
- The `http.host` and `http.host.raw` buffers do not include a CRLF (0x0D 0x0A) at the end. If you want to match the end of the buffer, use a relative 'isdataat' or a PCRE (although PCRE will be worse on performance).
- The `http.host` buffer is normalized to be all lower case.
- The content match that `http.host` applies to must be all lower case or have the `nocase` flag set.
- `http.host.raw` matches the unnormalized buffer so matching will be case-sensitive (unless `nocase` is set).
- If a request contains multiple "Host" headers, the values will be concatenated in the `http.host` and `http.host.raw` buffers, in the order seen from top to bottom, with a comma and space (", ") between each of them.

  Example request:

  ```
  GET /test.html HTTP/1.1
  Host: ABC.com
  Accept: */*
  Host: efg.net
  ```

  `http.host` buffer contents:

  ```
  abc.com, efg.net
  ```

  `http.host.raw` buffer contents:

  ```
  ABC.com, efg.net
  ```

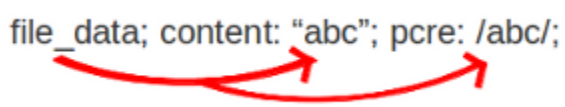
- Corresponding PCRE modifier (`http_host`): `W`
- Corresponding PCRE modifier (`http_raw_host`): `Z`

8.12.30 file.data

With `file.data`, the HTTP response body is inspected, just like with `http.response_body`. The `file.data` keyword is a sticky buffer. `file.data` also works for HTTP request body and can be used in other protocols than HTTP1.

Example:

```
alert http any any -> any any (file.data; content:"abc"; content:"xyz";)
```



The `file.data` keyword affects all following content matches, until the `pkt_data` keyword is encountered or it reaches the end of the rule. This makes it a useful shortcut for applying many content matches to the HTTP response body, eliminating the need to modify each content match individually.

As the body of a HTTP response can be very large, it is inspected in smaller chunks.

How much of the response/server body is inspected is controlled in your *libhtp configuration section* via the `response-body-limit` setting.

If the HTTP body is a flash file compressed with 'deflate' or 'lzma', it can be decompressed and `file.data` can match on the decompress data. Flash decompression must be enabled under `libhtp` configuration:

```
# Decompress SWF files.
# 2 types: 'deflate', 'lzma', 'both' will decompress deflate and lzma
# compress-depth:
# Specifies the maximum amount of data to decompress,
# set 0 for unlimited.
# decompress-depth:
# Specifies the maximum amount of decompressed data to obtain,
# set 0 for unlimited.
swf-decompression:
  enabled: yes
  type: both
  compress-depth: 0
  decompress-depth: 0
```

Notes

- file.data is the preferred notation, however, file_data is still recognized by the engine and works as well.
- If a HTTP body is using gzip or deflate, `file.data` will match on the decompressed data.
- Negated matching is affected by the chunked inspection. E.g. 'content:!"<html";' could not match on the first chunk, but would then possibly match on the 2nd. To avoid this, use a depth setting. The depth setting takes the body size into account. Assuming that the `response-body-minimal-inspect-size` is bigger than 1k, 'content:!"<html"; depth:1024;' can only match if the pattern '<html' is absent from the first inspected chunk.
- Refer to *File Keywords* for additional information.

Multiple Buffer Matching

`file.data` supports multiple buffer matching, see *Multiple Buffer Matching*.

8.13 File Keywords

Suricata comes with several rule keywords to match on various file properties. They depend on properly configured *File Extraction*.

8.13.1 file.data

The `file.data` sticky buffer matches on contents of files that are seen in flows that Suricata evaluates. The various payload keywords can be used (e.g. `startswith`, `nocase` and `bsize`) with `file.data`.

Example:

```
 alert smtp any any -> any any (msg:"smtp app layer file.data example"; \
file.data; content:"example file content"; sid:1; rev:1)

 alert http any any -> any any (msg:"http app layer file.data example"; \
file.data; content:"example file content"; sid:2; rev:1)

 alert http2 any any -> any any (msg:"http2 app layer file.data example"; \
file.data; content:"example file content"; sid:3; rev:1;)

 alert nfs any any -> any any (msg:"nfs app layer file.data example"; \
file.data; content:" "; sid:5; rev:1)

 alert ftp-data any any -> any any (msg:"ftp app layer file.data example"; \
file.data; content:"example file content"; sid:6; rev:1;)

 alert tcp any any -> any any (msg:"tcp file.data example"; \
file.data; content:"example file content"; sid:4; rev:1)
```

Note file_data is the legacy notation but can still be used.

8.13.2 file.name

`file.name` is a sticky buffer that is used to look at filenames that are seen in flows that Suricata evaluates. The various payload keywords can be used (e.g. `startswith`, `nocase` and `bsize`) with `file.name`.

Example:

```
file.name; content:"examplefilename";
```

`file.name` supports multiple buffer matching, see *Multiple Buffer Matching*.

Note `filename` can still be used. A notable difference between `file.name` and `filename` is that `filename` assumes `nocase` by default. In the example below the two signatures are considered the same.

Example:

```
filename:"examplefilename";

file.name; content:"examplefilename"; nocase;
```

8.13.3 fileext

`fileext` is used to look at individual file extensions that are seen in flows that Suricata evaluates.

Example:

```
fileext:"pdf";
```

Note: `fileext` does not allow partial matches. For example, if a PDF file (.pdf) is seen by a Suricata signature with fileext:"pd"; the signature will not produce an alert.

Note: `fileext` assumes `nocase` by default. This means that a file with the extension .PDF will be seen the same as if the file had an extension of .pdf.

Note: `fileext` and `file.name` can both be used to match on file extensions. In the example below the two signatures are considered the same.

Example:

```
fileext:"pdf";

file.name; content:".pdf"; nocase; endswith;
```

Note: While``fileeext`` and `file.name` can both be used to match on file extensions, `file.name` allows for partial matching on file extensions. The following would match on a file with the extension of .pd as well as .pdf.

Example:

```
file.name; content:".pd";
```

8.13.4 file.magic

Matches on the information libmagic returns about a file.

Example:

```
file.magic; content:"executable for MS Windows";
```

Note `filemagic` can still be used. The only difference between `file.magic` and `file.magic` is that `filemagic` assumes `nocase` by default. In the example below the two signatures are considered the same.

Example:

```
filemagic:"executable for MS Windows";

file.magic; content:"executable for MS Windows"; nocase;
```

Note: Suricata currently uses its underlying operating systems version/implementation of libmagic. Different versions and implementations of libmagic do not return the same information. Additionally there are varying Suricata performance impacts based on the version and implementation of libmagic. Additional information about Suricata and libmagic can be found here: https://redmine.openinfosecfoundation.org/issues/437

`file.magic` supports multiple buffer matching, see *Multiple Buffer Matching*.

8.13.5 filestore

Stores files to disk if the signature matched.

Syntax:

```
filestore:<direction>,<scope>;
```

direction can be:

- request/to_server: store a file in the request / to_server direction
- response/to_client: store a file in the response / to_client direction
- both: store both directions

scope can be:

- file: only store the matching file (for filename,fileext,filemagic matches)
- tx: store all files from the matching HTTP transaction
- ssn/flow: store all files from the TCP session/flow.

If direction and scope are omitted, the direction will be the same as the rule and the scope will be per file.

8.13.6 filemd5

Match file *MD5* against list of MD5 checksums.

Syntax:

```
filemd5:[!]filename;
```

The filename is expanded to include the rule dir. In the default case it will become /etc/suricata/rules/filename. Use the exclamation mark to get a negated match. This allows for white listing.

Examples:

```
filemd5:md5-blacklist;
filemd5:!md5-whitelist;
```

File format

The file format is simple. It's a text file with a single md5 per line, at the start of the line, in hex notation. If there is extra info on the line it is ignored.

Output from md5sum is fine:

```
2f8d0355f0032c3e6311c6408d7c2dc2  util-path.c
b9cf5cf347a70e02fde975fc4e117760  util-pidfile.c
02aaa6c3f4dbae65f5889eeb8f2bbb8d  util-pool.c
dd5fc1ee7f2f96b5f12d1a854007a818  util-print.c
```

Just MD5's are good as well:

```
2f8d0355f0032c3e6311c6408d7c2dc2
b9cf5cf347a70e02fde975fc4e117760
02aaa6c3f4dbae65f5889eeb8f2bbb8d
dd5fc1ee7f2f96b5f12d1a854007a818
```

Memory requirements

Each MD5 uses 16 bytes of memory. 20 Million MD5's use about 310 MiB of memory.

See also: https://blog.inliniac.net/2012/06/09/suricata-md5-blacklisting/

8.13.7 filesha1

Match file SHA1 against list of SHA1 checksums.

Syntax:

```
filesha1:[!]filename;
```

The filename is expanded to include the rule dir. In the default case it will become /etc/suricata/rules/filename. Use the exclamation mark to get a negated match. This allows for white listing.

Examples:

```
filesha1:sha1-blacklist;
filesha1:!sha1-whitelist;
```

File format

Same as md5 file format.

8.13.8 filesha256

Match file SHA256 against list of SHA256 checksums.

Syntax:

```
filesha256:[!]filename;
```

The filename is expanded to include the rule dir. In the default case it will become /etc/suricata/rules/filename. Use the exclamation mark to get a negated match. This allows for white listing.

Examples:

```
filesha256:sha256-blacklist;
filesha256:!sha256-whitelist;
```

File format

Same as md5 file format.

8.13.9 filesize

Match on the size of the file as it is being transferred.

Syntax:

```
filesize:<value>;
```

Possible units are KB, MB and GB, without any unit the default is bytes.

Examples:

```
filesize:100; # exactly 100 bytes
filesize:100<>200; # greater than 100 and smaller than 200
filesize:>100MB; # greater than 100 megabytes
filesize:<100MB; # smaller than 100 megabytes
```

Note: For files that are not completely tracked because of packet loss or stream.reassembly.depth being reached on the "greater than" is checked. This is because Suricata can know a file is bigger than a value (it has seen some of it already), but it can't know if the final size would have been within a range, an exact value or smaller than a value.

8.14 DNS Keywords

There are some more content modifiers (If you are unfamiliar with content modifiers, please visit the page *Payload Keywords* These ones make sure the signature checks a specific part of the network-traffic.

8.14.1 dns.opcode

This keyword matches on the **opcode** found in the DNS header flags.

Syntax

```
dns.opcode:[!]<number>
```

Examples

Match on DNS requests and responses with **opcode** 4:

```
dns.opcode:4;
```

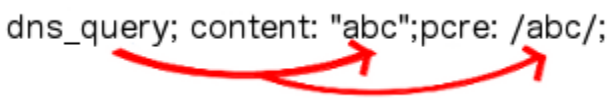
Match on DNS requests where the **opcode** is NOT 0:

```
dns.opcode:!0;
```

8.14.2 dns.query

With **dns.query** the DNS request queries are inspected. The dns.query keyword works a bit different from the normal content modifiers. When used in a rule all contents following it are affected by it. Example:

alert dns any any -> any any (msg:"Test dns.query option"; dns.query; content:"google"; nocase; sid:1;)



The **dns.query** keyword affects all following contents, until pkt_data is used or it reaches the end of the rule.

Note: **dns.query** is equivalent to the older **dns_query**.

Normalized Buffer

Buffer contains literal domain name

- <length> values (as seen in a raw DNS request) are literal '.' characters
- no leading <length> value
- No terminating NULL (0x00) byte (use a negated relative `isdataat` to match the end)

Example DNS request for "mail.google.com" (for readability, hex values are encoded between pipes):

DNS query on the wire (snippet):

```
|04|mail|06|google|03|com|00|
```

`dns.query` buffer:

```
mail.google.com
```

Multiple Buffer Matching

`dns.query` supports multiple buffer matching, see *Multiple Buffer Matching*.

8.15 SSL/TLS Keywords

Suricata comes with several rule keywords to match on various properties of TLS/SSL handshake. Matches are string inclusion matches.

8.15.1 tls.cert_subject

Match TLS/SSL certificate Subject field.

Examples:

```
tls.cert_subject; content:"CN=*.googleusercontent.com"; isdataat:!1,relative;
tls.cert_subject; content:"google.com"; nocase; pcre:"/google\.com$/";
```

`tls.cert_subject` is a 'sticky buffer'.

`tls.cert_subject` can be used as `fast_pattern`.

`tls.cert_subject` supports multiple buffer matching, see *Multiple Buffer Matching*.

tls.subject

Legacy keyword to match TLS/SSL certificate Subject field.

example:

```
tls.subject:"CN=*.googleusercontent.com"
```

Case sensitive, can't use 'nocase', or other modifiers.

Note: `tls.cert_subject` replaces the following legacy keywords: `tls_cert_subject` and `tls.subject`. It's recommended that rules be converted to use the new one.

8.15.2 tls.cert_issuer

Match TLS/SSL certificate Issuer field.

Examples:

```
tls.cert_issuer; content:"WoSign"; nocase; isdataat:!1,relative;
tls.cert_issuer; content:"StartCom"; nocase; pcre:"/StartCom$/";
```

`tls.cert_issuer` is a 'sticky buffer'.

`tls.cert_issuer` can be used as `fast_pattern`.

tls.issuerdn

Legacy keyword to match TLS/SSL certificate IssuerDN field

example:

```
tls.issuerdn:!"CN=Google-Internet-Authority"
```

Case sensitive, can't use 'nocase', or other modifiers.

Note: `tls.cert_issuer` replaces the following legacy keywords: `tls_cert_issuer` and `tls.issuerdn`. It's recommended that rules be converted to use the new one.

8.15.3 tls.cert_serial

Match on the serial number in a certificate.

Example:

```
alert tls any any -> any any (msg:"match cert serial"; \
  tls.cert_serial; content:"5C:19:B7:B1:32:3B:1C:A1"; sid:200012;)
```

`tls.cert_serial` is a 'sticky buffer'.

`tls.cert_serial` can be used as `fast_pattern`.

`tls.cert_serial` replaces the previous keyword name: `tls_cert_serial`. You may continue to use the previous name, but it's recommended that rules be converted to use the new name.

8.15.4 tls.cert_fingerprint

Match on the SHA-1 fingerprint of the certificate.

Example:

```
alert tls any any -> any any (msg:"match cert fingerprint"; \
  tls.cert_fingerprint; \
  content:"4a:a3:66:76:82:cb:6b:23:bb:c3:58:47:23:a4:63:a7:78:a4:a1:18"; \
  sid:200023;)
```

`tls.cert_fingerprint` is a 'sticky buffer'.

`tls.cert_fingerprint` can be used as `fast_pattern`.

`tls.cert_fingerprint` replaces the previous keyword name: `tls_cert_fingerprint` may continue to use the previous name, but it's recommended that rules be converted to use the new name.

8.15.5 tls.sni

Match TLS/SSL Server Name Indication field.

Examples:

```
tls.sni; content:"oisf.net"; nocase; isdataat:!1,relative;
tls.sni; content:"oisf.net"; nocase; pcre:"/oisf.net$/";
```

`tls.sni` is a 'sticky buffer'.

`tls.sni` can be used as `fast_pattern`.

`tls.sni` replaces the previous keyword name: `tls_sni`. You may continue to use the previous name, but it's recommended that rules be converted to use the new name.

8.15.6 tls_cert_notbefore

Match on the NotBefore field in a certificate.

Example:

```
alert tls any any -> any any (msg:"match cert NotBefore"; \
  tls_cert_notbefore:1998-05-01<>2008-05-01; sid:200005;)
```

8.15.7 tls_cert_notafter

Match on the NotAfter field in a certificate.

Example:

```
alert tls any any -> any any (msg:"match cert NotAfter"; \
  tls_cert_notafter:>2015; sid:200006;)
```

8.15.8 tls_cert_expired

Match returns true if certificate is expired. It evaluates the validity date from the certificate.

Usage:

```
tls_cert_expired;
```

8.15.9 tls_cert_valid

Match returns true if certificate is not expired. It only evaluates the validity date. It does *not* do cert chain validation. It is the opposite of `tls_cert_expired`.

Usage:

```
tls_cert_valid;
```

8.15.10 tls.certs

Do a "raw" match on each of the certificates in the TLS certificate chain.

Example:

```
alert tls any any -> any any (msg:"match bytes in TLS cert"; tls.certs; \
  content:"|06 09 2a 86|"; sid:200070;)
```

`tls.certs` is a 'sticky buffer'.

`tls.certs` can be used as `fast_pattern`.

`tls.certs` supports multiple buffer matching, see *Multiple Buffer Matching*.

8.15.11 tls.version

Match on negotiated TLS/SSL version.

Supported values: "1.0", "1.1", "1.2", "1.3"

It is also possible to match versions using a hex string.

Examples:

```
tls.version:1.2;
tls.version:0x7f12;
```

The first example matches TLSv1.2, whilst the last example matches TLSv1.3 draft 16.

8.15.12 ssl_version

Match version of SSL/TLS record.

Supported values "sslv2", "sslv3", "tls1.0", "tls1.1", "tls1.2", "tls1.3"

Example:

```
alert tls any any -> any any (msg:"match TLSv1.2"; \
  ssl_version:tls1.2; sid:200030;)
```

It is also possible to match on several versions at the same time.

Example:

```
alert tls any any -> any any (msg:"match SSLv2 and SSLv3"; \
  ssl_version:sslv2,sslv3; sid:200031;)
```

The list can be prefixed with ! to match if version is different than all the versions listed in the signature. Such a negation does not match on a yet undetermined version.

8.15.13 tls.fingerprint

match TLS/SSL certificate SHA1 fingerprint

example:

```
tls.fingerprint:!"f3:40:21:48:70:2c:31:bc:b5:aa:22:ad:63:d6:bc:2e:b3:46:e2:5a"
```

Case sensitive, can't use 'nocase'.

The tls.fingerprint buffer is lower case so you must use lower case letters for this to match.

8.15.14 tls.store

store TLS/SSL certificate on disk. The location can be specified in the *output.tls-store.certs-log-dir* parameter of the yaml configuration file, cf *TLS parameters and certificates logging (tls.log)*..

8.15.15 ssl_state

The `ssl_state` keyword matches the state of the SSL connection. The possible states are `client_hello`, `server_hello`, `client_keyx`, `server_keyx` and `unknown`. You can specify several states with `|` (OR) to check for any of the specified states.

8.15.16 tls.random

Matches on the 32 bytes of the TLS random field.

Example:

```
alert tls any any -> any any (msg:"TLS random test"; \
  tls.random; content:"|9b ce 7a 5e 57 5d 77 02 07 c2 9d be 24 01 cc f0 5d cd e1 d2 a5␣
↪86 9c 4a 3e ee 38 db 55 1a d9 bc|"; sid: 200074;)
```

`tls.random` is a sticky buffer.

8.15.17 tls.random_time

Matches on the first 4 bytes of the TLS random field.

Example:

```
alert tls any any -> any any (msg:"TLS random_time test"; \
  tls.random_time; content:"|9b ce 7a 5e|"; sid: 200075;)
```

`tls.random_time` is a sticky buffer.

8.15.18 tls.random_bytes

Matches on the last 28 bytes of the TLS random field.

Example:

```
alert tls any any -> any any (msg:"TLS random_bytes test"; \
  tls.random_bytes; content:"|57 5d 77 02 07 c2 9d be 24 01 cc f0 5d cd e1 d2 a5 86 9c␣
↪4a 3e ee 38 db 55 1a d9 bc|"; sid: 200076;)
```

`tls.random_bytes` is a sticky buffer.

8.15.19 tls.cert_chain_len

Matches on the TLS certificate chain length.

tls.cert_chain_len supports <, >, <>, *!* and using an exact value.

Example:

```
 alert tls any any -> any any (msg:"cert chain exact value"; \
tls.cert_chain_len:1; classtype:misc-activity; sid:1; rev:1;)

 alert tls any any -> any any (msg:"cert chain less than value"; \
tls.cert_chain_len:<2; classtype:misc-activity; sid:2; rev:1;)

 alert tls any any -> any any (msg:"cert chain greater than value"; \
tls.cert_chain_len:>0; classtype:misc-activity; sid:2; rev:1;)

 alert tls any any -> any any (msg:"cert chain greater than less than value";\
tls.cert_chain_len:0<>2; classtype:misc-activity; sid:3; rev:1;)

 alert tls any any -> any any (msg:"cert chain not value"; \
tls.cert_chain_len:!2; classtype:misc-activity; sid:4; rev:1;)
```

8.16 SSH Keywords

Suricata has several rule keywords to match on different elements of SSH connections.

8.16.1 ssh.proto

Match on the version of the SSH protocol used. `ssh.proto` is a sticky buffer, and can be used as a fast pattern. `ssh.proto` replaces the previous buffer name: `ssh_proto`. You may continue to use the previous name, but it's recommended that existing rules be converted to use the new name.

Format:

```
ssh.proto;
```

Example:

alert ssh any any -> any any (msg:"match SSH protocol version"; ssh.proto; content:"2.0"; sid:1000010;)

The example above matches on SSH connections with SSH version 2.0.

8.16.2 ssh.software

Match on the software string from the SSH banner. `ssh.software` is a sticky buffer, and can be used as fast pattern.

`ssh.software` replaces the previous keyword names: `ssh_software` & `ssh.softwareversion`. You may continue to use the previous name, but it's recommended that rules be converted to use the new name.

Format:

```
ssh.software;
```

Example:

alert ssh any any -> any any (msg:"match SSH software string"; ssh.software; content:"openssh"; nocase; sid:1000020;)

The example above matches on SSH connections where the software string contains "openssh".

8.16.3 ssh.protoversion

Matches on the version of the SSH protocol used. A value of `2_compat` includes SSH version 1.99.

Format:

```
ssh.protoversion:[0-9](\.[0-9])?|2_compat;
```

Example:

alert ssh any any -> any any (msg:"SSH v2 compatible"; ssh.protoversion:2_compat; sid:1;)

The example above matches on SSH connections with SSH version 2 or 1.99.

alert ssh any any -> any any (msg:"SSH v1.10"; ssh.protoversion:1.10; sid:1;)

The example above matches on SSH connections with SSH version 1.10 only.

8.16.4 ssh.softwareversion

This keyword has been deprecated. Please use `ssh.software` instead. Matches on the software string from the SSH banner.

Example:

alert ssh any any -> any any (msg:"match SSH software string"; ssh.softwareversion:"OpenSSH"; sid:10000040;)

Suricata comes with a Hassh integration (https://github.com/salesforce/hassh). Hassh is used to fingerprint ssh clients and servers.

Hassh must be enabled in the Suricata config file (set 'app-layer.protocols.ssh.hassh' to 'yes').

8.16.5 ssh.hassh

Match on hassh (md5 of of hassh algorithms of client).

Example:

```
alert ssh any any -> any any (msg:"match hassh"; \
    ssh.hassh; content:"ec7378c1a92f5a8dde7e8b7a1ddf33d1";\
    sid:1000010;)
```

`ssh.hassh` is a 'sticky buffer'.

`ssh.hassh` can be used as `fast_pattern`.

8.16.6 ssh.hassh.string

Match on Hassh string (hassh algorithms of client).

Example:

```
alert ssh any any -> any any (msg:"match hassh-string"; \
    ssh.hassh.string; content:"none,zlib@openssh.com,zlib"; \
    sid:1000030;)
```

`ssh.hassh.string` is a 'sticky buffer'.

`ssh.hassh.string` can be used as `fast_pattern`.

8.16.7 ssh.hassh.server

Match on hassh (md5 of hassh algorithms of server).

Example:

```
alert ssh any any -> any any (msg:"match SSH hash-server"; \
    ssh.hassh.server; content:"b12d2871a1189eff20364cf5333619ee"; \
    sid:1000020;)
```

`ssh.hassh.server` is a 'sticky buffer'.

`ssh.hassh.server` can be used as `fast_pattern`.

8.16.8 ssh.hassh.server.string

Match on hassh string (hassh algorithms of server).

Example::

> **alert ssh any any -> any any (msg:"match SSH hash-server-string";**
> ssh.hassh.server.string; content:"umac-64-etm@openssh.com,umac-128-etm@openssh.com"; sid:1000040;)

`ssh.hassh.server.string` is a 'sticky buffer'.

`ssh.hassh.server.string` can be used as `fast_pattern`.

8.17 JA3/JA4 Keywords

Suricata comes with JA3 (https://github.com/salesforce/ja3) and JA4 (https://github.com/FoxIO-LLC/ja4) integration. JA3 and JA4 are used to fingerprint TLS and QUIC clients.

Support must be enabled in the Suricata config file (set `app-layer.protocols.tls.ja{3,4}-fingerprints` to `yes`). If it is not explicitly disabled (`no`) , it will be enabled if a loaded rule requires it. Note that JA3/JA4 support can also be disabled at compile time; it is possible to use the `requires: feature ja{3,4};` keyword to skip rules if no JA3/JA4 support is present.

8.17.1 ja3.hash

Match on JA3 hash (md5).

Example:

```
alert tls any any -> any any (msg:"match JA3 hash"; \
    ja3.hash; content:"e7eca2baf4458d095b7f45da28c16c34"; \
    sid:100001;)
```

`ja3.hash` is a 'sticky buffer'.

`ja3.hash` can be used as `fast_pattern`.

`ja3.hash` replaces the previous keyword name: `ja3_hash`. You may continue to use the previous name, but it's recommended that rules be converted to use the new name.

8.17.2 ja3.string

Match on JA3 string.

Example:

```
alert tls any any -> any any (msg:"match JA3 string"; \
    ja3.string; content:"19-20-21-22"; \
    sid:100002;)
```

`ja3.string` is a 'sticky buffer'.

`ja3.string` can be used as `fast_pattern`.

`ja3.string` replaces the previous keyword name: `ja3_string`. You may continue to use the previous name, but it's recommended that rules be converted to use the new name.

8.17.3 ja3s.hash

Match on JA3S hash (md5).

Example:

```
alert tls any any -> any any (msg:"match JA3S hash"; \
    ja3s.hash; content:"b26c652e0a402a24b5ca2a660e84f9d5"; \
    sid:100003;)
```

`ja3s.hash` is a 'sticky buffer'.

`ja3s.hash` can be used as `fast_pattern`.

8.17.4 ja3s.string

Match on JA3S string.

Example:

```
alert tls any any -> any any (msg:"match on JA3S string"; \
    ja3s.string; content:"771,23-35"; sid:100004;)
```

`ja3s.string` is a 'sticky buffer'.

`ja3s.string` can be used as `fast_pattern`.

8.17.5 ja4.hash

Match on JA4 hash (e.g. `q13d0310h3_55b375c5d22e_cd85d2d88918`).

Example:

```
alert quic any any -> any any (msg:"match JA4 hash"; \
    ja4.hash; content:"q13d0310h3_55b375c5d22e_cd85d2d88918"; \
    sid:100001;)
```

`ja4.hash` is a 'sticky buffer'.

`ja4.hash` can be used as `fast_pattern`.

8.18 Modbus Keyword

The modbus keyword can be used for matching on various properties of Modbus requests.

There are three ways of using this keyword:

- matching on functions properties with the setting "function";
- matching on directly on data access with the setting "access";
- matching on unit identifier with the setting "unit" only or with the previous setting "function" or "access".

With the setting **function**, you can match on:

- an action based on a function code field and a sub-function code when applicable;
- one of three categories of Modbus functions;
- public functions that are publicly defined (setting "public")
- user-defined functions (setting "user")
- reserved functions that are dedicated to proprietary extensions of Modbus (keyword "reserved")
- one of the two sub-groups of public functions:
  - assigned functions whose definition is already given in the Modbus specification (keyword "assigned");
  - unassigned functions, which are reserved for future use (keyword "unassigned").

Syntax:

```
modbus: function <value>
modbus: function <value>, subfunction <value>
modbus: function [!] <assigned | unassigned | public | user | reserved | all>
```

Sign '!' is negation

Examples:

```
modbus: function 21                # Write File record function
modbus: function 4, subfunction 4  # Force Listen Only Mode (Diagnostics) function
modbus: function assigned          # defined by Modbus Application Protocol␣
↪Specification V1.1b3
modbus: function public            # validated by the Modbus.org community
modbus: function user              # internal use and not supported by the specification
modbus: function reserved          # used by some companies for legacy products and not␣
↪available for public use
modbus: function !reserved         # every function but reserved function
```

With the **access** setting, you can match on:

- a type of data access (read or write);
- one of primary tables access (Discretes Input, Coils, Input Registers and Holding Registers);
- a range of addresses access;
- a written value.

Syntax:

```
modbus: access <read | write>
modbus: access read <discretes | coils | input | holding>
modbus: access read <discretes | coils | input | holding>, address <value>
modbus: access write < coils | holding>
modbus: access write < coils | holding>, address <value>
modbus: access write < coils | holding>, address <value>, value <value>
```

With _<value>_ setting matches on the address or value as it is being accessed or written as follows:

```
address 100      # exactly address 100
address 100<>200 # greater than address 100 and smaller than address 200
address >100     # greater than address 100
address <100     # smaller than address 100
```

Examples:

```
modbus: access read                                  # Read access
modbus: access write                                 # Write access
modbus: access read input                            # Read access to Discretes Input␣
↪table
modbus: access write coils                           # Write access to Coils table
modbus: access read discretes, address <100          # Read access at address smaller␣
↪than 100 of Discretes Input table
modbus: access write holding, address 500, value >200  # Write value greater than 200 at␣
↪address 500 of Holding Registers table
```

With the setting **unit**, you can match on:

- a MODBUS slave address of a remote device connected on the sub-network behind a bridge or a gateway. The destination IP address identifies the bridge itself and the bridge uses the MODBUS unit identifier to forward the request to the right slave device.

Syntax:

```
modbus: unit <value>
modbus: unit <value>, function <value>
modbus: unit <value>, function <value>, subfunction <value>
modbus: unit <value>, function [!] <assigned | unassigned | public | user | reserved |␣
↪all>
modbus: unit <value>, access <read | write>
modbus: unit <value>, access read <discretes | coils | input | holding>
modbus: unit <value>, access read <discretes | coils | input | holding>, address <value>
modbus: unit <value>, access write < coils | holding>
modbus: unit <value>, access write < coils | holding>, address <value>
modbus: unit <value>, access write < coils | holding>, address <value>, value <value>
```

With _<value>_ setting matches on the address or value as it is being accessed or written as follows:

```
unit 10     # exactly unit identifier 10
unit 10<>20 # greater than unit identifier 10 and smaller than unit identifier 20
unit >10    # greater than unit identifier 10
unit <10    # smaller than unit identifier 10
```

Examples:

```
modbus: unit 10                                                    # Unit identifier␣
↪10
modbus: unit 10, function 21                                       # Unit identifier␣
↪10 and write File record function
modbus: unit 10, function 4, subfunction 4                         # Unit identifier␣
↪10 and force Listen Only Mode (Diagnostics) function
modbus: unit 10, function assigned                                 # Unit identifier␣
↪10 and assigned function
modbus: unit 10, function !reserved                                # Unit identifier␣
↪10 and every function but reserved function
modbus: unit 10, access read                                       # Unit identifier␣
↪10 and Read access
modbus: unit 10, access write coils                                # Unit identifier␣
↪10 and Write access to Coils table
modbus: unit >10, access read discretes, address <100              # Greater than␣
↪unit identifier 10 and Read access at address smaller than 100 of Discretes Input table
modbus: unit 10<>20, access write holding, address 500, value >200    # Greater than␣
↪unit identifier 10 and smaller than unit identifier 20 and Write value greater than␣
↪200 at address 500 of Holding Registers table
```

(cf. http://www.modbus.org/docs/Modbus_Application_Protocol_V1_1b3.pdf)

Note: Address of read and write are starting at 1. So if your system is using a start at 0, you need to add 1 the address values.

Note: According to MODBUS Messaging on TCP/IP Implementation Guide V1.0b, it is recommended to keep the TCP connection opened with a remote device and not to open and close it for each MODBUS/TCP transaction. In that case, it is important to set the depth of the stream reassembling as unlimited (stream.reassembly.depth: 0)

Note: According to MODBUS Messaging on TCP/IP Implementation Guide V1.0b, the MODBUS slave device addresses on serial line are assigned from 1 to 247 (decimal). Address 0 is used as broadcast address.

(cf. http://www.modbus.org/docs/Modbus_Messaging_Implementation_Guide_V1_0b.pdf)

Paper and presentation (in french) on Modbus support are available : http://www.ssi.gouv.fr/agence/publication/detection-dintrusion-dans-les-systemes-industriels-suricata-et-le-cas-modbus/

8.19 DCERPC Keywords

Following keywords can be used for matching on fields in headers and payloads of DCERPC packets over UDP, TCP and SMB.

8.19.1 dcerpc.iface

Match on the value of the interface UUID in a DCERPC header. If *any_frag* option is given, the match shall be done on all fragments. If it's not, the match shall only happen on the first fragment.

The format of the keyword:

```
dcerpc.iface:<uuid>;
dcerpc.iface:<uuid>,[>,<,!,=]<iface_version>;
dcerpc.iface:<uuid>,any_frag;
dcerpc.iface:<uuid>,[>,<,!,=]<iface_version>,any_frag;
```

Examples:

```
dcerpc.iface:367abb81-9844-35f1-ad32-98f038001003;
dcerpc.iface:367abb81-9844-35f1-ad32-98f038001003,!10;
dcerpc.iface:367abb81-9844-35f1-ad32-98f038001003,any_frag;
dcerpc.iface:367abb81-9844-35f1-ad32-98f038001003,>1,any_frag;
```

ET Open rule example:

alert tcp any any -> $HOME_NET any (msg:"ET NETBIOS DCERPC WMI Remote Process Execution"; flow:to_server,established; dce_iface:00000143-0000-0000-c000-000000000046; classtype:bad-unknown; sid:2027167; rev:1; metadata:affected_product Windows_XP_Vista_7_8_10_Server_32_64_Bit, attack_target Client_Endpoint, created_at 2019_04_09, deployment Internal, former_category NETBIOS, signature_severity Informational, updated_at 2019_04_09;)

8.19.2 dcerpc.opnum

Match on one or many operation numbers and/or operation number range within the interface in a DCERPC header.

The format of the keyword:

```
dcerpc.opnum:<u16>;
dcerpc.opnum:[>,<,!,=]<u16>;
dcerpc.opnum:<u16>,<u16>,<u16>....;
dcerpc.opnum:<u16>-<u16>;
```

Examples:

```
dcerpc.opnum:15;
dcerpc.opnum:>10;
dcerpc.opnum:12,24,62,61;
dcerpc.opnum:12,18-24,5;
dcerpc.opnum:12-14,12,121,62-78;
```

8.19.3 dcerpc.stub_data

Match on the stub data in a given DCERPC packet. It is a 'sticky buffer'.

Example:

```
dcerpc.stub_data; content:"123456";
```

8.19.4 Additional information

More information on the protocol can be found here:

- DCERPC: https://pubs.opengroup.org/onlinepubs/9629399/chap1.htm

8.20 DHCP keywords

8.20.1 dhcp.leasetime

DHCP lease time (integer).

Syntax:

```
dhcp.leasetime:[op]<number>
```

The time can be matched exactly, or compared using the _op_ setting:

```
dhcp.leasetime:3    # exactly 3
dhcp.leasetime:<3   # smaller than 3
dhcp.leasetime:>=2  # greater or equal than 2
```

Signature example:

```
alert dhcp any any -> any any (msg:"small DHCP lease time (<3)"; dhcp.leasetime:<3;␣
↪sid:1; rev:1;)
```

8.20.2 dhcp.rebinding_time

DHCP rebinding time (integer).

Syntax:

```
dhcp.rebinding_time:[op]<number>
```

The time can be matched exactly, or compared using the _op_ setting:

```
dhcp.rebinding_time:3    # exactly 3
dhcp.rebinding_time:<3   # smaller than 3
dhcp.rebinding_time:>=2  # greater or equal than 2
```

Signature example:

```
alert dhcp any any -> any any (msg:"small DHCP rebinding time (<3)"; dhcp.rebinding_time:
↪<3; sid:1; rev:1;)
```

8.20.3 dhcp.renewal_time

DHCP renewal time (integer).

Syntax:

```
dhcp.renewal_time:[op]<number>
```

The time can be matched exactly, or compared using the _op_ setting:

```
dhcp.renewal_time:3    # exactly 3
dhcp.renewal_time:<3   # smaller than 3
dhcp.renewal_time:>=2  # greater or equal than 2
```

Signature example:

```
alert dhcp any any -> any any (msg:"small DHCP renewal time (<3)"; dhcp.renewal_time:<3;␣
↪sid:1; rev:1;)
```

8.21 DNP3 Keywords

The DNP3 keywords can be used to match on fields in decoded DNP3 messages. The keywords are based on Snort's DNP3 keywords and aim to be 100% compatible.

8.21.1 dnp3_func

This keyword will match on the application function code found in DNP3 request and responses. It can be specified as the integer value or the symbolic name of the function code.

Syntax

```
dnp3_func:<value>;
```

Where value is one of:

- An integer value between 0 and 255 inclusive.
- Function code name:
  - confirm
  - read
  - write
  - select
  - operate
  - direct_operate
  - direct_operate_nr
  - immed_freeze
  - immed_freeze_nr
  - freeze_clear
  - freeze_clear_nr
  - freeze_at_time
  - freeze_at_time_nr
  - cold_restart
  - warm_restart
  - initialize_data
  - initialize_appl
  - start_appl
  - stop_appl
  - save_config
  - enable_unsolicited
  - disable_unsolicited
  - assign_class
  - delay_measure
  - record_current_time
  - open_file

- close_file
- delete_file
- get_file_info
- authenticate_file
- abort_file
- activate_config
- authenticate_req
- authenticate_err
- response
- unsolicited_response
- authenticate_resp

8.21.2 dnp3_ind

This keyword matches on the DNP3 internal indicator flags in the response application header.

Syntax

```
dnp3_ind:<flag>{,<flag>...}
```

Where flag is the name of the internal indicator:

- all_stations
- class_1_events
- class_2_events
- class_3_events
- need_time
- local_control
- device_trouble
- device_restart
- no_func_code_support
- object_unknown
- parameter_error
- event_buffer_overflow
- already_executing
- config_corrupt
- reserved_2
- reserved_1

This keyword will match of any of the flags listed are set. To match on multiple flags (AND type match), use dnp3_ind for each flag that must be set.

Examples

```
dnp3_ind:all_stations;
```

```
dnp3_ind:class_1_events,class_2_events;
```

8.21.3 dnp3_obj

This keyword matches on the DNP3 application data objects.

Syntax

```
dnp3_obj:<group>,<variation>
```

Where <group> and <variation> are integer values between 0 and 255 inclusive.

8.21.4 dnp3_data

This keyword will cause the following content options to match on the re-assembled application buffer. The reassembled application buffer is a DNP3 fragment with CRCs removed (which occur every 16 bytes), and will be the complete fragment, possibly reassembled from multiple DNP3 link layer frames.

Syntax

```
dnp3_data;
```

Example

```
dnp3_data; content:"|c3 06|";
```

8.22 ENIP/CIP Keywords

The enip_command and cip_service keywords can be used for matching on various properties of ENIP requests.

There are three ways of using this keyword:

- matching on ENIP command with the setting "enip_command";
- matching on CIP Service with the setting "cip_service".
- matching both the ENIP command and the CIP Service with "enip_command" and "cip_service" together

For the ENIP command, we are matching against the command field found in the ENIP encapsulation.

For the CIP Service, we use a maximum of 3 comma separated values representing the Service, Class and Attribute. These values are described in the CIP specification. CIP Classes are associated with their Service, and CIP Attributes are associated with their Service. If you only need to match up until the Service, then only provide the Service value. If you want to match to the CIP Attribute, then you must provide all 3 values.

Syntax:

```
enip_command:<value>
cip_service:<value(s)>
enip_command:<value>, cip_service:<value(s)>
```

Examples:

```
enip_command:99
cip_service:75
cip_service:16,246,6
enip_command:111, cip_service:5
```

(cf. http://read.pudn.com/downloads166/ebook/763211/EIP-CIP-V1-1.0.pdf)

Information on the protocol can be found here: http://literature.rockwellautomation.com/idc/groups/literature/documents/wp/enet-wp001_-en-p.pdf

8.23 FTP/FTP-DATA Keywords

8.23.1 ftpdata_command

Filter ftp-data channel based on command used on the FTP command channel. Currently supported commands are RETR (get on a file) and STOR (put on a file).

Syntax:

```
ftpdata_command:(retr|stor)
```

Examples:

```
ftpdata_command:retr
ftpdata_command:stor
```

Signature example:

```
alert ftp-data any any -> any any (msg:"FTP store password"; filestore; filename:
↪"password"; ftpdata_command:stor; sid:3; rev:1;)
```

8.23.2 ftpbounce

Detect FTP bounce attacks.

Syntax:

```
ftpbounce
```

8.24 Kerberos Keywords

8.24.1 krb5_msg_type

This keyword allows to match the Kerberos messages by its type (integer). It is possible to specify the following values defined in RFC4120:

- 10 (AS-REQ)
- 11 (AS-REP)
- 12 (TGS-REQ)
- 13 (TGS-REP)
- 30 (ERROR)

Syntax:

```
krb5_msg_type:<number>
```

Signature examples:

```
alert krb5 any any -> any any (msg:"Kerberos 5 AS-REQ message"; krb5_msg_type:10; sid:3;␣
↪rev:1;)
alert krb5 any any -> any any (msg:"Kerberos 5 AS-REP message"; krb5_msg_type:11; sid:4;␣
↪rev:1;)
alert krb5 any any -> any any (msg:"Kerberos 5 TGS-REQ message"; krb5_msg_type:12; sid:5;
↪ rev:1;)
alert krb5 any any -> any any (msg:"Kerberos 5 TGS-REP message"; krb5_msg_type:13; sid:6;
↪ rev:1;)
alert krb5 any any -> any any (msg:"Kerberos 5 ERROR message"; krb5_msg_type:30; sid:7;␣
↪rev:1;)
```

Note: AP-REQ and AP-REP are not currently supported since those messages are embedded in other application protocols.

8.24.2 krb5_cname

Kerberos client name, provided in the ticket (for AS-REQ and TGS-REQ messages).

If the client name from the Kerberos message is composed of several parts, the name is compared to each part and the match will succeed if any is identical.

Comparison is case-sensitive.

Syntax:

```
krb5_cname; content:"name";
```

Signature example:

```
alert krb5 any any -> any any (msg:"Kerberos 5 des server name"; krb5_cname; content:"des
↪"; sid:4; rev:1;)
```

krb5_cname is a 'sticky buffer'.

krb5_cname can be used as fast_pattern.

krb5.cname supports multiple buffer matching, see *Multiple Buffer Matching*.

8.24.3 krb5_sname

Kerberos server name, provided in the ticket (for AS-REQ and TGS-REQ messages) or in the error message.

If the server name from the Kerberos message is composed of several parts, the name is compared to each part and the match will succeed if any is identical.

Comparison is case-sensitive.

Syntax:

```
krb5_sname; content:"name";
```

Signature example:

```
alert krb5 any any -> any any (msg:"Kerberos 5 krbtgt server name"; krb5_sname; content:
↪"krbtgt"; sid:5; rev:1;)
```

krb5_sname is a 'sticky buffer'.

krb5_sname can be used as fast_pattern.

krb5.sname supports multiple buffer matching, see *Multiple Buffer Matching*.

8.24.4 krb5_err_code

Kerberos error code (integer). This field is matched in Kerberos error messages only.

For a list of error codes, refer to RFC4120 section 7.5.9.

Syntax:

```
krb5_err_code:<number>
```

Signature example:

```
alert krb5 any any -> any any (msg:"Kerberos 5 error C_PRINCIPAL_UNKNOWN"; krb5_err_
↪code:6; sid:6; rev:1;)
```

8.24.5 krb5.weak_encryption (event)

Event raised if the encryption parameters selected by the server are weak or deprecated. For example, using a key size smaller than 128, or using deprecated ciphers like DES.

Syntax:

```
app-layer-event:krb5.weak_encryption
```

Signature example:

```
alert krb5 any any -> any any (msg:"SURICATA Kerberos 5 weak encryption parameters";␣
↪flow:to_client; app-layer-event:krb5.weak_encryption; classtype:protocol-command-
↪decode; sid:2226001; rev:1;)
```

8.24.6 krb5.malformed_data (event)

Event raised in case of a protocol decoding error.

Syntax:

```
app-layer-event:krb5.malformed_data
```

Signature example:

```
alert krb5 any any -> any any (msg:"SURICATA Kerberos 5 malformed request data"; flow:to_
↪server; app-layer-event:krb5.malformed_data; classtype:protocol-command-decode;␣
↪sid:2226000; rev:1;)
```

8.24.7 krb5.ticket_encryption

Kerberos ticket encryption (enumeration).

For a list of encryption types, refer to RFC3961 section 8.

Syntax:

```
krb5.ticket_encryption: (!)"weak" or (space or comma)-separated list of integer or␣
↪string values for an encryption type
```

Signature example:

```
alert krb5 any any -> any any (krb5.ticket_encryption: weak; sid:1;)
alert krb5 any any -> any any (krb5.ticket_encryption: 23; sid:2;)
alert krb5 any any -> any any (krb5.ticket_encryption: rc4-hmac,rc4-hmac-exp; sid:3;)
```

8.25 SMB Keywords

SMB keywords used in both SMB1 and SMB2 protocols.

8.25.1 smb.named_pipe

Match on SMB named pipe in tree connect.

Examples:

```
smb.named_pipe; content:"IPC"; endswith;
smb.named_pipe; content:"strange"; nocase; pcre:"/really$/";
```

`smb.named_pipe` is a 'sticky buffer'.

`smb.named_pipe` can be used as `fast_pattern`.

8.25.2 smb.share

Match on SMB share name in tree connect.

Examples:

```
smb.share; content:"shared"; endswith;
smb.share; content:"strange"; nocase; pcre:"/really$/";
```

`smb.share` is a 'sticky buffer'.

`smb.share` can be used as `fast_pattern`.

8.25.3 smb.ntlmssp_user

Match on SMB ntlmssp user in session setup.

Examples:

```
smb.ntlmssp_user; content:"doe"; endswith;
smb.ntlmssp_user; content:"doe"; nocase; pcre:"/j(ohn|ane).*doe$/";
```

`smb.ntlmssp_user` is a 'sticky buffer'.

`smb.ntlmssp_user` can be used as `fast_pattern`.

8.25.4 smb.ntlmssp_domain

Match on SMB ntlmssp domain in session setup.

Examples:

```
smb.ntlmssp_domain; content:"home"; endswith;
smb.ntlmssp_domain; content:"home"; nocase; pcre:"/home(sweet)*$/";
```

`smb.ntlmssp_domain` is a 'sticky buffer'.

`smb.ntlmssp_domain` can be used as `fast_pattern`.

8.26 SNMP keywords

8.26.1 snmp.version

SNMP protocol version (integer). Expected values are 1, 2 (for version 2c) or 3.

Syntax:

```
snmp.version:[op]<number>
```

The version can be matched exactly, or compared using the _op_ setting:

```
snmp.version:3    # exactly 3
snmp.version:<3   # smaller than 3
snmp.version:>=2  # greater or equal than 2
```

Signature example:

```
alert snmp any any -> any any (msg:"old SNMP version (<3)"; snmp.version:<3; sid:1;␣
↪rev:1;)
```

8.26.2 snmp.community

SNMP community strings are like passwords for SNMP messages in version 1 and 2c. In version 3, the community string is likely to be encrypted. This keyword will not match if the value is not accessible.

The default value for the read-only community string is often "public", and "private" for the read-write community string.

Comparison is case-sensitive.

Syntax:

```
snmp.community; content:"private";
```

Signature example:

```
alert snmp any any -> any any (msg:"SNMP community private"; snmp.community; content:
↪"private"; sid:2; rev:1;)
```

`snmp.community` is a 'sticky buffer'.

`snmp.community` can be used as `fast_pattern`.

8.26.3 snmp.usm

SNMP User-based Security Model (USM) is used in version 3. It corresponds to the user name.

Comparison is case-sensitive.

Syntax:

```
snmp.usm; content:"admin";
```

Signature example:

```
alert snmp any any -> any any (msg:"SNMP usm admin"; snmp.usm; content:"admin"; sid:2;␣
↪rev:1;)
```

`snmp.usm` is a 'sticky buffer'.

`snmp.usm` can be used as `fast_pattern`.

8.26.4 snmp.pdu_type

SNMP PDU type (integer).

Common values are:

- 0: GetRequest
- 1: GetNextRequest
- 2: Response
- 3: SetRequest
- 4: TrapV1 (obsolete, was the old Trap-PDU in SNMPv1)
- 5: GetBulkRequest
- 6: InformRequest
- 7: TrapV2
- 8: Report

This keyword will not match if the value is not accessible within (for ex, an encrypted SNMP v3 message).

Syntax:

```
snmp.pdu_type:<number>
```

Signature example:

```
alert snmp any any -> any any (msg:"SNMP response"; snmp.pdu_type:2; sid:3; rev:1;)
```

8.27 Base64 keywords

Suricata supports decoding base64 encoded data from buffers and matching on the decoded data.

This is achieved by using two keywords, `base64_decode` and `base64_data`. Both keywords must be used in order to generate an alert.

8.27.1 base64_decode

Decodes base64 data from a buffer and makes it available for the base64_data function.

Syntax:

```
base64_decode:bytes <value>, offset <value>, relative;
```

The `bytes` option specifies how many bytes Suricata should decode and make available for base64_data. This number is limited to 64KiB. The decoding will stop at the end of the buffer.

The `offset` option specifies how many bytes Suricata should skip before decoding. Bytes are skipped relative to the start of the payload buffer if the `relative` is not set.

The `relative` option makes the decoding start relative to the previous content match. Default behavior is to start at the beginning of the buffer. This option makes `offset` skip bytes relative to the previous match.

Note: Regarding `relative` and `base64_decode`:

The content match that you want to decode relative to must be the first match in the stream.

Note: `base64_decode` follows RFC 4648 by default i.e. encounter with any character that is not found in the base64 alphabet leads to rejection of that character and the rest of the string.

See Redmine Bug 5223: https://redmine.openinfosecfoundation.org/issues/5223 and RFC 4648: https://www.rfc-editor.org/rfc/rfc4648#section-3.3

8.27.2 base64_data

base64_data is a `sticky buffer`.

Enables content matching on the data previously decoded by base64_decode.

8.27.3 Example

Here is an example of a rule matching on the base64 encoded string "test" that is found inside the http_uri buffer.

It starts decoding relative to the known string "somestring" with the known offset of 1. This must be the first occurrence of "somestring" in the buffer.

Example:

```
Buffer content:
http_uri = "GET /en/somestring&dGVzdAo=&not_base64"

Rule:
alert http any any -> any any (msg:"Example"; http.uri; content:"somestring"; \
     base64_decode:bytes 8, offset 1, relative; \
     base64_data; content:"test"; sid:10001; rev:1;)

Buffer content:
http_uri = "GET /en/somestring&dGVzdAo=&not_base64"

Rule:
alert http any any -> any any (msg:"Example"; content:"somestring"; http_uri; \
     base64_decode:bytes 8, offset 1, relative; \
     base64_data; content:"test"; sid:10001; rev:1;)
```

Note: `fast_pattern` is ineffective with `base64_data`

8.28 SIP Keywords

The SIP keywords are implemented as sticky buffers and can be used to match on fields in SIP messages.

Keyword	Direction
sip.method	Request
sip.uri	Request
sip.request_line	Request
sip.stat_code	Response
sip.stat_msg	Response
sip.response_line	Response
sip.protocol	Both

8.28.1 sip.method

This keyword matches on the method found in a SIP request.

Syntax

```
sip.method; content:<method>;
```

Examples of methods are:

- INVITE
- BYE
- REGISTER
- CANCEL
- ACK
- OPTIONS

Examples

```
sip.method; content:"INVITE";
```

8.28.2 sip.uri

This keyword matches on the uri found in a SIP request.

Syntax

```
sip.uri; content:<uri>;
```

Where <uri> is an uri that follows the SIP URI scheme.

Examples

```
sip.uri; content:"sip:sip.url.org";
```

8.28.3 sip.request_line

This keyword forces the whole SIP request line to be inspected.

Syntax

```
sip.request_line; content:<request_line>;
```

Where <request_line> is a partial or full line.

Examples

```
sip.request_line; content:"REGISTER sip:sip.url.org SIP/2.0"
```

8.28.4 sip.stat_code

This keyword matches on the status code found in a SIP response.

Syntax

```
sip.stat_code; content:<stat_code>
```

Where <status_code> belongs to one of the following groups of codes:

- 1xx - Provisional Responses
- 2xx - Successful Responses
- 3xx - Redirection Responses
- 4xx - Client Failure Responses
- 5xx - Server Failure Responses
- 6xx - Global Failure Responses

Examples

```
sip.stat_code; content:"100";
```

8.28.5 sip.stat_msg

This keyword matches on the status message found in a SIP response.

Syntax

```
sip.stat_msg; content:<stat_msg>
```

Where <stat_msg> is a reason phrase associated to a status code.

Examples

```
sip.stat_msg; content:"Trying";
```

8.28.6 sip.response_line

This keyword forces the whole SIP response line to be inspected.

Syntax

```
sip.response_line; content:<response_line>;
```

Where <response_line> is a partial or full line.

Examples

```
sip.response_line; content:"SIP/2.0 100 OK"
```

8.28.7 sip.protocol

This keyword matches the protocol field from a SIP request or response line.

If the response line is 'SIP/2.0 100 OK', then this buffer will contain 'SIP/2.0'

Syntax

```
sip.protocol; content:<protocol>
```

Where <protocol> is the SIP protocol version.

Example

```
sip.protocol; content:"SIP/2.0"
```

8.29 RFB Keywords

The `rfb.name` and `rfb.sectype` keywords can be used for matching on various properties of RFB (Remote Framebuffer, i.e. VNC) handshakes.

8.29.1 rfb.name

Match on the value of the RFB desktop name field.

Examples:

```
rfb.name; content:"Alice's desktop";
rfb.name; pcre:"/.* \(screen [0-9]\)$/";
```

`rfb.name` is a 'sticky buffer'.

`rfb.name` can be used as `fast_pattern`.

8.29.2 rfb.secresult

Match on the value of the RFB security result, e.g. `ok`, `fail`, `toomany` or `unknown`.

Examples:

```
rfb.secresult: ok;
rfb.secresult: unknown;
```

8.29.3 rfb.sectype

Match on the value of the RFB security type field, e.g. `2` for VNC challenge-response authentication, `0` for no authentication, and `30` for Apple's custom Remote Desktop authentication.

This keyword takes a numeric argument after a colon and supports additional qualifiers, such as:

- > (greater than)
- < (less than)
- >= (greater than or equal)
- <= (less than or equal)

Examples:

```
rfb.sectype:2;
rfb.sectype:>=3;
```

8.29.4 Additional information

More information on the protocol can be found here: https://tools.ietf.org/html/rfc6143

8.30 MQTT Keywords

Various keywords can be used for matching on fields in fixed and variable headers of MQTT messages as well as payload values.

8.30.1 mqtt.protocol_version

Match on the value of the MQTT protocol version field in the fixed header.

The format of the keyword:

```
mqtt.protocol_version:<min>-<max>;
mqtt.protocol_version:[<|>]<number>;
mqtt.protocol_version:<value>;
```

Examples:

mqtt.protocol_version:5;

8.30.2 mqtt.type

Match on the MQTT message type (also: control packet type). Valid values are :

- `CONNECT`
- `CONNACK`
- `PUBLISH`
- `PUBACK`
- `PUBREC`
- `PUBREL`
- `PUBCOMP`
- `SUBSCRIBE`
- `SUBACK`
- `UNSUBSCRIBE`
- `UNSUBACK`
- `PINGREQ`
- `PINGRESP`

- DISCONNECT
- AUTH
- UNASSIGNED

where UNASSIGNED refers to message type code 0.

Examples:

```
mqtt.type:CONNECT;
mqtt.type:PUBLISH;
```

8.30.3 mqtt.flags

Match on a combination of MQTT header flags, separated by commas (,). Flags may be prefixed by ! to indicate negation, i.e. a flag prefixed by ! must *not* be set to match.

Valid flags are:

- dup (duplicate message)
- retain (message should be retained on the broker)

Examples:

```
mqtt.flags:dup,!retain;
mqtt.flags:retain;
```

8.30.4 mqtt.qos

Match on the Quality of Service request code in the MQTT fixed header. Valid values are:

- 0 (fire and forget)
- 1 (at least one delivery)
- 2 (exactly one delivery)

Examples:

```
mqtt.qos:0;
mqtt.qos:2;
```

8.30.5 mqtt.reason_code

Match on the numeric value of the reason code that is used in MQTT 5.0 for some message types. Please refer to the specification for the meaning of these values, which are often specific to the message type in question.

Examples:

```
# match on attempts to unsubscribe from a non-subscribed topic
mqtt.type:UNSUBACK; mqtt.reason_code:17;

# match on publications that were accepted but there were no subscribers
mqtt.type:PUBACK; mqtt.reason_code:16;
```

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```
# match on connection attempts by banned clients
mqtt.CONNACK; mqtt.reason_code:138;

# match on failed connection attempts due to bad credentials
mqtt.CONNACK; mqtt.reason_code:134;

# match on connections terminated by server shutdowns
mqtt.DISCONNECT; mqtt.reason_code:139;
```

This keyword is also available under the alias `mqtt.connack.return_code` for completeness.

8.30.6 mqtt.connack.session_present

Match on the MQTT CONNACK `session_present` flag. Values can be `yes`, `true`, `no` or `false`.

Examples:

```
mqtt.CONNACK; mqtt.connack.session_present:true;
```

8.30.7 mqtt.connect.clientid

Match on the self-assigned client ID in the MQTT CONNECT message.

Examples:

```
mqtt.connect.clientid; pcre:"/^mosq.*/";
mqtt.connect.clientid; content:"myclient";
```

`mqtt.connect.clientid` is a 'sticky buffer' and can be used as `fast_pattern`.

8.30.8 mqtt.connect.flags

Match on a combination of MQTT CONNECT flags, separated by commas (`,`). Flags may be prefixed by `!` to indicate negation, i.e. a flag prefixed by `!` must *not* be set to match.

Valid flags are:

- `username` (message contains a username)
- `password` (message contains a password)
- `will` (message contains a will definition)
- `will_retain` (will should be retained on broker)
- `clean_session` (start with a clean session)

Examples:

```
mqtt.connect.flags:username,password,!will;
mqtt.connect.flags:username,!password;
mqtt.connect.flags:clean_session;
```

8.30.9 mqtt.connect.password

Match on the password credential in the MQTT CONNECT message.

Examples:

```
mqtt.connect.password; pcre:"/^123[0-9]*/";
mqtt.connect.password; content:"swordfish";
```

`mqtt.connect.password` is a 'sticky buffer' and can be used as `fast_pattern`.

8.30.10 mqtt.connect.username

Match on the username credential in the MQTT CONNECT message.

Examples:

```
mqtt.connect.username; content:"benson";
```

`mqtt.connect.username` is a 'sticky buffer' and can be used as `fast_pattern`.

8.30.11 mqtt.connect.willmessage

Match on the will message in the MQTT CONNECT message, if a will is defined.

Examples:

```
mqtt.connect.willmessage; pcre:"/^fooba[rz]/";
mqtt.connect.willmessage; content:"hunter2";
```

`mqtt.connect.willmessage` is a 'sticky buffer' and can be used as `fast_pattern`.

8.30.12 mqtt.connect.willtopic

Match on the will topic in the MQTT CONNECT message, if a will is defined.

Examples:

```
mqtt.connect.willtopic; pcre:"/^hunter[0-9]/";
```

`mqtt.connect.willtopic` is a 'sticky buffer' and can be used as `fast_pattern`.

8.30.13 mqtt.publish.message

Match on the payload to be published in the MQTT PUBLISH message.

Examples:

```
mqtt.type:PUBLISH; mqtt.publish.message; pcre:"/uid=[0-9]+/";
# match on published JPEG images
mqtt.type:PUBLISH; mqtt.publish.message; content:"|FF D8 FF E0|"; startswith;
```

`mqtt.publish.message` is a 'sticky buffer' and can be used as `fast_pattern`.

8.30.14 mqtt.publish.topic

Match on the topic to be published to in the MQTT PUBLISH message.

Examples:

```
mqtt.publish.topic; content:"mytopic";
```

`mqtt.publish.topic` is a 'sticky buffer' and can be used as `fast_pattern`.

8.30.15 mqtt.subscribe.topic

Match on any of the topics subscribed to in a MQTT SUBSCRIBE message.

Examples:

```
mqtt.subscribe.topic; content:"mytopic";
```

`mqtt.subscribe.topic` is a 'sticky buffer' and can be used as `fast_pattern`.

`mqtt.subscribe.topic` supports multiple buffer matching, see *Multiple Buffer Matching*.

8.30.16 mqtt.unsubscribe.topic

Match on any of the topics unsubscribed from in a MQTT UNSUBSCRIBE message.

Examples:

```
mqtt.unsubscribe.topic; content:"mytopic";
```

`mqtt.unsubscribe.topic` is a 'sticky buffer' and can be used as `fast_pattern`.

`mqtt.unsubscribe.topic` supports multiple buffer matching, see *Multiple Buffer Matching*.

8.30.17 Additional information

More information on the protocol can be found here:

- MQTT 3.1: https://public.dhe.ibm.com/software/dw/webservices/ws-mqtt/mqtt-v3r1.html
- MQTT 3.1.1: https://docs.oasis-open.org/mqtt/mqtt/v3.1.1/mqtt-v3.1.1.html
- MQTT 5.0: https://docs.oasis-open.org/mqtt/mqtt/v5.0/mqtt-v5.0.html

8.31 IKE Keywords

The keywords

- `ike.init_spi`
- `ike.resp_spi`
- `ike.chosen_sa_attribute`
- `ike.exchtype`
- `ike.vendor`

- `ike.key_exchange_payload`
- `ike.key_exchange_payload_length`
- `ike.nonce_payload`
- `ike.nonce_payload_length`

can be used for matching on various properties of IKE connections.

8.31.1 ike.init_spi, ike.resp_spi

Match on an exact value of the Security Parameter Index (SPI) for the Initiator or Responder.

Examples:

```
ike.init_spi; content:"18fe9b731f9f8034";
ike.resp_spi; content:"a00b8ef0902bb8ec";
```

`ike.init_spi` and `ike.resp_spi` are 'sticky buffer'.

`ike.init_spi` and `ike.resp_spi` can be used as `fast_pattern`.

8.31.2 ike.chosen_sa_attribute

Match on an attribute value of the chosen Security Association (SA) by the Responder. Supported for IKEv1 are: `alg_enc`, `alg_hash`, `alg_auth`, `alg_dh`, `alg_prf`, `sa_group_type`, `sa_life_type`, `sa_life_duration`, `sa_key_length` and `sa_field_size`. IKEv2 supports `alg_enc`, `alg_auth`, `alg_prf` and `alg_dh`.

If there is more than one chosen SA the event `MultipleServerProposal` is set. The attributes of the first SA are used for this keyword.

Examples:

```
ike.chosen_sa_attribute:alg_hash=2;
ike.chosen_sa_attribute:sa_key_length=128;
```

8.31.3 ike.exchtype

Match on the value of the Exchange Type.

This keyword takes a numeric argument after a colon and supports additional qualifiers, such as:

- > (greater than)
- < (less than)
- >= (greater than or equal)
- <= (less than or equal)
- `arg1-arg2` (range)

Examples:

```
ike.exchtype:5;
ike.exchtype:>=2;
```

8.31.4 ike.vendor

Match a vendor ID against the list of collected vendor IDs.

Examples:

```
ike.vendor:4a131c81070358455c5728f20e95452f;
```

`ike.vendor` supports multiple buffer matching, see *Multiple Buffer Matching*.

8.31.5 ike.key_exchange_payload

Match against the public key exchange payload (e.g. Diffie-Hellman) of the server or client.

Examples:

```
ike.key_exchange_payload; content:"|6d026d5616c45be05e5b898411e9|"
```

`ike.key_exchange_payload` is a 'sticky buffer'.

`ike.key_exchange_payload` can be used as `fast_pattern`.

8.31.6 ike.key_exchange_payload_length

Match against the length of the public key exchange payload (e.g. Diffie-Hellman) of the server or client.

This keyword takes a numeric argument after a colon and supports additional qualifiers, such as:

- > (greater than)
- < (less than)
- >= (greater than or equal)
- <= (less than or equal)
- `arg1-arg2` (range)

Examples:

```
ike.key_exchange_payload_length:>132
```

8.31.7 ike.nonce_payload

Match against the nonce of the server or client.

Examples:

```
ike.nonce_payload; content:"|6d026d5616c45be05e5b898411e9|"
```

`ike.nonce_payload` is a 'sticky buffer'.

`ike.nonce_payload` can be used as `fast_pattern`.

8.31.8 ike.nonce_payload_length

Match against the length of the nonce of the server or client.

This keyword takes a numeric argument after a colon and supports additional qualifiers, such as:

- > (greater than)
- < (less than)
- >= (greater than or equal)
- <= (less than or equal)
- `arg1-arg2` (range)

Examples:

```
ike.nonce_payload_length:132
ike.nonce_payload_length:>132
```

8.31.9 Additional information

More information on the protocol and the data contained in it can be found here: https://tools.ietf.org/html/rfc2409

8.32 HTTP2 Keywords

HTTP2 frames are grouped into transactions based on the stream identifier it it is not 0. For frames with stream identifier 0, whose effects are global for the connection, a transaction is created for each frame.

8.32.1 http2.frametype

Match on the frame type present in a transaction.

Examples:

```
http2.frametype:GOAWAY;
```

8.32.2 http2.errorcode

Match on the error code in a GOWAY or RST_STREAM frame

Examples:

```
http2.errorcode: NO_ERROR;
http2.errorcode: INADEQUATE_SECURITY;
```

8.32.3 http2.priority

Match on the value of the HTTP2 priority field present in a PRIORITY or HEADERS frame.

This keyword takes a numeric argument after a colon and supports additional qualifiers, such as:

- > (greater than)
- < (less than)
- `x-y` (range between values x and y)

Examples:

```
http2.priority:2;
http2.priority:>100;
http2.priority:32-64;
```

8.32.4 http2.window

Match on the value of the HTTP2 value field present in a WINDOWUPDATE frame.

This keyword takes a numeric argument after a colon and supports additional qualifiers, such as:

- > (greater than)
- < (less than)
- `x-y` (range between values x and y)

Examples:

```
http2.window:1;
http2.window:<100000;
```

8.32.5 http2.size_update

Match on the size of the HTTP2 Dynamic Headers Table. More information on the protocol can be found here: https://tools.ietf.org/html/rfc7541#section-6.3

This keyword takes a numeric argument after a colon and supports additional qualifiers, such as:

- > (greater than)
- < (less than)
- `x-y` (range between values x and y)

Examples:

```
http2.size_update:1234;
http2.size_update:>4096;
```

8.32.6 http2.settings

Match on the name and value of a HTTP2 setting from a SETTINGS frame.

This keyword takes a numeric argument after a colon and supports additional qualifiers, such as:

- > (greater than)
- < (less than)
- `x-y` (range between values x and y)

Examples:

```
http2.settings:SETTINGS_ENABLE_PUSH=0;
http2.settings:SETTINGS_HEADER_TABLE_SIZE>4096;
```

8.32.7 http2.header_name

Match on the name of a HTTP2 header from a HEADER frame (or PUSH_PROMISE or CONTINUATION).

Examples:

```
http2.header_name; content:"agent";
```

`http2.header_name` is a 'sticky buffer'.

`http2.header_name` can be used as `fast_pattern`.

`http2.header_name` supports multiple buffer matching, see *Multiple Buffer Matching*.

8.32.8 Additional information

More information on the protocol can be found here: https://tools.ietf.org/html/rfc7540

8.33 Quic Keywords

Suricata implements initial support for Quic by parsing the Quic version.

Suricata also derives a CYU hash for earlier versions of Quic.

Quic app-layer parsing must be enabled in the Suricata config file (set 'app-layer.protocols.quic.enabled' to 'yes').

8.33.1 quic.cyu.hash

Match on the CYU hash

Examples:

```
alert quic any any -> any any (msg:"QUIC CYU HASH"; \
  quic.cyu.hash; content:"7b3ceb1adc974ad360cfa634e8d0a730"; \
  sid:1;)
```

`quic.cyu.hash` supports multiple buffer matching, see *Multiple Buffer Matching*.

8.33.2 quic.cyu.string

Match on the CYU string

Examples:

```
alert quic any any -> any any (msg:"QUIC CYU STRING"; \
  quic.cyu.string; content:"46,PAD-SNI-VER-CCS-UAID-TCID-PDMD-SMHL-ICSL-NONP-MIDS-SCLS-
↪CSCT-COPT-IRTT-CFCW-SFCW"; \
  sid:2;)
```

`quic.cyu.string` supports multiple buffer matching, see *Multiple Buffer Matching*.

8.33.3 quic.version

Sticky buffer for matching on the Quic header version in long headers.

Examples:

```
alert quic any any -> any any (msg:"QUIC VERSION"; \
  quic.version; content:"Q046"; \
  sid:3;)
```

8.33.4 Additional information

More information on CYU Hash can be found here: https://engineering.salesforce.com/gquic-protocol-analysis-and-fingerprinting-in-zeek-a4178855d75f

More information on the protocol can be found here: https://datatracker.ietf.org/doc/html/draft-ietf-quic-transport-17

8.34 Generic App Layer Keywords

8.34.1 app-layer-protocol

Match on the detected app-layer protocol.

Syntax:

```
app-layer-protocol:[!]<protocol>;
```

Examples:

```
app-layer-protocol:ssh;
app-layer-protocol:!tls;
app-layer-protocol:failed;
```

A special value 'failed' can be used for matching on flows in which protocol detection failed. This can happen if Suricata doesn't know the protocol or when certain 'bail out' conditions happen.

Bail out conditions

Protocol detection gives up in several cases:

- both sides are inspected and no match was found
- side A detection failed, side B has no traffic at all (e.g. FTP data channel)
- side A detection failed, side B has so little data detection is inconclusive

In these last 2 cases the `app-layer-event:applayer_proto_detection_skipped` is set.

8.34.2 app-layer-event

Match on events generated by the App Layer Parsers and the protocol detection engine.

Syntax:

```
app-layer-event:<event name>;
```

Examples:

```
app-layer-event:applayer_mismatch_protocol_both_directions;
app-layer-event:http.gzip_decompression_failed;
```

Protocol Detection

applayer_mismatch_protocol_both_directions

The toserver and toclient directions have different protocols. For example a client talking HTTP to a SSH server.

applayer_wrong_direction_first_data

Some protocol implementations in Suricata have a requirement with regards to the first data direction. The HTTP parser is an example of this.

https://redmine.openinfosecfoundation.org/issues/993

applayer_detect_protocol_only_one_direction

Protocol detection only succeeded in one direction. For FTP and SMTP this is expected.

applayer_proto_detection_skipped

Protocol detection was skipped because of *Bail out conditions*.

8.35 Xbits Keyword

Set, unset, toggle and check for bits stored per host or ip_pair.

Syntax:

```
xbits:<set|unset|isset|isnotset|toggle>,<name>,track <ip_src|ip_dst|ip_pair>;
xbits:<set|unset|isset|toggle>,<name>,track <ip_src|ip_dst|ip_pair> \
    [,expire <seconds>];
xbits:<set|unset|isset|toggle>,<name>,track <ip_src|ip_dst|ip_pair> \
    [,expire <seconds>];
```

8.35.1 Notes

- No difference between using `hostbits` and `xbits` with `track ip_<src|dst>`
- If you `set` on a client request and use `track ip_dst`, if you want to match on the server response, you check it (`isset`) with `track ip_src`.
- To not alert, use `noalert;`
- the `toggle` option will flip the value of the xbits.
- See also:
  - https://blog.inliniac.net/2014/12/21/crossing-the-streams-in-suricata/
  - http://www.cipherdyne.org/blog/2013/07/crossing-the-streams-in-ids-signature-languages.html

YAML settings

Bits that are stored per host are stored in the Host table. This means that host table settings affect hostsbits and xbits per host.

Bits that are stored per IP pair are stored in the IPPair table. This means that ippair table settings, especially memcap, affect xbits per ip_pair.

Threading

Due to subtle timing issues between threads the order of sets and checks can be slightly unpredictable.

Unix Socket

Hostbits can be added, removed and listed through the unix socket.

Add:

```
suricatasc -c "add-hostbit <ip> <bit name> <expire in seconds>"
suricatasc -c "add-hostbit 1.2.3.4 blacklist 3600"
```

If a hostbit is added for an existing hostbit, it's expiry timer is updated.

Remove:

```
suricatasc -c "remove-hostbit <ip> <bit name>"
suricatasc -c "remove-hostbit 1.2.3.4 blacklist"
```

List:

```
suricatasc -c "list-hostbit <ip>"
suricatasc -c "list-hostbit 1.2.3.4"
```

This results in:

```
{
    "message":
    {
       "count": 1,
       "hostbits":
            [{
                "expire": 89,
                "name": "blacklist"
            }]
    },
    "return": "OK"
}
```

Examples

Creating a SSH blacklist

Below is an example of rules incoming to a SSH server.

The first 2 rules match on a SSH software version often used in bots. They drop the traffic and create an 'xbit' 'badssh' for the source ip. It expires in an hour:

```
drop ssh any any -> $MYSERVER 22 (msg:"DROP libssh incoming";   \
  flow:to_server,established; ssh.softwareversion:"libssh";     \
  xbits:set, badssh, track ip_src, expire 3600; sid:4000000005;)
drop ssh any any -> $MYSERVER 22 (msg:"DROP PUTTY incoming";    \
  flow:to_server,established; ssh.softwareversion:"PUTTY";      \
  xbits:set, badssh, track ip_src, expire 3600; sid:4000000007;)
```

Then the following rule simply drops any incoming traffic to that server that is on that 'badssh' list:

```
drop ssh any any -> $MYSERVER 22 (msg:"DROP BLACKLISTED";       \
  xbits:isset, badssh, track ip_src; sid:4000000006;)
```

8.36 Alert Keywords

In addition to the action, alerting behavior can be controlled in the rule body using the `noalert` and `alert` keywords. Additionally, alerting behavior is controlled by *Thresholding Keywords*.

8.36.1 noalert

A rule that specifies `noalert` will not generate an alert when it matches, but rule actions will still be performed.

`noalert` is often used in rules that set a `flowbit` for common patterns.

`noalert` is meant for use with rule actions `alert`, `drop`, `reject` that all explicitly or implicitly include `alert`.

alert http any any -> any any (http.user_agent; content:"Mozilla/5.0"; startwith; endswith; flowbits:set,mozilla-ua; noalert; sid:1;)

This example sets a flowbit "mozilla-ua" on matching, but does not generate an alert due to the presence of `noalert`.

Note: this option is also used as `flowbits:noalert;`, see *Flow Keywords*

8.36.2 alert

A rule that specifies `alert` will generate an alert, even if the rule action doesn't imply alerting.

This keyword can be used to implement an "alert then pass"-logic.

pass http any any -> any any (http.user_agent; content:"Mozilla/5.0"; startwith; endswith; alert; sid:1;)

This example would pass the rest of the HTTP flow with the Mozilla/5.0 user-agent, generating an alert for the "pass" event.

8.37 Thresholding Keywords

Thresholding can be configured per rule and also globally, see *Global-Thresholds*.

Note: mixing rule and global thresholds is not supported in 1.3 and before. See bug #425. For the state of the support in 1.4 see *Global thresholds vs rule thresholds*

8.37.1 threshold

The threshold keyword can be used to control the rule's alert frequency. It has 3 modes: threshold, limit and both.

Syntax:

```
threshold: type <threshold|limit|both>, track <by_src|by_dst|by_rule|by_both>, count <N>,
↪ seconds <T>
```

type "threshold"

This type can be used to set a minimum threshold for a rule before it generates alerts. A threshold setting of N means on the Nth time the rule matches an alert is generated.

Example:

```
alert tcp !$HOME_NET any -> $HOME_NET 25 (msg:"ET POLICY Inbound Frequent Emails -␣
↪Possible Spambot Inbound"; \
flow:established; content:"mail from|3a|"; nocase;                                ␣
↪                 \
threshold: type threshold, track by_src, count 10, seconds 60;                    ␣
↪                 \
reference:url,doc.emergingthreats.net/2002087; classtype:misc-activity; sid:2002087;␣
↪rev:10;)
```

This signature only generates an alert if we get 10 inbound emails or more from the same server in a time period of one minute.

If a signature sets a flowbit, flowint, etc. those actions are still performed for each of the matches.

> *Rule actions drop (IPS mode) and reject are applied to each packet (not only the one that meets the threshold condition).*

type "limit"

This type can be used to make sure you're not getting flooded with alerts. If set to limit N, it alerts at most N times.

Example:

```
alert http $HOME_NET any -> any $HTTP_PORTS (msg:"ET USER_AGENTS Internet Explorer 6 in␣
↪use - Significant Security Risk"; \
flow:to_server,established; content:"|0d 0a|User-Agent|3a| Mozilla/4.0 (compatible|3b|␣
↪MSIE 6.0|3b|";                \
threshold: type limit, track by_src, seconds 180, count 1;                        ␣
↪                              \
reference:url,doc.emergingthreats.net/2010706; classtype:policy-violation; sid:2010706;␣
↪rev:7;)
```

In this example at most 1 alert is generated per host within a period of 3 minutes if MSIE 6.0 is detected.

If a signature sets a flowbit, flowint, etc. those actions are still performed for each of the matches.

> *Rule actions drop (IPS mode) and reject are applied to each packet (not only the one that meets the limit condition).*

type "both"

This type is a combination of the "threshold" and "limit" types. It applies both thresholding and limiting.

Example:

```
alert tcp $HOME_NET 5060 -> $EXTERNAL_NET any (msg:"ET VOIP Multiple Unauthorized SIP␣
↪Responses TCP"; \
flow:established,from_server; content:"SIP/2.0 401 Unauthorized"; depth:24;       ␣
↪        \
```

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```
threshold: type both, track by_src, count 5, seconds 360;
↪        \
reference:url,doc.emergingthreats.net/2003194; classtype:attempted-dos; sid:2003194;
↪rev:6;)
```

This alert will only generate an alert if within 6 minutes there have been 5 or more "SIP/2.0 401 Unauthorized" responses, and it will alert only once in that 6 minutes.

If a signature sets a flowbit, flowint, etc. those actions are still performed for each of the matches.

> *Rule actions drop (IPS mode) and reject are applied to each packet.*

8.37.2 detection_filter

The detection_filter keyword can be used to alert on every match after a threshold has been reached. It differs from the threshold with type threshold in that it generates an alert for each rule match after the initial threshold has been reached, where the latter will reset it's internal counter and alert again when the threshold has been reached again.

Syntax:

```
detection_filter: track <by_src|by_dst|by_rule|by_both>, count <N>, seconds <T>
```

Example:

```
alert http $EXTERNAL_NET any -> $HOME_NET any \
     (msg:"ET WEB_SERVER WebResource.axd access without t (time) parameter - possible
↪ASP padding-oracle exploit"; \
     flow:established,to_server; content:"GET"; http_method; content:"WebResource.axd";
↪http_uri; nocase;          \
     content:!"&t="; http_uri; nocase; content:!"&amp|3b|t="; http_uri; nocase;
↪                           \
     detection_filter:track by_src,count 15,seconds 2;
↪                           \
     reference:url,netifera.com/research/; reference:url,www.microsoft.com/technet/
↪security/advisory/2416728.mspx; \
     classtype:web-application-attack; sid:2011807; rev:5;)
```

Alerts each time after 15 or more matches have occurred within 2 seconds.

If a signature sets a flowbit, flowint, etc. those actions are still performed for each of the matches.

> *Rule actions drop (IPS mode) and reject are applied to each packet that generate an alert*

8.38 IP Reputation Keyword

IP Reputation can be used in rules through a new rule keyword "iprep".

For more information about IP Reputation see *IP Reputation Config* and *IP Reputation Format*.

8.38.1 iprep

The iprep directive matches on the IP reputation information for a host.

```
iprep:<side to check>,<category>,<operator>,<reputation score>
```

side to check: <any|src|dst|both>

`category`: the category short name

`operator`: <, <=, >, >=, =

`reputation score`: 0-127

Example:

```
alert ip $HOME_NET any -> any any (msg:"IPREP internal host talking to CnC server";
↪flow:to_server; iprep:dst,CnC,>,30; sid:1; rev:1;)
```

This rule will alert when a system in `$HOME_NET` acts as a client while communicating with any IP in the CnC category that has a reputation score set to greater than 30.

isset and isnotset

`isset` and `isnotset` can be used to test reputation "membership"

```
iprep:<side to check>,<category>,<isset|issnotset>
```

`side to check`: <any|src|dst|both>

`category`: the category short name

To test whether an IP is part of an iprep set at all, the `isset` can be used. It acts as a `>=,0` statement.

drop ip $HOME_NET any -> any any (iprep:src,known-bad-hosts,isset; sid:1;)

In this example traffic to any IP with a score in `known-bad-hosts` would be blocked.

`isnotset` can be used to test if an IP is not a part of the set.

drop ip $HOME_NET any -> any any (iprep:src,trusted-hosts,isnotset; sid:1;)

In this example traffic for a host w/o a trust score would be blocked.

IP-only

The "iprep" keyword is compatible to "IP-only" rules. This means that a rule like:

```
alert ip any any -> any any (msg:"IPREP High Value CnC"; iprep:src,CnC,>,100; sid:1;
↪rev:1;)
```

will only be checked once per flow-direction.

8.39 IP Addresses Match

Matching on IP addresses can be done via the IP tuple parameters or via the iprep keywords (see *IP Reputation Keyword*). Some keywords providing interaction with datasets are also available.

8.39.1 ip.src

The *ip.src* keyword is a sticky buffer to match on source IP address. It matches on the binary representation and is compatible with datasets of types *ip* and *ipv4*.

Example:

```
alert tcp $EXTERNAL_NET any -> $HOME_NET any (msg:"Inbound bad list"; flow:to_server; ip.
↪src; dataset:isset,badips,type ip,load badips.list; sid:1; rev:1;)
```

8.39.2 ip.dst

The *ip.dst* keyword is a sticky buffer to match on destination IP address. It matches on the binary representation and is compatible with the dataset of type *ip* and *ipv4*.

Example:

```
alert tcp $HOME_NET any -> any any (msg:"Outbound bad list"; flow:to_server; ip.dst;␣
↪dataset:isset,badips,type ip,load badips.list; sid:1; rev:1;)
```

8.40 Config Rules

Config rules are rules that when matching, will change the configuration of Suricata for a flow, transaction, packet or other unit.

Example:

```
config dns any any -> any any (dns.query; content:"suricata"; config: logging disable,␣
↪type tx, scope tx; sid:1;)
```

This example will detect if a DNS query contains the string *suricata* and if so disable the DNS transaction logging. This means that *eve.json* records, but also Lua output, will not be generated/triggered for this DNS transaction.

8.40.1 Keyword

The *config* rule keyword provides the setting and the scope of the change.

Syntax:

```
config:<subsys> <action>, type <type>, scope <scope>;
```

subsys can be set to:

- *logging* setting affects logging.

type can be set to:

- *tx* sub type of the *subsys*. If *subsys* is set to *logging*, setting the *type* to *tx* means transaction logging is affected.

scope can be set to:

- *tx* setting affects the matching transaction.

The *action* in <*subsys*> is currently limited to *disable*.

8.40.2 Action

Config rules can, but don't have to, use the *config* rule action. The *config* rule action won't generate an alert when the rule matches, but the rule actions will still be applied. It is equivalent to *alert ... (noalert; ...)*.

8.41 Datasets

Using the `dataset` and `datarep` keyword it is possible to match on large amounts of data against any sticky buffer.

For example, to match against a DNS black list called `dns-bl`:

```
dns.query; dataset:isset,dns-bl;
```

These keywords are aware of transforms. So to look up a DNS query against a MD5 black list:

```
dns.query; to_md5; dataset:isset,dns-bl;
```

8.41.1 Global config (optional)

Datasets can optionally be defined in the main config. Sets can also be declared from the rule syntax.

Example of sets for tracking unique values:

```
datasets:
  ua-seen:
    type: string
    state: ua-seen.lst
  dns-sha256-seen:
    type: sha256
    state: dns-sha256-seen.lst
```

Rules to go with the above:

alert dns any any -> any any (msg:"dns list test"; dns.query; to_sha256; dataset:isset,dns-sha256-seen; sid:123; rev:1;)

alert http any any -> any any (msg: "http user-agent test"; http.user_agent; dataset:set,ua-seen; sid:234; rev:1;)

It is also possible to optionally define global default memcap and hashsize.

Example:

```
datasets:
  defaults:
    memcap: 100mb
    hashsize: 2048
  ua-seen:
```

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```
    type: string
    load: ua-seen.lst
```

or define memcap and hashsize per dataset.

Example:

```
datasets:
  ua-seen:
    type: string
    load: ua-seen.lst
    memcap: 10mb
    hashsize: 1024
```

Note: The *hashsize* should be close to the amount of entries in the dataset to avoid collisions. If it's set too low, this could result in rather long startup time.

8.41.2 Rule keywords

dataset

Datasets are binary: something is in the set or it's not.

Syntax:

```
dataset:<cmd>,<name>,<options>;

dataset:<set|unset|isset|isnotset>,<name> \
    [, type <string|md5|sha256|ipv4|ip>, save <file name>, load <file name>, state <file␣
↪name>, memcap <size>, hashsize <size>];
```

type <type>
the data type: string, md5, sha256, ipv4, ip

load <file name>
file name for load the data when Suricata starts up

state
sets file name for loading and saving a dataset

save <file name>
advanced option to set the file name for saving the in-memory data when Suricata exits.

memcap <size>
maximum memory limit for the respective dataset

hashsize <size>
allowed size of the hash for the respective dataset

Note: 'type' is mandatory and needs to be set.

Note: 'load' and 'state' or 'save' and 'state' cannot be mixed.

Example rules could look like:

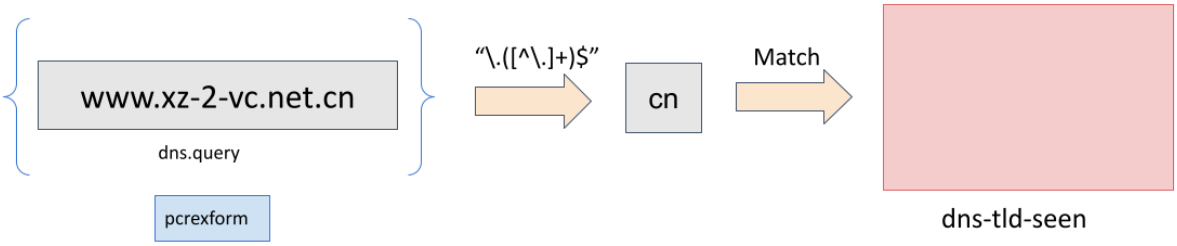
1. Detect unique User-Agents:

alert http any any -> any any (msg:"LOCAL HTTP new UA"; http.user_agent; dataset:set,http-ua-seen, type string, state http-ua-seen.csv; sid:8000001; rev:1;)

2. Detect unique TLDs:

alert dns $HOME_NET any -> any any (msg:"LOCAL DNS unique TLD"; dns.query; pcrexform:"\.([^\.]+)$"; dataset:set,dns-tld-seen, type string, state dns-tld-seen.csv; sid:8000002; rev:1;)

Following image is a pictorial representation of how the `pcrexform` works on domain names to find TLDs in the dataset `dns-tld-seen`:



Notice how it is not possible to do certain operations alone with datasets (example 2 above), but, it is possible to use a combination of other rule keywords. Keep in mind the cost of additional keywords though e.g. in the second example rule above, negative performance impact can be expected due to `pcrexform`.

datarep

Data Reputation allows matching data against a reputation list.

Syntax:

```
datarep:<name>,<operator>,<value>, \
    [, load <file name>, type <string|md5|sha256|ipv4|ip>, memcap <size>, hashsize <size>
↪];
```

Example rules could look like:

```
alert dns any any -> any any (dns.query; to_md5; datarep:dns_md5, >, 200, load dns_md5.
↪rep, type md5, memcap 100mb, hashsize 2048; sid:1;)
alert dns any any -> any any (dns.query; to_sha256; datarep:dns_sha256, >, 200, load dns_
↪sha256.rep, type sha256; sid:2;)
alert dns any any -> any any (dns.query; datarep:dns_string, >, 200, load dns_string.rep,
↪ type string; sid:3;)
```

In these examples the DNS query string is checked against three different reputation lists. A MD5 list, a SHA256 list, and a raw string (buffer) list. The rules will only match if the data is in the list and the reputation value is higher than 200.

8.41.3 Rule Reloads

Sets that are defined in the yaml, or sets that only use *state* or *save*, are considered *dynamic* sets. These are not reloaded during rule reloads.

Sets that are defined in rules using only *load* are considered *static* tests. These are not expected to change during runtime. During rule reloads these are reloaded from disk. This reload is effective when the complete rule reload process is complete.

8.41.4 Unix Socket

dataset-add

Unix Socket command to add data to a set. On success, the addition becomes active instantly.

Syntax:

```
dataset-add <set name> <set type> <data>
```

set name
: Name of an already defined dataset

type
: Data type: string, md5, sha256, ipv4, ip

data
: Data to add in serialized form (base64 for string, hex notation for md5/sha256, string representation for ipv4/ip)

Example adding 'google.com' to set 'myset':

```
dataset-add myset string Z29vZ2xlLmNvbQ==
```

dataset-remove

Unix Socket command to remove data from a set. On success, the removal becomes active instantly.

Syntax:

```
dataset-remove <set name> <set type> <data>
```

set name
: Name of an already defined dataset

type
: Data type: string, md5, sha256, ipv4, ip

data
: Data to remove in serialized form (base64 for string, hex notation for md5/sha256, string representation for ipv4/ip)

dataset-clear

Unix Socket command to remove all data from a set. On success, the removal becomes active instantly.

Syntax:

```
dataset-clear <set name> <set type>
```

set name
Name of an already defined dataset

type
Data type: string, md5, sha256, ipv4, ip

dataset-lookup

Unix Socket command to test if data is in a set.

Syntax:

```
dataset-lookup <set name> <set type> <data>
```

set name
Name of an already defined dataset

type
Data type: string, md5, sha256, ipv4, ip

data
Data to test in serialized form (base64 for string, hex notation for md5/sha256, string notation for ipv4/ip)

Example testing if 'google.com' is in the set 'myset':

```
dataset-lookup myset string Z29vZ2xlLmNvbQ==
```

dataset-dump

Unix socket command to trigger a dump of datasets to disk.

Syntax:

```
dataset-dump
```

8.41.5 File formats

Datasets use a simple CSV format where data is per line in the file.

data types

string
in the file as base64 encoded string

md5
in the file as hex encoded string

sha256
in the file as hex encoded string

ipv4
in the file as string

ip
in the file as string, it can be IPv6 or IPv4 address (standard notation or IPv4 in IPv6 one)

dataset

Datasets have a simple structure, where there is one piece of data per line in the file.

Syntax:

```
<data>
```

e.g. for ua-seen with type string:

```
TW96aWxsYS80LjAgKGNvbXBhdGlibGU7ICk=
```

which when piped to `base64 -d` reveals its value:

```
Mozilla/4.0 (compatible; )
```

datarep

The datarep format follows the dataset, expect that there are 1 more CSV field:

Syntax:

```
<data>,<value>
```

8.41.6 File Locations

Dataset filenames configured in the `suricata.yaml` can exist anywhere on your filesytem.

When a dataset filename is specified in rule, the following *rules* are applied:

- For `load`, the filename is opened relative to the rule file containing the rule. Absolute filenames and parent directory traversals are allowed.
- For `save` and `state` the filename is relative to `$LOCALSTATEDIR/suricata/data`. On many installs this will be `/var/lib/suricata/data`, but run `suricata --build-info` and check the value of `--localstatedir` to verify this location onn your installation.
  - Absolute filenames, or filenames containing parent directory traversal (`..`) are not allowed unless the configuration paramater `datasets.allow-absolute-filenames` is set to `true`.

8.41.7 Security

As datasets potentially allow a rule distributor write access to your system with `save` and `state` dataset rules, the locations allowed are strict by default, however there are two dataset options to tune the security of rules utilizing dataset filenames:

```
datasets:
  rules:
    # Set to true to allow absolute filenames and filenames that use
    # ".." components to reference parent directories in rules that specify
    # their filenames.
    allow-absolute-filenames: false

    # Allow datasets in rules write access for "save" and
    # "state". This is enabled by default, however write access is
    # limited to the data directory.
    allow-write: true
```

By setting `datasets.rules.allow-write` to false, all `save` and `state` rules will fail to load. This option is enabled by default to preserve compatiblity with previous 6.0 Suricata releases, however may change in a future major release.

Pre-Suricata 6.0.13 behavior can be restored by setting `datasets.rules.allow-absolute-filenames` to `true`, however allowing so will allow any rule to overwrite any file on your system that Suricata has write access to.

8.42 Lua Scripting for Detection

Note: Lua is disabled by default for use in rules, it must be enabled in the configuration file. See the `security.lua` section of `suricata.yaml` and enable `allow-rules`.

Syntax:

```
lua:[!]<scriptfilename>;
```

The script filename will be appended to your default rules location.

The script has 2 parts, an init function and a match function. First, the init.

8.42.1 Init function

```
function init (args)
    local needs = {}
    needs["http.request_line"] = tostring(true)
    return needs
end
```

The init function registers the buffer(s) that need inspection. Currently the following are available:

- packet -- entire packet, including headers
- payload -- packet payload (not stream)
- buffer -- the current sticky buffer

- stream
- dnp3
- dns.request
- dns.response
- dns.rrname
- ssh
- smtp
- tls
- http.uri
- http.uri.raw
- http.request_line
- http.request_headers
- http.request_headers.raw
- http.request_cookie
- http.request_user_agent
- http.request_body
- http.response_headers
- http.response_headers.raw
- http.response_body
- http.response_cookie

All the HTTP buffers have a limitation: only one can be inspected by a script at a time.

8.42.2 Match function

```
function match(args)
    a = tostring(args["http.request_line"])
    if #a > 0 then
        if a:find("^POST%s+/.*%.php%s+HTTP/1.0$") then
            return 1
        end
    end

    return 0
end
```

The script can return 1 or 0. It should return 1 if the condition(s) it checks for match, 0 if not.

Entire script:

```
function init (args)
    local needs = {}
    needs["http.request_line"] = tostring(true)
    return needs
```

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```
end

function match(args)
    a = tostring(args["http.request_line"])
    if #a > 0 then
        if a:find("^POST%s+/.*%.php%s+HTTP/1.0$") then
            return 1
        end
    end

    return 0
end

return 0
```

A comprehensive list of existing lua functions - with examples - can be found at *Lua functions* (some of them, however, work only for the lua-output functionality).

8.43 Differences From Snort

This document is intended to highlight the major differences between Suricata and Snort that apply to rules and rule writing.

Where not specified, the statements below apply to Suricata. In general, references to Snort refer to the version 2.9 branch.

8.43.1 Automatic Protocol Detection

- Suricata does automatic protocol detection of the following application layer protocols:
  - dcerpc
  - dnp3
  - dns
  - http
  - imap (detection only by default; no parsing)
  - ftp
  - modbus (disabled by default; minimalist probe parser; can lead to false positives)
  - smb
  - smb2 (disabled internally inside the engine)
  - smtp
  - ssh
  - tls (SSLv2, SSLv3, TLSv1, TLSv1.1 and TLSv1.2)
- In Suricata, protocol detection is port agnostic (in most cases). In Snort, in order for the `http_inspect` and other preprocessors to be applied to traffic, it has to be over a configured port.

  - Some configurations for app-layer in the Suricata yaml can/do by default specify specific destination ports (e.g. DNS)
  - **You can look on 'any' port without worrying about the performance impact that you would have to be concerned about with Snort.**
- If the traffic is detected as HTTP by Suricata, the `http_*` buffers are populated and can be used, regardless of port(s) specified in the rule.
- You don't have to check for the http protocol (i.e. `alert http ...`) to use the `http_*` buffers although it is recommended.
- If you are trying to detect legitimate (supported) application layer protocol traffic and don't want to look on specific port(s), the rule should be written as `alert <protocol> ...` with `any` in place of the usual protocol port(s). For example, when you want to detect HTTP traffic and don't want to limit detection to a particular port or list of ports, the rules should be written as `alert http ...` with `any` in place of `$HTTP_PORTS`.
  - You can also use `app-layer-protocol:<protocol>;` inside the rule instead.

  So, instead of this Snort rule:

```
alert tcp $HOME_NET any -> $EXTERNAL_NET $HTTP_PORTS ...
```

  Do this for Suricata:

```
alert http $HOME_NET -> $EXTERNAL_NET any ...
```

  Or:

```
alert tcp $HOME_NET any -> $EXTERNAL_NET any (app-layer-protocol:http; ...
```

8.43.2 `urilen` Keyword

- Ranges given in the `urilen` keyword are inclusive for Snort but not inclusive for Suricata.

  Example: `urilen:2<>10`

  - Snort interprets this as, "the URI length must be **greater than or equal to** 2, and **less than or equal to** 10".
  - Suricata interprets this as "the URI length must be **greater than** 2 and **less than** 10".
  - There is a request to have Suricata behave like Snort in future versions – https://redmine.openinfosecfoundation.org/issues/1416
    - Currently on hold
- By default, with *Suricata*, `urilen` applies to the **normalized** buffer
  - Use `,raw` for raw buffer
  - e.g. `urilen:>20,raw;`
- By default, with *Snort*, `urilen` applies to the **raw** buffer
  - Use `,norm` for normalized buffer
  - e.g. `urilen:>20,norm;`

8.43.3 `http_uri` Buffer

- In Snort, the `http_uri` buffer normalizes '+' characters (0x2B) to spaces (0x20).
  - Suricata can do this as well but you have to explicitly set `query-plusspace-decode: yes` in the `libhtp` section of Suricata's yaml file.
- https://redmine.openinfosecfoundation.org/issues/1035
- https://github.com/inliniac/suricata/pull/620

8.43.4 `http_header` Buffer

- In Snort, the `http_header` buffer includes the CRLF CRLF (0x0D 0x0A 0x0D 0x0A) that separates the end of the last HTTP header from the beginning of the HTTP body. Suricata includes a CRLF after the last header in the `http_header` buffer but not an extra one like Snort does. If you want to match the end of the buffer, use either the `http_raw_header` buffer, a relative `isdataat` (e.g. `isdataat:!1,relative`) or a PCRE (although PCRE will be worse on performance).
- Suricata *will* include CRLF CRLF at the end of the `http_raw_header` buffer like Snort does.
- Snort will include a *leading* CRLF in the `http_header` buffer of *server responses* (but not client requests). Suricata does not have the leading CRLF in the `http_header` buffer of the server response or client request.
- In the `http_header` buffer, Suricata will normalize HTTP header lines such that there is a single space (0x20) after the colon (':') that separates the header name from the header value; this single space replaces zero or more whitespace characters (including tabs) that may be present in the raw HTTP header line immediately after the colon. If the extra whitespace (or lack thereof) is important for matching, use the `http_raw_header` buffer instead of the `http_header` buffer.
- Snort will also normalize superfluous whitespace between the header name and header value like Suricata does but only if there is at least one space character (0x20 only so not 0x90) immediately after the colon. This means that, unlike Suricata, if there is no space (or if there is a tab) immediately after the colon before the header value, the content of the header line will remain unchanged in the `http_header` buffer.
- When there are duplicate HTTP headers (referring to the header name only, not the value), the normalized buffer (`http_header`) will concatenate the values in the order seen (from top to bottom), with a comma and space (", ") between each of them. If this hinders detection, use the `http_raw_header` buffer instead.

  Example request:

  ```
  GET /test.html HTTP/1.1
  Content-Length: 44
  Accept: */*
  Content-Length: 55
  ```

  The Content-Length header line becomes this in the `http_header` buffer:

  ```
  Content-Length: 44, 55
  ```

- The HTTP 'Cookie' and 'Set-Cookie' headers are **NOT** included in the `http_header` buffer; instead they are extracted and put into their own buffer – `http_cookie`. See the *http_cookie Buffer* section.
- The HTTP 'Cookie' and 'Set-Cookie' headers **ARE** included in the `http_raw_header` buffer so if you are trying to match on something like particular header ordering involving (or not involving) the HTTP Cookie headers, use the `http_raw_header` buffer.

- If 'enable_cookie' is set for Snort, the HTTP Cookie header names and trailing CRLF (i.e. "Cookie: \r\n" and "Set-Cooke \r\n") are kept in the `http_header` buffer. This is not the case for Suricata which removes the entire "Cookie" or "Set-Cookie" line from the `http_header` buffer.
- Other HTTP headers that have their own buffer (`http_user_agent`, `http_host`) are not removed from the `http_header` buffer like the Cookie headers are.
- When inspecting server responses and `file_data` is used, content matches in `http_*` buffers should come before `file_data` unless you use `pkt_data` to reset the cursor before matching in `http_*` buffers. Snort will not complain if you use `http_*` buffers after `file_data` is set.

8.43.5 `http_cookie` Buffer

- The `http_cookie` buffer will NOT include the header name, colon, or leading whitespace. i.e. it will not include "Cookie: " or "Set-Cookie: ".
- The `http_cookie` buffer does not include a CRLF (0x0D 0x0A) at the end. If you want to match the end of the buffer, use a relative `isdataat` or a PCRE (although PCRE will be worse on performance).
- There is no `http_raw_cookie` buffer in Suricata. Use `http_raw_header` instead.
- You do not have to configure anything special to use the 'http_cookie' buffer in Suricata. This is different from Snort where you have to set `enable_cookie` in the `http_inspect_server` preprocessor config in order to have the `http_cookie` buffer treated separate from the `http_header` buffer.
- If Snort has 'enable_cookie' set and multiple "Cookie" or "Set-Cookie" headers are seen, it will concatenate them together (with no separator between them) in the order seen from top to bottom.
- If a request contains multiple "Cookie" or "Set-Cookie" headers, the values will be concatenated in the Suricata `http_cookie` buffer, in the order seen from top to bottom, with a comma and space (", ") between each of them.

  Example request:

  ```
  GET /test.html HTTP/1.1
  Cookie: monster
  Accept: */*
  Cookie: elmo
  ```

  Suricata `http_cookie` buffer contents:

  ```
  monster, elmo
  ```

  Snort `http_cookie` buffer contents:

  ```
  monsterelmo
  ```

- Corresponding PCRE modifier: `C` (same as Snort)

8.43.6 New HTTP keywords

Suricata supports several HTTP keywords that Snort doesn't have.

Examples are `http_user_agent`, `http_host` and `http_content_type`.

See *HTTP Keywords* for all HTTP keywords.

8.43.7 `byte_extract` Keyword

- Suricata supports `byte_extract` from `http_*` buffers, including `http_header` which does not always work as expected in Snort.
- In Suricata, variables extracted using `byte_extract` must be used in the same buffer, otherwise they will have the value "0" (zero). Snort does allow cross-buffer byte extraction and usage.
- Be sure to always positively and negatively test Suricata rules that use `byte_extract` and `byte_test` to verify that they work as expected.

8.43.8 `byte_jump` Keyword

- Suricata allows a variable name from `byte_extract` or `byte_math` to be specified for the `nbytes` value. The value of `nbytes` must adhere to the same constraints as if it were supplied directly in the rule.

8.43.9 `byte_math` Keyword

- Suricata accepts `dce` as an endian value or as a separate keyword. `endian dce` or `dce` are equivalent.
- Suricata's rule parser rejects rules that repeat keywords in a single rule. E.g., `byte_math: endian big, endian little`.
- Suricata's rule parser accepts `rvalue` values of `0` to the maximum uint32 value. Snort rejects `rvalue` values of `0` and requires values to be between `[1..max-uint32 value]`.
- Suricata will never match if there's a zero divisor. Division by 0 is undefined.

8.43.10 `byte_test` Keyword

- Suricata allows a variable name from `byte_extract` or `byte_math` to be specified for the `nbytes` value. The value of `nbytes` must adhere to the same constraints as though a value was directly supplied by the rule.
- Suricata allows a variable name from `byte_extract` to be specified for the `nbytes` value. The value of `nbytes` must adhere to the same constraints as if it were supplied directly in the rule.

8.43.11 `isdataat` Keyword

- The `rawbytes` keyword is supported in the Suricata syntax but doesn't actually do anything.
- Absolute `isdataat` checks will succeed if the offset used is **less than** the size of the inspection buffer. This is true for Suricata and Snort.
- For *relative* `isdataat` checks, there is a **1 byte difference** in the way Snort and Suricata do the comparisons.
  - Suricata will succeed if the relative offset is **less than or equal to** the size of the inspection buffer. This is different from absolute `isdataat` checks.

  - Snort will succeed if the relative offset is **less than** the size of the inspection buffer, just like absolute `isdataat` checks.
  - Example - to check that there is no data in the inspection buffer after the last content match:
    * Snort: `isdataat:!0,relative;`
    * Suricata: `isdataat:!1,relative;`

- With Snort, the "inspection buffer" used when checking an `isdataat` keyword is generally the packet/segment with some exceptions:
  - With PAF enabled the PDU is examined instead of the packet/segment. When `file_data` or `base64_data` has been set, it is those buffers (unless `rawbytes` is set).
  - With some preprocessors - modbus, gtp, sip, dce2, and dnp3 - the buffer can be particular portions of those protocols (unless `rawbytes` is set).
  - With some preprocessors - rpc_decode, ftp_telnet, smtp, and dnp3 - the buffer can be particular *decoded* portions of those protocols (unless `rawbytes` is set).
- With Suricata, the "inspection buffer" used when checking an absolute `isdataat` keyword is the packet/segment if looking at a packet (e.g. `alert tcp-pkt...`) or the reassembled stream segments.
- In Suricata, a *relative* `isdataat` keyword **will apply to the buffer of the previous content match**. So if the previous content match is a `http_*` buffer, the relative `isdataat` applies to that buffer, starting from the end of the previous content match in that buffer. *Snort does not behave like this!*
- For example, this Suricata rule looks for the string ".exe" at the end of the URI; to do the same thing in the normalized URI buffer in Snort you would have to use a PCRE – `pcre:"/\x2Eexe$/U";`

```
alert http $HOME_NET any -> $EXTERNAL_NET any (msg:".EXE File Download Request";␣
↪flow:established,to_server; content:"GET"; http_method; content:".exe"; http_uri;␣
↪isdataat:!1,relative; priority:3; sid:18332111;)
```

- If you are unclear about behavior in a particular instance, you are encouraged to positively and negatively test your rules that use an `isdataat` keyword.

8.43.12 Relative PCRE

- You can do relative PCRE matches in normalized/special buffers with Suricata. Example:

```
content:".php?sign="; http_uri; pcre:"/^[a-zA-Z0-9]{8}$/UR";
```

- With Snort you can't combine the "relative" PCRE option ('R') with other buffer options like normalized URI ('U') – you get a syntax error.

8.43.13 `tls*` Keywords

In addition to TLS protocol identification, Suricata supports the storing of certificates to disk, verifying the validity dates on certificates, matching against the calculated SHA1 fingerprint of certificates, and matching on certain TLS/SSL certificate fields including the following:

- Negotiated TLS/SSL version.
- Certificate Subject field.
- Certificate Issuer field.
- Certificate SNI Field

For details see *SSL/TLS Keywords*.

8.43.14 `dns_query` Keyword

- Sets the detection pointer to the DNS query.
- Works like `file_data` does ("sticky buffer") but for a DNS request query.
- Use `pkt_data` to reset the detection pointer to the beginning of the packet payload.
- See *DNS Keywords* for details.

8.43.15 IP Reputation and `iprep` Keyword

- Snort has the "reputation" preprocessor that can be used to define whitelist and blacklist files of IPs which are used generate GID 136 alerts as well as block/drop/pass traffic from listed IPs depending on how it is configured.
- Suricata also has the concept of files with IPs in them but provides the ability to assign them:
  - Categories
  - Reputation score
- Suricata rules can leverage these IP lists with the `iprep` keyword that can be configured to match on:
  - Direction
  - Category
  - Value (reputation score)
- *Reputation*
- *IP Reputation Config*
- *IP Reputation Keyword*
- *IP Reputation Format*
- https://blog.inliniac.net/2012/11/21/ip-reputation-in-suricata/

8.43.16 Flowbits

- Suricata fully supports the setting and checking of flowbits (including the same flowbit) on the same packet/stream. Snort does not always allow for this.
- In Suricata, `flowbits:isset` is checked after the fast pattern match but before other `content` matches. In Snort, `flowbits:isset` is checked in the order it appears in the rule, from left to right.
- If there is a chain of flowbits where multiple rules set flowbits and they are dependent on each other, then the order of the rules or the `sid` values can make a difference in the rules being evaluated in the proper order and generating alerts as expected. See bug 1399 - https://redmine.openinfosecfoundation.org/issues/1399.
- *Flow Keywords*

8.43.17 flowbits:noalert;

A common pattern in existing rules is to use `flowbits:noalert;` to make sure a rule doesn't generate an alert if it matches.

Suricata allows using just `noalert;` as well. Both have an identical meaning in Suricata.

8.43.18 Negated Content Match Special Case

- For Snort, a *negated* content match where the starting point for searching is at or beyond the end of the inspection buffer will never return true.
  - For negated matches, you want it to return true if the content is not found.
  - This is believed to be a Snort bug rather than an engine difference but it was reported to Sourcefire and acknowledged many years ago indicating that perhaps it is by design.
  - This is not the case for Suricata which behaves as expected.

    Example HTTP request:

    ```
    POST /test.php HTTP/1.1
    Content-Length: 9

    user=suri
    ```

    This rule snippet will never return true in Snort but will in Suricata:

    ```
    content:!"snort"; offset:10; http_client_body;
    ```

8.43.19 File Extraction

- Suricata has the ability to match on files from FTP, HTTP and SMTP streams and log them to disk.
- Snort has the "file" preprocessor that can do something similar but it is experimental, development of it has been stagnant for years, and it is not something that should be used in a production environment.
- Files can be matched on using a number of keywords including:
  - `filename`
  - `fileext`
  - `filemagic`
  - `filesize`
  - `filemd5`
  - `filesha1`
  - `filesha256`
  - `filesize`
  - See *File Keywords* for a full list.
- The `filestore` keyword tells Suricata to save the file to disk.
- Extracted files are logged to disk with meta data that includes things like timestamp, src/dst IP, protocol, src/dst port, HTTP URI, HTTP Host, HTTP Referer, filename, file magic, md5sum, size, etc.

- There are a number of configuration options and considerations (such as stream reassembly depth and libhtp body-limit) that should be understood if you want fully utilize file extraction in Suricata.
- *File Keywords*
- *File Extraction*
- https://blog.inliniac.net/2011/11/29/file-extraction-in-suricata/
- https://blog.inliniac.net/2014/11/11/smtp-file-extraction-in-suricata/

8.43.20 Lua Scripting

- Suricata has the `lua` (or `luajit`) keyword which allows for a rule to reference a Lua script that can access the packet, payload, HTTP buffers, etc.
- Provides powerful flexibility and capabilities that Snort does not have.
- More details in: *Lua Scripting for Detection*

8.43.21 Fast Pattern

- Snort's fast pattern matcher is always case insensitive; Suricata's is case sensitive unless 'nocase' is set on the content match used by the fast pattern matcher.
- Snort will truncate fast pattern matches based on the `max-pattern-len` config (default no limit) unless `fast_pattern:only` is used in the rule. Suricata does not do any automatic fast pattern truncation cannot be configured to do so.
- Just like in Snort, in Suricata you can specify a substring of the content string to be use as the fast pattern match. e.g. `fast_pattern:5,20;`
- In Snort, leading NULL bytes (0x00) will be removed from content matches when determining/using the longest content match unless `fast_pattern` is explicitly set. Suricata does not truncate anything, including NULL bytes.
- Snort does not allow for all `http_*` buffers to be used for the fast pattern match (e.g. `http_raw_*`, `http_method`, `http_cookie`, etc.). Suricata lets you use any 'http_*' buffer you want for the fast pattern match, including `http_raw_*' and ``http_cookie` buffers.
- Suricata supports the `fast_pattern:only` syntax but technically it is not really implemented; the `only` is silently ignored when encountered in a rule. It is still recommended that you use `fast_pattern:only` where appropriate in case this gets implemented in the future and/or if the rule will be used by Snort as well.
- With Snort, unless `fast_pattern` is explicitly set, content matches in normalized HTTP Inspect buffers (e.g. http content modifiers such `http_uri`, `http_header`, etc.) take precedence over non-HTTP Inspect content matches, even if they are shorter. Suricata does the same thing and gives a higher 'priority' (precedence) to `http_*` buffers (except for `http_method`, `http_stat_code`, and `http_stat_msg`).
- See *Suricata Fast Pattern Determination Explained* for full details on how Suricata automatically determines which content to use as the fast pattern match.
- When in doubt about what is going to be use as the fast pattern match by Suricata, set `fast_pattern` explicitly in the rule and/or run Suricata with the `--engine-analysis` switch and view the generated file (`rules_fast_pattern.txt`).
- Like Snort, the fast pattern match is checked before `flowbits` in Suricata.

- Using Hyperscan as the MPM matcher (`mpm-algo` setting) for Suricata can greatly improve performance, especially when it comes to fast pattern matching. Hyperscan will also take into account depth and offset when doing fast pattern matching, something the other algorithms and Snort do not do.
- *fast_pattern*

8.43.22 Don't Cross The Streams

Suricata will examine network traffic as individual packets and, in the case of TCP, as part of a (reassembled) stream. However, there are certain rule keywords that only apply to packets only (`dsize`, `flags`, `ttl`) and certain ones that only apply to streams only (`http_*`) and you can't mix packet and stream keywords. Rules that use packet keywords will inspect individual packets only and rules that use stream keywords will inspect streams only. Snort is a little more forgiving when you mix these – for example, in Snort you can use `dsize` (a packet keyword) with `http_*` (stream keywords) and Snort will allow it although, because of `dsize`, it will only apply detection to individual packets (unless PAF is enabled then it will apply it to the PDU).

If `dsize` is in a rule that also looks for a stream-based application layer protocol (e.g. `http`), Suricata will not match on the *first application layer packet* since `dsize` make Suricata evaluate the packet and protocol detection doesn't happen until after the protocol is checked for that packet; *subsequent* packets in that flow should have the application protocol set appropriately and will match rules using `dsize` and a stream-based application layer protocol.

If you need to check sizes on a stream in a rule that uses a stream keyword, or in a rule looking for a stream-based application layer protocol, consider using the `stream_size` keyword and/or `isdataat`.

Suricata also supports these protocol values being used in rules and Snort does not:

- `tcp-pkt` – example:
  - `alert tcp-pkt ...`
  - This tells Suricata to only apply the rule to TCP packets and not the (reassembled) stream.
- `tcp-stream` – example:
  - `alert tcp-stream ...`
  - This tells Suricata to inspect the (reassembled) TCP stream only.

8.43.23 Alerts

- In Snort, the number of alerts generated for a packet/stream can be limited by the `event_queue` configuration.
- Suricata has an internal hard-coded limit of 15 alerts per packet/stream (and this cannot be configured); all rules that match on the traffic being analyzed will fire up to that limit.
- Sometimes Suricata will generate what appears to be two alerts for the same TCP packet. This happens when Suricata evaluates the packet by itself and as part of a (reassembled) stream.

8.43.24 Buffer Reference Chart

Buffer	Snort 2.9.x Support?	Suricata Support?	PCRE flag	Can be used as Fast Pattern?	Suricata Fast Pattern Priority (lower number is higher priority)
content (no modifier)	YES	YES	<none>	YES	3
http_method	YES	YES	M	Suricata only	3
http_stat_code	YES	YES	S	Suricata only	3
http_stat_msg	YES	YES	Y	Suricata only	3
uricontent	YES but deprecated, use http_uri instead	YES but deprecated, use http_uri instead	U	YES	2
http_uri	YES	YES	U	YES	2
http_raw_uri	YES	YES	I	Suricata only	2
http_header	YES	YES	H	YES	2
http_raw_header	YES	YES	D	Suricata only	2
http_cookie	YES	YES	C	Suricata only	2
http_raw_cookie	YES	NO (use http_raw_header instead)	K	NO	n/a
http_host	NO	YES	W	Suricata only	2
http_raw_host	NO	YES	Z	Suricata only	2
http_client_body	YES	YES	P	YES	2
http_server_body	NO	YES	Q	Suricata only	2
http_user_agent	NO	YES	V	Suricata only	2
dns_query	NO	YES	n/a*	Suricata only	2
tls_sni	NO	YES	n/a*	Suricata only	2
tls_cert_issuer	NO	YES	n/a*	Suricata only	2
tls_cert_subject	NO	YES	n/a*	Suricata only	2
file_data	YES	YES	n/a*	YES	2

* Sticky buffer

8.44 Multiple Buffer Matching

Suricata 7 and newer now supports matching contents in multiple buffers within the same transaction.

For example a single DNS transaction that has two queries in it:

query 1: example.net query 2: something.com

Example rule:

alert dns $HOME_NET any -> $EXTERNAL_NET any (msg:"DNS Multiple Question Example Rule"; dns.query; content:"example"; dns.query; content:".com"; classtype:misc-activity; sid:1; rev:1;)

Within the single DNS query transaction, there are two queries and Suricata will set up two instances of a dns.query buffer.

The first `dns.query` buffer will look for content:"example";

The second `dns.query` buffer will look for content:".com";

The example rule will alert on the example query since all the content matches are satisfied for the rule.

For matching multiple headers in HTTP2 traffic a rule using the new functionality would look like:

alert http2 any any -> any any (msg:"HTTP2 Multiple Header Buffer Example"; flow:established,to_server; http.request_header; content:"method|3a 20|GET"; http.request_header; content:"authority|3a 20|example.com"; classtype:misc-activity; sid:1; rev:1;)

With HTTP2 there are multiple headers seen in the same flow record. We now have a way to write a rule in a more efficient way using the multiple buffer capability.

Note Existing behavior when using sticky buffers still applies:

Example rule:

alert dns $HOME_NET any -> $EXTERNAL_NET any (msg:"DNS Query Sticky Buffer Classic Example Rule"; dns.query; content:"example"; content:".net"; classtype:misc-activity; sid:1; rev:1;)

The above rule will alert on a single dns query containing "example.net" or "example.domain.net" since the rule content matches are within a single `dns.query` buffer and all content match requirements of the rule are met.

Note: This is new behavior. In versions of Suricata prior to version 7 multiple statements of the same sticky buffer did not make a second instance of the buffer. For example:

dns.query; content:"example"; dns.query; content:".com";

would be equivalent to:

dns.query; content:"example"; content:".com";

Using our example from above, the first query is for example.net which matches content:"example"; but does not match content:".com";

The second query is for something.com which would match on the content:".com"; but not the content:"example";

So with the Suricata behavior prior to Suricata 7, the signature would not fire in this case since both content conditions will not be met.

Multiple buffer matching is currently enabled for use with the following keywords:

- `dns.query`
- `file.data`
- `file.magic`
- `file.name`
- `http.request_header`
- `http.response_header`
- `http2.header_name`
- `ike.vendor`
- `krb5_cname`
- `krb5_sname`
- `mqtt.subscribe.topic`
- `mqtt.unsubscribe.topic`
- `quic.cyu.hash`
- `quic.cyu.string`
- `tls.certs`

- `tls.cert_subject`

8.45 Tag

The *tag* keyword allows tagging of the current and future packets.

Tagged packets can be logged in *EVE* and conditional PCAP logging.

Tagging is limited to a scope: *host* or *session* (flow). When using *host* a direction can be specified: *src* or *dst*. Tagging will then occur based on the *src* or *dst* IP address of the packet generating the alert.

Tagging is further controlled by count: *packets*, *bytes* or *seconds*. If the count is ommited built-in defaults will be used:

- for *session*: 256 packets
- for *host*: 256 packets for the destination IP of the packet triggering the alert

The *tag* keyword can appear multiple times in a rule.

8.45.1 Syntax

```
tag:<scope>[,<count>, <metric>[,<direction>]];
```

Values for *scope*: *session* and *host* Values for *metric*: *packets*, *bytes*, *seconds* Values for *direction*: *src* and *dst*

Note: "direction" can only be specified if scope is "host" and both "count" and "metric" are also specified.

8.45.2 Examples

Keyword:

```
tag:session;                # tags next 256 packets in the flow
tag:host;                   # tags next 256 packets for the dst ip of the alert
tag:host,100,packets,src;   # tags next 100 packets for src ip of the alert
tag:host,3600,seconds,dst;  # tags packets for dst host for the next hour
```

Full rule examples:

alert dns any any -> any any (dns.query; content:"evil"; tag:host,60,seconds,src; sid:1;)

alert http any any -> any any (http.method; content:"POST"; tag:session; sid:1;)

8.45.3 How to Use Tags

EVE

Tags can be set to generate *EVE tag* records:

```
outputs:
  - eve-log:
      enabled: yes
      filename: eve.json
      types:
        - alert:
            tagged-packets: true
```

The tagged packets will then be logged with *event_type*: *packet*:

```
{
  "timestamp": "2020-06-03T10:29:17.850417+0000",
  "flow_id": 1576832511820424,
  "event_type": "packet",
  "src_ip": "192.168.0.27",
  "src_port": 54634,
  "dest_ip": "192.168.0.103",
  "dest_port": 22,
  "proto": "TCP",
  "pkt_src": "wire/pcap",
  "packet":
↪"CAAn6mWJAPSNvfrHCABFAAAogkVAAIAG9rfAqAAbwKgAZ9VqABZvnJXH5Zf6aFAQEAljEwAAAAAAAAAA",
  "packet_info": {
    "linktype": 1
  }
}
```

EVE: *Eve JSON Output*

Conditional PCAP Logging

Using the conditional PCAP logging option the tag keyword can control which packets are logged by the PCAP logging.

```
outputs:
  - pcap-log:
      enabled: yes
      filename: log.pcap
      limit: 1000mb
      max-files: 2000
      compression: none
      mode: normal
      use-stream-depth: no #If set to "yes" packets seen after reaching stream␣
↪inspection depth are ignored. "no" logs all packets
      honor-pass-rules: no # If set to "yes", flows in which a pass rule matched will␣
↪stop being logged.
      # Use "all" to log all packets or use "alerts" to log only alerted packets and␣
↪flows or "tag"
      # to log only flow tagged via the "tag" keyword
      conditional: tag
```

PCAP Logging: *PCAP log*

8.45.4 Tracking by Host/Flow

When the tags are using the *session* scope, the tag is added to the *Flow* structure. If a packet has no flow, no tagging will happen. No errors/warnings are generated for this.

See *Flow Settings* for managing flow limits and resources.

When tags are using the *host* scope, the tag is stored with a *Host* object in the host table. The Host table size will affect effectiveness of per host tags.

See *Host Settings* for managing host table size.

CHAPTER

NINE

RULE MANAGEMENT

9.1 Rule Management with Suricata-Update

While it is possible to download and install rules manually, it is recommended to use a management tool for this. `suricata-update` is the official way to update and manage rules for Suricata.

`suricata-update` is bundled with Suricata and is normally installed with it. For instructions on installing manually, see http://suricata-update.readthedocs.io/en/latest/quickstart.html#install-suricata-update

Note: `suricata-update` is bundled with Suricata version 4.1 and later. It can be used with older versions as well. It will have to be installed separately in that case.

To download the Emerging Threats Open ruleset, it is enough to simply run:

```
sudo suricata-update
```

This will download the ruleset into */var/lib/suricata/rules/*

Suricata's configuration will have to be updated to have a rules config like this:

```
default-rule-path: /var/lib/suricata/rules
rule-files:
  - suricata.rules
```

Now (re)start Suricata.

9.1.1 Updating your rules

To update the rules, simply run

```
sudo suricata-update
```

It is recommended to update your rules frequently.

9.1.2 Using other rulesets

Suricata-Update is capable of making other rulesets accessible as well.

To see what is available, fetch the master index from the OISF hosts:

```
sudo suricata-update update-sources
```

Then have a look at what is available:

```
sudo suricata-update list-sources
```

This will give a result similar to

```
Name: oisf/trafficid
  Vendor: OISF
  Summary: Suricata Traffic ID ruleset
  License: MIT
Name: ptresearch/attackdetection
  Vendor: Positive Technologies
  Summary: Positive Technologies Attack Detection Team ruleset
  License: Custom
Name: sslbl/ssl-fp-blacklist
  Vendor: Abuse.ch
  Summary: Abuse.ch SSL Blacklist
  License: Non-Commercial
Name: et/open
  Vendor: Proofpoint
  Summary: Emerging Threats Open Ruleset
  License: MIT
Name: scwx/security
  Vendor: Secureworks
  Summary: Secureworks suricata-security ruleset.
  License: Commercial
  Parameters: secret-code
  Subscription: https://www.secureworks.com/contact/ (Please reference CTU Countermeasures)
Name: scwx/malware
  Vendor: Secureworks
  Summary: Secureworks suricata-malware ruleset.
  License: Commercial
  Parameters: secret-code
  Subscription: https://www.secureworks.com/contact/ (Please reference CTU Countermeasures)
Name: et/pro
  Vendor: Proofpoint
  Summary: Emerging Threats Pro Ruleset
  License: Commercial
  Replaces: et/open
  Parameters: secret-code
  Subscription: https://www.proofpoint.com/us/threat-insight/et-pro-ruleset
```

Each of the rulesets has a name that has a 'vendor' prefix, followed by a set name. For example, OISF's traffic id ruleset is called 'oisf/trafficid'.

To enable 'oisf/trafficid', enter:

```
sudo suricata-update enable-source oisf/trafficid
sudo suricata-update
```

Now restart Suricata again and the rules from the OISF TrafficID ruleset are loaded.

To see which rulesets are currently active, use "list-enabled-sources".

9.1.3 Controlling which rules are used

By default `suricata-update` will merge all rules into a single file "/var/lib/suricata/rules/suricata.rules".

To enable rules that are disabled by default, use */etc/suricata/enable.conf*

```
2019401                  # enable signature with this sid
group:emerging-icmp.rules # enable this rulefile
re:trojan                # enable all rules with this string
```

Similarly, to disable rules use */etc/suricata/disable.conf* :

```
2019401                  # disable signature with this sid
group:emerging-info.rules # disable this rulefile
re:heartbleed            # disable all rules with this string
```

After updating these files, rerun `suricata-update` again:

```
sudo suricata-update
```

Finally restart Suricata.

9.1.4 Further reading

See https://suricata-update.readthedocs.io/en/latest/

9.2 Adding Your Own Rules

If you would like to create a rule yourself and use it with Suricata, this guide might be helpful.

Start creating a file for your rule. Use one of the following examples in your console/terminal window:

```
sudo nano local.rules
sudo vim local.rules
```

Write your rule, see *Rules Format* and save it.

Update the Suricata configuration file so your rule is included. Use one of the following examples:

```
sudo nano /etc/suricata/suricata.yaml
sudo vim /etc/suricata/suricata.yaml
```

and make sure your local.rules file is added to the list of rules:

```
default-rule-path: /usr/local/etc/suricata/rules

rule-files:
  - suricata.rules
  - /path/to/local.rules
```

Now, run Suricata and see if your rule is being loaded.

```
suricata -c /etc/suricata/suricata.yaml -i wlan0
```

If the rule failed to load, Suricata will display as much information as it has when it deemed the rule un-loadable. Pay special attention to the details: look for mistakes in special characters, spaces, capital characters, etc.

Next, check if your log-files are enabled in the Suricata configuration file `suricata.yaml`.

If you had to correct your rule and/or modify Suricata's YAML configuration file, you'll have to restart Suricata.

If you see your rule is successfully loaded, you can double check your rule by doing something that should trigger it.

By default, Suricata will log alerts to two places

- `eve.json`
- `fast.log`

These files will be located in the log output directory which is set by one of two methods:

1. Suricata configuration file: see `default-log-dir` for the name of the directory
2. Suricata command line: Using `-l /path/to/log-dir` creates log files in the named directory.

The following example assumes that the log directory is named `/var/log/suricata`

```
tail -f /var/log/suricata/fast.log
```

If you would make a rule like this:

```
alert http any any -> any any (msg:"Do not read gossip during work";
content:"Scarlett"; nocase; classtype:policy-violation; sid:1; rev:1;)
```

Your alert should look like this:

```
09/15/2011-16:50:27.725288  [**] [1:1:1] Do not read gossip during work [**]
[Classification: Potential Corporate Privacy Violation] [Priority: 1] {TCP} 192.168.0.
↪32:55604 -> 68.67.185.210:80
```

9.3 Rule Reloads

Suricata can reload the rules without restarting. This way, there is minimal service disruption.

This works by sending Suricata a signal or by using the unix socket. When Suricata is told to reload the rules these are the basic steps it takes:

- Load new config to update rule variables and values.
- Load new rules
- Construct new detection engine
- Swap old and new detection engines
- Make sure all threads are updated
- Free old detection engine

Suricata will continue to process packets normally during this process. Keep in mind though, that the system should have enough memory for both detection engines.

Signal:

```
kill -USR2 $(pidof suricata)
```

There are two methods available when using the Unix socket.

Blocking reload

```
suricatasc -c reload-rules
```

Non blocking reload

```
suricatasc -c ruleset-reload-nonblocking
```

It is also possible to get information about the last reload via dedicated commands. See *Commands in standard running mode* for more information.

9.4 Rules Profiling

If Suricata is built with the *--enable-profiling-rules* then the ruleset profiling can be activated on demand from the unix socket and dumped from it.

To start profiling

```
suricatasc -c ruleset-profile-start
```

To stop profiling

```
suricatasc -c ruleset-profile-stop
```

To dump profiling

```
suricatasc -c ruleset-profile
```

A typical scenario to get rules performance would be

```
suricatasc -c ruleset-profile-start
sleep 30
suricatasc -c ruleset-profile-stop
suricatasc -c ruleset-profile
```

On busy systems, using the sampling capability to capture performance on a subset of packets can be obtained via the *sample-rate* variable in the *profiling* section in the *suricata.yaml* file.

CHAPTER

TEN

MAKING SENSE OUT OF ALERTS

When an alert happens it's important to figure out what it means. Is it serious? Relevant? A false positive?

To find out more about the rule that fired, it's always a good idea to look at the actual rule.

The first thing to look at in a rule is the description that follows the `msg` keyword. Let's consider an example:

```
msg:"ET SCAN sipscan probe";
```

The "ET" indicates the rule came from the Emerging Threats (Proofpoint) project. "SCAN" indicates the purpose of the rule is to match on some form of scanning. Following that, a more or less detailed description is given.

Most rules contain some pointers to more information in the form of the "reference" keyword.

Consider the following example rule:

```
alert tcp $HOME_NET any -> $EXTERNAL_NET $HTTP_PORTS \
  (msg:"ET CURRENT_EVENTS Adobe 0day Shovelware"; \
  flow:established,to_server; content:"GET "; nocase; depth:4; \
  content:!"|0d 0a|Referer\:"; nocase; \
  uricontent:"/ppp/listdir.php?dir="; \
  pcre:"/\/[a-z]{2}\/[a-z]{4}01\/ppp\/listdir\.php\?dir=/U"; \
  classtype:trojan-activity; \
  reference:url,isc.sans.org/diary.html?storyid=7747; \
  reference:url,doc.emergingthreats.net/2010496; \
  reference:url,www.emergingthreats.net/cgi-bin/cvsweb.cgi/sigs/CURRENT_EVENTS/CURRENT_
↪Adobe; \
  sid:2010496; rev:2;)
```

In this rule, the reference keyword indicates 3 urls to visit for more information:

```
isc.sans.org/diary.html?storyid=7747
doc.emergingthreats.net/2010496
www.emergingthreats.net/cgi-bin/cvsweb.cgi/sigs/CURRENT_EVENTS/CURRENT_Adobe
```

Some rules contain a reference like: `"reference:cve,2009-3958;"` should allow you to find info about the specific CVE using your favorite search engine.

It's not always straight forward and sometimes not all of that information is available publicly. Usually asking about it on the signature support channel can be helpful.

In *Rule Management with Suricata-Update* more information on the rule sources and their documentation and support methods can be found.

In many cases, looking at just the alert and the packet that triggered it won't be enough to be conclusive. When using the default Eve settings a lot of metadata will be added to the alert.

For example, if a rule fired that indicates your web application is attacked, looking at the metadata might reveal that the web application replied with `404 not found`. This will usually mean the attack failed but not always.

Not every protocol leads to metadata generation, so when running an IDS engine like Suricata, it's often recommended to combine it with full packet capture. Using tools like Evebox, Sguil or Snorby, the full TCP session or UDP flow can be inspected.

Obviously there is a lot more to Incidence Response, but this should get you started.

CHAPTER

ELEVEN

PERFORMANCE

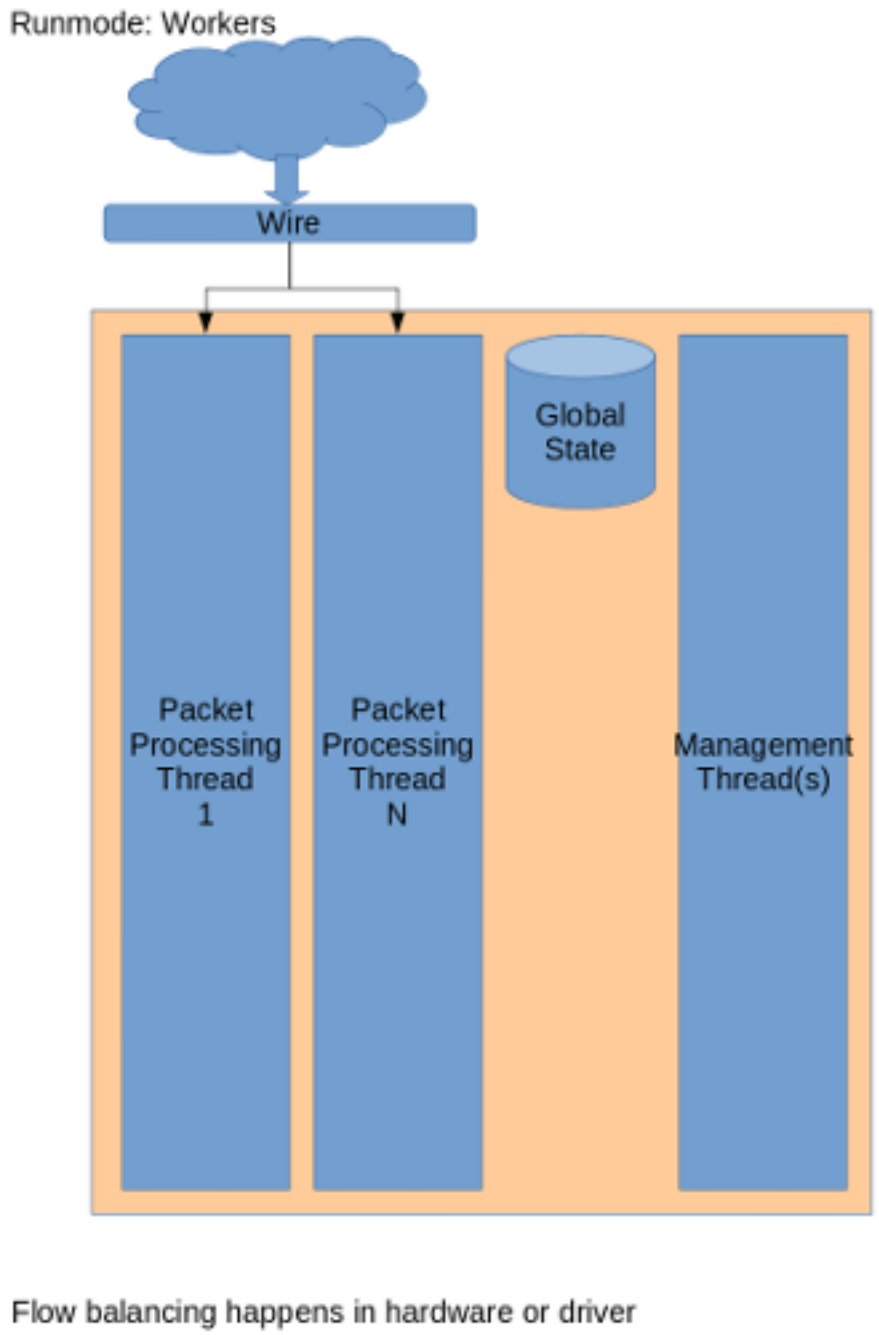
11.1 Runmodes

Suricata consists of several 'building blocks' called threads, thread-modules and queues. A thread is like a process that runs on a computer. Suricata is multi-threaded, so multiple threads are active at once. A thread-module is a part of a functionality. One module is for example for decoding a packet, another is the detect-module and another one the output-module. A packet can be processed by more than one thread. The packet will then be passed on to the next thread through a queue. Packets will be processed by one thread at a time, but there can be multiple packets being processed at a time by the engine (see *Max-pending-packets*). A thread can have one or more thread-modules. If they have more modules, they can only be active one a a time. The way threads, modules and queues are arranged together is called the "Runmode".

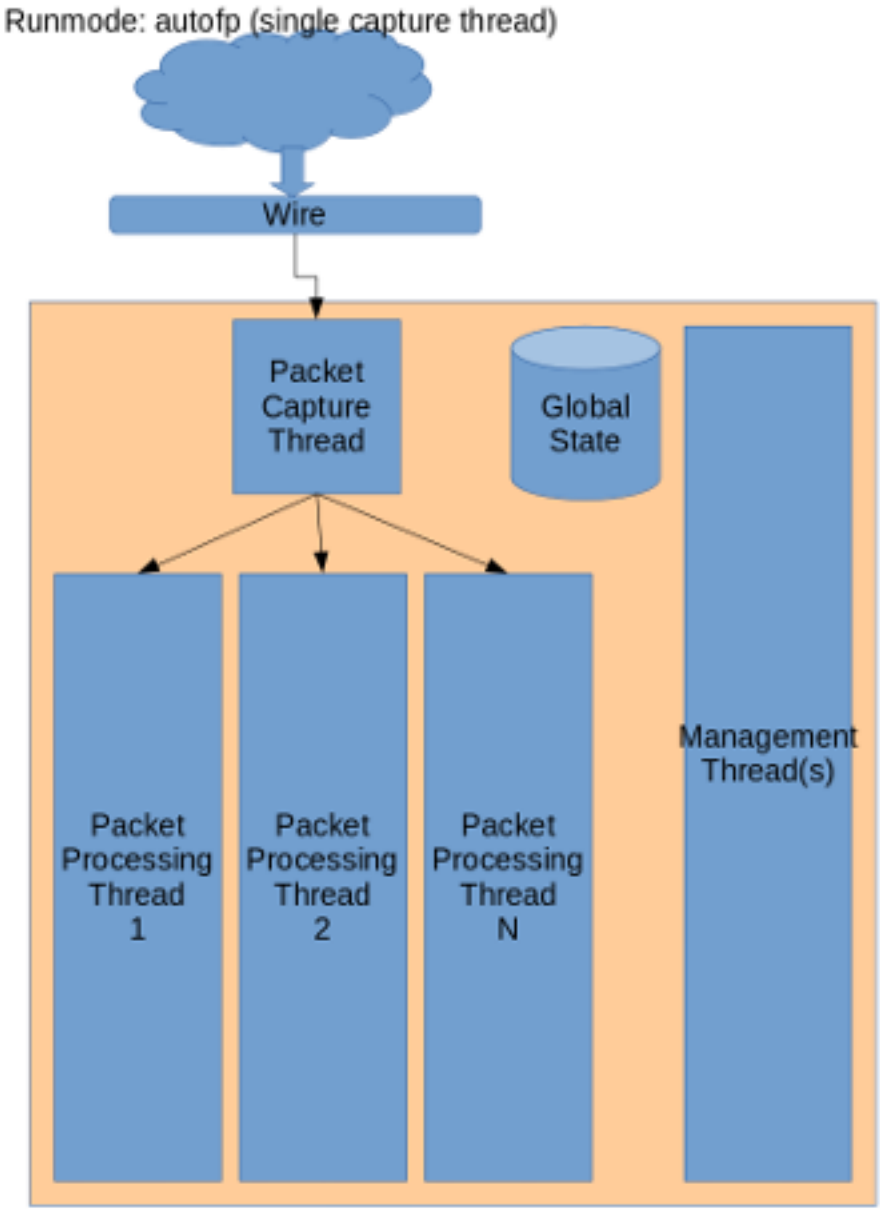
11.1.1 Different runmodes

You can choose a runmode out of several predefined runmodes. The command line option `--list-runmodes` shows all available runmodes. All runmodes have a name: single, workers, autofp.

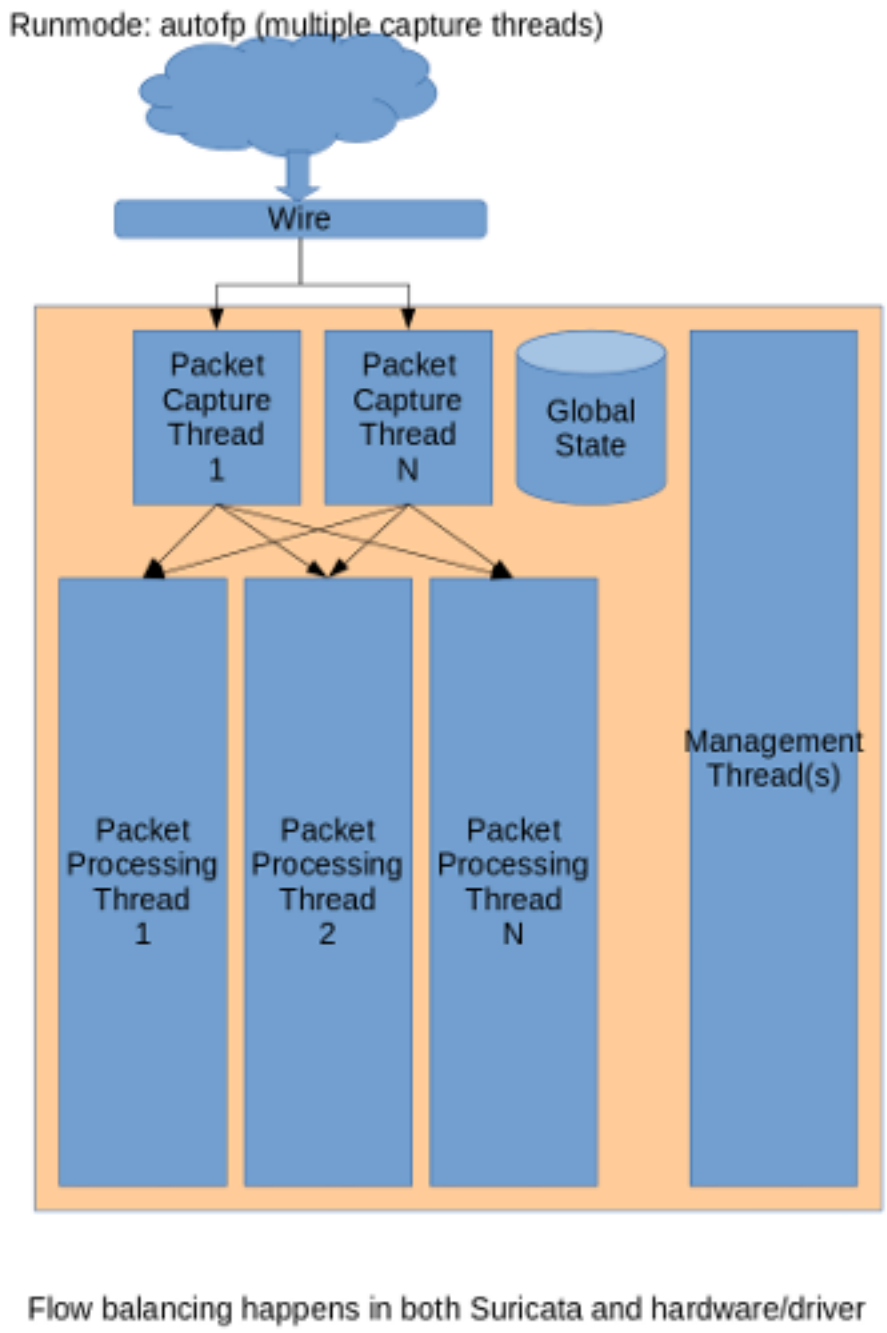
Generally, the `workers` runmode performs the best. In this mode the NIC/driver makes sure packets are properly balanced over Suricata's processing threads. Each packet processing thread then contains the full packet pipeline.



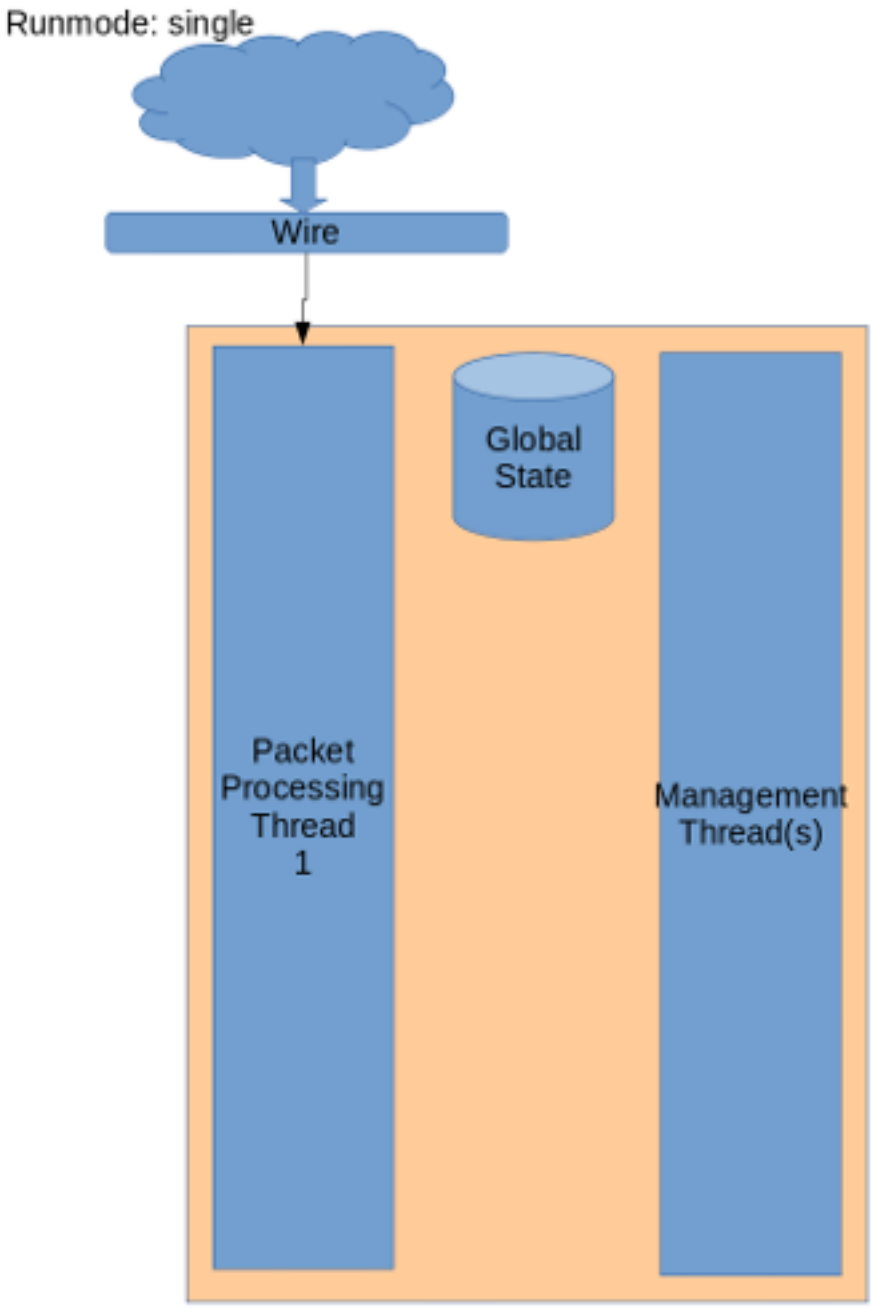
For processing PCAP files, or in case of certain IPS setups (like NFQ), `autofp` is used. Here there are one or more capture threads, that capture the packet and do the packet decoding, after which it is passed on to the `flow worker` threads.



Flow balancing happens inside Suricata



Finally, the `single` runmode is the same as the `workers` mode, however there is only a single packet processing thread. This is mostly useful during development.



For more information about the command line options concerning the runmode, see *Command Line Options*.

11.1.2 Load balancing

Suricata may use different ways to load balance the packets to process between different threads with the configuration option *autofp-scheduler*.

The default value is *hash*, which means the packet is assigned to threads using the 5-7 tuple hash, which is also used anyways to store the flows in memory.

This option can also be set to - *ippair* : packets are assigned to threads using addresses only. - *ftp-hash* : same as *hash* except for flows that may be ftp or ftp-data so that these flows get processed by the same thread. Like so, there is no concurrency issue in recognizing ftp-data flows due to processing them before the ftp flow got processed. In case of such a flow, a variant of the hash is used.

11.2 Packet Capture

11.2.1 Load balancing

To get the best performance, Suricata will need to run in 'workers' mode. This effectively means that there are multiple threads, each running a full packet pipeline and each receiving packets from the capture method. This means that we rely on the capture method to distribute the packets over the various threads. One critical aspect of this is that Suricata needs to get both sides of a flow in the same thread, in the correct order.

The AF_PACKET and PF_RING capture methods both have options to select the 'cluster-type'. These default to 'cluster_flow' which instructs the capture method to hash by flow (5 tuple). This hash is symmetric. Netmap does not have a cluster_flow mode built-in. It can be added separately by using the "'lb' tool":https://github.com/luigirizzo/netmap/tree/main/apps/lb

On multi-queue NICs, which is almost any modern NIC, RSS settings need to be considered.

11.2.2 RSS

Receive Side Scaling is a technique used by network cards to distribute incoming traffic over various queues on the NIC. This is meant to improve performance but it is important to realize that it was designed for normal traffic, not for the IDS packet capture scenario. RSS using a hash algorithm to distribute the incoming traffic over the various queues. This hash is normally *not* symmetrical. This means that when receiving both sides of a flow, each side may end up in a different queue. Sadly, when deploying Suricata, this is the common scenario when using span ports or taps.

The problem here is that by having both sides of the traffic in different queues, the order of processing of packets becomes unpredictable. Timing differences on the NIC, the driver, the kernel and in Suricata will lead to a high chance of packets coming in at a different order than on the wire. This is specifically about a mismatch between the two traffic directions. For example, Suricata tracks the TCP 3-way handshake. Due to this timing issue, the SYN/ACK may only be received by Suricata long after the client to server side has already started sending data. Suricata would see this traffic as invalid.

None of the supported capture methods like AF_PACKET, PF_RING or NETMAP can fix this problem for us. It would require buffering and packet reordering which is expensive.

To see how many queues are configured:

```
$ ethtool -l ens2f1
Channel parameters for ens2f1:
Pre-set maximums:
RX:             0
TX:             0
```

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```
Other:          1
Combined:       64
Current hardware settings:
RX:             0
TX:             0
Other:          1
Combined:       8
```

Some NIC's allow you to set it into a symmetric mode. The Intel X(L)710 card can do this in theory, but the drivers aren't capable of enabling this yet (work is underway to try to address this). Another way to address is by setting a special "Random Secret Key" that will make the RSS symmetrical. See http://www.ndsl.kaist.edu/~kyoungsoo/papers/TR-symRSS.pdf (PDF).

In most scenario's however, the optimal solution is to reduce the number of RSS queues to 1:

Example:

```
# Intel X710 with i40e driver:
ethtool -L $DEV combined 1
```

Some drivers do not support setting the number of queues through ethtool. In some cases there is a module load time option. Read the driver docs for the specifics.

11.2.3 Offloading

Network cards, drivers and the kernel itself have various techniques to speed up packet handling. Generally these will all have to be disabled.

LRO/GRO lead to merging various smaller packets into big 'super packets'. These will need to be disabled as they break the dsize keyword as well as TCP state tracking.

Checksum offloading can be left enabled on AF_PACKET and PF_RING, but needs to be disabled on PCAP, NETMAP and others.

11.2.4 Recommendations

Read your drivers documentation! E.g. for i40e the ethtool change of RSS queues may lead to kernel panics if done wrong.

Generic: set RSS queues to 1 or make sure RSS hashing is symmetric. Disable NIC offloading.

AF_PACKET: 1 RSS queue and stay on kernel <=4.2 or make sure you have >=4.4.16, >=4.6.5 or >=4.7. Exception: if RSS is symmetric cluster-type 'cluster_qm' can be used to bind Suricata to the RSS queues. Disable NIC offloading except the rx/tx csum.

PF_RING: 1 RSS queue and use cluster-type 'cluster_flow'. Disable NIC offloading except the rx/tx csum.

NETMAP: 1 RSS queue. There is no flow based load balancing built-in, but the 'lb' tool can be helpful. Another option is to use the 'autofp' runmode. Exception: if RSS is symmetric, load balancing is based on the RSS hash and multiple RSS queues can be used. Disable all NIC offloading.

11.3 Tuning Considerations

Settings to check for optimal performance.

11.3.1 max-pending-packets: <number>

This setting controls the number simultaneous packets that the engine can handle. Setting this higher generally keeps the threads more busy, but setting it too high will lead to degradation.

Suggested setting: 10000 or higher. Max is ~65000. This setting is per thread. The memory is set up at start and the usage is as follows:

```
number_of.threads X max-pending-packets X (default-packet-size + ~750 bytes)
```

11.3.2 mpm-algo: <ac|hs|ac-bs|ac-ks>

Controls the pattern matcher algorithm. AC (`Aho-Corasick`) is the default. On supported platforms, *Hyperscan* is the best option. On commodity hardware if Hyperscan is not available the suggested setting is `mpm-algo: ac-ks` (`Aho-Corasick` Ken Steele variant) as it performs better than `mpm-algo: ac`

11.3.3 detect.profile: <low|medium|high|custom>

The detection engine tries to split out separate signatures into groups so that a packet is only inspected against signatures that can actually match. As in large rule set this would result in way too many groups and memory usage similar groups are merged together. The profile setting controls how aggressive this merging is done. The default setting of `high` usually is good enough.

The "custom" setting allows modification of the group sizes:

```
custom-values:
  toclient-groups: 100
  toserver-groups: 100
```

In general, increasing will improve performance. It will lead to minimal increase in memory usage. The default value for `toclient-groups` and `toserver-groups` with `detect.profile: high` is 75.

11.3.4 detect.sgh-mpm-context: <auto|single|full>

The multi pattern matcher can have it's context per signature group (full) or globally (single). Auto selects between single and full based on the **mpm-algo** selected. ac, ac-bs, ac-ks, hs default to "single". Setting this to "full" with `mpm-algo: ac` or `mpm-algo: ac-ks` offers better performance. Setting this to "full" with `mpm-algo: hs` is not recommended as it leads to much higher startup time. Instead with Hyperscan either `detect.profile: high` or bigger custom group size settings can be used as explained above which offers better performance than `ac` and `ac-ks` even with `detect.sgh-mpm-context: full`.

11.3.5 af-packet

If using `af-packet` (default on Linux) it is recommended that af-packet v3 is used for IDS/NSM deployments. For IPS it is recommended af-packet v2. To make sure af-packet v3 is used it can specifically be enforced it in the `af-packet` config section of suricata.yaml like so:

```
af-packet:
 - interface: eth0
   ....
   ....
   ....
   use-mmap: yes
   tpacket-v3: yes
```

11.3.6 ring-size

Ring-size is another `af-packet` variable that can be considered for tuning and performance benefits. It basically means the buffer size for packets per thread. So if the setting is `ring-size: 100000` like below:

```
af-packet:
 - interface: eth0
   threads: 5
   ring-size: 100000
```

it means there will be 100,000 packets allowed in each buffer of the 5 threads. If any of the buffers gets filled (for example packet processing can not keep up) that will result in packet `drop` counters increasing in the stats logs.

The memory used for those is set up and dedicated at start and is calculated as follows:

```
af-packet.threads X af-packet.ring-size X (default-packet-size + ~750 bytes)
```

where `af-packet.threads`, `af-packet.ring-size`, `default-packet-size` are the values set in suricata.yaml. Config values for example for af-packet could be quickly displayed with on the command line as well with `suricata --dump-config |grep af-packet`.

11.3.7 stream.bypass

Another option that can be used to improve performance is `stream.bypass`. In the example below:

```
stream:
 memcap: 64mb
 checksum-validation: yes      # reject wrong csums
 inline: auto                  # auto will use inline mode in IPS mode, yes or no set it␣
↪statically
 bypass: yes
 reassembly:
   memcap: 256mb
   depth: 1mb                  # reassemble 1mb into a stream
   toserver-chunk-size: 2560
   toclient-chunk-size: 2560
   randomize-chunk-size: yes
```

Inspection will be skipped when `stream.reassembly.depth` of 1mb is reached for a particular flow.

11.4 Hyperscan

11.4.1 Introduction

"Hyperscan is a high performance regular expression matching library (...)" (https://www.intel.com/content/www/us/en/developer/articles/technical/introduction-to-hyperscan.html)

In Suricata it can be used to perform multi pattern matching (mpm) or single pattern matching (spm).

Support for hyperscan in Suricata was initially implemented by Justin Viiret and Jim Xu from Intel via https://github.com/OISF/suricata/pull/1965.

Hyperscan is only for Intel x86 based processor architectures at this time. For ARM processors, vectorscan is a drop in replacement for hyperscan, https://github.com/VectorCamp/vectorscan.

11.4.2 Basic Installation (Package)

Some Linux distributions include hyperscan in their respective package collections.

Fedora 37+/Centos 8+: sudo dnf install hyperscan-devel Ubuntu/Debian: sudo apt-get install libhyperscan-dev

11.4.3 Advanced Installation (Source)

Hyperscan has the following dependencies in order to build from source:

- boost development libraries (minimum boost library version is 1.58)
- cmake
- C++ compiler (e.g. gcc-c++)
- libpcap development libraries
- pcre2 development libraries
- python3
- ragel
- sqlite development libraries

Note: git is an additional dependency if cloning the hyperscan GitHub repository. Otherwise downloading the hyperscan zip from the GitHub repository will work too.

The steps to build and install hyperscan are:

```
git clone https://github.com/intel/hyperscan
cd hyperscan
cmake -DBUILD_STATIC_AND_SHARED=1
cmake --build ./
sudo cmake --install ./
```

Note: Hyperscan can take a a long time to build/compile.

Note: It may be necessary to add /usr/local/lib or /usr/local/lib64 to the *ld* search path. Typically this is done by adding a file under /etc/ld.so.conf.d/ with the contents of the directory location of libhs.so.5 (for hyperscan 5.x).

11.4.4 Using Hyperscan

Confirm that the suricata version installed has hyperscan enabled.

```
suricata --build-info | grep Hyperscan
  Hyperscan support:                       yes
```

To use hyperscan support, edit the suricata.yaml. Change the mpm-algo and spm-algo values to 'hs'.

Alternatively, use this command-line option: --set mpm-algo=hs --set spm-algo=hs

Note: The default suricata.yaml configuration settings for mpm-algo and spm-algo are "auto". Suricata will use hyperscan if it is present on the system in case of the "auto" setting.

If the current suricata installation does not have hyperscan support, refer to *Installation*

11.5 High Performance Configuration

11.5.1 NIC

One of the major dependencies for Suricata's performance is the Network Interface Card. There are many vendors and possibilities. Some NICs have and require their own specific instructions and tools of how to set up the NIC. This ensures the greatest benefit when running Suricata. Vendors like Napatech, Netronome, Accolade, Myricom include those tools and documentation as part of their sources.

For Intel, Mellanox and commodity NICs the following suggestions below could be utilized.

It is recommended that the latest available stable NIC drivers are used. In general when changing the NIC settings it is advisable to use the latest `ethtool` version. Some NICs ship with their own `ethtool` that is recommended to be used. Here is an example of how to set up the ethtool if needed:

```
wget https://mirrors.edge.kernel.org/pub/software/network/ethtool/ethtool-5.2.tar.xz
tar -xf ethtool-5.2.tar.xz
cd ethtool-5.2
./configure && make clean && make && make install
/usr/local/sbin/ethtool --version
```

When doing high performance optimisation make sure `irqbalance` is off and not running:

```
service irqbalance stop
```

Depending on the NIC's available queues (for example Intel's x710/i40 has 64 available per port/interface) the worker threads can be set up accordingly. Usually the available queues can be seen by running:

```
/usr/local/sbin/ethtool -l eth1
```

Some NICs - generally lower end 1Gbps - do not support symmetric hashing see *Packet Capture*. On those systems due to considerations for out of order packets the following setup with af-packet is suggested (the example below uses `eth1`):

```
/usr/local/sbin/ethtool -L eth1 combined 1
```

then set up af-packet with number of desired workers threads `threads: auto` (auto by default will use number of CPUs available) and `cluster-type: cluster_flow` (also the default setting)

For higher end systems/NICs a better and more performant solution could be utilizing the NIC itself a bit more. x710/i40 and similar Intel NICs or Mellanox MT27800 Family [ConnectX-5] for example can easily be set up to do a bigger chunk of the work using more RSS queues and symmetric hashing in order to allow for increased performance on the Suricata side by using af-packet with `cluster-type: cluster_qm` mode. In that mode with af-packet all packets linked by network card to a RSS queue are sent to the same socket. Below is an example of a suggested config set up based on a 16 core one CPU/NUMA node socket system using x710:

```
rmmod i40e && modprobe i40e
ifconfig eth1 down
/usr/local/sbin/ethtool -L eth1 combined 16
/usr/local/sbin/ethtool -K eth1 rxhash on
/usr/local/sbin/ethtool -K eth1 ntuple on
ifconfig eth1 up
/usr/local/sbin/ethtool -X eth1 hkey␣
↪6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A
↪equal 16
/usr/local/sbin/ethtool -A eth1 rx off
/usr/local/sbin/ethtool -C eth1 adaptive-rx off adaptive-tx off rx-usecs 125
/usr/local/sbin/ethtool -G eth1 rx 1024
```

The commands above can be reviewed in detail in the help or manpages of the `ethtool`. In brief the sequence makes sure the NIC is reset, the number of RSS queues is set to 16, load balancing is enabled for the NIC, a low entropy toeplitz key is inserted to allow for symmetric hashing, receive offloading is disabled, the adaptive control is disabled for lowest possible latency and last but not least, the ring rx descriptor size is set to 1024. Make sure the RSS hash function is Toeplitz:

```
/usr/local/sbin/ethtool -X eth1 hfunc toeplitz
```

Let the NIC balance as much as possible:

```
for proto in tcp4 udp4 tcp6 udp6; do
   /usr/local/sbin/ethtool -N eth1 rx-flow-hash $proto sdfn
done
```

In some cases:

```
/usr/local/sbin/ethtool -N eth1 rx-flow-hash $proto sd
```

might be enough or even better depending on the type of traffic. However not all NICs allow it. The `sd` specifies the multi queue hashing algorithm of the NIC (for the particular proto) to use src IP, dst IP only. The `sdfn` allows for the tuple src IP, dst IP, src port, dst port to be used for the hashing algorithm. In the af-packet section of suricata.yaml:

```
af-packet:
 - interface: eth1
   threads: 16
   cluster-id: 99
   cluster-type: cluster_qm
   ...
   ...
```

11.5.2 CPU affinity and NUMA

Intel based systems

If the system has more then one NUMA node there are some more possibilities. In those cases it is generally recommended to use as many worker threads as cpu cores available/possible - from the same NUMA node. The example below uses a 72 core machine and the sniffing NIC that Suricata uses located on NUMA node 1. In such 2 socket configurations it is recommended to have Suricata and the sniffing NIC to be running and residing on the second NUMA node as by default CPU 0 is widely used by many services in Linux. In a case where this is not possible it is recommended that (via the cpu affinity config section in suricata.yaml and the irq affinity script for the NIC) CPU 0 is never used.

In the case below 36 worker threads are used out of NUMA node 1's CPU, af-packet runmode with `cluster-type: cluster_qm`.

If the CPU's NUMA set up is as follows:

```
lscpu
Architecture:        x86_64
CPU op-mode(s):      32-bit, 64-bit
Byte Order:          Little Endian
CPU(s):              72
On-line CPU(s) list: 0-71
Thread(s) per core:  2
Core(s) per socket:  18
Socket(s):           2
NUMA node(s):        2
Vendor ID:           GenuineIntel
CPU family:          6
Model:               79
Model name:          Intel(R) Xeon(R) CPU E5-2697 v4 @ 2.30GHz
Stepping:            1
CPU MHz:             1199.724
CPU max MHz:         3600.0000
CPU min MHz:         1200.0000
BogoMIPS:            4589.92
Virtualization:      VT-x
L1d cache:           32K
L1i cache:           32K
L2 cache:            256K
L3 cache:            46080K
NUMA node0 CPU(s):   0-17,36-53
NUMA node1 CPU(s):   18-35,54-71
```

It is recommended that 36 worker threads are used and the NIC set up could be as follows:

```
rmmod i40e && modprobe i40e
ifconfig eth1 down
/usr/local/sbin/ethtool -L eth1 combined 36
/usr/local/sbin/ethtool -K eth1 rxhash on
/usr/local/sbin/ethtool -K eth1 ntuple on
ifconfig eth1 up
./set_irq_affinity local eth1
/usr/local/sbin/ethtool -X eth1 hkey␣
```

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```
↪6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A
↪equal 36
/usr/local/sbin/ethtool -A eth1 rx off tx off
/usr/local/sbin/ethtool -C eth1 adaptive-rx off adaptive-tx off rx-usecs 125
/usr/local/sbin/ethtool -G eth1 rx 1024
for proto in tcp4 udp4 tcp6 udp6; do
    echo "/usr/local/sbin/ethtool -N eth1 rx-flow-hash $proto sdfn"
    /usr/local/sbin/ethtool -N eth1 rx-flow-hash $proto sdfn
done
```

In the example above the `set_irq_affinity` script is used from the NIC driver's sources. In the cpu affinity section of suricata.yaml config:

```
# Suricata is multi-threaded. Here the threading can be influenced.
threading:
 cpu-affinity:
   - management-cpu-set:
       cpu: [ "1-10" ]  # include only these CPUs in affinity settings
   - receive-cpu-set:
       cpu: [ "0-10" ]  # include only these CPUs in affinity settings
   - worker-cpu-set:
       cpu: [ "18-35", "54-71" ]
       mode: "exclusive"
       prio:
         low: [ 0 ]
         medium: [ "1" ]
         high: [ "18-35","54-71" ]
         default: "high"
```

In the af-packet section of suricata.yaml config :

```
- interface: eth1
  # Number of receive threads. "auto" uses the number of cores
  threads: 18
  cluster-id: 99
  cluster-type: cluster_qm
  defrag: no
  use-mmap: yes
  mmap-locked: yes
  tpacket-v3: yes
  ring-size: 100000
  block-size: 1048576
- interface: eth1
  # Number of receive threads. "auto" uses the number of cores
  threads: 18
  cluster-id: 99
  cluster-type: cluster_qm
  defrag: no
  use-mmap: yes
  mmap-locked: yes
  tpacket-v3: yes
  ring-size: 100000
  block-size: 1048576
```

That way 36 worker threads can be mapped (18 per each af-packet interface slot) in total per CPUs NUMA 1 range - 18-35,54-71. That part is done via the `worker-cpu-set` affinity settings. `ring-size` and `block-size` in the config section above are decent default values to start with. Those can be better adjusted if needed as explained in *Tuning Considerations*.

AMD based systems

Another example can be using an AMD based system where the architecture and design of the system itself plus the NUMA node's interaction is different as it is based on the HyperTransport (HT) technology. In that case per NUMA thread/lock would not be needed. The example below shows a suggestion for such a configuration utilising af-packet, `cluster-type: cluster_flow`. The Mellanox NIC is located on NUMA 0.

The CPU set up is as follows:

```
Architecture:          x86_64
CPU op-mode(s):        32-bit, 64-bit
Byte Order:            Little Endian
CPU(s):                128
On-line CPU(s) list:   0-127
Thread(s) per core:    2
Core(s) per socket:    32
Socket(s):             2
NUMA node(s):          8
Vendor ID:             AuthenticAMD
CPU family:            23
Model:                 1
Model name:            AMD EPYC 7601 32-Core Processor
Stepping:              2
CPU MHz:               1200.000
CPU max MHz:           2200.0000
CPU min MHz:           1200.0000
BogoMIPS:              4391.55
Virtualization:        AMD-V
L1d cache:             32K
L1i cache:             64K
L2 cache:              512K
L3 cache:              8192K
NUMA node0 CPU(s):     0-7,64-71
NUMA node1 CPU(s):     8-15,72-79
NUMA node2 CPU(s):     16-23,80-87
NUMA node3 CPU(s):     24-31,88-95
NUMA node4 CPU(s):     32-39,96-103
NUMA node5 CPU(s):     40-47,104-111
NUMA node6 CPU(s):     48-55,112-119
NUMA node7 CPU(s):     56-63,120-127
```

The `ethtool`, `show_irq_affinity.sh` and `set_irq_affinity_cpulist.sh` tools are provided from the official driver sources. Set up the NIC, including offloading and load balancing:

```
ifconfig eno6 down
/opt/mellanox/ethtool/sbin/ethtool -L eno6 combined 15
/opt/mellanox/ethtool/sbin/ethtool -K eno6 rxhash on
/opt/mellanox/ethtool/sbin/ethtool -K eno6 ntuple on
```

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```
ifconfig eno6 up
/sbin/set_irq_affinity_cpulist.sh 1-7,64-71 eno6
/opt/mellanox/ethtool/sbin/ethtool -X eno6 hfunc toeplitz
/opt/mellanox/ethtool/sbin/ethtool -X eno6 hkey␣
↪6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A
```

In the example above (1-7,64-71 for the irq affinity) CPU 0 is skipped as it is usually used by default on Linux systems by many applications/tools. Let the NIC balance as much as possible:

```
for proto in tcp4 udp4 tcp6 udp6; do
   /usr/local/sbin/ethtool -N eth1 rx-flow-hash $proto sdfn
done
```

In the cpu affinity section of suricata.yaml config :

```
# Suricata is multi-threaded. Here the threading can be influenced.
threading:
 set-cpu-affinity: yes
 cpu-affinity:
   - management-cpu-set:
      cpu: [ "120-127" ]  # include only these cpus in affinity settings
   - receive-cpu-set:
      cpu: [ 0 ]  # include only these cpus in affinity settings
   - worker-cpu-set:
      cpu: [ "8-55" ]
      mode: "exclusive"
      prio:
        high: [ "8-55" ]
        default: "high"
```

In the af-packet section of suricata.yaml config:

```
- interface: eth1
  # Number of receive threads. "auto" uses the number of cores
  threads: 48 # 48 worker threads on cpus "8-55" above
  cluster-id: 99
  cluster-type: cluster_flow
  defrag: no
  use-mmap: yes
  mmap-locked: yes
  tpacket-v3: yes
  ring-size: 100000
  block-size: 1048576
```

In the example above there are 15 RSS queues pinned to cores 1-7,64-71 on NUMA node 0 and 40 worker threads using other CPUs on different NUMA nodes. The reason why CPU 0 is skipped in this set up is as in Linux systems it is very common for CPU 0 to be used by default by many tools/services. The NIC itself in this config is positioned on NUMA 0 so starting with 15 RSS queues on that NUMA node and keeping those off for other tools in the system could offer the best advantage.

Note: Performance and optimization of the whole system can be affected upon regular NIC driver and pkg/kernel upgrades so it should be monitored regularly and tested out in QA/test environments first. As a general suggestion it

is always recommended to run the latest stable firmware and drivers as instructed and provided by the particular NIC vendor.

Other considerations

Another advanced option to consider is the `isolcpus` kernel boot parameter is a way of allowing CPU cores to be isolated for use of general system processes. That way ensures total dedication of those CPUs/ranges for the Suricata process only.

`stream.wrong_thread` / `tcp.pkt_on_wrong_thread` are counters available in `stats.log` or `eve.json` as `event_type: stats` that indicate issues with the load balancing. There could be traffic/NICs settings related as well. In very high/heavily increasing counter values it is recommended to experiment with a different load balancing method either via the NIC or for example using XDP/eBPF. There is an issue open https://redmine.openinfosecfoundation.org/issues/2725 that is a placeholder for feedback and findings.

11.6 Statistics

The stats.log produces statistics records on a fixed interval, by default every 8 seconds.

11.6.1 stats.log file

```
-------------------------------------------------------------------
Counter                    | TM Name                   | Value
-------------------------------------------------------------------
flow.memuse                | FlowManagerThread         | 6557568
flow.spare                 | FlowManagerThread         | 10002
flow.emerg_mode_entered    | FlowManagerThread         | 0
flow.emerg_mode_over       | FlowManagerThread         | 0
decoder.pkts               | RxPcapem21                | 450001754
decoder.bytes              | RxPcapem21                | 409520714250
decoder.ipv4               | RxPcapem21                | 449584047
decoder.ipv6               | RxPcapem21                | 9212
decoder.ethernet           | RxPcapem21                | 450001754
decoder.raw                | RxPcapem21                | 0
decoder.sll                | RxPcapem21                | 0
decoder.tcp                | RxPcapem21                | 448124337
decoder.udp                | RxPcapem21                | 542040
decoder.sctp               | RxPcapem21                | 0
decoder.icmpv4             | RxPcapem21                | 82292
decoder.icmpv6             | RxPcapem21                | 9164
decoder.ppp                | RxPcapem21                | 0
decoder.pppoe              | RxPcapem21                | 0
decoder.gre                | RxPcapem21                | 0
decoder.vlan               | RxPcapem21                | 0
decoder.avg_pkt_size       | RxPcapem21                | 910
decoder.max_pkt_size       | RxPcapem21                | 1514
defrag.ipv4.fragments      | RxPcapem21                | 4
defrag.ipv4.reassembled    | RxPcapem21                | 1
defrag.ipv4.timeouts       | RxPcapem21                | 0
```

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```
defrag.ipv6.fragments      | RxPcapem21                | 0
defrag.ipv6.reassembled    | RxPcapem21                | 0
defrag.ipv6.timeouts       | RxPcapem21                | 0
tcp.sessions               | Detect                    | 41184
tcp.ssn_memcap_drop        | Detect                    | 0
tcp.pseudo                 | Detect                    | 2087
tcp.invalid_checksum       | Detect                    | 8358
tcp.no_flow                | Detect                    | 0
tcp.reused_ssn             | Detect                    | 11
tcp.memuse                 | Detect                    | 36175872
tcp.syn                    | Detect                    | 85902
tcp.synack                 | Detect                    | 83385
tcp.rst                    | Detect                    | 84326
tcp.segment_memcap_drop    | Detect                    | 0
tcp.stream_depth_reached   | Detect                    | 109
tcp.reassembly_memuse      | Detect                    | 67755264
tcp.reassembly_gap         | Detect                    | 789
detect.alert               | Detect                    | 14721
```

Detecting packet loss

At shut down, Suricata reports the packet loss statistics it gets from pcap, pfring or afpacket

```
[18088] 30/5/2012 -- 07:39:18 - (RxPcapem21) Packets 451595939, bytes 410869083410
[18088] 30/5/2012 -- 07:39:18 - (RxPcapem21) Pcap Total:451674222 Recv:451596129␣
↪Drop:78093 (0.0%).
```

Usually, this is not the complete story though. These are kernel drop stats, but the NIC may also have dropped packets. Use ethtool to get to those:

```
# ethtool -S em2
NIC statistics:
     rx_packets: 35430208463
     tx_packets: 216072
     rx_bytes: 32454370137414
     tx_bytes: 53624450
     rx_broadcast: 17424355
     tx_broadcast: 133508
     rx_multicast: 5332175
     tx_multicast: 82564
     rx_errors: 47
     tx_errors: 0
     tx_dropped: 0
     multicast: 5332175
     collisions: 0
     rx_length_errors: 0
     rx_over_errors: 0
     rx_crc_errors: 51
     rx_frame_errors: 0
     rx_no_buffer_count: 0
     rx_missed_errors: 0
```

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```
    tx_aborted_errors: 0
    tx_carrier_errors: 0
    tx_fifo_errors: 0
    tx_heartbeat_errors: 0
    tx_window_errors: 0
    tx_abort_late_coll: 0
    tx_deferred_ok: 0
    tx_single_coll_ok: 0
    tx_multi_coll_ok: 0
    tx_timeout_count: 0
    tx_restart_queue: 0
    rx_long_length_errors: 0
    rx_short_length_errors: 0
    rx_align_errors: 0
    tx_tcp_seg_good: 0
    tx_tcp_seg_failed: 0
    rx_flow_control_xon: 0
    rx_flow_control_xoff: 0
    tx_flow_control_xon: 0
    tx_flow_control_xoff: 0
    rx_long_byte_count: 32454370137414
    rx_csum_offload_good: 35270755306
    rx_csum_offload_errors: 65076
    alloc_rx_buff_failed: 0
    tx_smbus: 0
    rx_smbus: 0
    dropped_smbus: 0
```

11.6.2 Kernel drops

stats.log contains interesting information in the capture.kernel_packets and capture.kernel_drops. The meaning of them is different following the capture mode.

In AF_PACKET mode:

- kernel_packets is the number of packets correctly sent to userspace
- kernel_drops is the number of packets that have been discarded instead of being sent to userspace

In PF_RING mode:

- kernel_packets is the total number of packets seen by pf_ring
- kernel_drops is the number of packets that have been discarded instead of being sent to userspace

In the Suricata stats.log the TCP data gap counter is also an indicator, as it accounts missing data packets in TCP streams:

```
tcp.reassembly_gap         | Detect                    | 789
```

Ideally, this number is 0. Not only pkt loss affects it though, also bad checksums and stream engine running out of memory.

11.6.3 Tools to plot graphs

Some people made nice tools to plot graphs of the statistics file.

- ipython and matplotlib script
- Monitoring with Zabbix or other and Code on GitHub

11.7 Ignoring Traffic

In some cases there are reasons to ignore certain traffic. Certain hosts may be trusted, or perhaps a backup stream should be ignored.

11.7.1 capture filters (BPF)

Through BPFs the capture methods pcap, af-packet, netmap and pf_ring can be told what to send to Suricata, and what not. For example a simple filter 'tcp' will only capture tcp packets.

If some hosts and or nets need to be ignored, use something like "not (host IP1 or IP2 or IP3 or net NET/24)".

Example:

```
not host 1.2.3.4
```

Capture filters are specified on the command-line after all other options:

```
suricata -i eth0 -v not host 1.2.3.4
suricata -i eno1 -c suricata.yaml tcp or udp
```

Capture filters can be set per interface in the pcap, af-packet, netmap and pf_ring sections. It can also be put in a file:

```
echo "not host 1.2.3.4" > capture-filter.bpf
suricata -i ens5f0 -F capture-filter.bpf
```

Using a capture filter limits what traffic Suricata processes. So the traffic not seen by Suricata will not be inspected, logged or otherwise recorded.

BPF and IPS

In case of IPS modes using af-packet and netmap, BPFs affect how traffic is forwarded. If a capture NIC does not capture a packet because of a BPF, it will also not be forwarded to the peering NIC.

So in the example of *not host 1.2.3.4*, traffic to and from the IP *1.2.3.4* is effectively dropped.

11.7.2 pass rules

Pass rules are Suricata rules that if matching, pass the packet and in case of TCP the rest of the flow. They look like normal rules, except that instead of *alert* or *drop* they use *pass* as the action.

Example:

```
pass ip 1.2.3.4 any <> any any (msg:"pass all traffic from/to 1.2.3.4"; sid:1;)
```

A big difference with capture filters is that logs such as Eve or http.log are still generated for this traffic.

11.7.3 suppress

Suppress rules can be used to make sure no alerts are generated for a host. This is not efficient however, as the suppression is only considered post-matching. In other words, Suricata first inspects a rule, and only then will it consider per-host suppressions.

Example:

```
suppress gen_id 0, sig_id 0, track by_src, ip 1.2.3.4
```

11.7.4 encrypted traffic

The TLS app layer parser has the ability to stop processing encrypted traffic after the initial handshake. By setting the *app-layer.protocols.tls.encryption-handling* option to *bypass* the rest of this flow is ignored. If flow bypass is enabled, the bypass is done in the kernel or in hardware.

11.7.5 bypassing traffic

Aside from using the `bypass` keyword in rules, there are three other ways to bypass traffic.

- Within suricata (local bypass). Suricata reads a packet, decodes it, checks it in the flow table. If the corresponding flow is local bypassed then it simply skips all streaming, detection and output and the packet goes directly out in IDS mode and to verdict in IPS mode.
- Within the kernel (capture bypass). When Suricata decides to bypass it calls a function provided by the capture method to declare the bypass in the capture. For NFQ this is a simple mark that will be used by the iptables/nftablesruleset. For AF_PACKET this will be a call to add an element in an eBPF hash table stored in kernel.
- Within the NIC driver. This method relies upon XDP, XDP can process the traffic prior to reaching the kernel.

Additional bypass documentation:

https://suricon.net/wp-content/uploads/2017/12/SuriCon17-Manev_Purzynski.pdf https://www.stamus-networks.com/2016/09/28/suricata-bypass-feature/

11.8 Packet Profiling

In this guide will be explained how to enable packet profiling and use it with the most recent code of Suricata on Ubuntu. It is based on the assumption that you have already installed Suricata once from the GIT repository.

Packet profiling is convenient in case you would like to know how long packets take to be processed. It is a way to figure out why certain packets are being processed quicker than others, and this way a good tool for developing Suricata.

Update Suricata by following the steps from *Installation from GIT*. Start at the end at

```
cd suricata/suricata
git pull
```

And follow the described next steps. To enable packet profiling, make sure you enter the following during the configuring stage:

```
./configure --enable-profiling
```

Find a folder in which you have pcaps. If you do not have pcaps yet, you can get these with Wireshark. See Sniffing Packets with Wireshark.

Go to the directory of your pcaps. For example:

```
cd  ~/Desktop
```

With the ls command you can see the content of the folder. Choose a folder and a pcap file

for example:

```
cd ~/Desktop/2011-05-05
```

Run Suricata with that pcap:

```
suricata -c /etc/suricata/suricata.yaml -r log.pcap.(followed by the number/name of your␣
↪pcap)
```

for example:

```
suricata -c /etc/suricata/suricata.yaml -r log.pcap.1304589204
```

11.9 Rule Profiling

```
---------------------------------------------------------------------------
Date: 9/5/2013 -- 14:59:58
---------------------------------------------------------------------------
 Num      Rule         Gid      Rev      Ticks        %      Checks   Matches  Max Ticks␣
↪  Avg Ticks   Avg Match   Avg No Match
-------- ------------ -------- -------- ------------ ------ -------- -------- -----------
↪ ----------- ----------- --------------
1        2210021      1        3        12037        4.96   1        1        12037     ␣
↪ 12037.00    12037.00    0.00
2        2210054      1        1        107479       44.26  12       0        35805     ␣
↪ 8956.58     0.00        8956.58
```

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```
3        2210053      1        1        4513         1.86   1        0        4513      ␣
↪ 4513.00     0.00        4513.00
4        2210023      1        1        3077         1.27   1        0        3077      ␣
↪ 3077.00     0.00        3077.00
5        2210008      1        1        3028         1.25   1        0        3028      ␣
↪ 3028.00     0.00        3028.00
6        2210009      1        1        2945         1.21   1        0        2945      ␣
↪ 2945.00     0.00        2945.00
7        2210055      1        1        2945         1.21   1        0        2945      ␣
↪ 2945.00     0.00        2945.00
8        2210007      1        1        2871         1.18   1        0        2871      ␣
↪ 2871.00     0.00        2871.00
9        2210005      1        1        2871         1.18   1        0        2871      ␣
↪ 2871.00     0.00        2871.00
10       2210024      1        1        2846         1.17   1        0        2846      ␣
↪ 2846.00     0.00        2846.00
```

The meaning of the individual fields:

- Ticks -- total ticks spent on this rule, so a sum of all inspections
- % -- share of this single sig in the total cost of inspection
- Checks -- number of times a signature was inspected
- Matches -- number of times it matched. This may not have resulted in an alert due to suppression and thresholding.
- Max ticks -- single most expensive inspection
- Avg ticks -- per inspection average, so "ticks" / "checks".
- Avg match -- avg ticks spent resulting in match
- Avg No Match -- avg ticks spent resulting in no match.

The "ticks" are CPU clock ticks: http://en.wikipedia.org/wiki/CPU_time

11.10 Tcmalloc

'tcmalloc' is a library Google created as part of the google-perftools suite for improving memory handling in a threaded program. It's very simple to use and does work fine with Suricata. It leads to minor speed ups and also reduces memory usage quite a bit.

11.10.1 Installation

On Ubuntu, install the libtcmalloc-minimal4 package:

```
apt-get install libtcmalloc-minimal4
```

On Fedora, install the gperftools-libs package:

```
yum install gperftools-libs
```

11.10.2 Usage

Use the tcmalloc by preloading it:

Ubuntu:

```
LD_PRELOAD="/usr/lib/x86_64-linux-gnu/libtcmalloc_minimal.so.4" suricata -c suricata.
↪yaml -i eth0
```

Fedora:

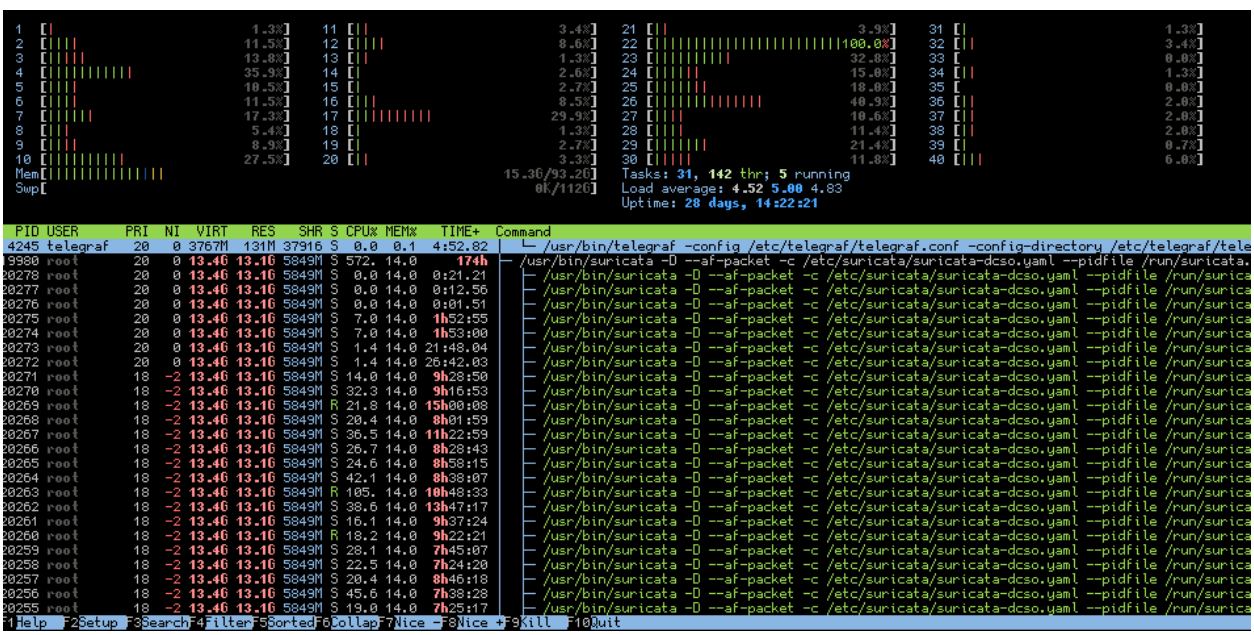
```
LD_PRELOAD="/usr/lib64/libtcmalloc_minimal.so.4" suricata -c suricata.yaml -i eth0
```

11.11 Performance Analysis

There are many potential causes for performance issues. In this section we will guide you through some options. The first part will cover basic steps and introduce some helpful tools. The second part will cover more in-depth explanations and corner cases.

11.11.1 System Load

The first step should be to check the system load. Run a top tool like **htop** to get an overview of the system load and if there is a bottleneck with the traffic distribution. For example if you can see that only a small number of cpu cores hit 100% all the time and others don't, it could be related to a bad traffic distribution or elephant flows like in the screenshot where one core peaks due to one big elephant flow.



If all cores are at peak load the system might be too slow for the traffic load or it might be misconfigured. Also keep an eye on memory usage, if the actual memory usage is too high and the system needs to swap it will result in very poor performance.

The load will give you a first indication where to start with the debugging at specific parts we describe in more detail in the second part.

11.11.2 Logfiles

The next step would be to check all the log files with a focus on **stats.log** and **suricata.log** if any obvious issues are seen. The most obvious indicator is the **capture.kernel_drops** value that ideally would not even show up but should be below 1% of the **capture.kernel_packets** value as high drop rates could lead to a reduced amount of events and alerts.

If **memcap** is seen in the stats the memcap values in the configuration could be increased. This can result to higher memory usage and should be taken into account when the settings are changed.

Don't forget to check any system logs as well, even a **dmesg** run can show potential issues.

11.11.3 Suricata Load

Besides the system load, another indicator for potential performance issues is the load of Suricata itself. A helpful tool for that is **perf** which helps to spot performance issues. Make sure you have it installed and also the debug symbols installed for Suricata or the output won't be very helpful. This output is also helpful when you report performance issues as the Suricata Development team can narrow down possible issues with that.

```
sudo perf top -p $(pidof suricata)
```

If you see specific function calls at the top in red it's a hint that those are the bottlenecks. For example if you see **IPOnlyMatchPacket** it can be either a result of high drop rates or incomplete flows which result in decreased performance. To look into the performance issues on a specific thread you can pass **-t TID** to perf top. In other cases you can see functions that give you a hint that a specific protocol parser is used a lot and can either try to debug a performance bug or try to filter related traffic.

```
Samples: 176K of event 'cycles', 4000 Hz, Event count (approx.): 89969570589 lost: 0/0 drop: 0/0
Overhead  Shared Object                     Symbol
  21.99%  suricata                          [.] IPOnlyMatchPacket
   4.64%  libhs.so.5.1.0                    [.] 0x0000000000739ee1
   2.64%  suricata                          [.] FlowGetFlowFromHash
   2.56%  suricata                          [.] DetectRun.part.16
   1.65%  libpthread-2.28.so                [.] __pthread_mutex_lock
   1.59%  [kernel]                          [k] tpacket_rcv
   1.36%  libhs.so.5.1.0                    [.] 0x0000000000739f32
   1.15%  [kernel]                          [k] i40e_napi_poll
   0.90%  suricata                          [.] AFPReadFromRingV3
   0.86%  libhs.so.5.1.0                    [.] 0x0000000000736ac9
   0.83%  suricata                          [.] FlowManager
   0.82%  libluajit-5.1.so.2.1.0            [.] 0x000000000000bdd2
   0.82%  [kernel]                          [k] memcpy_erms
   0.68%  libhs.so.5.1.0                    [.] 0x0000000000736adc
   0.67%  suricata                          [.] SCHSMatchEvent
   0.65%  [kernel]                          [k] __netif_receive_skb_core
   0.64%  suricata                          [.] DetectPortLookupGroup
   0.61%  suricata                          [.] DetectAddressMatchIPv4
   0.60%  libhs.so.5.1.0                    [.] avx512_hs_scan
   0.58%  libhs.so.5.1.0                    [.] 0x0000000000739ef4
   0.55%  [kernel]                          [k] eth_type_trans
   0.52%  libpthread-2.28.so                [.] __pthread_mutex_unlock_usercnt
   0.51%  suricata                          [.] FlowHandlePacketUpdate
   0.51%  libhs.so.5.1.0                    [.] 0x000000000073a743
   0.51%  [kernel]                          [k] packet_rcv_fanout
   0.50%  suricata                          [.] Prefilter
   0.45%  suricata                          [.] PacketPoolGetPacket
   0.41%  suricata                          [.] OutputLoggerLog
   0.39%  suricata                          [.] FlowWorker
   0.36%  libhs.so.5.1.0                    [.] 0x0000000000736ad5
   0.36%  suricata                          [.] StatsIncr
   0.35%  libhs.so.5.1.0                    [.] 0x000000000073a700
   0.35%  libluajit-5.1.so.2.1.0            [.] 0x0000000000001ab7e
   0.35%  libhs.so.5.1.0                    [.] 0x0000000000739f70
   0.34%  suricata                          [.] DecodeIPV4
   0.34%  libhs.so.5.1.0                    [.] 0x0000000000739f23
   0.33%  libhs.so.5.1.0                    [.] 0x000000000067fec6
   0.33%  libhs.so.5.1.0                    [.] 0x0000000000736aeb
   0.32%  suricata                          [.] hashword
   0.32%  suricata                          [.] TmThreadsSlotVarRun
   0.31%  libhs.so.5.1.0                    [.] 0x0000000000739f14
   0.31%  libtcmalloc_minimal.so.4.5.3      [.] tc_deletearray_aligned_nothrow
   0.31%  [kernel]                          [k] __build_skb
   0.29%  libhs.so.5.1.0                    [.] 0x0000000000739f03
   0.29%  [kernel]                          [k] kmem_cache_free
   0.29%  libhs.so.5.1.0                    [.] 0x0000000000739eed
   0.29%  suricata                          [.] TmqhOutputPacketpool
   0.28%  libc-2.28.so                      [.] 0x000000000015c6ff
   0.28%  suricata                          [.] SCHSSearch
   0.28%  libtcmalloc_minimal.so.4.5.3      [.] tc_malloc
For a higher level overview, try: perf top --sort comm,dso
```

In general try to play around with the different configuration options that Suricata does provide with a focus on the options described in *High Performance Configuration*.

11.11.4 Traffic

In most cases where the hardware is fast enough to handle the traffic but the drop rate is still high it's related to specific traffic issues.

Basics

Some of the basic checks are:

- Check if the traffic is bidirectional, if it's mostly unidirectional you're missing relevant parts of the flow (see **tshark** example at the bottom). Another indicator could be a big discrepancy between SYN and SYN-ACK as well as RST counter in the Suricata stats.
- Check for encapsulated traffic, while GRE, MPLS etc. are supported they could also lead to performance issues. Especially if there are several layers of encapsulation.
- Use tools like **iftop** to spot elephant flows. Flows that have a rate of over 1Gbit/s for a long time can result in one cpu core peak at 100% all the time and increasing the droprate while it might not make sense to dig deep into this traffic.
- Another approach to narrow down issues is the usage of **bpf filter**. For example filter all HTTPS traffic with **not port 443** to exclude traffic that might be problematic or just look into one specific port **port 25** if you expect some issues with a specific protocol. See *Ignoring Traffic* for more details.
- If VLAN is used it might help to disable **vlan.use-for-tracking** in scenarios where only one direction of the flow has the VLAN tag.

Advanced

There are several advanced steps and corner cases when it comes to a deep dive into the traffic.

If VLAN QinQ (IEEE 802.1ad) is used be very cautious if you use **cluster_qm** in combination with Intel drivers and AF_PACKET runmode. While the RFC expects ethertype 0x8100 and 0x88A8 in this case (see https://en.wikipedia.org/wiki/IEEE_802.1ad) most implementations only add 0x8100 on each layer. If the first seen layer has the same VLAN tag but the inner one has different VLAN tags it will still end up in the same queue in **cluster_qm** mode. This was observed with the i40e driver up to 2.8.20 and the firmware version up to 7.00, feel free to report if newer versions have fixed this (see https://suricata.io/support/).

If you want to use **tshark** to get an overview of the traffic direction use this command:

```
sudo tshark -i $INTERFACE -q -z conv,ip -a duration:10
```

The output will show you all flows within 10s and if you see 0 for one direction you have unidirectional traffic, thus you don't see the ACK packets for example. Since Suricata is trying to work on flows this will have a rather big impact on the visibility. Focus on fixing the unidirectional traffic. If it's not possible at all you can enable **async-oneside** in the **stream** configuration setting.

Check for other unusual or complex protocols that aren't supported very well. You can try to filter those to see if it has any impact on the performance. In this example we filter Cisco Fabric Path (ethertype 0x8903) with the bpf filter **not ether proto 0x8903** as it's assumed to be a performance issue (see https://redmine.openinfosecfoundation.org/issues/3637)

Elephant Flows

The so called Elephant Flows or traffic spikes are quite difficult to deal with. In most cases those are big file transfers or backup traffic and it's not feasible to decode the whole traffic. From a network security monitoring perspective it's often enough to log the metadata of that flow and do a packet inspection at the beginning but not the whole flow.

If you can spot specific flows as described above then try to filter those. The easiest solution would be a bpf filter but that would still result in a performance impact. Ideally you can filter such traffic even sooner on driver or NIC level (see eBPF/XDP) or even before it reaches the system where Suricata is running. Some commercial packet broker support such filtering where it's called **Flow Shunting** or **Flow Slicing**.

11.11.5 Rules

The Ruleset plays an important role in the detection but also in the performance capability of Suricata. Thus it's recommended to look into the impact of enabled rules as well.

If you run into performance issues and struggle to narrow it down start with running Suricata without any rules enabled and use the tools again that have been explained at the first part. Keep in mind that even without signatures enabled Suricata still does most of the decoding and traffic analysis, so a fair amount of load should still be seen. If the load is still very high and drops are seen and the hardware should be capable to deal with such traffic loads you should deep dive if there is any specific traffic issue (see above) or report the performance issue so it can be investigated (see https://suricata.io/join-our-community/).

Suricata also provides several specific traffic related signatures in the rules folder that could be enabled for testing to spot specific traffic issues. Those are found the **rules** and you should start with **decoder-events.rules**, **stream-events.rules** and **app-layer-events.rules**.

It can also be helpful to use *Rule Profiling* and/or *Packet Profiling* to find problematic rules or traffic pattern. This is achieved by compiling Suricata with **--enable-profiling** but keep in mind that this has an impact on performance and should only be used for troubleshooting.

CHAPTER

TWELVE

CONFIGURATION

12.1 Suricata.yaml

Suricata uses the Yaml format for configuration. The Suricata.yaml file included in the source code, is the example configuration of Suricata. This document will explain each option.

At the top of the YAML-file you will find % YAML 1.1. Suricata reads the file and identifies the file as YAML.

12.1.1 Max-pending-packets

With the max-pending-packets setting you can set the number of packets you allow Suricata to process simultaneously. This can range from one packet to tens of thousands/hundreds of thousands of packets. It is a trade of higher performance and the use of more memory (RAM), or lower performance and less use of memory. A high number of packets being processed results in a higher performance and the use of more memory. A low number of packets, results in lower performance and less use of memory. Choosing a low number of packets being processed while having many CPU's/CPU cores, can result in not making use of the whole computer-capacity. (For instance: using one core while having three waiting for processing packets.)

```
max-pending-packets: 1024
```

12.1.2 Runmodes

By default the runmode option is disabled. With the runmodes setting you can set the runmode you would like to use. For all runmodes available, enter **--list-runmodes** in your command line. For more information, see *Runmodes*.

```
runmode: autofp
```

12.1.3 Default-packet-size

For the max-pending-packets option, Suricata has to keep packets in memory. With the default-packet-size option, you can set the size of the packets on your network. It is possible that bigger packets have to be processed sometimes. The engine can still process these bigger packets, but processing it will lower the performance.

```
default-packet-size: 1514
```

12.1.4 User and group

It is possible to set the user and group to run Suricata as:

```
run-as:
  user: suri
  group: suri
```

12.1.5 PID File

This option sets the name of the PID file when Suricata is run in daemon mode. This file records the Suricata process ID.

```
pid-file: /var/run/suricata.pid
```

Note: This configuration file option only sets the PID file when running in daemon mode. To force creation of a PID file when not running in daemon mode, use the `--pidfile` command line option.

Also, if running more than one Suricata process, each process will need to specify a different pid-file location.

12.1.6 Action-order

All signatures have different properties. One of those is the Action property. This one determines what will happen when a signature matches. There are four types of Action. A summary of what will happen when a signature matches and contains one of those Actions:

1) Pass

If a signature matches and contains pass, Suricata stops scanning the packet and skips to the end of all rules (only for the current packet). If the signature matches on a TCP connection, the entire flow will be passed but details of the flow will still be logged.

2) Drop

This only concerns the IPS/inline mode. If the program finds a signature that matches, containing drop, it stops immediately. The packet will not be sent any further. Drawback: The receiver does not receive a message of what is going on, resulting in a time-out (certainly with TCP). Suricata generates an alert for this packet.

3) Reject

This is an active rejection of the packet. Both receiver and sender receive a reject packet. There are two types of reject packets that will be automatically selected. If the offending packet concerns TCP, it will be a Reset-packet. For all other protocols it will be an ICMP-error packet. Suricata also generates an alert. When in Inline/IPS mode, the offending packet will also be dropped like with the 'drop' action.

4) Alert

If a signature matches and contains alert, the packet will be treated like any other non-threatening packet, except for this one an alert will be generated by Suricata. Only the system administrator can notice this alert.

Inline/IPS can block network traffic in two ways. One way is by drop and the other by reject.

Rules will be loaded in the order of which they appear in files. But they will be processed in a different order. Signatures have different priorities. The most important signatures will be scanned first. There is a possibility to change the order of priority. The default order is: pass, drop, reject, alert.

```
action-order:
 - pass
 - drop
 - reject
 - alert
```

This means a pass rule is considered before a drop rule, a drop rule before a reject rule and so on.

12.1.7 Packet alert queue settings

It is possible to configure the size of the alerts queue that is used to append alerts triggered by each packet.

This will influence how many alerts would be perceived to have matched against a given packet. The default value is 15. If an invalid setting or no value is provided, the engine will fall back to the default.

```
#Define maximum number of possible alerts that can be triggered for the same
# packet. Default is 15
packet-alert-max: 15
```

We recommend that you use the default value for this setting unless you are seeing a high number of discarded alerts (`alert_queue_overflow`) - see the *Discarded and Suppressed Alerts Stats* section for more details.

Impact on engine behavior

Internally, the Suricata engine represents each packet with a data structure that has its own alert queue. The max size of the queue is defined by `packet-alert-max`. The same rule can be triggered by the same packet multiple times. As long as there is still space in the alert queue, those are appended.

Rules that have the `noalert` keyword will be checked - in case their signatures have actions that must be applied to the Packet or Flow, then suppressed. They have no effect in the final alert queue.

Rules are queued by priority: higher priority rules may be kept instead of lower priority ones that may have been triggered earlier, if Suricata reaches `packet-alert-max` for a given packet (a.k.a. packet alert queue overflow).

Packet alert queue overflow

Once the alert queue reaches its max size, we are potentially at packet alert queue overflow, so new alerts will only be appended in case their rules have a higher priority id (this is the internal id attributed by the engine, not the signature id).

This may happen in two different situations:

- a higher priority rule is triggered after a lower priority one: the lower priority rule is replaced in the queue;
- a lower priority rule is triggered: the rule is just discarded.

Note: This behavior does not mean that triggered `drop` rules would have their action ignored, in IPS mode.

Discarded and Suppressed Alerts Stats

Both scenarios previously described will be logged as *detect.alert_queue_overflow* in the stats logs (in stats.log and eve-log's stats event).

When `noalert` rules match, they appear in the stats logs as *detect.alerts_suppressed*.

```
Date: 4/6/2022 -- 17:18:08 (uptime: 0d, 00h 00m 00s)
------------------------------------------------------------------------------------
Counter                                         | TM Name                   | Value
------------------------------------------------------------------------------------
detect.alert                                    | Total                     | 3
detect.alert_queue_overflow                     | Total                     | 4
detect.alerts_suppressed                        | Total                     | 1
```

In this example from a stats.log, we read that 8 alerts were generated: 3 were kept in the packet queue while 4 were discarded due to packets having reached max size for the alert queue, and 1 was suppressed due to coming from a `noalert` rule.

12.1.8 Splitting configuration in multiple files

Some users might have a need or a wish to split their suricata.yaml file into separate files, this is available via the 'include' and '!include' keyword. The first example is of taking the contents of the outputs section and storing them in outputs.yaml.

```
# outputs.yaml
- fast
    enabled: yes
    filename: fast.log
    append: yes

...
```

```
# suricata.yaml
...

outputs: !include outputs.yaml

...
```

The second scenario is where multiple sections are migrated to a different YAML file.

```
# host_1.yaml

max-pending-packets: 2048

outputs:
    - fast
        enabled: yes
        filename: fast.log
        append: yes
```

```
# suricata.yaml

include: host_1.yaml

...
```

If the same section, say outputs is later redefined after the include statement it will overwrite the included file. Therefore any include statement at the end of the document will overwrite the already configured sections.

12.1.9 Event output

Default logging directory

In the /var/log/suricata directory, all of Suricata's output (alerts and events) will be stored.

```
default-log-dir: /var/log/suricata
```

This directory can be overridden by entering the -l command line parameter or by changing the directory directly in Yaml. To change it with the -l command line parameter, enter the following:

```
suricata -c suricata.yaml -i eth0 -l /var/log/suricata-logs/
```

Stats

Engine statistics such as packet counters, memory use counters and others can be logged in several ways. A separate text log 'stats.log' and an EVE record type 'stats' are enabled by default.

The stats have a global configuration and a per logger configuration. Here the global config is documented.

```
# global stats configuration
stats:
  enabled: yes
  # The interval field (in seconds) controls at what interval
  # the loggers are invoked.
  interval: 8
  # Add decode events as stats.
  #decoder-events: true
  # Decoder event prefix in stats. Has been 'decoder' before, but that leads
  # to missing events in the eve.stats records. See issue #2225.
  #decoder-events-prefix: "decoder.event"
  # Add stream events as stats.
  #stream-events: false
  # Exception policy stats counters options
  # (Note: if exception policy: ignore, counters are not logged)
  exception-policy:
    #global-stats: true           # default: false. True will log stats for all
                                  # valid exception policies
    #per-app-proto-errors: false  # default: false. True will log errors for
                                    # each app-proto. Warning: VERY verbose
```

Statistics can be *enabled* or disabled here.

Statistics are dumped on an *interval*. Setting this below 3 or 4 seconds is not useful due to how threads are synchronized internally.

The decoder events that the decoding layer generates, can create a counter per event type. This behaviour is enabled by default. The *decoder-events* option can be set to *false* to disable.

In 4.1.x there was a naming clash between the regular decoder counters and the decoder-event counters. This lead to a fair amount of decoder-event counters not being shown in the EVE.stats records. To address this without breaking existing setups, a config option *decoder-events-prefix* was added to change the naming of the decoder-events from decoder.<proto>.<event> to decoder.event.<proto>.<event>. In 5.0 this became the default. See issue 2225.

Similar to the *decoder-events* option, the *stream-events* option controls whether the stream-events are added as counters as well. This is disabled by default.

If any exception policy is enabled, stats counters are logged. To control verbosity for application layer protocol errors, leave *per-app-proto-errors* as false.

Outputs

There are several types of output. The general structure is:

```
outputs:
  - fast:
    enabled: yes
    filename: fast.log
    append: yes/no
```

Enabling all of the logs, will result in a much lower performance and the use of more disc space, so enable only the outputs you need.

Line based alerts log (fast.log)

This log contains alerts consisting of a single line. Example of the appearance of a single fast.log-file line:

```
10/05/10-10:08:59.667372  [**] [1:2009187:4] ET WEB_CLIENT ACTIVEX iDefense
  COMRaider ActiveX Control Arbitrary File Deletion [**] [Classification: Web
  Application Attack] [Priority: 3] {TCP} xx.xx.232.144:80 -> 192.168.1.4:56068
```

```
-fast:                      #The log-name.
   enabled:yes              #This log is enabled. Set to 'no' to disable.
   filename: fast.log       #The name of the file in the default logging directory.
   append: yes/no           #If this option is set to yes, the last filled fast.log-file␣
↪will not be
                            #overwritten while restarting Suricata.
```

Eve (Extensible Event Format)

This is an JSON output for alerts and events. It allows for easy integration with 3rd party tools like logstash.

```
outputs:
  # Extensible Event Format (nicknamed EVE) event log in JSON format
  - eve-log:
      enabled: yes
      filetype: regular #regular|syslog|unix_dgram|unix_stream|redis
      filename: eve.json
      # Enable for multi-threaded eve.json output; output files are amended
      # with an identifier, e.g., eve.9.json
      #threaded: false
      #prefix: "@cee: " # prefix to prepend to each log entry
      # the following are valid when type: syslog above
      #identity: "suricata"
      #facility: local5
      #level: Info ## possible levels: Emergency, Alert, Critical,
                   ## Error, Warning, Notice, Info, Debug
      #redis:
      #  server: 127.0.0.1
      #  port: 6379
      #  async: true ## if redis replies are read asynchronously
      #  mode: list ## possible values: list|lpush (default), rpush, channel|publish
      #             ## lpush and rpush are using a Redis list. "list" is an alias for␣
↪lpush
      #             ## publish is using a Redis channel. "channel" is an alias for␣
↪publish
      #  key: suricata ## key or channel to use (default to suricata)
      # Redis pipelining set up. This will enable to only do a query every
      # 'batch-size' events. This should lower the latency induced by network
      # connection at the cost of some memory. There is no flushing implemented
      # so this setting as to be reserved to high traffic suricata.
      #  pipelining:
      #    enabled: yes ## set enable to yes to enable query pipelining
      #    batch-size: 10 ## number of entry to keep in buffer

      # Include top level metadata. Default yes.
      #metadata: no

      types:
        - alert:
            # payload: yes             # enable dumping payload in Base64
            # payload-buffer-size: 4kb # max size of payload buffer to output in eve-log
            # payload-printable: yes   # enable dumping payload in printable (lossy)␣
↪format
            # packet: yes              # enable dumping of packet (without stream␣
↪segments)
            # http-body: yes           # Requires metadata; enable dumping of http body␣
↪in Base64
            # http-body-printable: yes # Requires metadata; enable dumping of http body␣
↪in printable format
```

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```
        # Enable the logging of tagged packets for rules using the
        # "tag" keyword.
        tagged-packets: yes

        # Configure the metadata to be logged along with an
        # alert. The following shows the default configuration
        # which is used if this field is not provided or simply
        # set to a truthful value. Setting of this section is only
        # required if you wish to enable/disable specific fields.
        #metadata:

          # Include the decoded application layer (ie. http, dns)
          app-layer: true

          # Log the current state of the flow record.
          flow: true

          rule:
            # Log the metadata field from the rule in a structured
            # format.
            metadata: true

            # Log the raw rule text.
            raw: false

        # HTTP X-Forwarded-For support by adding an extra field or overwriting
        # the source or destination IP address (depending on flow direction)
        # with the one reported in the X-Forwarded-For HTTP header. This is
        # helpful when reviewing alerts for traffic that is being reverse
        # or forward proxied.
        xff:
          enabled: no
          # Two operation modes are available, "extra-data" and "overwrite".
          mode: extra-data
          # Two proxy deployments are supported, "reverse" and "forward". In
          # a "reverse" deployment the IP address used is the last one, in a
          # "forward" deployment the first IP address is used.
          deployment: reverse
          # Header name where the actual IP address will be reported, if more
          # than one IP address is present, the last IP address will be the
          # one taken into consideration.
          header: X-Forwarded-For
      - http:
        extended: yes     # enable this for extended logging information
        # custom allows additional http fields to be included in eve-log
        # the example below adds three additional fields when uncommented
        #custom: [Accept-Encoding, Accept-Language, Authorization]
      - dns:
        # Use version 2 logging with the new format:
        # dns answers will be logged in one single event
        # rather than an event for each of the answers.
        # Without setting a version the version
```

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```
            # will fallback to 1 for backwards compatibility.
            version: 2

            # Enable/disable this logger. Default: enabled.
            #enabled: no

            # Control logging of requests and responses:
            # - requests: enable logging of DNS queries
            # - responses: enable logging of DNS answers
            # By default both requests and responses are logged.
            #requests: no
            #responses: no

            # Format of answer logging:
            # - detailed: array item per answer
            # - grouped: answers aggregated by type
            # Default: all
            #answer-format: [detailed, grouped]

            # Answer types to log.
            # Default: all
            #answer-types: [a, aaaa, cname, mx, ns, ptr, txt]
        - dns:
            # Version 1 DNS logger.
            # Deprecated: Will be removed by May 2022.
            version: 1

            enabled: no
            # control logging of queries and answers
            # default yes, no to disable
            query: yes     # enable logging of DNS queries
            answer: yes    # enable logging of DNS answers
            # control which RR types are logged
            # all enabled if custom not specified
            #custom: [a, aaaa, cname, mx, ns, ptr, txt]
        - tls:
            extended: yes     # enable this for extended logging information
            # output TLS transaction where the session is resumed using a
            # session id
            #session-resumption: no
            # ja4 hashes in tls records will never be logged unless
            # the following is set to on. (Default off)
            # ja4: off
            # custom allows to control which tls fields that are included
            # in eve-log
            #custom: [subject, issuer, session_resumed, serial, fingerprint, sni,␣
↪version, not_before, not_after, certificate, chain]
        - files:
            force-magic: no   # force logging magic on all logged files
            # force logging of checksums, available hash functions are md5,
            # sha1 and sha256
            #force-hash: [md5]
```

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```
        #- drop:
        #    alerts: yes      # log alerts that caused drops
        #    flows: all       # start or all: 'start' logs only a single drop
        #                     # per flow direction. All logs each dropped pkt.
        - smtp:
            #extended: yes # enable this for extended logging information
            # this includes: bcc, message-id, subject, x_mailer, user-agent
            # custom fields logging from the list:
            #  reply-to, bcc, message-id, subject, x-mailer, user-agent, received,
            #  x-originating-ip, in-reply-to, references, importance, priority,
            #  sensitivity, organization, content-md5, date
            #custom: [received, x-mailer, x-originating-ip, relays, reply-to, bcc]
            # output md5 of fields: body, subject
            # for the body you need to set app-layer.protocols.smtp.mime.body-md5
            # to yes
            #md5: [body, subject]

        # NFS logging.
        - nfs
        # IKE logging.
        - ike
        # BitTorrent DHT logging.
        - bittorrent-dht
        - quic:
            # ja4 hashes in crecords will never be logged unless
            # the following is set to on. (Default off)
            # ja4: off
        - ssh
        - stats:
            totals: yes       # stats for all threads merged together
            threads: no       # per thread stats
            deltas: no        # include delta values
        - dhcp:
            # DHCP logging.
            enabled: yes
            # When extended mode is on, all DHCP messages are logged
            # with full detail. When extended mode is off (the
            # default), just enough information to map a MAC address
            # to an IP address is logged.
            extended: no
        # bi-directional flows
        - flow
        # uni-directional flows
        #- netflow

        # An event for logging metadata, specifically pktvars when
        # they are set, but will also include the full metadata object.
        #- metadata
```

For more advanced configuration options, see *Eve JSON Output*.

The format is documented in *Eve JSON Format*.

TLS parameters and certificates logging (tls.log)

The TLS handshake parameters can be logged in a line based log as well. By default, the logfile is *tls.log* in the suricata log directory. See *Custom TLS logging* for details about the configuration and customization of the log format.

Furthermore there is an output module to store TLS certificate files to disk. This is similar to *File-store (File Extraction)*, but for TLS certificates.

Example:

```
# output module to store certificates chain to disk
- tls-store:
    enabled: yes
    #certs-log-dir: certs # directory to store the certificates files
```

A line based log of HTTP requests (http.log)

This log keeps track of all HTTP-traffic events. It contains the HTTP request, hostname, URI and the User-Agent. This information will be stored in the http.log (default name, in the suricata log directory). This logging can also be performed through the use of the *Eve-log capability*.

Example of a HTTP-log line with non-extended logging:

```
07/01/2014-04:20:14.338309 vg.no [**] / [**] Mozilla/5.0 (Macintosh; Intel Mac OS X 10_9_
↪2)
AppleWebKit/537.36 (KHTML, like Gecko) Chrome/35.0.1916.114 Safari/537.36 [**]
192.168.1.6:64685 -> 195.88.54.16:80
```

Example of a HTTP-log line with extended logging:

```
07/01/2014-04:21:06.994705 vg.no [**] / [**] Mozilla/5.0 (Macintosh; Intel Mac OS X 10_9_
↪2)
AppleWebKit/537.36 (KHTML, like Gecko) Chrome/35.0.1916.114 Safari/537.36 [**] <no␣
↪referer> [**]
GET [**] HTTP/1.1 [**] 301 => http://www.vg.no/ [**] 239 bytes [**] 192.168.1.6:64726 ->␣
↪195.88.54.16:80
```

```
- http-log:                     #The log-name.
    enabled: yes                #This log is enabled. Set 'no' to disable.
    filename: http.log          #The name of the file in the default logging directory.
    append: yes/no              #If this option is set to yes, the last filled http.log-
↪file will not be
                                # overwritten while restarting Suricata.
    extended: yes               # If set to yes more information is written about the␣
↪event.
```

Packet log (pcap-log)

With the pcap-log option you can save all packets, that are registered by Suricata, in a log file named _log.pcap_. This way, you can take a look at all packets whenever you want. In the normal mode a pcap file is created in the default-log-dir. It can also be created elsewhere if a absolute path is set in the yaml-file.

The file that is saved in example the default -log-dir /var/log/suricata, can be be opened with every program which supports the pcap file format. This can be Wireshark, TCPdump, Suricata, Snort and many others.

The pcap-log option can be enabled and disabled.

There is a size limit for the pcap-log file that can be set. The default limit is 32 MB. If the log-file reaches this limit, the file will be rotated and a new one will be created. The pcap-log option has an extra functionality for "Sguil":http://sguil.sourceforge.net/ that can be enabled in the 'mode' option. In the sguil mode the "sguil_base_dir" indicates the base directory. In this base dir the pcaps are created in a Sguil-specific directory structure that is based on the day:

```
$sguil_base_dir/YYYY-MM-DD/$filename.<timestamp>
```

If you would like to use Suricata with Sguil, do not forget to enable (and if necessary modify) the base dir in the suricata.yaml file. Remember that in the 'normal' mode, the file will be saved in default-log-dir or in the absolute path (if set).

The pcap files can be compressed before being written to disk by setting the compression option to lz4. This option is incompatible with sguil mode. Note: On Windows, this option increases disk I/O instead of reducing it. When using lz4 compression, you can enable checksums using the lz4-checksum option, and you can set the compression level lz4-level to a value between 0 and 16, where higher levels result in higher compression.

By default all packets are logged except:

- TCP streams beyond stream.reassembly.depth
- encrypted streams after the key exchange

It is possible to do conditional pcap logging by using the *conditional* option in the pcap-log section. By default the variable is set to *all* so all packets are logged. If the variable is set to *alerts* then only the flow with alerts will be logged. If the variable is set to *tag* then only packets tagged by signatures using the *tag* keyword will be logged to the pcap file. Please note that if *alerts* or *tag* is used, then in the case of TCP session, Suricata will use available information from the streaming engine to log data that have triggered the alert.

```
- pcap-log:
    enabled:  yes
    filename: log.pcap

    # Limit in MB.
    limit: 32

    mode: sguil # "normal" (default) or sguil.
    sguil_base_dir: /nsm_data/
    conditional: alerts
```

Verbose Alerts Log (alert-debug.log)

This is a log type that gives supplementary information about an alert. It is particularly convenient for people who investigate false positives and who write signatures. However, it lowers the performance because of the amount of information it has to store.

```
- alert-debug:                  #The log-name.
    enabled: no                 #This log is not enabled. Set 'yes' to enable.
    filename: alert-debug.log   #The name of the file in the default logging directory.
    append: yes/no              #If this option is set to yes, the last filled fast.log-
↪file will not be
                                # overwritten while restarting Suricata.
```

Stats

In stats you can set the options for stats.log. When enabling stats.log you can set the amount of time in seconds after which you want the output-data to be written to the log file.

```
- stats:
     enabled: yes               #By default, the stats-option is enabled
     filename: stats.log        #The log-name. Combined with the default logging␣
↪directory
                                #(default-log-dir) it will result in /var/log/suricata/
↪stats.log.
                                #This directory can be overruled with a absolute path. (A
                                #directory starting with / ).
     append: yes/no             #If this option is set to yes, the last filled fast.log-
↪file will not be
                                #overwritten while restarting Suricata.
```

The interval and several other options depend on the global stats section as described above.

Syslog

With this option it is possible to send all alert and event output to syslog.

```
- syslog:                       #This is a output-module to direct log-output to several␣
↪directions.
     enabled: no                #The use of this output-module is not enabled.
     facility: local5           #In this option you can set a syslog facility.
     level: Info                #In this option you can set the level of output. The␣
↪possible levels are:
                                #Emergency, Alert, Critical, Error, Warning, Notice,␣
↪Info and Debug.
```

File-store (File Extraction)

The *file-store* output enables storing of extracted files to disk and configures where they are stored.

The following shows the configuration options for version 2 of the *file-store* output.

```
- file-store:
    # This configures version 2 of the file-store.
    version: 2

    enabled: no

    # Set the directory for the filestore. If the path is not
    # absolute will be be relative to the default-log-dir.
    #dir: filestore

    # Write out a fileinfo record for each occurrence of a
    # file. Disabled by default as each occurrence is already logged
    # as a fileinfo record to the main eve-log.
    #write-fileinfo: yes

    # Force storing of all files. Default: no.
    #force-filestore: yes

    # Override the global stream-depth for sessions in which we want
    # to perform file extraction. Set to 0 for unlimited; otherwise,
    # must be greater than the global stream-depth value to be used.
    #stream-depth: 0

    # Uncomment the following variable to define how many files can
    # remain open for filestore by Suricata. Default value is 0 which
    # means files get closed after each write
    #max-open-files: 1000

    # Force logging of checksums, available hash functions are md5,
    # sha1 and sha256. Note that SHA256 is automatically forced by
    # the use of this output module as it uses the SHA256 as the
    # file naming scheme.
    #force-hash: [sha1, md5]
```

12.1.10 Detection engine

Inspection configuration

The detection-engine builds internal groups of signatures. Suricata loads signatures, with which the network traffic will be compared. The fact is, that many rules certainly will not be necessary. (For instance: if there appears a packet with the UDP-protocol, all signatures for the TCP-protocol won't be needed.) For that reason, all signatures will be divided in groups. However, a distribution containing many groups will make use of a lot of memory. Not every type of signature gets its own group. There is a possibility that different signatures with several properties in common, will be placed together in a group. The quantity of groups will determine the balance between memory and performance. A small amount of groups will lower the performance yet uses little memory. The opposite counts for a higher amount of groups. The engine allows you to manage the balance between memory and performance. To manage this, (by determining the amount of groups) there are several general options: high for good performance and more use of

memory, low for low performance and little use of memory. The option medium is the balance between performance and memory usage. This is the default setting. The option custom is for advanced users. This option has values which can be managed by the user.

```
detect:
  profile: medium
  custom-values:
    toclient-groups: 2
    toserver-groups: 25
  sgh-mpm-context: auto
  inspection-recursion-limit: 3000
  guess-applayer-tx: no
```

At all of these options, you can add (or change) a value. Most signatures have the adjustment to focus on one direction, meaning focusing exclusively on the server, or exclusively on the client.

If you take a look at example 4, *the Detection-engine grouping tree*, you see it has many branches. At the end of each branch, there is actually a 'sig group head'. Within that sig group head there is a container which contains a list with signatures that are significant for that specific group/that specific end of the branch. Also within the sig group head the settings for Multi-Pattern-Matcher (MPM) can be found: the MPM-context.

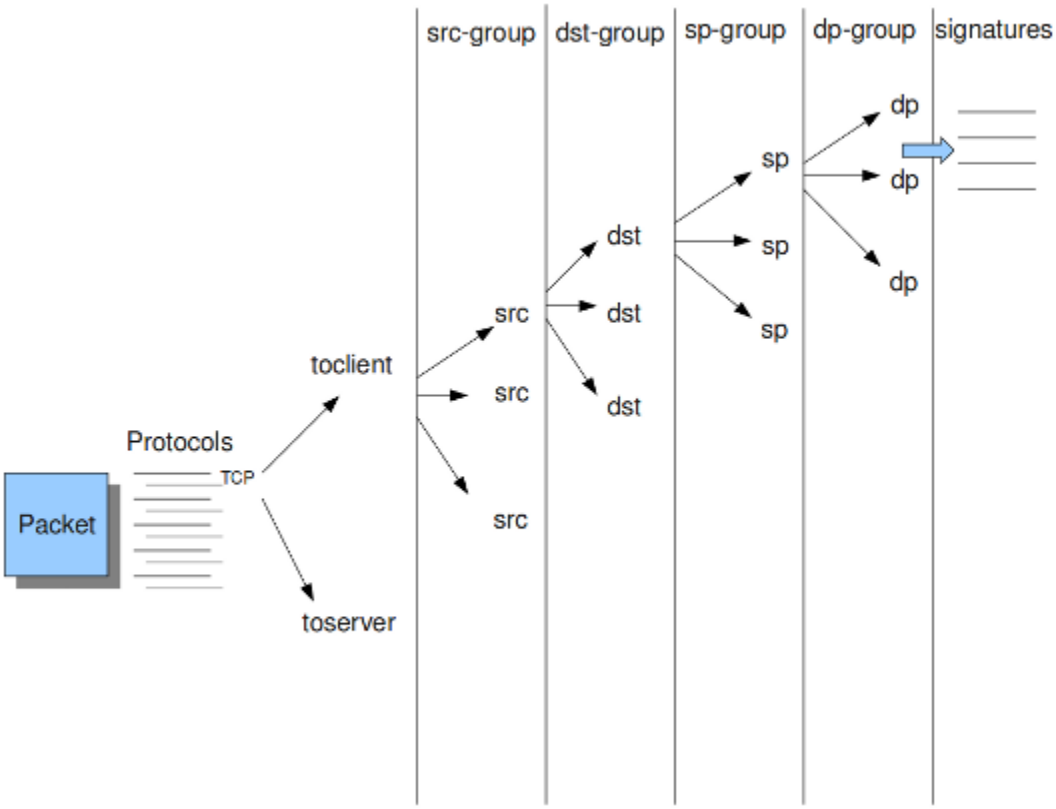
As will be described again at the part 'Pattern matching settings', there are several MPM-algorithms of which can be chosen from. Because every sig group head has its own MPM-context, some algorithms use a lot of memory. For that reason there is the option sgh-mpm-context to set whether the groups share one MPM-context, or to set that every group has its own MPM-context.

For setting the option sgh-mpm-context, you can choose from auto, full or single. The default setting is 'auto', meaning Suricata selects full or single based on the algorithm you use. 'Full' means that every group has its own MPM-context, and 'single' that all groups share one MPM-context. The algorithm "ac" uses a single MPM-context if the Sgh-MPM-context setting is 'auto'. The rest of the algorithms use full in that case.

The inspection-recursion-limit option has to mitigate that possible bugs in Suricata cause big problems. Often Suricata has to deal with complicated issues. It could end up in an 'endless loop' due to a bug, meaning it will repeat its actions over and over again. With the option inspection-recursion-limit you can limit this action.

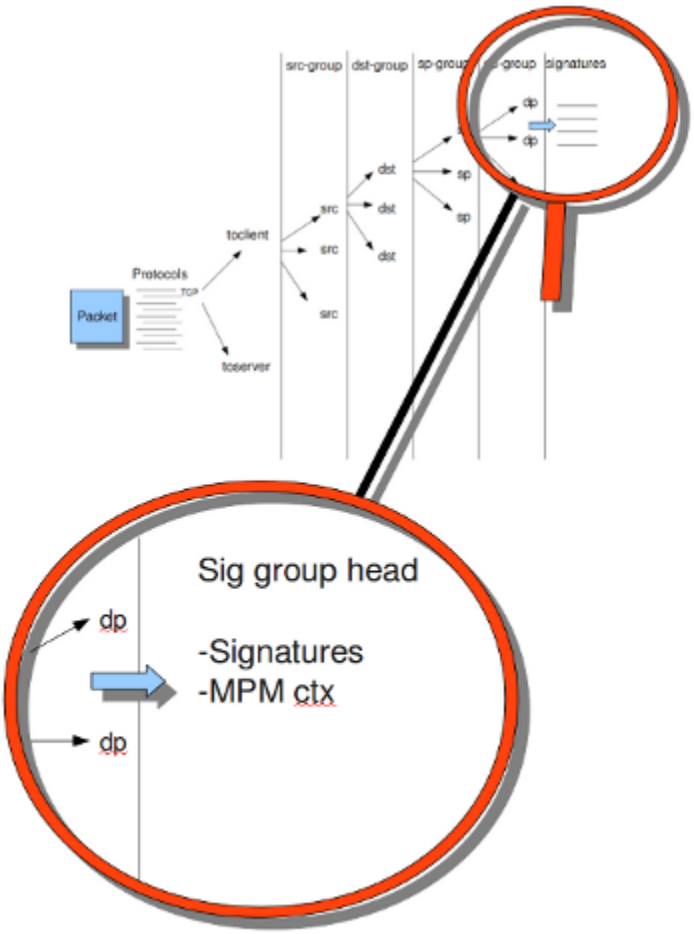
The `guess-applayer-tx` option controls whether the engine will try to guess and tie a transaction to a given alert if the matching signature doesn't have app-layer keywords. If enabled, AND ONLY ONE LIVE TRANSACTION EXISTS, that transaction's data will be added to the alert metadata. Note that this may not be the expected data, from an analyst's perspective.

Example 4 Detection-engine grouping tree




```
src             Stands for source IP-address.
dst             Stands for destination IP-address.
sp              Stands for source port.
dp              Stands for destination port.
```

Example 5 Detail grouping tree



Prefilter Engines

The concept of prefiltering is that there are far too many rules to inspect individually. The approach prefilter takes is that from each rule one condition is added to prefilter, which is then checked in one step. The most common example is MPM (also known as fast_pattern). This takes a single pattern per rule and adds it to the MPM. Only for those rules that have at least one pattern match in the MPM stage, individual inspection is performed.

Next to MPM, other types of keywords support prefiltering. ICMP itype, icode, icmp_seq and icmp_id for example. TCP window, IP TTL are other examples.

For a full list of keywords that support prefilter, see:

```
suricata --list-keywords=all
```

Suricata can automatically select prefilter options, or it can be set manually.

```
detect:
  prefilter:
    default: mpm
```

By default, only MPM/fast_pattern is used.

The prefilter engines for other non-MPM keywords can then be enabled in specific rules by using the 'prefilter' keyword.

E.g.

```
alert ip any any -> any any (ttl:123; prefilter; sid:1;)
```

To let Suricata make these decisions set default to 'auto':

```
detect:
  prefilter:
    default: auto
```

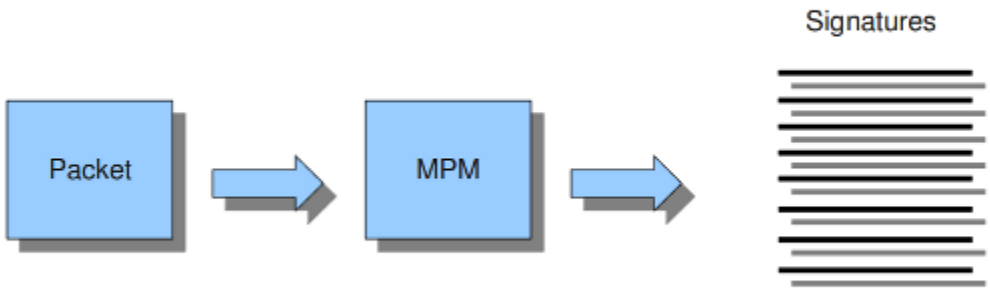
Pattern matcher settings

The multi-pattern-matcher (MPM) is a part of the detection engine within Suricata that searches for multiple patterns at once. Often, signatures have one or more patterns. Of each signature, one pattern is used by the multi-pattern-matcher. That way Suricata can exclude many signatures from being examined, because a signature can only match when all its patterns match.

These are the proceedings:

1) A packet comes in.
2) The packed will be analyzed by the Multi-pattern-matcher in search of patterns that match.
3) All patterns that match, will be further processed by Suricata (signatures).

Example 8 Multi-pattern-matcher



Suricata offers various implementations of different multi-pattern-matcher algorithm's. These can be found below.

To set the multi-pattern-matcher algorithm:

```
mpm-algo: ac
```

After 'mpm-algo', you can enter one of the following algorithms: ac, hs and ac-ks.

On *x86_64* hs (Hyperscan) should be used for best performance.

12.1.11 Threading

Suricata is multi-threaded. Suricata uses multiple CPUs/CPU cores so it can process a lot of network packets simultaneously. (In a single-core engine, the packets will be processed one at a time.)

There are four thread-modules: Packet acquisition, decode and stream application layer, detection, and outputs.

The packet acquisition module reads packets from the network.

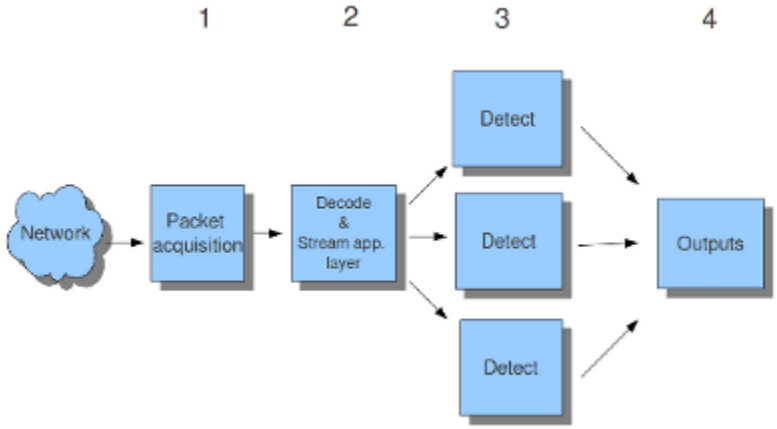
The decode module decodes the packets and the stream application application layer has three tasks:

```
First: it performs stream-tracking, meaning it is making sure all steps will be taken to␣
↪make a correct network-connection.
Second: TCP-network traffic comes in as packets. The Stream-Assembly engine reconstructs␣
↪the original stream.
Finally: the application layer will be inspected. HTTP and DCERPC will be analyzed.
```

The detection threads will compare signatures. There can be several detection threads so they can operate simultaneously.

In Outputs all alerts and events will be processed.

Example 6 Threading




```
Packet acquisition:             Reads packets from the network
Decode:                         Decodes packets.
Stream app. Layer:              Performs stream-tracking and reassembly.
Detect:                         Compares signatures.
Outputs:                        Processes all events and alerts.
```

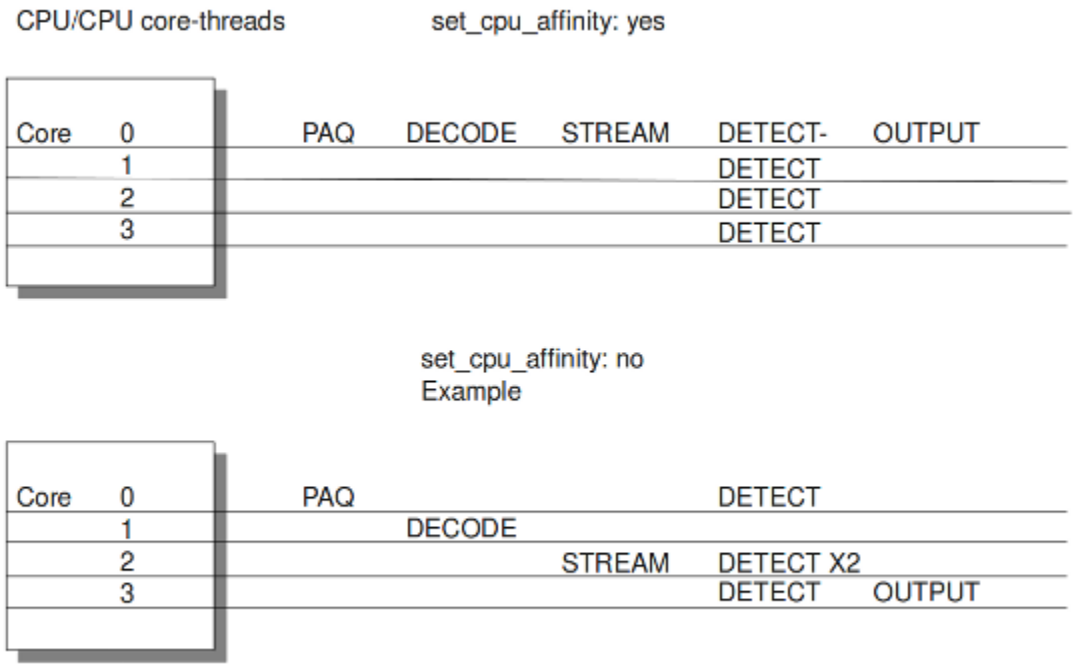
Most computers have multiple CPU's/ CPU cores. By default the operating system determines which core works on which thread. When a core is already occupied, another one will be designated to work on the thread. So, which core works on which thread, can differ from time to time.

There is an option within threading:

```
set-cpu-affinity: no
```

With this option you can cause Suricata setting fixed cores for every thread. In that case 1, 2 and 4 are at core 0 (zero). Each core has its own detect thread. The detect thread running on core 0 has a lower priority than the other threads running on core 0. If these other cores are to occupied, the detect thread on core 0 has not much packets to process. The detect threads running on other cores will process more packets. This is only the case after setting the option to 'yes'.

Example 7 Balancing workload



You can set the detect-thread-ratio:

```
detect-thread-ratio: 1.5
```

The detect thread-ratio will determine the amount of detect threads. By default it will be 1.5 x the amount of CPU's/CPU cores present at your computer. This will result in having more detection threads then CPU's/ CPU cores. Meaning you are oversubscribing the amount of cores. This may be convenient at times when there have to be waited for a detection thread. The remaining detection thread can become active.

You can alter the per-thread stack-size if the default provided by your build system is too small. The default value is provided by your build system; we suggest setting the value to 8MB if the default value is too small.

```
stack-size: 8MB
```

In the option 'cpu affinity' you can set which CPU's/cores work on which thread. In this option there are several sets of threads. The management-, receive-, worker- and verdict-set. These are fixed names and can not be changed. For each set there are several options: cpu, mode, and prio. In the option 'cpu' you can set the numbers of the CPU's/cores which will run the threads from that set. You can set this option to 'all', use a range (0-3) or a comma separated list (0,1). The option 'mode' can be set to 'balanced' or 'exclusive'. When set to 'balanced', the individual threads can be processed by all cores set in the option 'cpu'. If the option 'mode' is set to 'exclusive', there will be fixed cores for each thread. As

mentioned before, threads can have different priority's. In the option 'prio' you can set a priority for each thread. This priority can be low, medium, high or you can set the priority to 'default'. If you do not set a priority for a CPU, than the settings in 'default' will count. By default Suricata creates one 'detect' (worker) thread per available CPU/CPU core.

Note: The 'prio' settings could overwrite each other, make sure to not include the same CPU core in different 'prio' settings.

```
cpu-affinity:
  - management-cpu-set:
      cpu: [ 0 ]  # include only these cpus in affinity settings
  - receive-cpu-set:
      cpu: [ 0 ]  # include only these cpus in affinity settings
  - worker-cpu-set:
      cpu: [ "all" ]
      mode: "exclusive"
      # Use explicitly 3 threads and don't compute number by using
      # detect-thread-ratio variable:
      # threads: 3
      prio:
        low: [ 0 ]
        medium: [ "1-2" ]
        high: [ 3 ]
        default: "medium"
  - verdict-cpu-set:
      cpu: [ 0 ]
      prio:
        default: "high"
```

Relevant cpu-affinity settings for IDS/IPS modes

IDS mode

Runmode AutoFp:

```
management-cpu-set - used for management (example - flow.managers, flow.recyclers)
receive-cpu-set - used for receive and decode
worker-cpu-set - used for streamtcp,detect,output(logging),reject
```

Rumode Workers:

```
management-cpu-set - used for management (example - flow.managers, flow.recyclers)
worker-cpu-set - used for receive,streamtcp,decode,detect,output(logging),respond/reject
```

IPS mode

Runmode AutoFp:

```
management-cpu-set - used for management (example - flow.managers, flow.recyclers)
receive-cpu-set - used for receive and decode
worker-cpu-set - used for streamtcp,detect,output(logging)
verdict-cpu-set - used for verdict and respond/reject
```

Runmode Workers:

```
management-cpu-set - used for management (example - flow.managers, flow.recyclers)
worker-cpu-set - used for receive,streamtcp,decode,detect,output(logging),respond/reject,
↪ verdict
```

12.1.12 IP Defrag

Occasionally network packets appear fragmented. On some networks it occurs more often than on others. Fragmented packets exist of many parts. Before Suricata is able to inspect these kind of packets accurately, the packets have to be reconstructed. This will be done by a component of Suricata; the defragment-engine. After a fragmented packet is reconstructed by the defragment-engine, the engine sends on the reassembled packet to rest of Suricata.

At the moment Suricata receives a fragment of a packet, it keeps in memory that other fragments of that packet will appear soon to complete the packet. However, there is a possibility that one of the fragments does not appear. To prevent Suricata for keeping waiting for that packet (thereby using memory) there is a timespan after which Suricata discards the fragments (timeout). This occurs by default after 60 seconds.

In IPS mode, it is possible to tell the engine what to do in case the memcap for the defrag engine is reached: "drop-packet", "pass-packet", or "ignore" (default behavior).

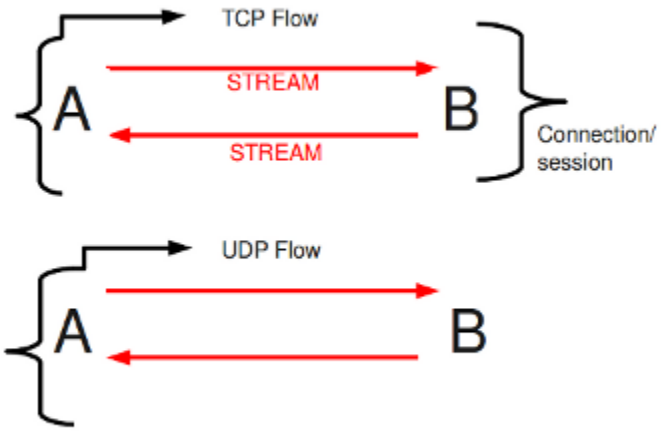
```
defrag:
  memcap: 32mb
  memcap-policy: ignore  # in IPS mode, what to do if memcap is reached
  hash-size: 65536
  trackers: 65535        # number of defragmented flows to follow
  max-frags: 65535       # number of fragments do keep (higher than trackers)
  prealloc: yes
  timeout: 60
```

12.1.13 Flow and Stream handling

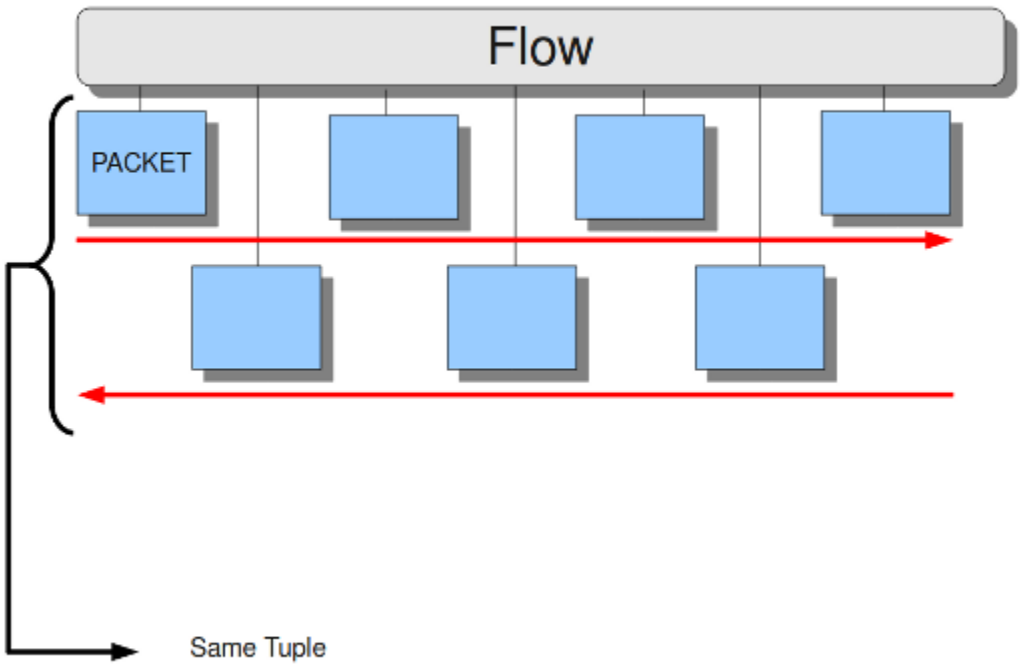
Flow Settings

Within Suricata, Flows are very important. They play a big part in the way Suricata organizes data internally. A flow is a bit similar to a connection, except a flow is more general. All packets having the same Tuple (protocol, source IP, destination IP, source-port, destination-port), belong to the same flow. Packets belonging to a flow are connected to it internally.

Example 9 Flow



Example 10 Tuple



Keeping track of all these flows, uses memory. The more flows, the more memory it will cost.

To keep control over memory usage, there are several options:

The option memcap for setting the maximum amount of bytes the flow-engine will use, hash-size for setting the size of the hash-table and prealloc for the following:

> For packets not yet belonging to a flow, Suricata creates a new flow. This is a relative expensive action. The risk coming with it, is that attackers /hackers can a attack the engine system at this part. When they make sure a computer gets a lot of packets with different tuples, the engine has to make a lot of new flows. This way, an attacker could flood the system. To mitigate the engine from being overloaded, this option instructs Suricata to keep a number of flows ready in memory. This way Suricata is less vulnerable to these kind of attacks.

The flow-engine has a management thread that operates independent from the packet processing. This thread is called the flow-manager. This thread ensures that wherever possible and within the memcap. There will be 10000 flows prepared.

In IPS mode, a memcap-policy exception policy can be set, telling Suricata what to do in case memcap is hit: 'drop-packet', 'pass-packet', 'reject', or 'ignore'.

```
flow:
  memcap: 33554432              #The maximum amount of bytes the flow-engine will make␣
↪use of.
  memcap-policy: bypass         #How to handle the flow if memcap is reached (IPS mode)
  hash_size: 65536              #Flows will be organized in a hash-table. With this␣
↪option you can set the
                                #size of the hash-table.
  Prealloc: 10000               #The amount of flows Suricata has to keep ready in␣
↪memory.
```

At the point the memcap will still be reached, despite prealloc, the flow-engine goes into the emergency-mode. In this mode, the engine will make use of shorter time-outs. It lets flows expire in a more aggressive manner so there will be more space for new Flows.

There are two options: emergency_recovery and prune_flows. The emergency recovery is set on 30. This is the percentage of prealloc'd flows after which the flow-engine will be back to normal (when 30 percent of the 10000 flows is completed).

> If during the emergency-mode, the aggressive time-outs do not have the desired result, this option is the final resort. It ends some flows even if they have not reached their time-outs yet. The prune-flows option shows how many flows there will be terminated at each time a new flow is set up.

```
emergency_recovery: 30                  #Percentage of 1000 prealloc'd flows.
prune_flows: 5                          #Amount of flows being terminated during the␣
↪emergency mode.
```

Flow Time-Outs

The amount of time Suricata keeps a flow in memory is determined by the Flow time-out.

There are different states in which a flow can be. Suricata distinguishes three flow-states for TCP and two for UDP. For TCP, these are: New, Established and Closed,for UDP only new and established. For each of these states Suricata can employ different timeouts.

The state new in a TCP-flow, means the period during the three way handshake. The state established is the state when the three way handshake is completed. The state closed in the TCP-flow: there a several ways to end a flow. This is by means of Reset or the Four-way FIN handshake.

New in a UDP-flow: the state in which packets are send from only one direction.

Established in a UDP-flow: packets are send from both directions.

In the example configuration the are settings for each protocol. TCP, UDP, ICMP and default (all other protocols).

```
flow-timeouts:

  default:
    new: 30                     #Time-out in seconds after the last activity in this␣
↪flow in a New state.
    established: 300            #Time-out in seconds after the last activity in this␣
↪flow in a Established
                                #state.
    emergency_new: 10           #Time-out in seconds after the last activity in this␣
↪flow in a New state
                                #during the emergency mode.
    emergency_established: 100  #Time-out in seconds after the last activity in this␣
↪flow in a Established
                                #state in the emergency mode.
  tcp:
    new: 60
    established: 3600
    closed: 120
    emergency_new: 10
    emergency_established: 300
    emergency_closed: 20
  udp:
    new: 30
    established: 300
    emergency_new: 10
    emergency_established: 100
  icmp:
    new: 30
    established: 300
    emergency_new: 10
    emergency_established: 100
```

Stream-engine

The Stream-engine keeps track of the TCP-connections. The engine exists of two parts: The stream tracking- and the reassembly-engine.

The stream-tracking engine monitors the state of a connection. The reassembly-engine reconstructs the flow as it used to be, so it will be recognized by Suricata.

The stream-engine has two memcaps that can be set. One for the stream-tracking-engine and one for the reassembly-engine. For both cases, in IPS mode, an exception policy (memcap-policy) can be set, telling Suricata what to do in case memcap is hit: 'drop-flow', 'drop-packet', 'pass-flow', 'pass-packet', 'bypass', 'reject', or 'ignore'.

The stream-tracking-engine keeps information of the flow in memory. Information about the state, TCP-sequence-numbers and the TCP window. For keeping this information, it can make use of the capacity the memcap allows.

TCP packets have a so-called checksum. This is an internal code which makes it possible to see if a packet has arrived in a good state. The stream-engine will not process packets with a wrong checksum. This option can be set off by entering 'no' instead of 'yes'.

```
stream:
  memcap: 64mb                # Max memory usage (in bytes) for TCP session tracking
  memcap-policy: ignore       # In IPS mode, call memcap policy if memcap is reached
  checksum_validation: yes    # Validate packet checksum, reject packets with invalid␣
↪checksums.
```

To mitigate Suricata from being overloaded by fast session creation, the option prealloc_sessions instructs Suricata to keep a number of sessions ready in memory.

A TCP-session starts with the three-way-handshake. After that, data can be sent and received. A session can last a long time. It can happen that Suricata will be started after a few TCP sessions have already been started. This way, Suricata misses the original setup of those sessions. This setup always includes a lot of information. If you want Suricata to check the stream from that time on, you can do so by setting the option 'midstream' to 'true'. The default setting is 'false'. In IPS mode, it is possible to define a 'midstream-policy', indicating whether Suricata should drop-flow, drop-packet, pass-flow, pass-packet, reject, or bypass a midstream flow. The default is ignore. Normally Suricata is able to see all packets of a connection. Some networks make it more complicated though. Some of the network-traffic follows a different route than the other part, in other words: the traffic goes asynchronous. To make sure Suricata will check the one part it does see, instead of getting confused, the option 'async-oneside' is brought to life. By default the option is set to 'false'.

Suricata inspects content in the normal/IDS mode in chunks. In the inline/IPS mode it does that on the sliding window way (see example ..) In the case Suricata is set in inline mode, it has to inspect packets immediately before sending it to the receiver. This way Suricata is able to drop a packet directly if needed.(see example . . .) It is important for Suricata to note which operating system it is dealing with, because operating systems differ in the way they process anomalies in streams. See *Host-os-policy*.

```
prealloc_sessions: 32768     # 32k sessions prealloc'd
midstream: false             # do not allow midstream session pickups
midstream-policy: drop-flow  # in IPS mode, drop flows that start midstream
async_oneside: false         # do not enable async stream handling
inline: no                   # stream inline mode
drop-invalid: yes            # drop invalid packets
bypass: no
```

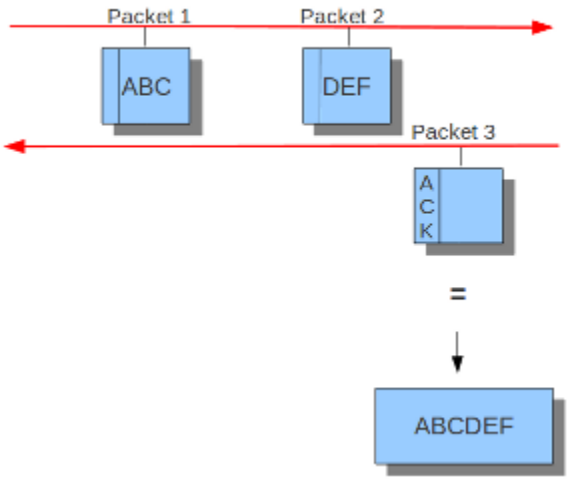
The `drop-invalid` option can be set to no to avoid blocking packets that are seen invalid by the streaming engine. This can be useful to cover some weird cases seen in some layer 2 IPS setup.

The `bypass` option activates 'bypass' for a flow/session when either side of the session reaches its `depth`.

> **Warning:** `bypass` can lead to missing important traffic. Use with care.

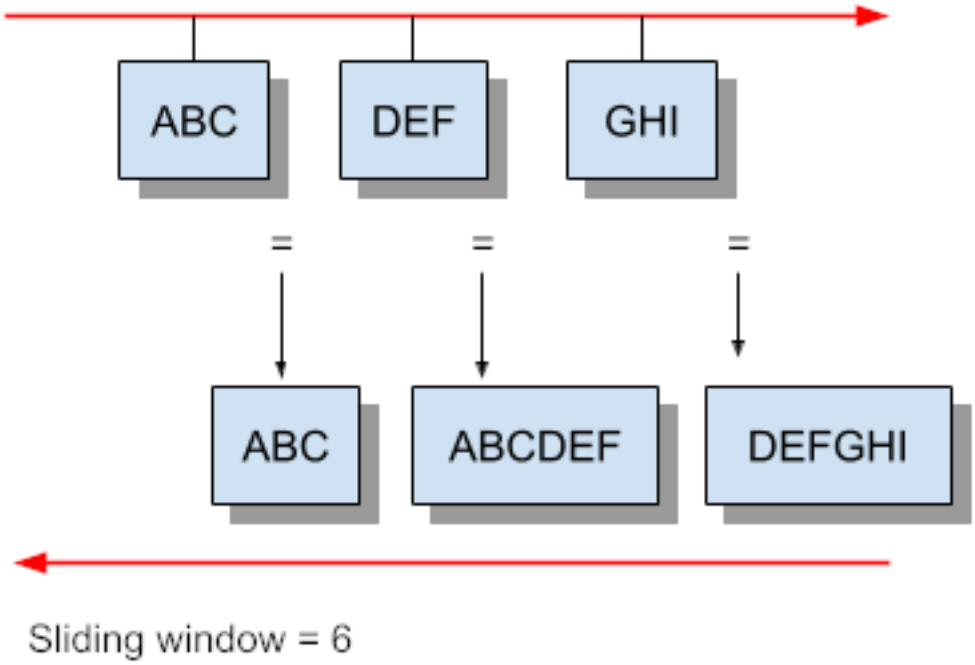
Example 11 Normal/IDS mode

Suricata inspects traffic in chunks.

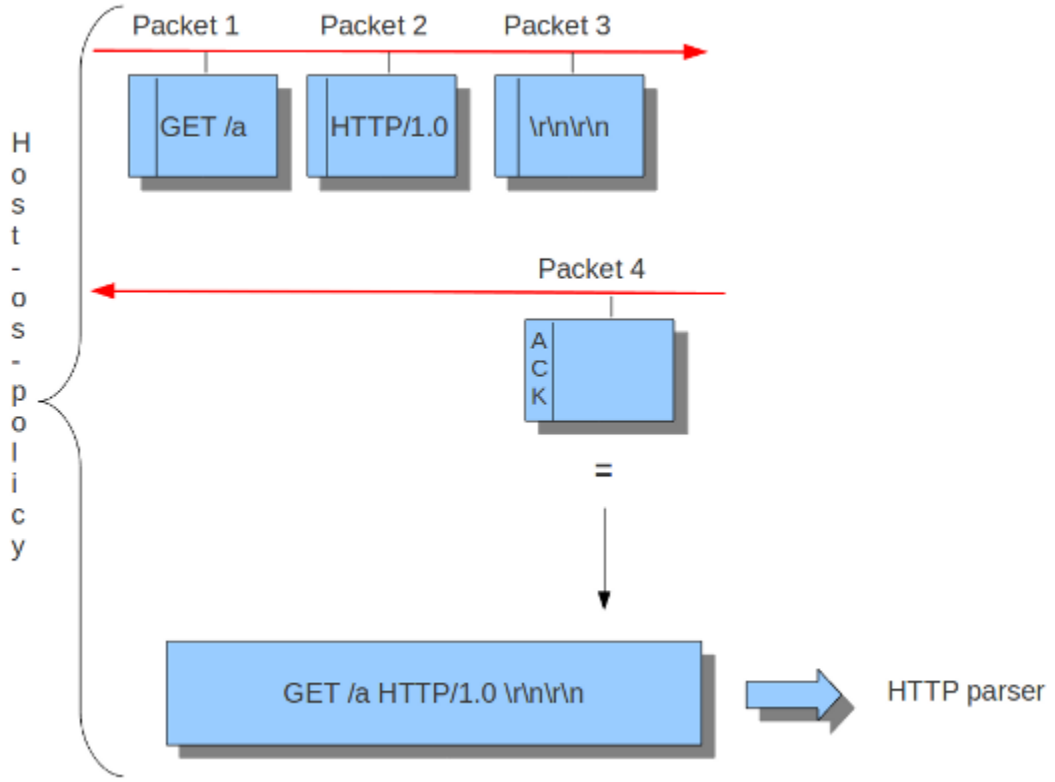


Example 12 Inline/IPS Sliding Window

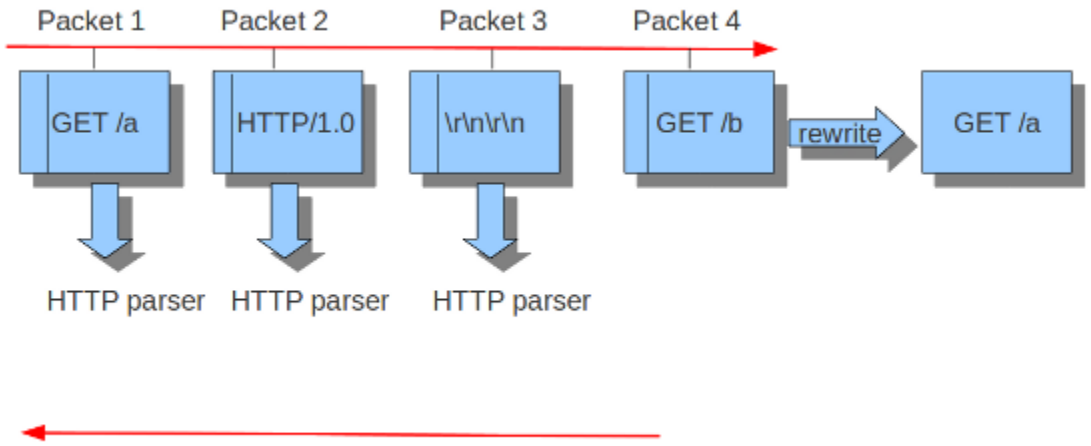
Suricata inspects traffic in a sliding window manner.



Example 13 Normal/IDS (reassembly on ACK'D data)



Example 14 Inline/IPS (reassembly on UNACK'D data)



The reassembly-engine has to keep data segments in memory in order to be able to reconstruct a stream. To avoid resource starvation a memcap is used to limit the memory used. In IPS mode, an exception policy (memcap-policy) can be set, telling Suricata what to do in case memcap is hit: 'drop-flow', 'drop-packet', 'pass-flow', 'pass-packet', 'bypass', 'reject', or 'ignore'.

Reassembling a stream is an expensive operation. With the option depth you can control how far into a stream reassembly is done. By default this is 1MB. This setting can be overridden per stream by the protocol parsers that do file

extraction.

Inspection of reassembled data is done in chunks. The size of these chunks is set with `toserver_chunk_size` and `toclient_chunk_size`. To avoid making the borders predictable, the sizes can be varied by adding in a random factor.

```
reassembly:
  memcap: 256mb             # Memory reserved for stream data reconstruction (in bytes)
  memcap-policy: ignore     # What to do when memcap for reassembly is hit
  depth: 1mb                # The depth of the reassembling.
  toserver_chunk_size: 2560 # inspect raw stream in chunks of at least this size
  toclient_chunk_size: 2560 # inspect raw stream in chunks of at least
  randomize-chunk-size: yes
  #randomize-chunk-range: 10
```

'Raw' reassembly is done for inspection by simple `content`, `pcre` keywords use and other payload inspection not done on specific protocol buffers like `http_uri`. This type of reassembly can be turned off:

```
reassembly:
  raw: no
```

Incoming segments are stored in a list in the stream. To avoid constant memory allocations a per-thread pool is used.

```
reassembly:
  segment-prealloc: 2048    # pre-alloc 2k segments per thread
```

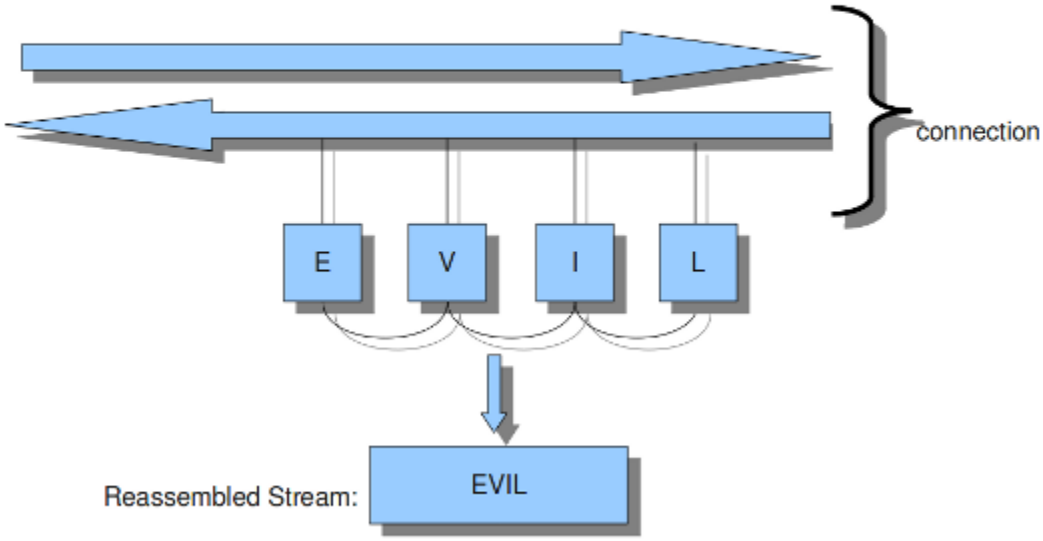
Resending different data on the same sequence number is a way to confuse network inspection.

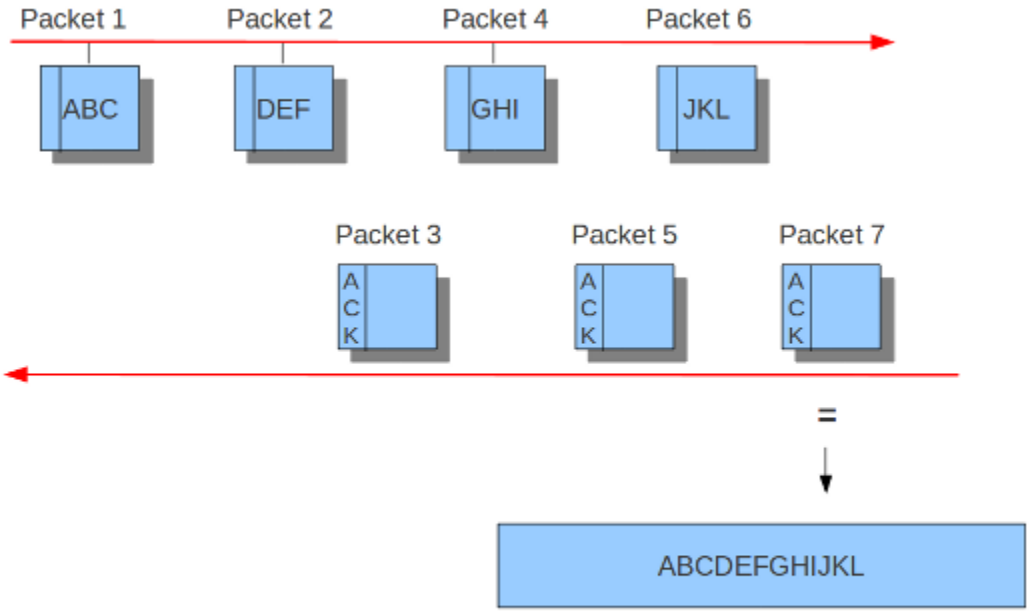
```
reassembly:
  check-overlap-different-data: true
```

Example 15 Stream reassembly

Stream Reassembly

Signature: EVIL





toserver_chunk_size: 10

TCP Urgent Handling

TCP Urgent pointer support is a complicated topic, where it is essentially impossible for a network device to know with certainty what the behavior of the receiving host is.

For this reason, many middleboxes strip the URG flag and reset the urgent pointer (see for example RFC 6093, 3.4).

Several options are provided to control how to deal with the urgent pointer.

Note: TCP urgent handling is considered experimental at this time

```
stream:
  reassembly:
  urgent:
    policy: oob              # drop, inline, oob (1 byte, see RFC 6093, 3.1), gap
    oob-limit-policy: drop
```

***stream.reassembly.urgent.policy*:**

- *drop*: drop URG packets before they affect the stream engine
- *inline*: ignore the urgent pointer and process all data inline
- *oob* (out of band): treat the last byte as out of band
- ***gap*: skip the last byte, but do no adjust sequence offsets, leading to** gaps in the data

If the urgent policy is set to *oob*, there is an additional setting. Since OOB data does advance the TCP sequence number, the stream engine tracks the number of bytes to make sure no GAPs in the non-OOB data are seen by the app-layer parsers and detection engine. This is currently limited to 64k per direction. If the number of OOB bytes exceeds that 64k, an additional policy is triggered: *stream.reassembly.urgent.oob-limit-policy*.

stream.reassembly.urgent.oob-limit-policy: - *drop*: drop URG packets before they affect the stream engine - *inline*: ignore the urgent pointer and process all data inline - *gap*: skip the last byte, but do no adjust sequence offsets, leading to gaps in the data

Observables

Each packet with the URG flag set, will increment the *tcp.urg* counter.

When dropping the URG packets, the packets will have the drop reason *ips.drop_reason.stream_urgent*, which is also a counter in the stats logging.

The stream event *stream-event:reassembly_urgent_oob_limit_reached* allows matching on the packet that reaches the OOB limit. Stream rule *2210066* matches on this.

If *stats.stream-events* are enabled the counter *stream.reassembly_urgent_oob_limit_reached* will be incremented if the OOB limit is reached.

12.1.14 Host Tracking

The Host table is used for tracking per IP address. This is used for tracking per IP thresholding, per IP tagging, storing *iprep* data and storing *hostbit*.

Settings

The configuration allows specifying the following settings: *hash-size*, *prealloc* and *memcap*.

```
host:
  hash-size: 4096
  prealloc: 1000
  memcap: 32mb
```

- *hash-size*: size of the hash table in number of rows
- *prealloc*: number of *Host* objects preallocated for efficiency
- *memcap*: max memory use for hosts, including the hash table size

Hosts are evicted from the hash table by the Flow Manager thread when all data in the host is expired (tag, threshold, etc). Hosts with iprep will not expire.

12.1.15 Application Layer Parsers

The `app-layer` section holds application layer specific configurations.

In IPS mode, a global exception policy accessed via the `error-policy` setting can be defined to indicate what the engine should do in case it encounters an app-layer error. Possible values are "drop-flow", "pass-flow", "bypass", "drop-packet", "pass-packet", "reject" or "ignore" (which maintains the default behavior).

Each supported protocol has a dedicated subsection under `protocols`.

Asn1_max_frames

Asn1 (Abstract Syntax One) is a standard notation to structure and describe data.

Within Asn1_max_frames there are several frames. To protect itself, Suricata will inspect a maximum of 256. You can set this amount differently if wanted.

Application layer protocols such as X.400 electronic mail, X.500 and LDAP directory services, H.323 (VoIP), BACnet and SNMP, use ASN.1 to describe the protocol data units (PDUs) they exchange. It is also extensively used in the Access and Non-Access Strata of UMTS.

Limit for the maximum number of asn1 frames to decode (default 256):

```
asn1_max_frames: 256
```

FTP

The FTP application layer parser is enabled by default and uses dynamic protocol detection.

By default, FTP control channel commands and responses are limited to 4096 bytes, but this value can be changed. When a command request or response exceeds the line length limit, the stored data will be truncated, however the parser will continue to watch for the end of line and acquire the next command. Commands that are truncated will be noted in the *eve* log file with the fields `command_truncated` or `reply_truncated`. Please note that this affects the control messages only, not FTP data (file transfers).

```
ftp:
  enabled: yes
  #memcap: 64mb

  # Maximum line length for control messages before they will be truncated.
  #max-line-length: 4kb
```

Configure HTTP (libhtp)

The library Libhtp is being used by Suricata to parse HTTP-sessions.

While processing HTTP-traffic, Suricata has to deal with different kind of servers which each process anomalies in HTTP-traffic differently. The most common web-server is Apache. This is an open source web-server program.

Besides Apache, IIS (Internet Information Services/Server) a web-server program of Microsoft is also well-known.

Like with host-os-policy, it is important for Suricata to know which IP-address/network-address is used by which server. In Libhtp this assigning of web-servers to IP-and network addresses is called personality.

Currently Available Personalities:

- Minimal
- Generic
- IDS (default)
- IIS_4_0
- IIS_5_0
- IIS_5_1
- IIS_6_0
- IIS_7_0
- IIS_7_5
- Apache
- Apache_2_2

You can assign names to each block of settings. Which in this case is -apache and -iis7. Under these names you can set IP-addresses, network-addresses the personality and a set of features.

The version-specific personalities know exactly how web servers behave, and emulate that. The IDS personality would try to implement a best-effort approach that would work reasonably well in the cases where you do not know the specifics.

The default configuration also applies to every IP-address for which no specific setting is available.

HTTP request bodies are often big, so they take a lot of time to process which has a significant impact on the performance. With the option 'request-body-limit' you can set the limit (in bytes) of the client-body that will be inspected. Setting it to 0 will inspect all of the body.

The same goes for HTTP response bodies.

```
libhtp:

  default-config:
    personality: IDS
    request-body-limit: 3072
    response-body-limit: 3072

  server-config:
     - apache:
         address: [192.168.1.0/24, 127.0.0.0/8, "::1"]
         personality: Apache_2_2
         request-body-limit: 0
         response-body-limit: 0

     - iis7:
         address:
           - 192.168.0.0/24
           - 192.168.10.0/24
         personality: IIS_7_0
         request-body-limit: 4096
         response-body-limit: 8192
```

Suricata makes available the whole set of libhtp customisations for its users.

You can now use these parameters in the conf to customise suricata's use of libhtp.

```
# Configures whether backslash characters are treated as path segment
# separators. They are not on Unix systems, but are on Windows systems.
# If this setting is enabled, a path such as "/one\two/three" will be
# converted to "/one/two/three".  Accepted values - yes, no.
#path-convert-backslash-separators: yes

# Configures whether input data will be converted to lowercase.
#path-convert-lowercase: yes

# Configures how the server reacts to encoded NUL bytes.
#path-nul-encoded-terminates: no

# Configures how the server reacts to raw NUL bytes.
#path-nul-raw-terminates: no

# Configures whether consecutive path segment separators will be
# compressed. When enabled, a path such as "/one//two" will be normalized
# to "/one/two". The backslash_separators and decode_separators
# parameters are used before compression takes place. For example, if
# backslash_separators and decode_separators are both enabled, the path
# "/one\\/two\/%5cthree/%2f//four" will be converted to
# "/one/two/three/four".  Accepted values - yes, no.
#path-separators-compress: yes
```

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```
# Configures whether encoded path segment separators will be decoded.
# Apache does not do this, but IIS does. If enabled, a path such as
# "/one%2ftwo" will be normalized to "/one/two". If the
# backslash_separators option is also enabled, encoded backslash
# characters will be converted too (and subsequently normalized to
# forward slashes).  Accepted values - yes, no.
#path-separators-decode: yes

# Configures whether %u-encoded sequences in path will be decoded. Such
# sequences will be treated as invalid URL encoding if decoding is not
# desireable.  Accepted values - yes, no.
#path-u-encoding-decode: yes

# Configures how server reacts to invalid encoding in path.  Accepted
# values - preserve_percent, remove_percent, decode_invalid, status_400
#path-url-encoding-invalid-handling: preserve_percent

# Controls whether the data should be treated as UTF-8 and converted
# to a single-byte stream using best-fit mapping
#path-utf8-convert-bestfit:yes

# Sets the replacement character that will be used to in the lossy
# best-fit mapping from Unicode characters into single-byte streams.
# The question mark is the default replacement character.
#path-bestfit-replacement-char: ?

# Configures whether plus characters are converted to spaces
# when decoding URL-encoded strings.
#query-plusspace-decode: yes

#   response-body-decompress-layer-limit:
#                           Limit to how many layers of compression will be
#                           decompressed. Defaults to 2.

#   uri-include-all:        Include all parts of the URI. By default the
#                           'scheme', username/password, hostname and port
#                           are excluded.

#   meta-field-limit:       Hard size limit for request and response size
#                           limits.

# inspection limits
    request-body-minimal-inspect-size: 32kb
    request-body-inspect-window: 4kb
    response-body-minimal-inspect-size: 40kb
    response-body-inspect-window: 16kb

# auto will use http-body-inline mode in IPS mode, yes or no set it statically
    http-body-inline: auto

# Decompress SWF files.
```

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```
# 2 types: 'deflate', 'lzma', 'both' will decompress deflate and lzma
# compress-depth:
# Specifies the maximum amount of data to decompress,
# set 0 for unlimited.
# decompress-depth:
# Specifies the maximum amount of decompressed data to obtain,
# set 0 for unlimited.
    swf-decompression:
      enabled: yes
      type: both
      compress-depth: 0
      decompress-depth: 0

# Take a random value for inspection sizes around the specified value.
# This lower the risk of some evasion technics but could lead
# detection change between runs. It is set to 'yes' by default.
#randomize-inspection-sizes: yes
# If randomize-inspection-sizes is active, the value of various
# inspection size will be chosen in the [1 - range%, 1 + range%]
# range
# Default value of randomize-inspection-range is 10.
#randomize-inspection-range: 10

# Can enable LZMA decompression
#lzma-enabled: false
# Memory limit usage for LZMA decompression dictionary
# Data is decompressed until dictionary reaches this size
#lzma-memlimit: 1 Mb
# Maximum decompressed size with a compression ratio
# above 2048 (only reachable by LZMA)
#compression-bomb-limit: 1 Mb
# Maximum time spent decompressing a single transaction in usec
#decompression-time-limit: 100000
# Maximum number of live transactions per flow
#max-tx: 512
# Maximum used number of HTTP1 headers in one request or response
#headers-limit: 1024
```

Other parameters are customizable from Suricata.

```
#   double-decode-path:     Double decode path section of the URI
#   double-decode-query:    Double decode query section of the URI
```

decompression-time-limit

decompression-time-limit was implemented to avoid DOS by resource exhaustion on inputs such as decompression bombs (found by fuzzing). The lower the limit, the better the protection against DOS is, but this may also lead to false positives. In case the time limit is reached, the app-layer event `http.compression_bomb` is set (this event can also set from other conditions). This can happen on slow configurations (hardware, ASAN, etc...)

Configure SMB

The SMB parser will parse version 1, 2 and 3 of the SMB protocol over TCP.

To enable the parser add the following to the `app-layer` section of the YAML.

```
smb:
  enabled: yes
  detection-ports:
    dp: 139, 445
```

The parser uses pattern based protocol detection and will fallback to `probing parsers` if the pattern based detection fails. As usual, the pattern based detection is port independent. The `probing parsers` will only run on the `detection-ports`.

SMB is commonly used to transfer the DCERPC protocol. This traffic is also handled by this parser.

Resource limits

Several options are available for limiting record sizes and data chunk tracking.

```
smb:
  enabled: yes
  max-read-size: 8mb
  max-write-size: 1mb

  max-read-queue-size: 16mb
  max-read-queue-cnt: 16

  max-write-queue-size: 16mb
  max-write-queue-cnt: 16

  dcerpc:
    max-stub-size: 1MiB
```

The *max-read-size* option can be set to control the max size of accepted READ records. Events will be raised if a READ request asks for too much data and/or if READ responses are too big. A value of 0 disables the checks.

The *max-write-size* option can be set to control the max size of accepted WRITE request records. Events will be raised if a WRITE request sends too much data. A value of 0 disables the checks.

Additionally if the *max-read-size* or *max-write-size* values in the "negotiate protocol response" exceeds this limit an event will also be raised.

To control the size of the DCERPC stub data, *dcerpc.max-stub-size* should be used. It is by default set to 1MiB.

For file tracking, extraction and file data inspection the parser queues up out of order data chunks for both READs and WRITEs. To avoid using too much memory the parser allows for limiting both the size in bytes and the number of queued chunks.

```
smb:
  enabled: yes

  max-read-queue-size: 16mb
  max-read-queue-cnt: 16

  max-write-queue-size: 16mb
  max-write-queue-cnt: 16
```

max-read-queue-size controls how many bytes can be used per SMB flow for out of order READs. *max-read-queue-cnt* controls how many READ chunks can be queued per SMB flow. Processing of these chunks will be blocked when any of the limits are exceeded, and an event will be raised.

max-write-queue-size and *max-write-queue-cnt* are as the READ variants, but then for WRITEs.

Configure DCERPC

DCERPC has one parameter that can be customized. *max-stub-size* is used to control the stub data size of a DCERPC request/response. By default, it is set to 1MiB.

Configure HTTP2

HTTP2 has 2 parameters that can be customized. The point of these 2 parameters is to find a balance between the completeness of analysis and the resource consumption.

http2.max-table-size refers to *SETTINGS_HEADER_TABLE_SIZE* from rfc 7540 section 6.5.2. Its default value is 4096 bytes, but it can be set to any uint32 by a flow.

http2.max-streams refers to *SETTINGS_MAX_CONCURRENT_STREAMS* from rfc 7540 section 6.5.2. Its default value is unlimited.

SSL/TLS

SSL/TLS parsers track encrypted SSLv2, SSLv3, TLSv1, TLSv1.1 and TLSv1.2 sessions.

Protocol detection is done using patterns and a probing parser running on only TCP/443 by default. The pattern based protocol detection is port independent.

```
tls:
  enabled: yes
  detection-ports:
    dp: 443

  # What to do when the encrypted communications start:
  # - default: keep tracking TLS session, check for protocol anomalies,
  #            inspect tls_* keywords. Disables inspection of unmodified
  #            'content' signatures.
  # - bypass:  stop processing this flow as much as possible. No further
  #            TLS parsing and inspection. Offload flow bypass to kernel
  #            or hardware if possible.
  # - full:    keep tracking and inspection as normal. Unmodified content
  #            keyword signatures are inspected as well.
  #
```

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```
  # For best performance, select 'bypass'.
  #
  #encryption-handling: default
```

Encrypted traffic

There is no decryption of encrypted traffic, so once the handshake is complete continued tracking of the session is of limited use. The `encryption-handling` option controls the behavior after the handshake.

If `encryption-handling` is set to `default` (or if the option is not set), Suricata will continue to track the SSL/TLS session. Inspection will be limited, as raw `content` inspection will still be disabled. There is no point in doing pattern matching on traffic known to be encrypted. Inspection for (encrypted) Heartbleed and other protocol anomalies still happens.

When `encryption-handling` is set to `bypass`, all processing of this session is stopped. No further parsing and inspection happens. If `stream.bypass` is enabled this will lead to the flow being bypassed, either inside Suricata or by the capture method if it supports it and is configured for it.

Finally, if `encryption-handling` is set to `full`, Suricata will process the flow as normal, without inspection limitations or bypass.

The option has replaced the `no-reassemble` option. If `no-reassemble` is present, and `encryption-handling` is not, `false` is interpreted as `encryption-handling: default` and `true` is interpreted as `encryption-handling: bypass`.

Modbus

According to MODBUS Messaging on TCP/IP Implementation Guide V1.0b, it is recommended to keep the TCP connection opened with a remote device and not to open and close it for each MODBUS/TCP transaction. In that case, it is important to set the stream-depth of the modbus as unlimited.

```
modbus:
  # Stream reassembly size for modbus, default is 0
  stream-depth: 0
```

MQTT

The maximum size of a MQTT message is 256MB, potentially containing a lot of payload data (such as properties, topics, or published payloads) that would end up parsed and logged. To acknowledge the fact that most MQTT messages, however, will be quite small and to reduce the potential for denial of service issues, it is possible to limit the maximum length of a message that Suricata should parse. Any message larger than the limit will just be logged with reduced metadata, and rules will only be evaluated against a subset of fields. The default is 1 MB.

```
mqtt:
  max-msg-length: 1mb
```

SMTP

SMTP parsers can extract files from attachments. It is also possible to extract raw conversations as files with the key `raw-extraction`. Note that in this case the whole conversation will be stored as a file, including SMTP headers and body content. The filename will be set to "rawmsg". Usual file-related signatures will match on the raw content of the email. This configuration parameter has a `false` default value. It is incompatible with `decode-mime`. If both are enabled, `raw-extraction` will be automatically disabled.

```
smtp:
  # extract messages in raw format from SMTP
  raw-extraction: true
```

Maximum transactions

SMTP, MQTT, FTP, PostgreSQL, SMB, DCERPC, HTTP1 and NFS have each a *max-tx* parameter that can be customized. *max-tx* refers to the maximum number of live transactions for each flow. An app-layer event *protocol.too_many_transactions* is triggered when this value is reached. The point of this parameter is to find a balance between the completeness of analysis and the resource consumption.

For HTTP2, this parameter is named *max-streams* as an HTTP2 stream will get translated into one Suricata transaction. This configuration parameter is used whatever the value of *SETTINGS_MAX_CONCURRENT_STREAMS* negotiated between a client and a server in a specific flow is.

12.1.16 Engine Logging

The engine logging system logs information about the application such as errors and other diagnostic information during startup, runtime and shutdown of the Suricata engine. This does not include Suricata generated alerts and events.

The engine logging system has the following log levels:

- error
- warning
- notice
- info
- perf
- config
- debug

Note that debug level logging will only be emitted if Suricata was compiled with the `--enable-debug` configure option.

The first option within the logging configuration is the default-log-level. This option determines the severity/importance level of information that will be displayed. Messages of lower levels than the one set here, will not be shown. The default setting is Info. This means that error, warning and info will be shown and the other levels won't be.

Default Configuration Example

```
# Logging configuration.  This is not about logging IDS alerts/events, but
# output about what Suricata is doing, like startup messages, errors, etc.
logging:
  # The default log level, can be overridden in an output section.
  # Note that debug level logging will only be emitted if Suricata was
  # compiled with the --enable-debug configure option.
  #
  # This value is overridden by the SC_LOG_LEVEL env var.
  default-log-level: notice

  # The default output format.  Optional parameter, should default to
  # something reasonable if not provided.  Can be overridden in an
  # output section.  You can leave this out to get the default.
  #
  # This console log format value can be overridden by the SC_LOG_FORMAT env var.
  #default-log-format: "%D: %S: %M"
  #
  # For the pre-7.0 log format use:
  #default-log-format: "[%i] %t [%S] - (%f:%l) <%d> (%n) -- "

  # A regex to filter output.  Can be overridden in an output section.
  # Defaults to empty (no filter).
  #
  # This value is overridden by the SC_LOG_OP_FILTER env var.
  default-output-filter:

  # Define your logging outputs.  If none are defined, or they are all
  # disabled you will get the default - console output.
  outputs:
  - console:
      enabled: yes
      # type: json
  - file:
      enabled: yes
      level: info
      filename: suricata.log
      # format: "[%i - %m] %z %d: %S: %M"
      # type: json
  - syslog:
      enabled: no
      facility: local5
      format: "[%i] <%d> -- "
      # type: json
```

Default Log Level

Example:

```
logging:
  default-log-level: info
```

This option sets the default log level. The default log level is *notice*. This value will be used in the individual logging configuration (console, file, syslog) if not otherwise set.

Note: The `-v` command line option can be used to quickly increase the log level at runtime. See *the -v command line option*.

The `default-log-level` set in the configuration value can be overridden by the `SC_LOG_LEVEL` environment variable.

Default Log Format

A logging line exists of two parts. First it displays meta information (Log-level, Suricata module), and finally the actual log message. Example:

```
i: suricata: This is Suricata version 7.0.2 RELEASE running in USER mode
```

(Here the part until the second *:* is the meta info, "This is Suricata version 7.0.2 RELEASE running in USER mode" is the actual message.)

It is possible to determine which information will be displayed in this line and (the manner how it will be displayed) in which format it will be displayed. This option is the so called format string:

```
default-log-format: "[%i] %t - (%f:%l) <%d> (%n) -- "
```

The % followed by a character has a special meaning. There are thirteen specified signs:

```
z:      ISO-like formatted timestamp: YYYY-MM-DD HH:MM:SS
t:      Original Suricata log timestamp: DD/MM/YYYY -- HH:MM::SS
p:      Process ID. Suricata's whole processing consists of multiple threads.
i:      Thread ID. ID of individual threads.
m:      Thread module name. (Outputs, Detect etc.)
d:      Log-level of specific log-event. (Error, info, debug etc.)
D:      Compact log format (E for Error, i for info etc.)
S:      Subsystem name.
T:      Thread name.
M:      Log message body.
f:      Filename. Name of C-file (source code) where log-event is generated.
l:      Line-number within the filename, where the log-event is generated in the source-
↪code.
n:      Function-name in the C-code (source code).
```

The last three options, f, l and n, are mainly convenient for developers.

The log-format can be overridden in the command line by the environment variable: SC_LOG_FORMAT

Output Filter

Within logging you can set an output-filter. With this output-filter you can set which part of the event-logs should be displayed. You can supply a regular expression (Regex). A line will be shown if the regex matches.

```
default-output-filter:              #In this option the regular expression can be␣
↪entered.
```

This value is overridden by the environment var: SC_LOG_OP_FILTER

Logging Outputs

There are different ways of displaying output. The output can appear directly on your screen, it can be placed in a file or via syslog. The last mentioned is an advanced tool for log-management. The tool can be used to direct log-output to different locations (files, other computers etc.)

```
outputs:
  - console:                                    #Output on your screen.
      enabled: yes                              #This option is enabled.
      #level: notice                            #Use a different level than the default.
  - file:                                       #Output stored in a file.
      enabled: no                               #This option is not enabled.
      filename: /var/log/suricata.log           #Filename and location on disc.
      level: info                               #Use a different level than the default.
  - syslog:                                     #This is a program to direct log-output␣
↪to several directions.
      enabled: no                               #The use of this program is not enabled.
      facility: local5                          #In this option you can set a syslog␣
↪facility.
      format: "[%i] <%d> -- "                   #The option to set your own format.
      #level: notice                            #Use a different level than the default.
```

12.1.17 Packet Acquisition

Data Plane Development Kit (DPDK)

Data Plane Development Kit is a framework for fast packet processing in data plane applications running on a wide variety of CPU architectures. DPDK's Environment Abstraction Layer (EAL) provides a generic interface to low-level resources. It is a unique way how DPDK libraries access NICs. EAL creates an API for an application to access NIC resources from the userspace level. In DPDK, packets are not retrieved via interrupt handling. Instead, the application polls the NIC for newly received packets.

DPDK allows the user space application to directly access memory where the NIC stores the packets. As a result, neither DPDK nor the application copies the packets for the inspection. The application directly processes packets via passed packet descriptors.

To use DPDK capture module, Suricata must be compiled with DPDK option enabled. Support for DPDK can be enabled in configure step of the build process such as:

```
./configure --enable-dpdk
```

Suricata makes use of DPDK for packet acquisition in workers runmode. The whole DPDK configuration resides in the *dpdk:* node. This node encapsulates 2 main subnodes, and those are eal-params and interfaces.

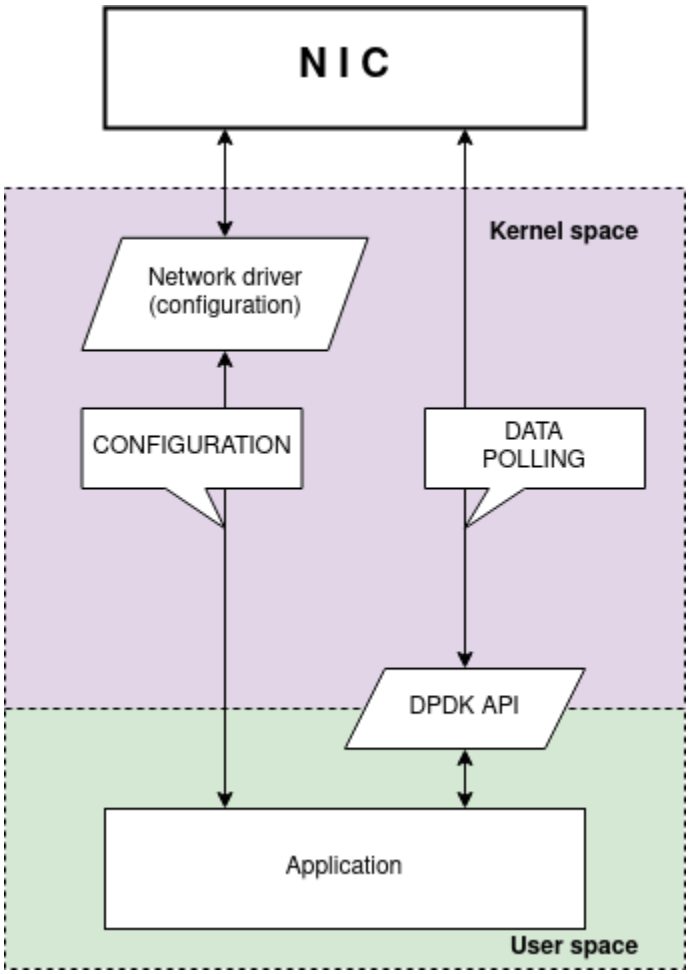

Fig. 1: *High-level overview of DPDK application*

```
dpdk:
  eal-params:
    proc-type: primary
    allow: ["0000:3b:00.0", "0000:3b:00.1"]
  interfaces:
    - interface: 0000:3b:00.0
      threads: auto
      promisc: true
      multicast: true
      checksum-checks: true
      checksum-checks-offload: true
      mtu: 1500
      mempool-size: 65535
      mempool-cache-size: 257
      rx-descriptors: 1024
      tx-descriptors: 1024
      copy-mode: none
      copy-iface: none # or PCIe address of the second interface
```

The DPDK arguments, which are typically provided through the command line, are contained in the node *dpdk.eal-params*. EAL is configured and initialized using these parameters. There are two ways to specify arguments: lengthy and short. Dashes are omitted when describing the arguments. This setup node can be used to set up the memory configuration, accessible NICs, and other EAL-related parameters, among other things. The node *dpdk.eal-params* also supports multiple arguments of the same type. This can be useful for EAL arguments such as *--vdev*, *--allow*, or *--block*. Values for these EAL arguments are specified as a comma-separated list. An example of such usage can be found in the example above where the *allow* argument only makes *0000:3b:00.0* and *0000:3b:00.1* accessible to Suricata. arguments with list node. such as --vdev, --allow, --block eal options. The definition of lcore affinity as an EAL parameter is a standard practice. However, lcore parameters like *-l*, *-c*, and *--lcores* ` are specified within the *suricata-yaml-threading* section to prevent configuration overlap.

The node *dpdk.interfaces* wraps a list of interface configurations. Items on the list follow the structure that can be found in other capture interfaces. The individual items contain the usual configuration options such as *threads*/*copy-mode*/*checksum-checks* settings. Other capture interfaces, such as AF_PACKET, rely on the user to ensure that NICs are appropriately configured. Configuration through the kernel does not apply to applications running under DPDK. The application is solely responsible for the initialization of the NICs it is using. So, before the start of Suricata, the NICs that Suricata uses, must undergo the process of initialization. As a result, there are extra configuration options (how NICs can be configured) in the items (interfaces) of the *dpdk.interfaces* list. At the start of the configuration process, all NIC offloads are disabled to prevent any packet modification. According to the configuration, checksum validation offload can be enabled to drop invalid packets. Other offloads can not currently be enabled. Additionally, the list items in *dpdk.interfaces* contain DPDK specific settings such as *mempool-size* or *rx-descriptors*. These settings adjust individual parameters of EAL. One of the entries in *dpdk.interfaces* is the *default* interface. When loading interface configuration and some entry is missing, the corresponding value of the *default* interface is used.

The worker threads must be assigned to specific cores. The configuration module *threading* must be used to set thread affinity. Worker threads can be pinned to cores in the array configured in *threading.cpu-affinity["worker-cpu-set"]*. Performance-oriented setups have everything (the NIC, memory, and CPU cores interacting with the NIC) based on one NUMA node. It is therefore required to know the layout of the server architecture to get the best results. The CPU core ids and NUMA locations can be determined for example from the output of */proc/cpuinfo* where *physical id* described the NUMA number. The NUMA node to which the NIC is connected to can be determined from the file */sys/class/net/<KERNEL NAME OF THE NIC>/device/numa_node*.

```
## Check ids and NUMA location of individual CPU cores
cat /proc/cpuinfo | grep 'physical id\|processor'
```

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```
## Check NUMA node of the NIC
## cat /sys/class/net/<KERNEL NAME OF THE NIC>/device/numa_node e.g.
cat /sys/class/net/eth1/device/numa_node
```

Suricata operates in workers runmode. Packet distribution relies on Receive Side Scaling (RSS), which distributes packets across the NIC queues. Individual Suricata workers then poll packets from the NIC queues. Internally, DPDK runmode uses a symmetric hash (0x6d5a) that redirects bi-flows to specific workers.

Before Suricata can be run, it is required to allocate a sufficient number of hugepages. For efficiency, hugepages are continuous chunks of memory (pages) that are larger (2 MB+) than what is typically used in the operating systems (4 KB). A lower count of pages allows faster lookup of page entries. The hugepages need to be allocated on the NUMA node where the NIC and affiniated CPU cores reside. For example, if the hugepages are allocated only on NUMA node 0 and the NIC is connected to NUMA node 1, then the application will fail to start. As a result, it is advised to identify the NUMA node to which the NIC is attached before allocating hugepages and setting CPU core affinity to that node. In case Suricata deployment uses multiple NICs, hugepages must be allocated on each of the NUMA nodes used by the Suricata deployment.

```
## To check number of allocated hugepages:
sudo dpdk-hugepages.py -s
# alternative (older) way
grep Huge /proc/meminfo

## Allocate 2 GB in hugepages on all available NUMA nodes:
# (number of hugepages depend on the default size of hugepages 2 MB / 1 GB)
sudo dpdk-hugepages.py --setup 2G
# alternative (older) way allocates 1024 2 MB hugepages but only on NUMA 0
echo 1024 | sudo tee \
  /sys/devices/system/node/node0/hugepages/hugepages-2048kB/nr_hugepages
```

DPDK memory pools hold packets received from NICs. These memory pools are allocated in hugepages. One memory pool is allocated per interface. The size of each memory pool can be individual and is set with the *mempool-size*. Memory (in bytes) for one memory pool is calculated as: *mempool-size * mtu*. The sum of memory pool requirements divided by the size of one hugepage results in the number of required hugepages. It causes no problem to allocate more memory than required, but it is vital for Suricata to not run out of hugepages.

The mempool cache is local to the individual CPU cores and holds packets that were recently processed. As the mempool is shared among all cores, the cache tries to minimize the required inter-process synchronization. The recommended size of the cache is covered in the YAML file.

To be able to run DPDK on Intel cards, it is required to change the default Intel driver to either *vfio-pci* or *igb_uio* driver. The process is described in DPDK manual page regarding Linux drivers. The Intel NICs have the amount of RX/TX descriptors capped at 4096. This should be possible to change by manually compiling the DPDK while changing the value of respective macros for the desired drivers (e.g. IXGBE_MAX_RING_DESC/I40E_MAX_RING_DESC). DPDK is natively supported by Mellanox and thus their NICs should work "out of the box".

Current DPDK support involves Suricata running on:

- **a physical machine with a physical NICs such as:**
  - mlx5 (ConnectX-4/ConnectX-5/ConnectX-6)
  - ixgbe
  - i40e
  - ice
- **a virtual machine with virtual interfaces such as:**

- e1000
- VMXNET3
- virtio-net

Other NICs using the same driver as mentioned above should work as well. The DPDK capture interface has not been tested neither with the virtual interfaces nor in the virtual environments like VMs, Docker or similar.

The minimal supported DPDK is version 19.11 which should be available in most repositories of major distributions. Alternatively, it is also possible to use *meson* and *ninja* to build and install DPDK from source files. It is required to have correctly configured tool *pkg-config* as it is used to load libraries and CFLAGS during the Suricata configuration and compilation. This can be tested by querying DPDK version as:

```
pkg-config --modversion libdpdk
```

Pf-ring

The Pf_ring is a library that aims to improve packet capture performance over libcap. It performs packet acquisition. There are three options within Pf_ring: interface, cluster-id and cluster-type.

```
pfring:
  interface: eth0    # In this option you can set the network-interface
                     # on which you want the packets of the network to be read.
```

Pf_ring will load balance packets based on flow. All packet acquisition threads that will participate in the load balancing need to have the same cluster-id. It is important to make sure this ID is unique for this cluster of threads, so that no other engine / program is making use of clusters with the same id.

```
cluster-id: 99
```

Pf_ring can load balance traffic using pf_ring-clusters. All traffic for pf_ring can be load balanced according to the configured cluster type value; in a round robin manner or a per flow manner that are part of the same cluster. All traffic for pf_ring will be load balanced across acquisition threads of the same cluster id.

The "inner" flow means that the traffic will be load balanced based on address tuple after the outer vlan has been removed.

Cluster Type	Value
cluster_flow	src ip, src_port, dst ip, dst port, proto, vlan
cluster_inner_flow	src ip, src port, dst ip, dst port, proto, vlan
cluster_inner_flow_2_tuple	src ip, dst ip
cluster_inner_flow_4_tuple	src ip, src port, dst ip, dst port
cluster_inner_flow_5_tuple	src ip, src port, dst ip, dst port, proto
cluster_round_robin	not recommended

The cluster_round_robin manner is a way of distributing packets one at a time to each thread (like distributing playing cards to fellow players). The cluster_flow manner is a way of distributing all packets of the same flow to the same thread. The flows itself will be distributed to the threads in a round-robin manner.

If your deployment has VLANs, the cluster types with "inner" will use the innermost address tuple for distribution.

The default cluster type is `cluster_flow`; the `cluster_round_robin` is not recommended with Suricata.

```
cluster-type: cluster_inner_flow_5_tuple
```

NFQ

Using NFQUEUE in iptables rules, will send packets to Suricata. If the mode is set to 'accept', the packet that has been send to Suricata by a rule using NFQ, will by default not be inspected by the rest of the iptables rules after being processed by Suricata. There are a few more options to NFQ to change this if desired.

If the mode is set to 'repeat', the packets will be marked by Suricata and be re-injected at the first rule of iptables. To mitigate the packet from being going round in circles, the rule using NFQ will be skipped because of the mark.

If the mode is set to 'route', you can make sure the packet will be send to another tool after being processed by Suricata. It is possible to assign this tool at the mandatory option 'route_queue'. Every engine/tool is linked to a queue-number. This number you can add to the NFQ rule and to the route_queue option.

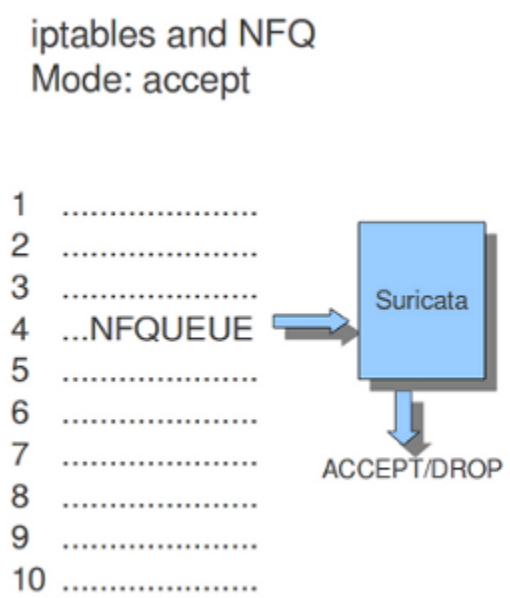
Add the numbers of the options repeat_mark and route_queue to the NFQ-rule:

```
iptables -I FORWARD -m mark ! --mark $MARK/$MASK -j NFQUEUE
```

```
nfq:
   mode: accept                  #By default the packet will be accepted or dropped by␣
↪Suricata
   repeat_mark: 1                #If the mode is set to 'repeat', the packets will be␣
↪marked after being
                                 #processed by Suricata.
   repeat_mask: 1
   route_queue: 2                #Here you can assign the queue-number of the tool that␣
↪Suricata has to
                                 #send the packets to after processing them.
```

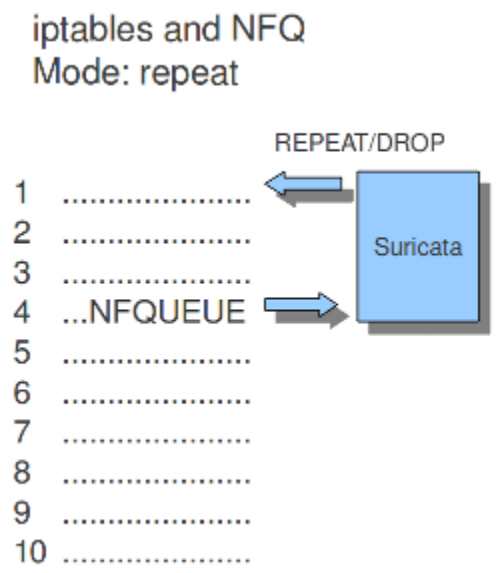
Example 1 NFQ1

mode: accept



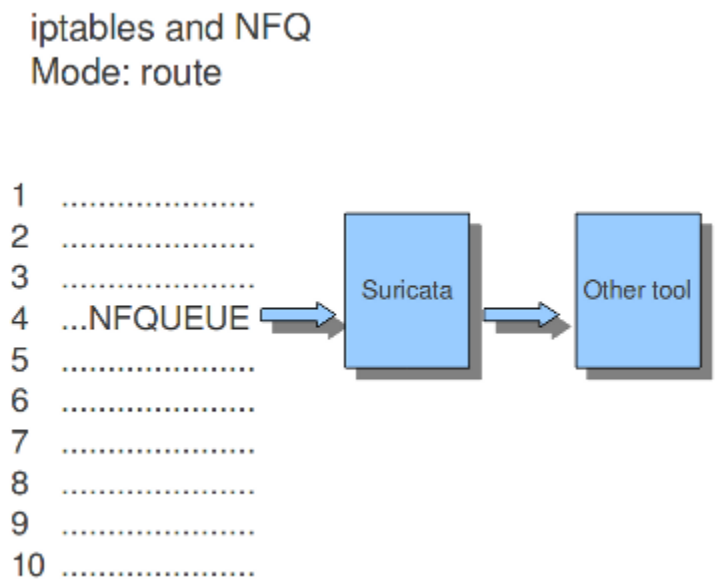
Example 2 NFQ

mode: repeat



Example 3 NFQ

mode: route



Ipfw

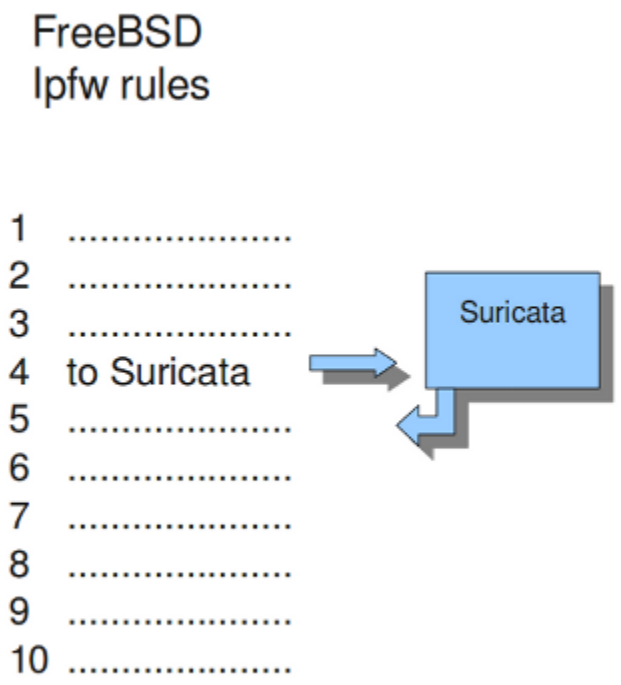
Suricata does not only support Linux, it supports the FreeBSD operating system (this is an open source Unix operating system) and Mac OS X as well. The in-line mode on FreeBSD uses ipfw (IP-firewall).

Certain rules in ipfw send network-traffic to Suricata. Rules have numbers. In this option you can set the rule to which the network-traffic will be placed back. Make sure this rule comes after the one that sends the traffic to Suricata, otherwise it will go around in circles.

The following tells the engine to re-inject packets back into the ipfw firewall at rule number 5500:

```
ipfw:
  ipfw-reinjection-rule-number: 5500
```

Example 16 Ipfw-reinjection.



12.1.18 Rules

Rule Files

Suricata by default is setup for rules to be managed by Suricata-Update with the following rule file configuration:

```
default-rule-path: /var/lib/suricata/rules
rule-files:
  - suricata.rules
```

A default installation of Suricata-Update will write out the rules to /var/lib/suricata/rules/suricata.rules.

You may want to edit this section if you are not using Suricata-Update or want to add rule files that are not managed by Suricata-Update, for example:

```
default-rule-path: /var/lib/suricata/rules
rule-files:
  - suricata.rules
  - /etc/suricata/rules/custom.rules
```

File names can be specific with an absolute path, or just the base name. If just the base name is provided it will be looked for in the `default-rule-path`.

If a rule file cannot be found, Suricata will log a warning message and continue to load, unless `--init-errors-fatal` has been specified on the command line, in which case Suricata will exit with an error code.

For more information on rule management see *Rule Management*.

Threshold-file

Within this option, you can state the directory in which the threshold-file will be stored. The default directory is: /etc/suricata/threshold.config

Classifications

The Classification-file is a file which makes the purpose of rules clear.

Some rules are just for providing information. Some of them are to warn you for serious risks like when you are being hacked etc.

In this classification-file, there is a part submitted to the rule to make it possible for the system-administrator to distinguish events.

A rule in this file exists of three parts: the short name, a description and the priority of the rule (in which 1 has the highest priority and 4 the lowest).

You can notice these descriptions returning in the rule and events / alerts.

```
Example:

configuration classification: misc-activity,Misc activity,3

Rule:

alert tcp $HOME_NET 21 -> $EXTERNAL_NET any (msg:"ET POLICY FTP Login Successful (non-
↪anonymous)";
flow:from_server,established;flowbits:isset,ET.ftp.user.login; flowbits:isnotset,ftp.
↪user.logged_in;
flowbits:set,ftp.user.logged_in; content:"230 ";pcre:!"/^230(\s+USER)?\s+(anonymous|ftp)/
↪smi";
classtype:misc-activity; reference:urldoc.emergingthreats.net/2003410,;
reference:url,www.emergingthreats.net/cgi-bin/cvsweb.cgi/sigs/POLICY/POLICY_FTP_Login;␣
↪sid:2003410; rev:7;)

Event/Alert:
```

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```
10/26/10-10:13:42.904785  [**] [1:2003410:7] ET POLICY FTP Login Successful (non-
↪anonymous) [**]
 [Classification: Misc activity[Priority: 3] {TCP} 192.168.0.109:21 -> x.x.x.x:34117
```

You can set the direction of the classification configuration.

```
classification-file: /etc/suricata/classification.config
```

Rule-vars

There are variables which can be used in rules.

Within rules, there is a possibility to set for which IP-address the rule should be checked and for which IP-address it should not.

This way, only relevant rules will be used. To prevent you from having to set this rule by rule, there is an option in which you can set the relevant IP-address for several rules. This option contains the address group vars that will be passed in a rule. So, after HOME_NET you can enter your home IP-address.

```
vars:
  address-groups:
    HOME_NET: "[192.168.0.0/16,10.0.0.0/8,172.16.0.0/12]"        #By using [], it is␣
↪possible to set
                                                                 #complicated variables.
    EXTERNAL_NET: any
    HTTP_SERVERS: "$HOME_NET"                                    #The $-sign tells that␣
↪what follows is
                                                                 #a variable.
    SMTP_SERVERS: "$HOME_NET"
    SQL_SERVERS: "$HOME_NET"
    DNS_SERVERS: "$HOME_NET"
    TELNET_SERVERS: "$HOME_NET"
    AIM_SERVERS: any
```

It is a convention to use upper-case characters.

There are two kinds of variables: Address groups and Port-groups. They both have the same function: change the rule so it will be relevant to your needs.

In a rule there is a part assigned to the address and one to the port. Both have their variable.

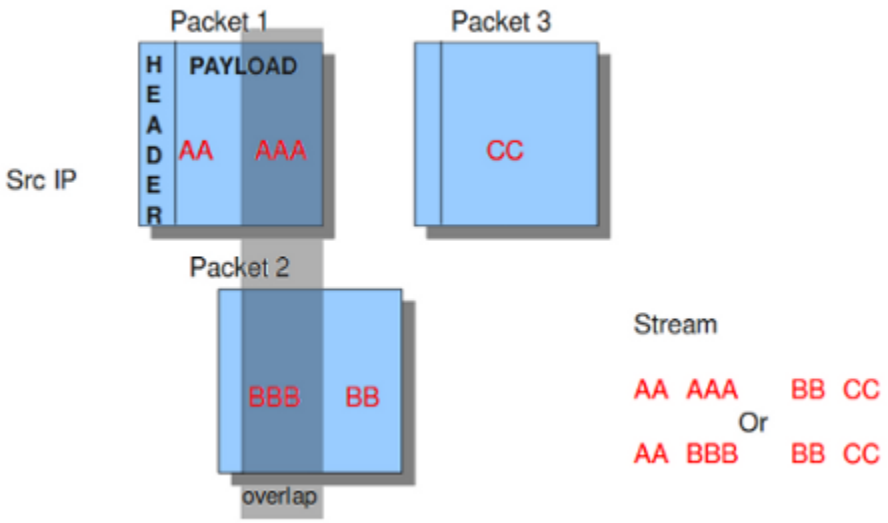
All options have to be set. If it is not necessary to set a specific address, you should enter 'any'.

```
port-groups:
  HTTP_PORTS: "80"
  SHELLCODE_PORTS: "!80"
  ORACLE_PORTS: 1521
  SSH_PORTS: 22
```

Host-os-policy

Operating systems differ in the way they process fragmented packets and streams. Suricata performs differently with anomalies for different operating systems. It is important to set of which operating system your IP-address makes use of, so Suricata knows how to process fragmented packets and streams. For example in stream-reassembly there can be packets with overlapping payloads.

Example 17 Overlapping payloads



In the configuration-file, the operating-systems are listed. You can add your IP-address behind the name of the operating system you make use of.

```
host-os-policy:
  windows: [0.0.0.0/0]
  bsd: []
  bsd_right: []
  old_linux: []
  linux: [10.0.0.0/8, 192.168.1.100, "8762:2352:6241:7245:E000:0000:0000:0000"]
  old_solaris: []
  solaris: ["::1"]
  hpux10: []
  hpux11: []
  irix: []
  macos: []
  vista: []
  windows2k3: []
```

12.1.19 Engine analysis and profiling

Suricata offers several ways of analyzing performance of rules and the engine itself.

Engine-analysis

The option engine-analysis provides information for signature writers about how Suricata organizes signatures internally.

Like mentioned before, signatures have zero or more patterns on which they can match. Only one of these patterns will be used by the multi pattern matcher (MPM). Suricata determines which patterns will be used unless the fast-pattern rule option is used.

The option engine-analysis creates a new log file in the default log dir. In this file all information about signatures and patterns can be found so signature writers are able to see which pattern is used and change it if desired.

To create this log file, you have to run Suricata with ./src/suricata -c suricata.yaml --engine-analysis.

```
engine-analysis:
   rules-fast-pattern: yes
```

Example:

```
[10703] 26/11/2010 -- 11:41:15 - (detect.c:560) <Info> (SigLoadSignatures)
-- Engine-Analysis for fast_pattern printed to file - /var/log/suricata/rules_fast_
↪pattern.txt

alert tcp any any -> any any (content:"Volume Serial Number"; sid:1292;)

== Sid: 1292 ==
Fast pattern matcher: content
Fast pattern set: no
Fast pattern only set: no
Fast pattern chop set: no
Content negated: no
Original content: Volume Serial Number
Final content: Volume Serial Number

---

alert tcp any any -> any any (content:"abc"; content:"defghi"; sid:1;)

== Sid: 1 ==
Fast pattern matcher: content
Fast pattern set: no
Fast pattern only set: no
Fast pattern chop set: no
Content negated: no
Original content: defghi
Final content: defghi

---

alert tcp any any -> any any (content:"abc"; fast_pattern:only; content:"defghi"; sid:1;)
```

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```
== Sid: 1 ==
Fast pattern matcher: content
Fast pattern set: yes
Fast pattern only set: yes
Fast pattern chop set: no
Content negated: no
Original content: abc
Final content: abc

---

alert tcp any any -> any any (content:"abc"; fast_pattern; content:"defghi"; sid:1;)

== Sid: 1 ==
Fast pattern matcher: content
Fast pattern set: yes
Fast pattern only set: no
Fast pattern chop set: no
Content negated: no
Original content: abc
Final content: abc

---

alert tcp any any -> any any (content:"abc"; fast_pattern:1,2; content:"defghi"; sid:1;)

== Sid: 1 ==
Fast pattern matcher: content
Fast pattern set: yes
Fast pattern only set: no
Fast pattern chop set: yes
Fast pattern offset, length: 1, 2
Content negated: no
Original content: abc
Final content: bc
```

Rule and Packet Profiling settings

Rule profiling is a part of Suricata to determine how expensive rules are. Some rules are very expensive while inspecting traffic. Rule profiling is convenient for people trying to track performance problems and resolving them. Also for people writing signatures.

Compiling Suricata with rule-profiling will have an impact on performance, even if the option is disabled in the configuration file.

To observe the rule-performance, there are several options.

```
profiling:
  rules:
    enabled: yes
```

This engine is not used by default. It can only be used if Suricata is compiled with:

```
-- enable-profiling
```

At the end of each session, Suricata will display the profiling statistics. The list will be displayed sorted.

This order can be changed as pleased. The choice is between ticks, avgticks, checks, maxticks and matches. The setting of your choice will be displayed from high to low.

The amount of time it takes to check the signatures, will be administrated by Suricata. This will be counted in ticks. One tick is one CPU computation. 3 GHz will be 3 billion ticks.

Beside the amount of checks, ticks and matches it will also display the average and the maximum of a rule per session at the end of the line.

The option Limit determines the amount of signatures of which the statistics will be shown, based on the sorting.

```
sort: avgticks
limit: 100
```

Example of how the rule statistics can look like;

```
Rule            Ticks           %     Checks         Matches           Max Tick        ␣
↪Avg
Ticks

7560            107766621       0.02    138             37               105155334      ␣
↪780917.54
11963           1605394413      0.29    2623             1               144418923      ␣
↪612045.14
7040            1431034011      0.26    2500             0               106018209      ␣
↪572413.60
5726            1437574662      0.26    2623             1               115632900      ␣
↪548065.06
7037            1355312799      0.24    2562             0               116048286      ␣
↪529005.78
11964           1276449255      0.23    2623             1               96412347       ␣
↪486637.15
7042            1272562974      0.23    2623             1               96405993       ␣
↪485155.54
5719            1233969192      0.22    2562             0               106439661      ␣
↪481642.93
5720            1204053246      0.21    2562             0               125155431      ␣
↪469966.14
```

Packet Profiling

```
packets:

  # Profiling can be disabled here, but it will still have a
  # performance impact if compiled in.


  enabled: yes                                  #this option is enabled by default
  filename: packet_stats.log                    #name of the file in which packet␣
```

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```
↪profiling information will be
                                                #stored.
  append: yes                                   #If set to yes, new packet profiling␣
↪information will be added to the
                                                #information that was saved last in the␣
↪file.

  # per packet csv output
  csv:

    # Output can be disabled here, but it will still have a
    # performance impact if compiled in.

    enabled: no                                #the sending of packet output to a csv-
↪file is by default disabled.
    filename: packet_stats.csv                 #name of the file in which csv packet␣
↪profiling information will be
                                               #stored
```

Packet profiling is enabled by default in suricata.yaml but it will only do its job if you compiled Suricata with --enable profiling.

The filename in which packet profiling information will be stored, is packet-stats.log. Information in this file can be added to the last information that was saved there, or if the append option is set to no, the existing file will be overwritten.

Per packet, you can send the output to a csv-file. This file contains one line for each packet with all profiling information of that packet. This option can be used only if Suricata is build with --enable-profiling and if the packet profiling option is enabled in yaml.

It is best to use runmode 'single' if you would like to profile the speed of the code. When using a single thread, there is no situation in which two threads have to wait for each other. When using two threads, the time threads might have to wait for each other will be taken in account when/during profiling packets. For more information see *Packet Profiling*.

12.1.20 Decoder

Teredo

The Teredo decoder can be disabled. It is enabled by default.

```
decoder:
  # Teredo decoder is known to not be completely accurate
  # it will sometimes detect non-teredo as teredo.
  teredo:
    enabled: true
    # ports to look for Teredo. Max 4 ports. If no ports are given, or
    # the value is set to 'any', Teredo detection runs on _all_ UDP packets.
    ports: $TEREDO_PORTS # syntax: '[3544, 1234]'
```

Using this default configuration, Teredo detection will run on UDP port 3544. If the *ports* parameter is missing, or set to *any*, all ports will be inspected for possible presence of Teredo.

IP-in-IP

IPv4

Enable decoding IP-in-IP tunneling for IPv4. There is also a dedicated option to set the parent flow for packets, when the engine sees such IP-in-IP packets. This option can be enabled regardless of enabled the ipip tunneling. As this may impact signature matching and flow tracking, these are disabled by default.

The stats counter *decoder.ipv4_in_ipv4* is associated with this setting.

```
# IP-in-IP tunneling for ipv4 over ipv4 handling.
# Disabled by default, as these will impact number of alerts seen, as well as
# number of flows.
# ipv4:
#   ipip:
#     enabled: true
#     track-parent-flow: true   # disabled by default
```

IPv6

By default, for IPv4 over IPv6 tunneling, the parent flow is not set up, as this can lead to discrepancies in alerts and flows detected. To enable this setting, change:

```
decoder:
  ipv6:
    ipip-ipv4:
      track-parent-flow: true
```

The same is true for IPv6 over IPv6. To enable parent flow setting in this case:

```
decoder:
  ipv6:
    ipip-ipv6:
      track-parent-flow: true
```

12.1.21 Advanced Options

stacktrace

Display diagnostic stacktraces when a signal unexpectedly terminates Suricata, e.g., such as SIGSEGV or SIGABRT. Requires the `libunwind` library to be available. The default value is to display the diagnostic message if a signal unexpectedly terminates Suricata -- e.g., `SIGABRT` or `SIGSEGV` occurs while Suricata is running.

```
logging:
    # Requires libunwind to be available when Suricata is configured and built.
    # If a signal unexpectedly terminates Suricata, displays a brief diagnostic
    # message with the offending stacktrace if enabled.
    #stacktrace-on-signal: on
```

luajit

states

Luajit has a strange memory requirement, it's 'states' need to be in the first 2G of the process' memory. For this reason when luajit is used the states are allocated at the process startup. This option controls how many states are preallocated.

If the pool is depleted a warning is generated. Suricata will still try to continue, but may fail if other parts of the engine take too much memory. If the pool was depleted a hint will be printed at the engines exit.

States are allocated as follows: for each detect script a state is used per detect thread. For each output script, a single state is used. Keep in mind that a rule reload temporary doubles the states requirement.

12.1.22 Configuration hardening

The *security* section of suricata.yaml is meant to provide in-depth security configuration options.

Besides landlock, (see *Using Landlock LSM*), one setting is available. *limit-noproc* is a boolean to prevent process creation by Suricata. If you do not need Suricata to create other processes or threads (you may need it for LUA scripts for instance or plugins), enable this to call *setrlimit* with *RLIMIT_NPROC* argument (see *man setrlimit*). This prevents potential exploits against Suricata to fork a new process, even if it does not prevent the call of *exec*.

Warning! This has no effect on Linux when running as root. If you want a hardened configuration, you probably want to set *run-as* configuration parameter so as to drop root privileges.

Beyond suricata.yaml, other ways to harden Suricata are - compilation : enabling ASLR and other exploit mitigation techniques. - environment : running Suricata on a device that has no direct access to Internet.

Lua

Suricata 7.0 disables Lua rules by default. Lua rules can be enabled in the `security.lua` section of the configuration file:

```
security:
  lua:
    # Allow Lua rules. Disabled by default.
    #allow-rules: false
```

12.2 Global-Thresholds

Thresholds can be configured in the rules themselves, see *Thresholding Keywords*. They are often set by rule writers based on their intelligence for creating a rule combined with a judgement on how often a rule will alert.

12.2.1 Threshold Config

Next to rule thresholding more thresholding can be configured on the sensor using the threshold.config.

threshold/event_filter

Syntax:

```
threshold gen_id <gid>, sig_id <sid>, type <threshold|limit|both>, \
  track <by_src|by_dst|by_rule|by_both>, count <N>, seconds <T>
```

rate_filter

Rate filters allow changing of a rule action when a rule matches.

Syntax:

```
rate_filter: rate_filter gen_id <gid>, sig_id <sid>, track <tracker>, \
  count <c>, seconds <s>, new_action <action>, timeout <timeout>
```

Example:

```
rate_filter gen_id 1, sig_id 1000, track by_rule, count 100, seconds 60, \
  new_action alert, timeout 30
```

gen_id

Generator id. Normally 1, but if a rule uses the `gid` keyword to set another value it has to be matched in the `gen_id`.

sig_id

Rule/signature id as set by the rule `sid` keyword.

track

Where to track the rule matches. When using by_src/by_dst the tracking is done per IP-address. The Host table is used for storage. When using by_rule it's done globally for the rule. Option by_both used to track per IP pair of source and destination. Packets going to opposite directions between same addresses tracked as the same pair.

count

Number of rule hits before the `rate_filter` is activated.

seconds

Time period within which the `count` needs to be reached to activate the `rate_filter`

new_action

New action that is applied to matching traffic when the `rate_filter` is in place.

Values:

```
<alert|drop|pass|reject>
```

Note: 'sdrop' and 'log' are supported by the parser but not implemented otherwise.

timeout

Time in seconds during which the `rate_filter` will remain active.

Example

Let's say we want to limit incoming connections to our SSH server. The rule `888` below simply alerts on SYN packets to the SSH port of our SSH server. If an IP-address triggers this more than 10 or more with a minute, the drop `rate_filter` is set with a timeout of 5 minutes.

Rule:

```
alert tcp any any -> $MY_SSH_SERVER 22 (msg:"Connection to SSH server"; \
  flow:to_server; flags:S,12; sid:888;)
```

Rate filter:

```
rate_filter gen_id 1, sig_id 888, track by_src, count 10, seconds 60, \
  new_action drop, timeout 300
```

suppress

Suppressions can be used to suppress alerts for a rule or a host/network. Actions performed when a rule matches, such as setting a flowbit, are still performed.

Syntax:

```
suppress gen_id <gid>, sig_id <sid>
suppress gen_id <gid>, sig_id <sid>, track <by_src|by_dst|by_either>, ip
↪<ip|subnet|addressvar>
```

Examples:

```
suppress gen_id 1, sig_id 2002087, track by_src, ip 209.132.180.67
```

This will make sure the signature 2002087 will never match for src host 209.132.180.67.

Other possibilities/examples:

```
suppress gen_id 1, sig_id 2003614, track by_src, ip 217.110.97.128/25
suppress gen_id 1, sig_id 2003614, track by_src, ip [192.168.0.0/16,10.0.0.0/8,172.16.0.
↪0/12]
suppress gen_id 1, sig_id 2003614, track by_src, ip $HOME_NET
suppress gen_id 1, sig_id 2003614, track by_either, ip 217.110.97.128/25
```

In the last example above, the `by_either` tracking means that if either the `source ip` or `destination ip` matches `217.110.97.128/25` the rule with sid 2003614 is suppressed.

12.2.2 Global thresholds vs rule thresholds

Note: this section applies to 1.4+ In 1.3 and before mixing rule and global thresholds is not supported.

When a rule has a threshold/detection_filter set a rule can still be affected by the global threshold file.

The rule below will only fire if 10 or more emails are being delivered/sent from a host within 60 seconds.

```
alert tcp any any -> any 25 (msg:"ET POLICY Inbound Frequent Emails - Possible Spambot␣
↪Inbound"; \
    flow:established; content:"mail from|3a|"; nocase;                              ␣
↪        \
    threshold: type threshold, track by_src, count 10, seconds 60;                  ␣
↪        \
    reference:url,doc.emergingthreats.net/2002087; classtype:misc-activity; sid:2002087;
↪ rev:10;)
```

Next, we'll see how global settings affect this rule.

Suppress

Suppressions can be combined with rules with thresholds/detection_filters with no exceptions.

```
suppress gen_id 1, sig_id 2002087, track by_src, ip 209.132.180.67
suppress gen_id 0, sig_id 0, track by_src, ip 209.132.180.67
suppress gen_id 1, sig_id 0, track by_src, ip 209.132.180.67
```

Each of the rules above will make sure 2002087 doesn't alert when the source of the emails is 209.132.180.67. It **will** alert for all other hosts.

```
suppress gen_id 1, sig_id 2002087
```

This suppression will simply convert the rule to "noalert", meaning it will never alert in any case. If the rule sets a flowbit, that will still happen.

Threshold/event_filter

When applied to a specific signature, thresholds and event_filters (threshold from now on) will override the signature setting. This can be useful for when the default in a signature doesn't suit your environment.

```
threshold gen_id 1, sig_id 2002087, type both, track by_src, count 3, seconds 5
threshold gen_id 1, sig_id 2002087, type threshold, track by_src, count 10, seconds 60
threshold gen_id 1, sig_id 2002087, type limit, track by_src, count 1, seconds 15
```

Each of these will replace the threshold setting for 2002087 by the new threshold setting.

Note: overriding all gids or sids (by using gen_id 0 or sig_id 0) is not supported. Bug https://redmine.openinfosecfoundation.org/issues/425.

Rate_filter

see https://redmine.openinfosecfoundation.org/issues/425.

12.3 Exception Policies

Suricata has a set of configuration variables to indicate what should the engine do when certain exception conditions, such as hitting a memcap, are reached.

They are called Exception Policies and are configurable via suricata.yaml. If enabled, the engine will call them when it reaches exception states. Stats for any applied exception policies can be found in counters related to the specific configuration setting (*read more*). Some configuration is available directly via the *stats settings*.

For developers or for researching purposes, there are also simulation options exposed in debug mode and passed via command-line. These exist to force or simulate failures or errors and understand Suricata behavior under such conditions. See *Command-line Options for Simulating Exceptions* for those.

12.3.1 Master Switch

It is possible to set all configuration policies via what we call "master switch". This offers a quick way to define what the engine should do in case of traffic exceptions, while still allowing for the flexibility of indicating a different behavior for specific exception policies your setup/environment may have the need to.

```
# Define a common behavior for all exception policies.
# In IPS mode, the default is drop-flow. For cases when that's not possible, the
# engine will fall to drop-packet. To fallback to old behavior (setting each of
# them individually, or ignoring all), set this to ignore.
# All values available for exception policies can be used, and there is one
# extra option: auto - which means drop-flow or drop-packet (as explained above)
# in IPS mode, and ignore in IDS mode. Exception policy values are: drop-packet,
# drop-flow, reject, bypass, pass-packet, pass-flow, ignore (disable).
exception-policy: auto
```

This value will be overwritten by specific exception policies whose settings are also defined in the yaml file.

Auto

In IPS mode, the default behavior for most of the exception policies is to fail close. This means droping the flow, or the packet, when the flow action is not supported. The default policy for the midstream exception will be ignore if midstream flows are accepted.

It is possible to disable this default, by setting the exception policies' "master switch" yaml config option to `ignore`.

In IDS mode, setting `auto` mode actually means disabling the `master-switch`, or ignoring the exception policies.

Note: If no exception policy is enabled, Suricata will not log exception policy stats.

12.3.2 Specific settings

Exception policies are implemented for:

Table 1: Exception Policy configuration variables

Config setting	Policy variable	Affects	Expected behavior
stream.memcap	memcap-policy	Flow or packet	If a stream memcap limit is reached, apply the memcap policy to the packet and/or flow.
stream.midstream	midstream-policy	Flow	If a session is picked up midstream, apply the midstream policy to the flow.
stream.reassembly.memcap	memcap-policy	Flow or packet	If stream reassembly reaches memcap limit, apply memcap policy to the packet and/or flow.
flow.memcap	memcap-policy	Packet	Apply policy when the memcap limit for flows is reached and no flow could be freed up. **Policy can only be applied to the packet.**
defrag.memcap	memcap-policy	Packet	Apply policy when the memcap limit for defrag is reached and no tracker could be picked up. **Policy can only be applied to the packet.**
app-layer	error-policy	Flow or packet	Apply policy if a parser reaches an error state. Policy can be applied to packet and/or flow.

To change any of these, go to the specific section in the suricata.yaml file (for more configuration details, check the *suricata.yaml's* documentation).

The possible values for the exception policies, and the resulting behaviors, are:

- `drop-flow`: disable decoding and parsing for the whole flow (packets, payload, application layer protocol), drop the packet and all future packets in the flow.
- `drop-packet`: drop the packet.
- `reject`: same as `drop-flow`, but reject the current packet as well (see `reject` action in Rule's *Action*).
- `rejectboth`: same as `reject`, except that it sends reject packets to both the source and destination addresses.
- `bypass`: bypass the flow. No further decoding or parsing is done. *Bypass* may be offloaded.
- `pass-flow`: disable payload and packet detection; stream reassembly, app-layer parsing and logging still happen.
- `pass-packet`: disable detection, still does stream updates and app-layer parsing (depending on which policy triggered it).
- `ignore`: do not apply exception policies (default behavior).

The *drop*, *pass* and *reject* are similar to the rule actions described in *rule actions*.

12.3.3 Exception Policies and Midstream Pick-up Sessions

Suricata behavior can be difficult to track in case of midstream session pick-ups. Consider this matrix illustrating the different interactions for midstream pick-ups enabled or not and the various exception policy values:

Table 2: **Exception Policy Behaviors - IDS Mode**

Exception Policy	Midstream pick-up sessions ENABLED (stream.midstream=true)	Midstream pick-up sessions DISABLED (stream.midstream=false)
Ignore	Session and app-layer traffic tracked and parsed, log app-layer traffic, **do** detection.	Session not tracked. No app-layer parsing or logging. No stream reassembly. No detection.
Drop-flow	Not valid.*	Not valid.*
Drop-packet	Not valid.*	Not valid.*
Reject / Reject-both	Not valid.*	Session not tracked, flow REJECTED.
Pass-flow	Session and app-layer traffic tracked and parsed, log app-layer traffic, **no** detection.	Session not tracked. No app-layer parsing or logging. No stream reassembly. No detection.
Pass-packet	Not valid.*	Not valid.*
Bypass	Not valid.*	Session not tracked. No app-layer parsing or logging. No stream reassembly. No detection.
Auto	Midstream policy applied: "ignore". Same behavior.	Midstream policy applied: "ignore". Same behavior.

The main difference between IDS and IPS scenarios is that in IPS mode flows can be allowed or blocked (as in with the PASS and DROP rule actions). Packet actions are not valid, as midstream pick-up is a configuration that affects the whole flow.

Table 3: **Exception Policy Behaviors - IPS Mode**

Exception Policy	Midstream pick-up sessions ENABLED (stream.midstream=true)	Midstream pick-up sessions DISABLED (stream.midstream=false)
Ignore	Session and app-layer traffic tracked and parsed, log app-layer traffic, **do** detection.	Session not tracked. No app-layer parsing or logging. No stream reassembly. No detection.
Drop-flow	Not valid.*	Session not tracked. No app-layer parsing or logging. No stream reassembly. No detection. Flow DROPPED.
Drop-packet	Not valid.*	Not valid.*
Reject / Rejectboth	Not valid.*	Session not tracked, flow DROPPED and REJECTED.
Pass-flow	Track session, parse and log app-layer traffic, **no** detection.	Session not tracked. No app-layer parsing or logging. No stream reassembly. No detection.
Pass-packet	Not valid.*	Not valid.*
Bypass	Not valid.*	Session not tracked. No app-layer parsing or logging. No stream reassembly. No detection. Packets ALLOWED.
Auto	Midstream policy applied: "ignore". Same behavior.	Midstream policy applied: "drop-flow". Same behavior.

Notes:

- Not valid means that Suricata will error out and won't start.

- `REJECT` will make Suricata send a Reset-packet unreach error to the sender of the matching packet.

12.3.4 Log Output

Flow Event

When an Exception Policy is triggered, this will be indicated in the flow log event for the associated flow, also indicating which target triggered that, and what policy was applied. **This is a configurable option, disabled by default.** If no exception policy is triggered, that field won't be present in the logs.

Note that this is true even if the policy is applied only to certain packets from a flow.

To enable logging of the triggered exception policies for a given flow, enable the yaml option:

```
output:
  - eve-log:
      enabled: yes
      types:
        - flow:
            exception-policy: true
```

Note: As exception policies targetting `flow memcap` and `defrag memcap` act on a per-packet level, these are not shown in the flow logs. Ticket #7884 (https://redmine.openinfosecfoundation.org/issues/7884) tracks work on this. For such cases, the exception policy stats counters are available.

In the log sample below, the flow triggered the `midstream policy`, leading to Suricata applying the behavior that had been configured for such scenario: *to pass the flow* (`pass_flow`). It also did trigger the `app_layer_error` exception policy, but that is set up to `ignore`:

```
"flow": {
  "pkts_toserver": 4,
  "pkts_toclient": 5,
  "bytes_toserver": 495,
  "bytes_toclient": 351,
  "start": "2016-07-13T22:42:07.199672+0000",
  "end": "2016-07-13T22:42:07.573174+0000",
  "age": 0,
  "state": "new",
  "reason": "shutdown",
  "alerted": false,
  "action": "pass",
  "exception_policy": [
     {
       "target": "stream_midstream",
       "policy": "pass_flow"
     },
     {
       "target": "app_layer_error",
       "policy": "ignore"
     }
   ]
}
```

Available Stats

There are stats counters for each supported exception policy scenario that will be logged when *exception policies and exception policy stats counters* are enabled. (By default, these stats counters are disabled, as they greatly increase the stats logs size):

Table 4: **Exception Policy Stats Counters**

Setting	Counters
stream.memcap	exception_policy.tcp.ssn_memcap
stream.reassembly.memcap	exception_policy.tcp.reassembly
stream.midstream	exception_policy.tcp.midstream
defrag.memcap	exception_policy.defrag.memcap
flow.memcap	exception_policy.flow.memcap
app-layer.error	• exception_policy.app_layer.error • app_layer.error.exception_policy

If a given exception policy does not apply for a setting, no related counter is logged.

Stats for application layer errors are available in summarized form or per application layer protocol. As the latter is extremely verbose, by default Suricata logs only the summary. If any further investigation is needed, it is recommended to enable per-app-proto exception policy error counters temporarily (for more, read *stats configuration*).

12.3.5 Command-line Options for Simulating Exceptions

It is also possible to force specific exception scenarios, to check engine behavior under failure or error conditions.

The available command-line options are:

- `simulate-applayer-error-at-offset-ts`: force an applayer error in the to server direction at the given offset.
- `simulate-applayer-error-at-offset-tc`: force an applayer error in the to client direction at the given offset.
- `simulate-packet-loss`: simulate that the packet with the given number (`pcap_cnt`) from the session was lost.
- `simulate-packet-tcp-reassembly-memcap`: simulate that the TCP stream reassembly reached memcap for the specified packet.
- `simulate-packet-tcp-ssn-memcap`: simulate that the TCP session hit the memcap for the specified packet.
- `simulate-packet-flow-memcap`: force the engine to assume that flow memcap is hit at the given packet.
- `simulate-packet-defrag-memcap`: force Suricata to assume memcap is hit when defragmenting specified packet.
- `simulate-alert-queue-realloc-failure`: prevent the engine from dynamically growing the temporary alert queue, during alerts processing.

12.3.6 Glossary

- **decoding**: traffic parsing on the packet level;
- **[app-layer] parsing**: traffic is parsed on the application layer level for events, anomalies and logging;
- **detection**: evaluate traffic against loaded rules to generate alerts and/ or block or allow traffic.

Common abbreviations

- applayer/ app-layer: application layer protocol
- memcap: (maximum) memory capacity available
- defrag: defragmentation

12.4 Snort.conf to Suricata.yaml

This guide is meant for those who are familiar with Snort and the snort.conf configuration format. This guide will provide a 1:1 mapping between Snort and Suricata configuration wherever possible.

12.4.1 Variables

snort.conf

```
ipvar HOME_NET any
ipvar EXTERNAL_NET any
...

portvar HTTP_PORTS [80,81,311,591,593,901,1220,1414,1741,1830,2301,2381,2809,3128,3702,
↪4343,4848,5250,7001,7145,7510,7777,7779,8000,8008,8014,8028,8080,8088,8090,8118,8123,
↪8180,8181,8243,8280,8800,8888,8899,9000,9080,9090,9091,9443,9999,11371,55555]
portvar SHELLCODE_PORTS !80
...
```

suricata.yaml

```
vars:
  address-groups:

    HOME_NET: "[192.168.0.0/16,10.0.0.0/8,172.16.0.0/12]"
    EXTERNAL_NET: "!$HOME_NET"

  port-groups:
    HTTP_PORTS: "80"
    SHELLCODE_PORTS: "!80"
```

Note that Suricata can automatically detect HTTP traffic regardless of the port it uses. So the HTTP_PORTS variable is not nearly as important as it is with Snort, **if** you use a Suricata enabled ruleset.

12.4.2 Decoder alerts

snort.conf

```
# Stop generic decode events:
config disable_decode_alerts

# Stop Alerts on experimental TCP options
config disable_tcpopt_experimental_alerts

# Stop Alerts on obsolete TCP options
config disable_tcpopt_obsolete_alerts

# Stop Alerts on T/TCP alerts
config disable_tcpopt_ttcp_alerts

# Stop Alerts on all other TCPOption type events:
config disable_tcpopt_alerts

# Stop Alerts on invalid ip options
config disable_ipopt_alerts
```

suricata.yaml

Suricata has no specific decoder options. All decoder related alerts are controlled by rules. See #Rules below.

12.4.3 Checksum handling

snort.conf

```
config checksum_mode: all
```

suricata.yaml

Suricata's checksum handling works *on-demand*. The stream engine checks TCP and IP checksum by default:

```
stream:
  checksum-validation: yes      # reject wrong csums
```

Alerting on bad checksums can be done with normal rules. See #Rules, decoder-events.rules specifically.

12.4.4 Various configs

Active response

snort.conf

```
# Configure active response for non inline operation. For more information, see REAMDE.
↪active
# config response: eth0 attempts 2
```

suricata.yaml

Active responses are handled automatically w/o config if rules with the "reject" action are used.

Dropping privileges

snort.conf

```
# Configure specific UID and GID to run snort as after dropping privs. For more␣
↪information see snort -h command line options
#
# config set_gid:
# config set_uid:
```

Suricata

To set the user and group use the --user <username> and --group <groupname> command-line options.

Snaplen

snort.conf

```
# Configure default snaplen. Snort defaults to MTU of in use interface. For more␣
↪information see README
#
# config snaplen:
#
```

Suricata always works at full snap length to provide full traffic visibility.

Bpf

snort.conf

```
# Configure default bpf_file to use for filtering what traffic reaches snort. For more␣
↪information see snort -h command line options (-F)
#
# config bpf_file:
#
```

suricata.yaml

BPF filters can be set per packet acquisition method, with the "bpf-filter: <file>" yaml option and in a file using the -F command line option.

For example:

```
pcap:
  - interface: eth0
    #buffer-size: 16777216
    #bpf-filter: "tcp and port 25"
    #checksum-checks: auto
    #threads: 16
    #promisc: no
    #snaplen: 1518
```

12.4.5 Log directory

snort.conf

```
# Configure default log directory for snort to log to.  For more information see snort -
↪h command line options (-l)
#
# config logdir:
```

suricata.yaml

```
default-log-dir: /var/log/suricata/
```

This value is overridden by the -l command-line option.

12.4.6 Packet acquisition

snort.conf

```
# Configure DAQ related options for inline operation. For more information, see README.
↪daq
#
# config daq: <type>
# config daq_dir: <dir>
# config daq_mode: <mode>
# config daq_var: <var>
#
# <type> ::= pcap | afpacket | dump | nfq | ipq | ipfw
# <mode> ::= read-file | passive | inline
# <var> ::= arbitrary <name>=<value passed to DAQ
# <dir> ::= path as to where to look for DAQ module so's
```

suricata.yaml

Suricata has all packet acquisition support built-in. It's configuration format is very verbose.

```
pcap:
  - interface: eth0
    #buffer-size: 16777216
    #bpf-filter: "tcp and port 25"
    #checksum-checks: auto
    #threads: 16
    #promisc: no
    #snaplen: 1518
pfring:
afpacket:
nfq:
ipfw:
```

Passive vs inline vs reading files is determined by how Suricata is invoked on the command line.

12.4.7 Rules

snort.conf:

In snort.conf a RULE_PATH variable is set, as well as variables for shared object (SO) rules and preprocessor rules.

```
var RULE_PATH ../rules
var SO_RULE_PATH ../so_rules
var PREPROC_RULE_PATH ../preproc_rules

include $RULE_PATH/local.rules
include $RULE_PATH/emerging-activex.rules
...
```

suricata.yaml:

In the suricata.yaml the default rule path is set followed by a list of rule files. Suricata does not have a concept of shared object rules or preprocessor rules. Instead of preprocessor rules, Suricata has several rule files for events set by the decoders, stream engine, http parser etc.

```
default-rule-path: /etc/suricata/rules
rule-files:
 - local.rules
 - emerging-activex.rules
```

The equivalent of preprocessor rules are loaded like normal rule files:

```
rule-files:
 - decoder-events.rules
 - stream-events.rules
 - http-events.rules
 - smtp-events.rules
```

12.5 Multi Tenancy

12.5.1 Introduction

Multi tenancy support allows different tenants to use different rule sets with different rule variables.

Tenants are identified by their *selector*; a *selector* can be a VLAN, interface/device, or from a pcap file ("direct").

12.5.2 YAML

Add a new section in the main ("master") Suricata configuration file -- `suricata.yaml` -- named `multi-detect`.

Settings:

- *enabled*: yes/no -> is multi-tenancy support enabled
- *selector*: direct (for unix socket pcap processing, see below), VLAN or device
- *loaders*: number of *loader* threads, for parallel tenant loading at startup
- *tenants*: list of tenants
- *config-path*: path from where the tenant yamls are loaded

  - id: tenant id (numeric values only)
  - yaml: separate yaml file with the tenant specific settings

- *mappings*:
  - VLAN id or device: The outermost VLAN is used to match.
  - tenant id: tenant to associate with the VLAN id or device

```
multi-detect:
  enabled: yes
  #selector: direct # direct or vlan or device
  selector: vlan
  loaders: 3

  tenants:
  - id: 1
    yaml: tenant-1.yaml
  - id: 2
    yaml: tenant-2.yaml
  - id: 3
    yaml: tenant-3.yaml

  mappings:
  - vlan-id: 1000
    tenant-id: 1
  - vlan-id: 2000
    tenant-id: 2
  - vlan-id: 1112
    tenant-id: 3
```

The tenant-1.yaml, tenant-2.yaml, tenant-3.yaml each contain a partial configuration:

```
# Set the default rule path here to search for the files.
# if not set, it will look at the current working dir
default-rule-path: /etc/suricata/rules
rule-files:
  - rules1

# You can specify a threshold config file by setting "threshold-file"
# to the path of the threshold config file:
# threshold-file: /etc/suricata/threshold.config

classification-file: /etc/suricata/classification.config
reference-config-file: /etc/suricata/reference.config

# Holds variables that would be used by the engine.
vars:

  # Holds the address group vars that would be passed in a Signature.
  # These would be retrieved during the Signature address parsing stage.
  address-groups:

    HOME_NET: "[192.168.0.0/16,10.0.0.0/8,172.16.0.0/12]"
```

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```
    EXTERNAL_NET: "!$HOME_NET"

    ...

  port-groups:

    HTTP_PORTS: "80"

    SHELLCODE_PORTS: "!80"

    ...
```

vlan-id

Assign tenants to VLAN ids. Suricata matches the outermost VLAN id with this value. Multiple VLANs can have the same tenant id. VLAN id values must be between 1 and 4094.

Example of VLAN mapping:

```
mappings:
- vlan-id: 1000
  tenant-id: 1
- vlan-id: 2000
  tenant-id: 2
- vlan-id: 1112
  tenant-id: 3
```

The mappings can also be modified over the unix socket, see below.

Note: can only be used if `vlan.use-for-tracking` is enabled.

device

Assign tenants to devices. A single tenant can be assigned to a device. Multiple devices can have the same tenant id.

Example of device mapping:

```
mappings:
- device: ens5f0
  tenant-id: 1
- device: ens5f1
  tenant-id: 3
```

The mappings are static and cannot be modified over the unix socket.

Note: Not currently supported for IPS.

Note: support depends on a capture method using the 'livedev' API. Currently these are: pcap, AF_PACKET, PF_RING and Netmap.

12.5.3 Per tenant settings

The following settings are per tenant:

- default-rule-path
- rule-files
- classification-file
- reference-config-file
- threshold-file
- address-vars
- port-vars

12.5.4 Unix Socket

Registration

`register-tenant <id> <yaml>`

Examples:

```
register-tenant 1 tenant-1.yaml
register-tenant 2 tenant-2.yaml
register-tenant 3 tenant-3.yaml
register-tenant 5 tenant-5.yaml
register-tenant 7 tenant-7.yaml
```

`unregister-tenant <id>`

```
unregister-tenant 2
unregister-tenant 1
```

Unix socket runmode (pcap processing)

The Unix Socket `pcap-file` command is used to associate the tenant with the pcap:

```
pcap-file traffic1.pcap /logs1/ 1
pcap-file traffic2.pcap /logs2/ 2
pcap-file traffic3.pcap /logs3/ 3
pcap-file traffic4.pcap /logs5/ 5
pcap-file traffic5.pcap /logs7/ 7
```

This runs the traffic1.pcap against tenant 1 and it logs into /logs1/, traffic2.pcap against tenant 2 and logs to /logs2/ and so on.

Live traffic mode

Multi-tenancy supports both VLAN and devices with live traffic.

In the master configuration yaml file, specify `device` or `vlan` for the `selector` setting.

Registration

Tenants can be mapped to vlan ids.

`register-tenant-handler <tenant id> vlan <vlan id>`

```
register-tenant-handler 1 vlan 1000
```

`unregister-tenant-handler <tenant id> vlan <vlan id>`

```
unregister-tenant-handler 4 vlan 1111
unregister-tenant-handler 1 vlan 1000
```

The registration of tenant and tenant handlers can be done on a running engine.

Reloads

Reloading all tenants:

`reload-tenants`

```
reload-tenants
```

Reloading a single tenant:

`reload-tenant <tenant id> [yaml path]`

```
reload-tenant 1 tenant-1.yaml
reload-tenant 5
```

The `[yaml path]` is optional. If it isn't provided, the original path of the tenant will be used during the reload.

12.5.5 Eve JSON output

When multi-tenant support is configured and the detect engine is active then all EVE-types that report based on flows will also report the corresponding `tenant_id` for events matching a tenant configuration.

12.6 Dropping Privileges After Startup

Currently, `libcap-ng` is needed for dropping privileges on Suricata after startup. For libcap, see status of feature request number #276 -- Libcap support for dropping privileges.

Most distributions have `libcap-ng` in their repositories.

To download the current version of libcap-ng from upstream, see also http://people.redhat.com/sgrubb/libcap-ng/ChangeLog

```
wget http://people.redhat.com/sgrubb/libcap-ng/libcap-ng-0.7.8.tar.gz
tar -xzvf libcap-ng-0.7.8.tar.gz
cd libcap-ng-0.7.8
./configure
make
make install
```

Download, configure, compile and install Suricata for your particular setup. See *Installation*. Depending on your environment, you may need to add the --with-libpcap_ng-libraries and --with-libpcap_ng-includes options during the configure step. e.g:

```
./configure --with-libcap_ng-libraries=/usr/local/lib \
  --with-libcap_ng-includes=/usr/local/include
```

Now, when you run Suricata, tell it what user and/or group you want it to run as after startup with the --user and --group options. e.g. (this assumes a 'suri' user and group):

```
suricata -D -i eth0 --user=suri --group=suri
```

You will also want to make sure your user/group permissions are set so Suricata can still write to its log files which are usually located in /var/log/suricata.

```
mkdir -p /var/log/suricata
chown -R root:suri /var/log/suricata
chmod -R 775 /var/log/suricata
```

12.7 Using Landlock LSM

Landlock is a Linux Security Module that has been introduced in Linux 5.13. It allows an application to sandbox itself by selecting access right to directories using a deny by default approach.

Given its nature, Suricata knows where it is going to read files and where it is going to write them. So it is possible to implement an efficient Landlock sandboxing policy.

Landlock is not active by default and needs to be activated in the YAML configuration. Configuration should come with sane default (defined at build time) and the command line options are used to dynamically add some permissions.

Please note that Landlock is in blocking mode by default so careful testing is needed in production.

To enable Landlock, edit the YAML and set `enabled` to `yes`:

```
landlock:
  enabled: yes
  directories:
    write:
      - /var/log/suricata/
      - /var/run/
    read:
      - /usr/
      - /etc/
      - /etc/suricata/
```

Following your running configuration you may have to add some directories. There are two lists you can use, `write` to add directories where write is needed and `read` for directories where read access is needed.

Landlock is not active in some distributions and you may need to activate it at boot by adding `lsm=landock` to the Linux command line. For example, on a Debian distribution with at least a linux 5.13, you can edit `/etc/default/grub` and update the `GRUB_CMDLINE_LINUX_DEFAULT` option:

```
GRUB_CMDLINE_LINUX_DEFAULT="quiet lsm=landlock"
```

Then run `sudo update-grub` and reboot.

You can check at boot if it is running by doing:

```
sudo dmesg | grep landlock || journalctl -kg landlock
```

If you are interested in reading more about Landlock, you can use https://docs.kernel.org/userspace-api/landlock.html as entry point.

12.8 systemd notification

12.8.1 Introduction

Suricata supports systemd notification with the aim of notifying the service manager of successful initialisation. The purpose is to enable the ability to start upon/await successful start-up for services/test frameworks that depend on a fully initialised Suricata .

During the initialisation phase Suricata synchronises the initialisation thread with all active threads to ensure they are in a running state. Once synchronisation has been completed a `READY=1` status notification is sent to the service manager using `sd_notify()`.

12.8.2 Example

A test framework requires Suricata to be capturing before the tests can be carried out. Writing a `test.service` and ensuring the correct execution order with `After=suricata.service` forces the unit to be started after `suricata.service`. This does not enforce Suricata has fully initialised. By configuring `suricata.service` as `Type=notify` instructs the service manager to wait for the notification before starting `test.service`.

12.8.3 Requirements

This feature is only supported for distributions under the following conditions:

1. Distribution contains `libsystemd`
2. Any distribution that runs under **systemd**
3. Unit file configuration: `Type=notify`
4. Contains development files for systemd shared library

To install development files: Fedora:

```
dnf -y install systemd-devel
```

Ubuntu/Debian:

```
apt -y install systemd-dev
```

This package shall be compile-time configured and therefore only built with distributions fulfilling requirements [1, 2]. For notification to the service manager the unit file must be configured as shown in requirement [3]. Upon all requirements being met the service manager will start and await `READY=1` status from Suricata. Otherwise the service manager will treat the service unit as `Type=simple` and consider it started immediately after the main process `ExecStart=` has been forked.

12.8.4 Additional Information

To confirm the system is running under systemd:

```
ps --no-headers -o comm 1
```

See: https://man7.org/linux/man-pages/man3/sd_notify.3.html for a detailed description on `sd_notify`.

See https://www.freedesktop.org/software/systemd/man/systemd.service.html for help writing systemd unit files.

12.9 Includes

A Suricata configuration file (typically `/etc/suricata/suricata.yaml`) may include other files allowing a configuration file to be broken into multiple files. The *special* field name `include` is used to include one or more files.

The contents of the *include* file are inlined at the level of the `include` statement. *Include* fields may also be included at any level within a mapping.

12.9.1 Including a Single File

```
include: filename.yaml
```

12.9.2 Including Multiple Files

```
include:
  - filename1.yaml
  - filename2.yaml
```

12.9.3 Include Inside a Mapping

```
vars:
  address-groups:
    include: address-groups.yaml
```

where `address-groups.yaml` contains:

```
%YAML 1.1
---
HOME_NET: "[192.168.0.0/16,10.0.0.0/8,172.16.0.0/12]"
```

is the equivalent of:

```yaml
vars:
  address-groups:
    HOME_NET: "[192.168.0.0/16,10.0.0.0/8,172.16.0.0/12]"
```

Note: Suricata versions less than 7 required multiple `include` statements to be specified to include more than one file. While Suricata 7.0 still supports this it will issue a deprecation warning. Suricata 8.0 will not allow multiple `include` statements at the same level as this is not allowed by YAML.

CHAPTER

THIRTEEN

REPUTATION

13.1 IP Reputation

13.1.1 IP Reputation Config

IP reputation has a few configuration directives, all disabled by default.

```
# IP Reputation
#reputation-categories-file: /etc/suricata/iprep/categories.txt
#default-reputation-path: /etc/suricata/iprep
#reputation-files:
# - reputation.list
```

reputation-categories-file

The categories file mapping numbered category values to short names.

```
reputation-categories-file: /etc/suricata/iprep/categories.txt
```

default-reputation-path

Path where reputation files from the "reputation-files" directive are loaded from by default.

```
default-reputation-path: /etc/suricata/iprep
```

reputation-files

YAML list of file names to load. In case of a absolute path the file is loaded directly, otherwise the path from "default-reputation-path" is pre-pended to form the final path.

```
reputation-files:
 - badhosts.list
 - knowngood.list
 - sharedhosting.list
```

Hosts

IP reputation information is stored in the host table, so the settings of the host table affect it.

Depending on the number of hosts reputation information is available for, the memcap and hash size may have to be increased.

Reloads

Sending Suricata a USR2 signal will reload the IP reputation data, along with the normal rules reload.

During the reload the host table will be updated to contain the new data. The iprep information is versioned. When the reload is complete, Suricata will automatically clean up the old iprep information.

Only the reputation files will be reloaded, the categories file won't be. If categories change, Suricata should be restarted.

File format

The format of the reputation files is described in the *IP Reputation Format* page.

13.1.2 IP Reputation Format

Description of IP Reputation file formats. For the configuration see *IP Reputation Config* and *IP Reputation Keyword* for the rule format.

Categories file

The categories file provides a mapping between a category number, short name, and long description. It's a simple CSV file:

```
<id>,<short name>,<description>
```

Example:

```
1,BadHosts,Known bad hosts
2,Google,Known google host
```

The maximum value for the category id is hard coded at 60 currently.

Reputation file

The reputation file lists a reputation score for hosts in the categories. It's a simple CSV file:

```
<ip>,<category>,<reputation score>
```

The IP is an IPv4 address in the quad-dotted notation or an IPv6 address. Both IP types support networks in CIDR notation. The category is the number as defined in the categories file. The reputation score is the confidence that this IP is in the specified category, represented by a number between 1 and 127 (0 means no data).

Example:

```
1.2.3.4,1,101
1.1.1.0/24,6,88
```

If an IP address has a score in multiple categories it should be listed in the file multiple times.

Example:

```
1.1.1.1,1,10
1.1.1.1,2,10
```

This lists 1.1.1.1 in categories 1 and 2, each with a score of 10.

The purpose of the IP reputation component is the ranking of IP Addresses within the Suricata Engine. It will collect, store, update and distribute reputation intelligence on IP Addresses. The hub and spoke architecture will allows the central database (The Hub) to collect, store and compile updated IP reputation details that are then distributed to user-side sensor databases (Spokes) for inclusion in user security systems. The reputation data update frequency and security action taken, is defined in the user security configuration.

The intent of IP Reputation is to allow sharing of intelligence regarding a vast number of IP addresses. This can be positive or negative intelligence classified into a number of categories. The technical implementation requires three major efforts; engine integration, the hub that redistributes reputation, and the communication protocol between hubs and sensors. The hub will have a number of responsibilities. This will be a separate module running on a separate system as any sensor. Most often it would run on a central database that all sensors already have communication with. It will be able to subscribe to one or more external feeds. The local admin should be able to define the feeds to be subscribed to, provide authentication credentials if required, and give a weight to that feed. The weight can be an overall number or a by category weight. This will allow the admin to minimize the influence a feed has on their overall reputation if they distrust a particular category or feed, or trust another implicitly. Feeds can be configured to accept feedback or not and will report so on connect. The admin can override and choose not to give any feedback, but the sensor should report these to the Hub upstream on connect. The hub will take all of these feeds and aggregate them into an average single score for each IP or IP Block, and then redistribute this data to all local sensors as configured. It should receive connections from sensors. The sensor will have to provide authentication and will provide feedback. The hub should redistribute that feedback from sensors to all other sensors as well as up to any feeds that accept feedback. The hub should also have an API to allow outside statistical analysis to be done to the database and fed back into the stream. For instance a local site may choose to change the reputation on all Russian IP blocks, etc.

For more information about IP Reputation see *IP Reputation Config*, *IP Reputation Keyword* and *IP Reputation Format*.

CHAPTER

FOURTEEN

INIT SCRIPTS

For Ubuntu with Upstart, the following can be used in `/etc/init/suricata.conf`:

```
# suricata
description "Intrusion Detection System Daemon"
start on runlevel [2345]
stop on runlevel [!2345]
expect fork
exec suricata -D --pidfile /var/run/suricata.pid -c /etc/suricata/suricata.yaml -i eth1
```

CHAPTER

FIFTEEN

SETTING UP IPS/INLINE FOR LINUX

15.1 Setting up IPS with Netfilter

In this guide, we'll discuss how to work with Suricata in layer3 *inline mode* using `iptables`.

First, start by compiling Suricata with NFQ support. For instructions see Ubuntu Installation. For more information about NFQ and `iptables`, see *NFQ*.

To check if you have NFQ enabled in your Suricata build, enter the following command:

```
suricata --build-info
```

and make sure that NFQ is listed in the output.

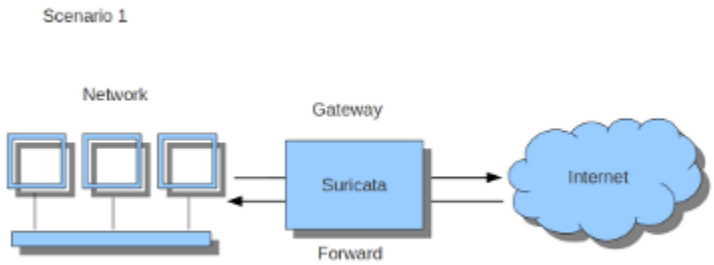
To run Suricata with the NFQ mode, you have to make use of the `-q` option. This option tells Suricata which queue numbers it should use.

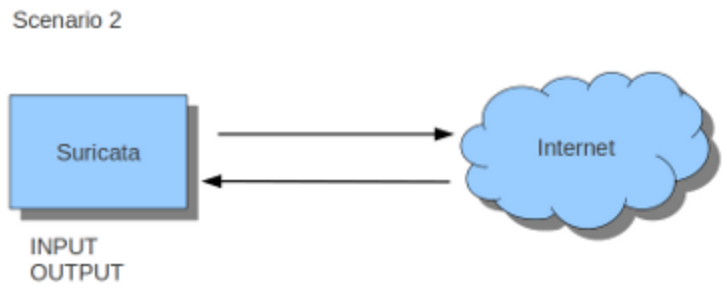
```
sudo suricata -c /etc/suricata/suricata.yaml -q 0
```

15.1.1 Iptables configuration

First of all, it is important to know which traffic you would like to send to Suricata. There are two choices:

1. Traffic that passes your computer
2. Traffic that is generated by your computer.





If Suricata is running on a gateway and is meant to protect the computers behind that gateway you are dealing with the first scenario: *forward_ing* .

If Suricata has to protect the computer it is running on, you are dealing with the second scenario: *host* (see drawing 2).

These two ways of using Suricata can also be combined.

The easiest rule in case of the gateway-scenario to send traffic to Suricata is:

```
sudo iptables -I FORWARD -j NFQUEUE
```

In this case, all forwarded traffic goes to Suricata.

In case of the host situation, these are the two most simple `iptables` rules;

```
sudo iptables -I INPUT -j NFQUEUE
sudo iptables -I OUTPUT -j NFQUEUE
```

It is possible to set a queue number. If you do not, the queue number will be 0 by default.

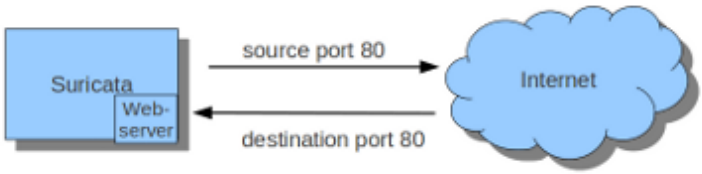
Imagine you want Suricata to check for example just TCP traffic, or all incoming traffic on port 80, or all traffic on destination-port 80, you can do so like this:

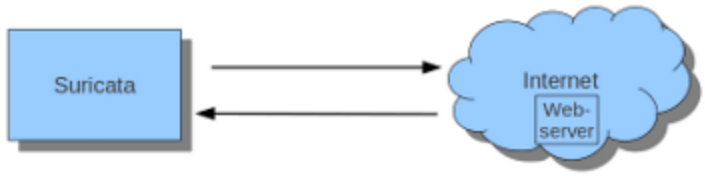
```
sudo iptables -I INPUT -p tcp  -j NFQUEUE
sudo iptables -I OUTPUT -p tcp -j NFQUEUE
```

In this case, Suricata checks just TCP traffic.

```
sudo iptables -I INPUT -p tcp --sport 80  -j NFQUEUE
sudo iptables -I OUTPUT -p tcp --dport 80 -j NFQUEUE
```

In this example, Suricata checks all packets for outgoing connections to port 80.

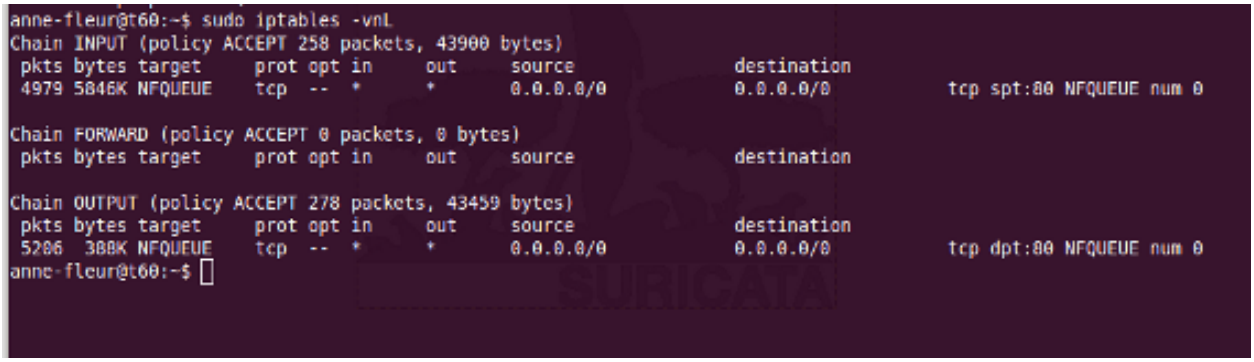




To see if you have set your `iptables` rules correct make sure Suricata is running and enter:

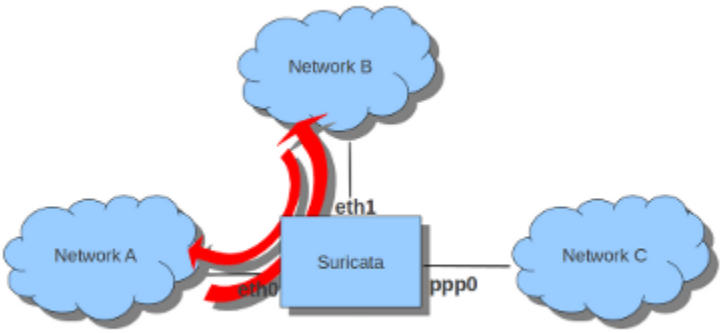
```
sudo iptables -vnL
```

In the example you can see if packets are being logged.



This description of the use of `iptables` is the way to use it with IPv4. To use it with IPv6 all previous mentioned commands have to start with `ip6tables`. It is also possible to let Suricata check both kinds of traffic.

There is also a way to use `iptables` with multiple networks (and interface cards). Example:




```
sudo iptables -I FORWARD -i eth0 -o eth1 -j NFQUEUE
sudo iptables -I FORWARD -i eth1 -o eth0 -j NFQUEUE
```

The options `-i` (input) `-o` (output) can be combined with all previous mentioned options.

If you would stop Suricata and use internet, the traffic will not come through. To make internet work correctly, first delete all `iptables` rules.

To erase all `iptables` rules, enter:

```
sudo iptables -F
```

15.1.2 NFtables configuration

The NFtables configuration is straight forward and allows mixing firewall rules with IPS. The concept is to create a dedicated chain for the IPS that will be evaluated after the firewalling rule. If your main table is named *filter* it can be created like so:

```
nft> add chain filter IPS { type filter hook forward priority 10;}
```

To send all forwarded packets to Suricata one can use

```
nft> add rule filter IPS queue
```

To only do it for packets exchanged between eth0 and eth1

```
nft> add rule filter IPS iif eth0 oif eth1 queue
nft> add rule filter IPS iif eth1 oif eth0 queue
```

15.1.3 NFQUEUE advanced options

The NFQUEUE mechanism supports some interesting options. The `nftables` configuration will be shown there but the features are also available in `iptables`.

The full syntax of the queuing mechanism is as follows:

```
nft add rule filter IPS queue num 3-5 options fanout,bypass
```

This rule sends matching packets to 3 load-balanced queues starting at 3 and ending at 5. To get the packets in Suricata with this setup, you need to specify multiple queues on command line:

```
suricata -q 3 -q 4 -q 5
```

fanout and *bypass* are the two available options:

- *fanout*: When used together with load balancing, this will use the CPU ID instead of connection hash as an index to map packets to the queues. The idea is that you can improve performance if there's one queue per CPU. This requires total with a number of queues superior to 1 to be specified.
- *bypass*: By default, if no userspace program is listening on an Netfilter queue, then all packets that are to be queued are dropped. When this option is used, the queue rule behaves like ACCEPT if there is no program listening, and the packet will move on to the next table.

The *bypass* option can be used to avoid downtime of link when Suricata is not running but this also means that the blocking feature will not be present.

15.2 Setting up IPS at Layer 2

15.2.1 AF_PACKET IPS mode

AF_PACKET capture method is supporting a IPS/Tap mode. In this mode, you just need the interfaces to be up. Suricata will take care of copying the packets from one interface to the other. No `iptables` or `nftables` configuration is necessary.

You need to dedicate two network interfaces for this mode. The configuration is made via configuration variable available in the description of an AF_PACKET interface.

For example, the following configuration will create a Suricata acting as IPS between interface `eth0` and `eth1`:

```
af-packet:
  - interface: eth0
    threads: 1
    defrag: no
    cluster-type: cluster_flow
    cluster-id: 98
    copy-mode: ips
    copy-iface: eth1
    buffer-size: 64535
    use-mmap: yes
  - interface: eth1
    threads: 1
    cluster-id: 97
    defrag: no
    cluster-type: cluster_flow
    copy-mode: ips
    copy-iface: eth0
    buffer-size: 64535
    use-mmap: yes
```

This is a basic af-packet configuration using two interfaces. Interface `eth0` will copy all received packets to `eth1` because of the *copy-** configuration variable

```
copy-mode: ips
copy-iface: eth1
```

The configuration on `eth1` is symmetric

```
copy-mode: ips
copy-iface: eth0
```

There are some important points to consider when setting up this mode:

- The implementation of this mode is dependent of the zero copy mode of AF_PACKET. Thus you need to set *use-mmap* to *yes* on both interface.
- MTU on both interfaces have to be equal: the copy from one interface to the other is direct and packets bigger then the MTU will be dropped by kernel.
- Set different values of *cluster-id* on both interfaces to avoid conflict.
- Any network card offloading creating bigger then physical layer datagram (like GRO, LRO, TSO) will result in dropped packets as the transmit path can not handle them.

- Set *stream.inline* to *auto* or *yes* so Suricata switches to blocking mode.

The *copy-mode* variable can take the following values:

- *ips*: the drop keyword is honored and matching packets are dropped.
- *tap*: no drop occurs, Suricata acts as a bridge

Some specific care must be taken to scale the capture method on multiple threads. As we can't use defrag that will generate too big frames, the in kernel load balancing will not be correct: the IP-only fragment will not reach the same thread as the full featured packet of the same flow because the port information will not be present.

A solution is to use eBPF load balancing to get an IP pair load balancing without fragmentation. The AF_PACKET IPS Configuration using multiple threads and eBPF load balancing looks like the following:

```
af-packet:
  - interface: eth0
    threads: 16
    defrag: no
    cluster-type: cluster_ebpf
    ebpf-lb-file: /usr/libexec/suricata/ebpf/lb.bpf
    cluster-id: 98
    copy-mode: ips
    copy-iface: eth1
    buffer-size: 64535
    use-mmap: yes
  - interface: eth1
    threads: 16
    cluster-id: 97
    defrag: no
    cluster-type: cluster_ebpf
    ebpf-lb-file: /usr/libexec/suricata/ebpf/lb.bpf
    copy-mode: ips
    copy-iface: eth0
    buffer-size: 64535
    use-mmap: yes
```

The eBPF file `/usr/libexec/suricata/ebpf/lb.bpf` may not be present on disk. See *eBPF and XDP* for more information.

15.2.2 DPDK IPS mode

In the same way as you would configure AF_PACKET IPS mode, you can configure the DPDK capture module. Prior to starting with IPS (inline) setup, it is recommended to go over *Data Plane Development Kit (DPDK)* manual page to understand the setup essentials.

DPDK IPS mode, similarly to AF-Packet, uses two interfaces. Packets received on the first network interface (`0000:3b:00.1`) are transmitted by the second network interface (`0000:3b:00.0`) and similarly, packets received on the second interface (`0000:3b:00.0`) are transmitted by the first interface (`0000:3b:00.1`). Packets are not altered in any way in this mode.

The following configuration snippet configures Suricata DPDK IPS mode between two NICs:

```
dpdk:
  eal-params:
    proc-type: primary
```

(continues on next page)

(continued from previous page)

```
  interfaces:
  - interface: 0000:3b:00.1
    threads: 4
    promisc: true
    multicast: true
    checksum-checks: true
    checksum-checks-offload: true
    mempool-size: 262143
    mempool-cache-size: 511
    rx-descriptors: 4096
    tx-descriptors: 4096
    copy-mode: ips
    copy-iface: 0000:3b:00.0
    mtu: 3000

  - interface: 0000:3b:00.0
    threads: 4
    promisc: true
    multicast: true
    checksum-checks: true
    checksum-checks-offload: true
    mempool-size: 262143
    mempool-cache-size: 511
    rx-descriptors: 4096
    tx-descriptors: 4096
    copy-mode: ips
    copy-iface: 0000:3b:00.1
    mtu: 3000
```

The previous DPDK configuration snippet outlines several things to consider:

- `copy-mode` - see Section *AF_PACKET IPS mode* for more details.
- `copy-iface` - see Section *AF_PACKET IPS mode* for more details.
- `threads` - all interface entries must have their thread count configured and paired/connected interfaces must be configured with the same amount of threads.
- `mtu` - MTU must be the same on both paired interfaces.

DPDK capture module also requires having CPU affinity set in the configuration file. For the best performance, every Suricata worker should be pinned to a separate CPU core that is not shared with any other Suricata thread (e.g. management threads). The following snippet shows a possible *Threading* configuration set-up for DPDK IPS mode.

```
threading:
  set-cpu-affinity: yes
  cpu-affinity:
    - management-cpu-set:
        cpu: [ 0 ]
    - worker-cpu-set:
        cpu: [ 2,4,6,8,10,12,14,16 ]
```

15.2.3 Netmap IPS mode

Using Netmap to support IPS requires setting up pairs of interfaces; packets are received on one interface within the pair, inspected by Suricata, and transmitted on the other paired interface. You can use native or host stack mode; host stack mode is used when the interface name contains the `^` character, e.g, `enp6s0f0^`. host stack mode does not require multiple physical network interfaces.

Netmap Host Stack Mode

Netmap's host stack mode allows packets that flow through Suricata to be used with other host OS applications, e.g., a firewall or similar. Additionally, host stack mode allows traffic to be received and transmitted on one network interface card.

With host stack mode, Netmap establishes a pair of host stack mode rings (one each for RX and TX). Packets pass through the host operating system network protocol stack. Ingress network packets flow from the network interface card to the network protocol stack and then into the host stack mode rings. Outbound packets flow from the host stack mode rings to the network protocol stack and finally, to the network interface card. Suricata receives packets from the host stack mode rings and, in IPS mode, places packets to be transmitted into the host stack mode rings. Packets transmitted by Suricata into the host stack mode rings are available for other host OS applications.

Paired network interfaces are specified in the `netmap` configuration section. For example, the following configuration will create a Suricata acting as IPS between interface `enp6s0f0` and `enp6s0f1`

```
netmap:
  - interface: enp6s0f0
    threads: auto
    copy-mode: ips
    copy-iface: enp6s0f1

  - interface: enp6s0f1
    threads: auto
    copy-mode: ips
    copy-iface: enp6s0f0
```

You can specify the `threads` value; the default value of `auto` will create a thread for each queue supported by the NIC; restrict the thread count by specifying a value, e.g., `threads: 1`

This is a basic netmap configuration using two interfaces. Suricata will copy packets between interfaces `enp6s0f0` and `en60sf1` because of the *copy-** configuration variable in interface's `enp6s0f0` configuration

```
copy-mode: ips
copy-iface: enp6s0f1
```

The configuration on `enp6s0f1` is symmetric

```
copy-mode: ips
copy-iface: enp6s0f0
```

The host stack mode feature of Netmap can be used. host stack mode doesn't require a second network interface.

This example demonstrates host stack mode with a single physical network interface `enp6s0f01`

```
- interface: enp60s0f0
  copy-mode: ips
  copy-iface: enp6s0f0^
```

The configuration on `enp6s0f0^` is symmetric

```
- interface: enp60s0f0^
  copy-mode: ips
  copy-iface: enp6s0f0
```

Suricata will use zero-copy mode when the runmode is `workers`.

There are some important points to consider when setting up this mode:

- Any network card offloading creating bigger then physical layer datagram (like GRO, LRO, TSO) will result in dropped packets as the transmit path can not handle them.
- Set *stream.inline* to *auto* or *yes* so Suricata switches to blocking mode. The default value is *auto*.

The *copy-mode* variable can take the following values:

- *ips*: the drop keyword is honored and matching packets are dropped.
- *tap*: no drop occurs, Suricata acts as a bridge

CHAPTER

SIXTEEN

SETTING UP IPS/INLINE FOR WINDOWS

This guide explains how to work with Suricata in layer 4 inline mode using WinDivert on Windows.

First start by compiling Suricata with WinDivert support. For instructions, see Windows Installation. This documentation has not yet been updated with WinDivert information, so make sure to add the following flags before configuring Suricata with `configure`:

```
--enable-windivert=yes --with-windivert-include=<include-dir> --with-windivert-libraries=
↪<libraries-dir>
```

WinDivert.dll and WinDivert.sys must be in the same directory as the Suricata executable. WinDivert automatically installs the driver when it is run. For more information about WinDivert, see https://www.reqrypt.org/windivert-doc.html.

To check if you have WinDivert enabled in your Suricata, enter the following command in an elevated command prompt or terminal:

```
suricata -c suricata.yaml --windivert [filter string]
```

For information on the WinDivert filter language, see https://www.reqrypt.org/windivert-doc.html#filter_language

If Suricata is running on a gateway and is meant to protect the network behind that gateway, you need to run WinDivert at the *NETWORK_FORWARD* layer. This can be achieved using the following command:

```
suricata -c suricata.yaml --windivert-forward [filter string]
```

The filter is automatically stopped and normal traffic resumes when Suricata is stopped.

A quick start is to examine all traffic, in which case you can use the following command:

```
suricata -c suricata.yaml --windivert[-forward] true
```

A few additional examples:

Only TCP traffic:

```
suricata -c suricata.yaml --windivert tcp
```

Only TCP traffic on port 80:

```
suricata -c suricata.yaml --windivert "tcp.DstPort == 80"
```

TCP and ICMP traffic:

```
suricata -c suricata.yaml --windivert "tcp or icmp"
```

CHAPTER

SEVENTEEN

OUTPUT

17.1 EVE

17.1.1 Eve JSON Output

The EVE output facility outputs alerts, anomalies, metadata, file info and protocol specific records through JSON.

The most common way to use this is through 'EVE', which is a firehose approach where all these logs go into a single file.

```
outputs:
  # Extensible Event Format (nicknamed EVE) event log in JSON format
  - eve-log:
      enabled: yes
      filetype: regular #regular|syslog|unix_dgram|unix_stream|redis
      filename: eve.json
      # Enable for multi-threaded eve.json output; output files are amended
      # with an identifier, e.g., eve.9.json
      #threaded: false
      #prefix: "@cee: " # prefix to prepend to each log entry
      # the following are valid when type: syslog above
      #identity: "suricata"
      #facility: local5
      #level: Info ## possible levels: Emergency, Alert, Critical,
                   ## Error, Warning, Notice, Info, Debug
      #redis:
      #  server: 127.0.0.1
      #  port: 6379
      #  async: true ## if redis replies are read asynchronously
      #  mode: list ## possible values: list|lpush (default), rpush, channel|publish
      #             ## lpush and rpush are using a Redis list. "list" is an alias for␣
↪lpush
      #             ## publish is using a Redis channel. "channel" is an alias for␣
↪publish
      #  key: suricata ## key or channel to use (default to suricata)
      # Redis pipelining set up. This will enable to only do a query every
      # 'batch-size' events. This should lower the latency induced by network
      # connection at the cost of some memory. There is no flushing implemented
      # so this setting as to be reserved to high traffic suricata.
      #  pipelining:
      #    enabled: yes ## set enable to yes to enable query pipelining
```

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```
      #    batch-size: 10 ## number of entry to keep in buffer

      # Include top level metadata. Default yes.
      #metadata: no

      types:
        - alert:
            # payload: yes             # enable dumping payload in Base64
            # payload-buffer-size: 4kb # max size of payload buffer to output in eve-log
            # payload-printable: yes   # enable dumping payload in printable (lossy)␣
↪format
            # packet: yes              # enable dumping of packet (without stream␣
↪segments)
            # http-body: yes           # Requires metadata; enable dumping of http body␣
↪in Base64
            # http-body-printable: yes # Requires metadata; enable dumping of http body␣
↪in printable format

            # Enable the logging of tagged packets for rules using the
            # "tag" keyword.
            tagged-packets: yes

            # Configure the metadata to be logged along with an
            # alert. The following shows the default configuration
            # which is used if this field is not provided or simply
            # set to a truthful value. Setting of this section is only
            # required if you wish to enable/disable specific fields.
            #metadata:

              # Include the decoded application layer (ie. http, dns)
              app-layer: true

              # Log the current state of the flow record.
              flow: true

              rule:
                # Log the metadata field from the rule in a structured
                # format.
                metadata: true

                # Log the raw rule text.
                raw: false

            # HTTP X-Forwarded-For support by adding an extra field or overwriting
            # the source or destination IP address (depending on flow direction)
            # with the one reported in the X-Forwarded-For HTTP header. This is
            # helpful when reviewing alerts for traffic that is being reverse
            # or forward proxied.
            xff:
              enabled: no
              # Two operation modes are available, "extra-data" and "overwrite".
              mode: extra-data
```

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```
          # Two proxy deployments are supported, "reverse" and "forward". In
          # a "reverse" deployment the IP address used is the last one, in a
          # "forward" deployment the first IP address is used.
          deployment: reverse
          # Header name where the actual IP address will be reported, if more
          # than one IP address is present, the last IP address will be the
          # one taken into consideration.
          header: X-Forwarded-For
      - http:
          extended: yes     # enable this for extended logging information
          # custom allows additional http fields to be included in eve-log
          # the example below adds three additional fields when uncommented
          #custom: [Accept-Encoding, Accept-Language, Authorization]
      - dns:
          # Use version 2 logging with the new format:
          # dns answers will be logged in one single event
          # rather than an event for each of the answers.
          # Without setting a version the version
          # will fallback to 1 for backwards compatibility.
          version: 2

          # Enable/disable this logger. Default: enabled.
          #enabled: no

          # Control logging of requests and responses:
          # - requests: enable logging of DNS queries
          # - responses: enable logging of DNS answers
          # By default both requests and responses are logged.
          #requests: no
          #responses: no

          # Format of answer logging:
          # - detailed: array item per answer
          # - grouped: answers aggregated by type
          # Default: all
          #answer-format: [detailed, grouped]

          # Answer types to log.
          # Default: all
          #answer-types: [a, aaaa, cname, mx, ns, ptr, txt]
      - dns:
          # Version 1 DNS logger.
          # Deprecated: Will be removed by May 2022.
          version: 1

          enabled: no
          # control logging of queries and answers
          # default yes, no to disable
          query: yes     # enable logging of DNS queries
          answer: yes    # enable logging of DNS answers
          # control which RR types are logged
          # all enabled if custom not specified
```

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```
            #custom: [a, aaaa, cname, mx, ns, ptr, txt]
        - tls:
            extended: yes     # enable this for extended logging information
            # output TLS transaction where the session is resumed using a
            # session id
            #session-resumption: no
            # ja4 hashes in tls records will never be logged unless
            # the following is set to on. (Default off)
            # ja4: off
            # custom allows to control which tls fields that are included
            # in eve-log
            #custom: [subject, issuer, session_resumed, serial, fingerprint, sni,␣
↪version, not_before, not_after, certificate, chain]
        - files:
            force-magic: no   # force logging magic on all logged files
            # force logging of checksums, available hash functions are md5,
            # sha1 and sha256
            #force-hash: [md5]
        #- drop:
        #    alerts: yes      # log alerts that caused drops
        #    flows: all       # start or all: 'start' logs only a single drop
        #                     # per flow direction. All logs each dropped pkt.
        - smtp:
            #extended: yes # enable this for extended logging information
            # this includes: bcc, message-id, subject, x_mailer, user-agent
            # custom fields logging from the list:
            #  reply-to, bcc, message-id, subject, x-mailer, user-agent, received,
            #  x-originating-ip, in-reply-to, references, importance, priority,
            #  sensitivity, organization, content-md5, date
            #custom: [received, x-mailer, x-originating-ip, relays, reply-to, bcc]
            # output md5 of fields: body, subject
            # for the body you need to set app-layer.protocols.smtp.mime.body-md5
            # to yes
            #md5: [body, subject]

        # NFS logging.
        - nfs
        # IKE logging.
        - ike
        # BitTorrent DHT logging.
        - bittorrent-dht
        - quic:
            # ja4 hashes in crecords will never be logged unless
            # the following is set to on. (Default off)
            # ja4: off
        - ssh
        - stats:
            totals: yes       # stats for all threads merged together
            threads: no       # per thread stats
            deltas: no        # include delta values
        - dhcp:
            # DHCP logging.
```

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```
            enabled: yes
            # When extended mode is on, all DHCP messages are logged
            # with full detail. When extended mode is off (the
            # default), just enough information to map a MAC address
            # to an IP address is logged.
            extended: no
        # bi-directional flows
        - flow
        # uni-directional flows
        #- netflow

        # An event for logging metadata, specifically pktvars when
        # they are set, but will also include the full metadata object.
        #- metadata
```

Each alert, http log, etc will go into this one file: 'eve.json'. This file can then be processed by 3rd party tools like Logstash (ELK) or jq.

If `ethernet` is set to yes, then ethernet headers will be added to events if available.

Output types

EVE can output to multiple methods. `regular` is a normal file. Other options are `syslog`, `unix_dgram`, `unix_stream` and `redis`.

Output types:

```
filetype: regular #regular|syslog|unix_dgram|unix_stream|redis
filename: eve.json
# Enable for multi-threaded eve.json output; output files are amended
# with an identifier, e.g., eve.9.json. Default: off
#threaded: off
#prefix: "@cee: " # prefix to prepend to each log entry
# the following are valid when type: syslog above
#identity: "suricata"
#facility: local5
#level: Info ## possible levels: Emergency, Alert, Critical,
             ## Error, Warning, Notice, Info, Debug
#ethernet: no # log ethernet header in events when available
#redis:
#  server: 127.0.0.1
#  port: 6379
#  async: true ## if redis replies are read asynchronously
#  mode: list ## possible values: list|lpush (default), rpush, channel|publish
#             ## lpush and rpush are using a Redis list. "list" is an alias for lpush
#             ## publish is using a Redis channel. "channel" is an alias for publish
#  key: suricata ## key or channel to use (default to suricata)
# Redis pipelining set up. This will enable to only do a query every
# 'batch-size' events. This should lower the latency induced by network
# connection at the cost of some memory. There is no flushing implemented
# so this setting as to be reserved to high traffic suricata.
#  pipelining:
```

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```
#    enabled: yes ## set enable to yes to enable query pipelining
#    batch-size: 10 ## number of entry to keep in buffer
```

Alerts

Alerts are event records for rule matches. They can be amended with metadata, such as the application layer record (HTTP, DNS, etc) an alert was generated for, and elements of the rule.

The alert is amended with application layer metadata for signatures using application layer keywords. It is also the case for protocols over UDP as each single packet is expected to contain a PDU.

For other signatures, the option `guess-applayer-tx` can be used to force the detect engine to tie a transaction to an alert. This transaction is not guaranteed to be the relevant one, depending on your use case and how you define relevant here. **WARNING: If there are multiple live transactions, none will get picked up.** This is to reduce the chances of logging unrelated data, and may lead to alerts being logged without metadata, in some cases. The alert event will have `tx_guessed: true` to recognize such alerts.

Metadata:

```
- alert:
    #payload: yes             # enable dumping payload in Base64
    #payload-buffer-size: 4kb # max size of payload buffer to output in eve-log
    #payload-printable: yes   # enable dumping payload in printable (lossy) format
    #packet: yes              # enable dumping of packet (without stream segments)
    #http-body: yes           # Requires metadata; enable dumping of http body in Base64
    #http-body-printable: yes # Requires metadata; enable dumping of http body in␣
↪printable format

    # metadata:

      # Include the decoded application layer (ie. http, dns)
      #app-layer: true

      # Log the current state of the flow record.
      #flow: true

      #rule:
        # Log the metadata field from the rule in a structured
        # format.
        #metadata: true

        # Log the raw rule text.
        #raw: false
```

Anomaly

Anomalies are event records created when packets with unexpected or anomalous values are handled. These events include conditions such as incorrect protocol values, incorrect protocol length values, and other conditions which render the packet suspect. Other conditions may occur during the normal progression of a stream; these are termed `stream` events are include control sequences with incorrect values or that occur out of expected sequence.

Anomalies are reported by and configured by type:

- Decode
- Stream
- Application layer

Metadata:

```
- anomaly:
    # Anomaly log records describe unexpected conditions such as truncated packets,
    # packets with invalid IP/UDP/TCP length values, and other events that render
    # the packet invalid for further processing or describe unexpected behavior on
    # an established stream. Networks which experience high occurrences of
    # anomalies may experience packet processing degradation.
    #
    # Anomalies are reported for the following:
    # 1. Decode: Values and conditions that are detected while decoding individual
    #    packets. This includes invalid or unexpected values for low-level protocol
    #    lengths as well.
    # 2. Stream: This includes stream related events (TCP 3-way handshake issues,
    #    unexpected sequence number, etc).
    # 3. Application layer: These denote application layer specific conditions that
    #    are unexpected, invalid or are unexpected given the application monitoring
    #    state.
    #
    # By default, anomaly logging is disabled. When anomaly logging is enabled,
    # application-layer anomaly reporting is enabled.
    #
    # Choose one or both types of anomaly logging and whether to enable
    # logging of the packet header for packet anomalies.
    types:
      #decode: no
      #stream: no
      #applayer: yes
    #packethdr: no
```

HTTP

HTTP transaction logging.

Config:

```
- http:
    extended: yes     # enable this for extended logging information
    # custom allows additional http fields to be included in eve-log
    # the example below adds three additional fields when uncommented
```

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```
    #custom: [Accept-Encoding, Accept-Language, Authorization]
    # set this value to one among {both, request, response} to dump all
    # http headers for every http request and/or response
    # dump-all-headers: [both, request, response]
```

List of custom fields:

Yaml Option	HTTP Header
accept	accept
accept_charset	accept-charset
accept_encoding	accept-encoding
accept_language	accept-language
accept_datetime	accept-datetime
authorization	authorization
cache_control	cache-control
cookie	cookie
from	from
max_forwards	max-forwards
origin	origin
pragma	pragma
proxy_authorization	proxy-authorization
range	range
te	te
via	via
x_requested_with	x-requested-with
dnt	dnt
x_forwarded_proto	x-forwarded-proto
x_authenticated_user	x-authenticated-user
x_flash_version	x-flash-version
accept_range	accept-range
age	age
allow	allow
connection	connection
content_encoding	content-encoding
content_language	content-language
content_length	content-length
content_location	content-location
content_md5	content-md5
content_range	content-range
content_type	content-type
date	date
etag	etags
expires	expires
last_modified	last-modified
link	link
location	location
proxy_authenticate	proxy-authenticate
referer	referer
refresh	refresh
retry_after	retry-after

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Yaml Option	HTTP Header
server	server
set_cookie	set-cookie
trailer	trailer
transfer_encoding	transfer-encoding
upgrade	upgrade
vary	vary
warning	warning
www_authenticate	www-authenticate
true_client_ip	true-client-ip
org_src_ip	org-src-ip
x_bluecoat_via	x-bluecoat-via

In the `custom` option values from both columns can be used. The `HTTP Header` column is case insensitive.

DNS

Note: As of Suricata 7.0 the v1 EVE DNS format has been removed.

DNS records are logged as one entry for the request, and one entry for the response.

YAML:

```
- dns:
    #version: 2

    # Enable/disable this logger. Default: enabled.
    #enabled: yes

    # Control logging of requests and responses:
    # - requests: enable logging of DNS queries
    # - responses: enable logging of DNS answers
    # By default both requests and responses are logged.
    #requests: no
    #responses: no

    # Format of answer logging:
    # - detailed: array item per answer
    # - grouped: answers aggregated by type
    # Default: all
    #formats: [detailed, grouped]

    # Types to log, based on the query type.
    # Default: all.
    #types: [a, aaaa, cname, mx, ns, ptr, txt]
```

TLS

TLS records are logged one record per session.

YAML:

```
- tls:
    extended: yes     # enable this for extended logging information
    # custom allows to control which tls fields that are included
    # in eve-log
    #custom: [subject, issuer, serial, fingerprint, sni, version, not_before, not_after,␣
↪certificate, chain, ja3, ja3s, ja4]
```

The default is to log certificate subject and issuer. If `extended` is enabled, then the log gets more verbose.

By using `custom` it is possible to select which TLS fields to log.

Drops

Drops are event types logged when the engine drops a packet.

Config:

```
- drop:
    alerts: yes      # log alerts that caused drops
    flows: all       # start or all: 'start' logs only a single drop
                     # per flow direction. All logs each dropped pkt.
    # Enable logging the final action taken on a packet by the engine
    # (will show more information in case of a drop caused by 'reject')
    verdict: yes
```

Date modifiers in filename

It is possible to use date modifiers in the eve-log filename.

```
outputs:
  - eve-log:
      filename: eve-%s.json
```

The example above adds epoch time to the filename. All the date modifiers from the C library should be supported. See the man page for `strftime` for all supported modifiers.

Threaded file output

By default, all output is written to the named filename in the outputs section. The `threaded` option enables each output thread to write to individual files. In this case, the `filename` will include a unique identifier.

With `threaded` enabled, the output will be split among many files -- and the aggregate of each file's contents must be treated together.

```
outputs:
  - eve-log:
      filename: eve.json
      threaded: on
```

This example will cause each Suricata thread to write to its own "eve.json" file. Filenames are constructed by adding a unique identifier to the filename. For example, `eve.7.json`.

Rotate log file

Eve-log can be configured to rotate based on time.

```
outputs:
  - eve-log:
      filename: eve-%Y-%m-%d-%H:%M.json
      rotate-interval: minute
```

The example above creates a new log file each minute, where the filename contains a timestamp. Other supported `rotate-interval` values are `hour` and `day`.

In addition to this, it is also possible to specify the `rotate-interval` as a relative value. One example is to rotate the log file each X seconds.

```
outputs:
  - eve-log:
      filename: eve-%Y-%m-%d-%H:%M:%S.json
      rotate-interval: 30s
```

The example above rotates eve-log each 30 seconds. This could be replaced with `30m` to rotate every 30 minutes, `30h` to rotate every 30 hours, `30d` to rotate every 30 days, or `30w` to rotate every 30 weeks.

Multiple Logger Instances

It is possible to have multiple 'EVE' instances, for example the following is valid:

```
outputs:
  - eve-log:
      enabled: yes
      type: file
      filename: eve-ips.json
      types:
        - alert
        - drop

  - eve-log:
      enabled: yes
      type: file
      filename: eve-nsm.json
      types:
        - http
        - dns
        - tls
```

So here the alerts and drops go into 'eve-ips.json', while http, dns and tls go into 'eve-nsm.json'.

With the exception of `drop`, you can specify multiples of the same logger type, however, `drop` can only be used once.

Note: The use of independent json loggers such as alert-json-log, dns-json-log, etc. has been deprecated and will be removed by June 2020. Please use multiple eve-log instances as documented above instead. Please see the deprecation

policy for more information.

File permissions

Log file permissions can be set individually for each logger. `filemode` can be used to control the permissions of a log file, e.g.:

```
outputs:
  - eve-log:
      enabled: yes
      filename: eve.json
      filemode: 600
```

The example above sets the file permissions on `eve.json` to 600, which means that it is only readable and writable by the owner of the file.

JSON flags

Several flags can be specified to control the JSON output in EVE:

```
outputs:
  - eve-log:
      json:
        # Sort object keys in the same order as they were inserted
        preserve-order: yes

        # Make the output more compact
        compact: yes

        # Escape all unicode characters outside the ASCII range
        ensure-ascii: yes

        # Escape the '/' characters in string with '\/'
        escape-slash: yes
```

All these flags are enabled by default, and can be modified per EVE instance.

Community Flow ID

Often Suricata is used in combination with other tools like Bro/Zeek. Enabling the community-id option in the eve-log section adds a new `community_id` field to each output.

Example:

```
{
  "timestamp": "2003-12-16T13:21:44.891921+0000",
  "flow_id": 1332028388187153,
  "pcap_cnt": 1,
  "event_type": "alert",
  ...
  "community_id": "1:LQU9qZlK+B5F3KDmev6m5PMibrg=",
```

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```
  "alert": {
    "action": "allowed",
    "gid": 1,
    "signature_id": 1,
  },
}
{
  "timestamp": "2003-12-16T13:21:45.037333+0000",
  "flow_id": 1332028388187153,
  "event_type": "flow",
  "flow": {
    "pkts_toserver": 5,
    "pkts_toclient": 4,
    "bytes_toserver": 338,
    "bytes_toclient": 272,
    "start": "2003-12-16T13:21:44.891921+0000",
    "end": "2003-12-16T13:21:45.346457+0000",
    "age": 1,
    "state": "closed",
    "reason": "shutdown",
    "alerted": true
  },
  "community_id": "1:LQU9qZlK+B5F3KDmev6m5PMibrg=",
}
```

Options

The output can be enabled per instance of the EVE logger.

The `community-id` option is boolean. If set to `true` it is enabled. The `community-id-seed` option specifies a unsigned 16 bit value that is used a seed to the hash that is calculated for the `community-id` output. This must be set to the same value on all tools that output this record.

YAML:

```
- eve-log:
    # Community Flow ID
    # Adds a 'community_id' field to EVE records. These are meant to give
    # a records a predictable flow id that can be used to match records to
    # output of other tools such as Bro.
    #
    # Takes a 'seed' that needs to be same across sensors and tools
    # to make the id less predictable.

    # enable/disable the community id feature.
    community-id: false
    # Seed value for the ID output. Valid values are 0-65535.
    community-id-seed: 0
```

Multi Tenancy

Suricata can be configured to support multiple tenants with different detection engine configurations. When these tenants are configured and the detection engine is running then all EVE logging will also report the `tenant_id` field for traffic matching a specific tenant.

17.1.2 Eve JSON Format

Example:

```
{
  "timestamp": "2017-04-07T22:24:37.251547+0100",
  "flow_id": 586497171462735,
  "pcap_cnt": 53381,
  "event_type": "alert",
  "src_ip": "192.168.2.14",
  "src_port": 50096,
  "dest_ip": "209.53.113.5",
  "dest_port": 80,
  "proto": "TCP",
  "metadata": {
    "flowbits": [
      "http.dottedquadhost"
    ]
  },
  "tx_id": 4,
  "alert": {
    "action": "allowed",
    "gid": 1,
    "signature_id": 2018358,
    "rev": 10,
    "signature": "ET HUNTING GENERIC SUSPICIOUS POST to Dotted Quad with Fake Browser 1",
    "category": "Potentially Bad Traffic",
    "severity": 2
  },
  "app_proto": "http"
}
```

Common Section

All the JSON log types share a common structure:

```
{"timestamp":"2009-11-24T21:27:09.534255","flow_id":ID_NUMBER, "event_type":"TYPE", ...
↪tuple... ,"TYPE":{ ... type specific content ... }}
```

Field: flow_id

Correlates the network protocol, flow logs EVE data and any evidence that Suricata has logged to an `alert` event and that alert's metadata, as well as to `fileinfo`/file transaction and anomaly logs, if available. The same correlation and logs are produced regardless if there is an alert, for any session/flow.

The ability to correlate EVE logs belonging to a specific session/flow was introduced in 2014 (see commit f1185d051c21).

Further below, you can see several examples of events logged by Suricata: an *alert* for an `HTTP` rule, `fileinfo`, *http*, *anomaly*, and *flow* events, all easily correlated using the `flow_id` EVE field:

```
$ jq 'select(.flow_id==1676750115612680)' eve.json
```

Event type: `alert`:


```
{
  "timestamp": "2023-09-18T06:13:41.532140+0000",
  "flow_id": 1676750115612680,
  "pcap_cnt": 130,
  "event_type": "alert",
  "src_ip": "142.11.240.191",
  "src_port": 35361,
  "dest_ip": "192.168.100.237",
  "dest_port": 49175,
  "proto": "TCP",
  "pkt_src": "wire/pcap",
  "ether": {
    "src_mac": "52:54:00:36:3e:ff",
    "dest_mac": "12:a9:86:6c:77:de"
  },
  "tx_id": 1,
  "alert": {
    "action": "allowed",
    "gid": 1,
    "signature_id": 2045001,
    "rev": 1,
    "signature": "ET ATTACK_RESPONSE Win32/LeftHook Stealer Browser Extension Config␣
↪Inbound",
    "category": "A Network Trojan was detected",
    "severity": 1,
    "metadata": {
      "affected_product": [
        "Windows_XP_Vista_7_8_10_Server_32_64_Bit"
      ],
      "attack_target": [
        "Client_Endpoint"
      ],
      "created_at": [
        "2023_04_17"
      ],
      "deployment": [
        "Perimeter"
      ],
```


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```
      "former_category": [
        "ATTACK_RESPONSE"
      ],
      "signature_severity": [
        "Major"
      ],
      "updated_at": [
        "2023_04_18"
      ]
    }
  },
  "http": {
    "hostname": "142.11.240.191",
    "http_port": 35361,
    "url": "/",
    "http_content_type": "text/xml",
    "http_method": "POST",
    "protocol": "HTTP/1.1",
    "status": 200,
    "length": 5362
  },
  "files": [
    {
      "filename": "/",
      "gaps": false,
      "state": "CLOSED",
      "stored": false,
      "size": 5362,
      "tx_id": 1
    }
  ],
  "app_proto": "http",
  "direction": "to_client",
  "flow": {
    "pkts_toserver": 13,
    "pkts_toclient": 12,
    "bytes_toserver": 1616,
    "bytes_toclient": 8044,
    "start": "2023-09-18T06:13:33.324862+0000",
    "src_ip": "192.168.100.237",
    "dest_ip": "142.11.240.191",
    "src_port": 49175,
    "dest_port": 35361
  }
}
```


Event type: `fileinfo`:


```
{
  "timestamp": "2023-09-18T06:13:33.903924+0000",
  "flow_id": 1676750115612680,
  "pcap_cnt": 70,
```


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```
  "event_type": "fileinfo",
  "src_ip": "192.168.100.237",
  "src_port": 49175,
  "dest_ip": "142.11.240.191",
  "dest_port": 35361,
  "proto": "TCP",
  "pkt_src": "wire/pcap",
  "ether": {
    "src_mac": "12:a9:86:6c:77:de",
    "dest_mac": "52:54:00:36:3e:ff"
  },
  "http": {
    "hostname": "142.11.240.191",
    "http_port": 35361,
    "url": "/",
    "http_content_type": "text/xml",
    "http_method": "POST",
    "protocol": "HTTP/1.1",
    "status": 200,
    "length": 212
  },
  "app_proto": "http",
  "fileinfo": {
    "filename": "/",
    "gaps": false,
    "state": "CLOSED",
    "stored": false,
    "size": 137,
    "tx_id": 0
  }
}
```

Event type: HTTP:

```
{
  "timestamp": "2023-09-18T06:13:33.903924+0000",
  "flow_id": 1676750115612680,
  "pcap_cnt": 70,
  "event_type": "http",
  "src_ip": "192.168.100.237",
  "src_port": 49175,
  "dest_ip": "142.11.240.191",
  "dest_port": 35361,
  "proto": "TCP",
  "pkt_src": "wire/pcap",
  "ether": {
    "src_mac": "12:a9:86:6c:77:de",
    "dest_mac": "52:54:00:36:3e:ff"
  },
  "tx_id": 0,
  "http": {
    "hostname": "142.11.240.191",
```

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```
    "http_port": 35361,
    "url": "/",
    "http_content_type": "text/xml",
    "http_method": "POST",
    "protocol": "HTTP/1.1",
    "status": 200,
    "length": 212,
    "request_headers": [
      {
        "name": "Content-Type",
        "value": "text/xml; charset=utf-8"
      },
      {
        "name": "SOAPAction",
        "value": "\"http://tempuri.org/Endpoint/CheckConnect\""
      },
      {
        "name": "Host",
        "value": "142.11.240.191:35361"
      },
      {
        "name": "Content-Length",
        "value": "137"
      },
      {
        "name": "Expect",
        "value": "100-continue"
      },
      {
        "name": "Accept-Encoding",
        "value": "gzip, deflate"
      },
      {
        "name": "Connection",
        "value": "Keep-Alive"
      }
    ],
    "response_headers": [
      {
        "name": "Content-Length",
        "value": "212"
      },
      {
        "name": "Content-Type",
        "value": "text/xml; charset=utf-8"
      },
      {
        "name": "Server",
        "value": "Microsoft-HTTPAPI/2.0"
      },
      {
        "name": "Date",
```


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```
        "value": "Mon, 18 Sep 2023 06:13:33 GMT"
      }
    ]
  }
}
```

Event type: `anomaly`:

```
{
  "timestamp": "2023-09-18T06:13:58.882971+0000",
  "flow_id": 1676750115612680,
  "pcap_cnt": 2878,
  "event_type": "anomaly",
  "src_ip": "192.168.100.237",
  "src_port": 49175,
  "dest_ip": "142.11.240.191",
  "dest_port": 35361,
  "proto": "TCP",
  "pkt_src": "wire/pcap",
  "ether": {
    "src_mac": "12:a9:86:6c:77:de",
    "dest_mac": "52:54:00:36:3e:ff"
  },
  "tx_id": 3,
  "anomaly": {
    "app_proto": "http",
    "type": "applayer",
    "event": "UNABLE_TO_MATCH_RESPONSE_TO_REQUEST",
    "layer": "proto_parser"
  }
}
```

Event type: `flow`:

```
{
  "timestamp": "2023-09-18T06:13:21.216460+0000",
  "flow_id": 1676750115612680,
  "event_type": "flow",
  "src_ip": "192.168.100.237",
  "src_port": 49175,
  "dest_ip": "142.11.240.191",
  "dest_port": 35361,
  "proto": "TCP",
  "app_proto": "http",
  "flow": {
    "pkts_toserver": 3869,
    "pkts_toclient": 1523,
    "bytes_toserver": 3536402,
    "bytes_toclient": 94102,
    "start": "2023-09-18T06:13:33.324862+0000",
    "end": "2023-09-18T06:14:13.752399+0000",
    "age": 40,
```

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```
    "state": "closed",
    "reason": "shutdown",
    "alerted": true,
    "exception_policy": [
      {
        "target": "stream_midstream",
        "policy": "ignore"
      }
    ]
  },
  "ether": {
    "dest_macs": [
      "52:54:00:36:3e:ff"
    ],
    "src_macs": [
      "12:a9:86:6c:77:de"
    ]
  },
  "tcp": {
    "tcp_flags": "1e",
    "tcp_flags_ts": "1e",
    "tcp_flags_tc": "1a",
    "syn": true,
    "rst": true,
    "psh": true,
    "ack": true,
    "state": "closed",
    "ts_max_regions": 1,
    "tc_max_regions": 1
  }
}
```

Note: It is possible to have even more detailed alert records, by enabling for instance logging http-body, or alert metadata (*alert output*).

Examples come from pcap found at https://app.any.run/tasks/ce7ca983-9e4b-4251-a7c3-fefa3da02ebe/.

Event types

The common part has a field "event_type" to indicate the log type.

```
"event_type":"TYPE"
```

When an application layer protocol event is detected, the common section will have an `app_proto` field.

```
"app_proto": "http"
```

PCAP fields

If Suricata is processing a pcap file, additional fields are added:

```
"pcap_cnt": 123
```

`pcap_cnt` contains the packet number in the pcap. This can be used to look up a packet in Wireshark for example.

```
"pcap_filename":"/path/to/file.pcap"
```

`pcap_filename` contains the file name and location of the pcap that generated the event.

Note: the pcap fields are only available on "real" packets, and are omitted from internal "pseudo" packets such as flow timeout packets.

Event type: Alert

This field contains data about a signature that matched, such as `signature_id` (`sid` in the rule) and the `signature` (`msg` in the rule).

It can also contain information about Source and Target of the attack in the `alert.source` and `alert.target` field if target keyword is used in the signature.

This event will also have the `pcap_cnt` field, when running in pcap mode, to indicate which packet triggered the signature.

```
"alert": {
  "action": "allowed",
  "gid": 1,
  "signature_id": 2024056,
  "rev": 4,
  "signature": "ET MALWARE Win32/CryptFile2 / Revenge Ransomware Checkin M3",
  "category": "Malware Command and Control Activity Detected",
  "severity": 1,
  "metadata": {
    "affected_product": [
      "Windows_XP_Vista_7_8_10_Server_32_64_Bit"
    ],
    "attack_target": [
      "Client_Endpoint"
    ],
    "created_at": [
      "2017_03_15"
    ],
    "deployment": [
      "Perimeter"
    ],
    "former_category": [
      "MALWARE"
    ],
    "malware_family": [
      "CryptFile2"
```

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```
    ],
    "performance_impact": [
      "Moderate"
    ],
    "signature_severity": [
      "Major"
    ],
    "updated_at": [
      "2020_08_04"
    ]
  }
},
```

Action field

Possible values: "allowed" and "blocked".

Example:

```
"action":"allowed"
```

Action is set to "allowed" unless a rule used the "drop" action and Suricata is in IPS mode, or when the rule used the "reject" action. It is important to note that this does not necessarily indicate the final verdict for a given packet or flow, since one packet may match on several rules.

Verdict

An object containning info on the final action that will be applied to a given packet, based on all the signatures triggered by it and other possible events (e.g., a flow drop). For that reason, it is possible for an alert with an action `allowed` to have a verdict `drop`, in IPS mode, for instance, if that packet was dropped due to a different alert.

- Action: `alert`, `pass`, `drop` (this latter only occurs in IPS mode)
- Reject-target: `to_server`, `to_client`, `both` (only occurs for 'reject' rules)
- Reject: an array of strings with possible reject types: `tcp-reset`, `icmp-prohib` (only occurs for 'reject' rules)

Example:

```
"verdict": {
   "action": "drop",
   "reject-target": "to_client",
   "reject": "[icmp-prohib]"
 }
```

Pcap Field

If pcap log capture is active in *multi* mode, a *capture_file* key will be added to the event with value being the full path of the pcap file where the corresponding packets have been extracted.

Event type: Anomaly

Events with type "anomaly" report unexpected conditions such as truncated packets, packets with invalid values, events that render the packet invalid for further processing or unexpected behaviors.

Networks which experience high occurrences of anomalies may experience packet processing degradation when anomaly logging is enabled.

Fields

- "type": Either "decode", "stream" or "applayer". In rare cases, type will be "unknown". When this occurs, an additional field named "code" will be present. Events with type "applayer" are detected by the application layer parsers.
- "event" The name of the anomalous event. Events of type "decode" are prefixed with "decoder"; events of type "stream" are prefixed with "stream".
- "code" If "type" is "unknown", than "code" contains the unrecognized event code. Otherwise, this field is not present.

The following field is included when "type" has the value "applayer":

- "layer" Indicates the handling layer that detected the event. This will be "proto_parser" (protocol parser), "proto_detect" (protocol detection) or "parser."

When `packethdr` is enabled, the first 32 bytes of the packet are included as a byte64-encoded blob in the main part of record. This applies to events of "type" "packet" or "stream" only.

Examples

```
"anomaly": {
  "type": "decode",
  "event": "decoder.icmpv4.unknown_type"
}

"anomaly": {
  "type": "decode",
  "event": "decoder.udp.pkt_too_small"
}

"anomaly": {
  "type": "decode",
  "event": "decoder.ipv4.wrong_ip_version"
}

"anomaly": {
  "type": "stream",
  "event": "stream.pkt_invalid_timestamp"
```

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```
}

{
  "timestamp": "1969-12-31T16:04:21.000000-0800",
  "pcap_cnt": 9262,
  "event_type": "anomaly",
  "src_ip": "208.21.2.184",
  "src_port": 0,
  "dest_ip": "10.1.1.99",
  "dest_port": 0,
  "proto": "UDP",
  "packet": "////////AQEBAQEBCABFAAA8xZ5AAP8R1+DQFQK4CgE=",
  "packet_info": {
    "linktype": 1
  },
  "anomaly": {
    "type": "decode",
    "event": "decoder.udp.pkt_too_small"
  }
}

{
  "timestamp": "2016-01-11T05:10:54.612110-0800",
  "flow_id": 412547343494194,
  "pcap_cnt": 1391293,
  "event_type": "anomaly",
  "src_ip": "192.168.122.149",
  "src_port": 49324,
  "dest_ip": "69.195.71.174",
  "dest_port": 443,
  "proto": "TCP",
  "app_proto": "tls",
  "anomaly": {
    "type": "applayer",
    "event": "APPLAYER_DETECT_PROTOCOL_ONLY_ONE_DIRECTION",
    "layer": "proto_detect"
  }
}

{
  "timestamp": "2016-01-11T05:10:52.828802-0800",
  "flow_id": 201217772575257,
  "pcap_cnt": 1391281,
  "event_type": "anomaly",
  "src_ip": "192.168.122.149",
  "src_port": 49323,
  "dest_ip": "69.195.71.174",
  "dest_port": 443,
  "proto": "TCP",
  "tx_id": 0,
  "app_proto": "tls",
  "anomaly": {
```

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```
    "type": "applayer",
    "event": "INVALID_RECORD_TYPE",
    "layer": "proto_parser"
  }
}
```

Event type: HTTP

Fields

- "hostname": The hostname this HTTP event is attributed to
- "url": URL at the hostname that was accessed
- "http_user_agent": The user-agent of the software that was used
- "http_content_type": The type of data returned (ex: application/x-gzip)
- "cookie"

In addition to these fields, if the extended logging is enabled in the suricata.yaml file the following fields are (can) also included:

- "length": The content size of the HTTP body
- "status": HTTP status code
- "protocol": Protocol / Version of HTTP (ex: HTTP/1.1)
- "http_method": The HTTP method (ex: GET, POST, HEAD)
- "http_refer": The referer for this action

In addition to the extended logging fields one can also choose to enable/add from more than 50 additional custom logging HTTP fields enabled in the suricata.yaml file. The additional fields can be enabled as following:

```
- eve-log:
    enabled: yes
    type: file #file|syslog|unix_dgram|unix_stream
    filename: eve.json
    # the following are valid when type: syslog above
    #identity: "suricata"
    #facility: local5
    #level: Info ## possible levels: Emergency, Alert, Critical,
                ## Error, Warning, Notice, Info, Debug
    types:
      - alert
      - http:
          extended: yes     # enable this for extended logging information
          # custom allows additional http fields to be included in eve-log
          # the example below adds three additional fields when uncommented
          #custom: [Accept-Encoding, Accept-Language, Authorization]
          custom: [accept, accept-charset, accept-encoding, accept-language,
          accept-datetime, authorization, cache-control, cookie, from,
          max-forwards, origin, pragma, proxy-authorization, range, te, via,
          x-requested-with, dnt, x-forwarded-proto, accept-range, age,
```

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```
            allow, connection, content-encoding, content-language,
            content-length, content-location, content-md5, content-range,
            content-type, date, etags, expires, last-modified, link, location,
            proxy-authenticate, referer, refresh, retry-after, server,
            set-cookie, trailer, transfer-encoding, upgrade, vary, warning,
            www-authenticate, x-flash-version, x-authenticated-user]
```

The benefits here of using the extended logging is to see if this action for example was a POST or perhaps if a download of an executable actually returned any bytes.

It is also possible to dump every header for HTTP requests/responses or both via the keyword `dump-all-headers`.

Examples

Event with non-extended logging:

```
"http": {
    "hostname": "www.digip.org",
    "url" :"\/jansson\/releases\/jansson-2.6.tar.gz",
    "http_user_agent": "<User-Agent>",
    "http_content_type": "application\/x-gzip"
}
```

In case the hostname shows a port number, such as in case there is a header "Host: www.test.org:1337":

```
"http": {
    "http_port": 1337,
    "hostname": "www.test.org",
    "url" :"\/this\/is\/test.tar.gz",
    "http_user_agent": "<User-Agent>",
    "http_content_type": "application\/x-gzip"
}
```

Event with extended logging:

```
"http": {
    "hostname": "direkte.vg.no",
    "url":".....",
    "http_user_agent": "<User-Agent>",
    "http_content_type": "application\/json",
    "http_refer": "http:\/\/www.vg.no\/",
    "http_method": "GET",
    "protocol": "HTTP\/1.1",
    "status":"200",
    "length":310
}
```

Event with `dump-all-headers` set to "both":

```
"http": {
    "hostname": "test.co.uk",
    "url":"\/test\/file.json",
```

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```
    "http_user_agent": "<User-Agent>",
    "http_content_type": "application\/json",
    "http_refer": "http:\/\/www.test.com\/",
    "http_method": "GET",
    "protocol": "HTTP\/1.1",
    "status":"200",
    "length":310,
    "request_headers": [
        {
            "name": "User-Agent",
            "value": "Wget/1.13.4 (linux-gnu)"
        },
        {
            "name": "Accept",
            "value": "*/*"
        },
    ],
    "response_headers": [
        {
            "name": "Date",
            "value": "Wed, 25 Mar 2015 15:40:41 GMT"
        },
    ]
}
```

Event type: DNS

A new version of dns logging has been introduced to improve how dns answers are logged.

With that new version, dns answers are logged in one event rather than an event for each answer.

It's possible to customize how a dns answer will be logged with the following formats:

- "detailed": "rrname", "rrtype", "rdata" and "ttl" fields are logged for each answer
- "grouped": answers logged are aggregated by their type (A, AAAA, NS, ...)

It will be still possible to use the old DNS logging format, you can control it with "version" option in dns configuration section.

Fields

Outline of fields seen in the different kinds of DNS events:

- "type": Indicating DNS message type, can be "answer" or "query".
- "id": Identifier field
- "version": Indicating DNS logging version in use
- "flags": Indicating DNS answer flag, in hexadecimal (ex: 8180 , please note 0x is not output)
- "qr": Indicating in case of DNS answer flag, Query/Response flag (ex: true if set)
- "aa": Indicating in case of DNS answer flag, Authoritative Answer flag (ex: true if set)

- "tc": Indicating in case of DNS answer flag, Truncation flag (ex: true if set)
- "rd": Indicating in case of DNS answer flag, Recursion Desired flag (ex: true if set)
- "ra": Indicating in case of DNS answer flag, Recursion Available flag (ex: true if set)
- "z": Indicating in case of DNS answer flag, Reserved bit (ex: true if set)
- "rcode": (ex: NOERROR)
- "rrname": Resource Record Name (ex: a domain name)
- "rrtype": Resource Record Type (ex: A, AAAA, NS, PTR)
- "rdata": Resource Data (ex: IP that domain name resolves to)
- "ttl": Time-To-Live for this resource record

More complex DNS record types may log additional fields for resource data:

- "soa": Section containing fields for the SOA (start of authority) record type
  - "mname": Primary name server for this zone
  - "rname": Authority's mailbox
  - "serial": Serial version number
  - "refresh": Refresh interval (seconds)
  - "retry": Retry interval (seconds)
  - "expire": Upper time limit until zone is no longer authoritative (seconds)
  - "minimum": Minimum ttl for records in this zone (seconds)
- "sshfp": section containing fields for the SSHFP (ssh fingerprint) record type
  - "fingerprint": Hex format of the fingerprint (ex: `12:34:56:78:9a:bc:de:...`)
  - "algo": Algorithm number (ex: 1 for RSA, 2 for DSS)
  - "type": Fingerprint type (ex: 1 for SHA-1)
- "srv": section containing fields for the SRV (location of services) record type
  - "target": Domain name of the target host (ex: `foo.bar.baz`)
  - "priority": Target priority (ex: 20)
  - "weight": Weight for target selection (ex: 1)
  - "port": Port on this target host of this service (ex: 5060)

One can control which RR types are logged by using the "types" field in the suricata.yaml file. If this field is not specified, all RR types are logged. More than 50 values can be specified with this field as shown below:

```
- eve-log:
    enabled: yes
    type: file #file|syslog|unix_dgram|unix_stream
    filename: eve.json
    # the following are valid when type: syslog above
    #identity: "suricata"
    #facility: local5
    #level: Info ## possible levels: Emergency, Alert, Critical,
                 ## Error, Warning, Notice, Info, Debug
    types:
```

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```
      - alert
      - dns:
        # Control logging of requests and responses:
        # - requests: enable logging of DNS queries
        # - responses: enable logging of DNS answers
        # By default both requests and responses are logged.
        requests: yes
        responses: yes
        # DNS record types to log, based on the query type.
        # Default: all.
        #types: [a, aaaa, cname, mx, ns, ptr, txt]
        types: [a, ns, md, mf, cname, soa, mb, mg, mr, null,
        wks, ptr, hinfo, minfo, mx, txt, rp, afsdb, x25, isdn,
        rt, nsap, nsapptr, sig, key, px, gpos, aaaa, loc, nxt,
        srv, atma, naptr, kx, cert, a6, dname, opt, apl, ds,
        sshfp, ipseckey, rrsig, nsec, dnskey, dhcid, nsec3,
        nsec3param, tlsa, hip, cds, cdnskey, spf, tkey,
        tsig, maila, any, uri]
```

Examples

Example of a DNS query for the IPv4 address of "twitter.com" (resource record type 'A'):

```
"dns": {
    "type": "query",
    "id": 16000,
    "rrname": "twitter.com",
    "rrtype":"A"
}
```

Example of a DNS answer with "detailed" format:

```
"dns": {
    "version": 2,
    "type": "answer",
    "id": 45444,
    "flags": "8180",
    "qr": true,
    "rd": true,
    "ra": true,
    "rcode": "NOERROR",
    "answers": [
      {
        "rrname": "www.suricata.io",
        "rrtype": "CNAME",
        "ttl": 3324,
        "rdata": "suricata.io"
      },
      {
        "rrname": "suricata.io",
        "rrtype": "A",
```

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```
        "ttl": 10,
        "rdata": "192.0.78.24"
      },
      {
        "rrname": "suricata.io",
        "rrtype": "A",
        "ttl": 10,
        "rdata": "192.0.78.25"
      }
    ]
}
```

Example of a DNS answer with "grouped" format:

```
"dns": {
    "version": 2,
    "type": "answer",
    "id": 18523,
    "flags": "8180",
    "qr": true,
    "rd": true,
    "ra": true,
    "rcode": "NOERROR",
    "grouped": {
      "A": [
        "192.0.78.24",
        "192.0.78.25"
      ],
      "CNAME": [
        "suricata.io"
      ]
    }
}
```

Example of a old DNS answer with an IPv4 (resource record type 'A') return:

```
"dns": {
    "type": "answer",
    "id":16000,
    "flags":"8180",
    "qr":true,
    "rd":true,
    "ra":true,
    "rcode":"NOERROR"
    "rrname": "twitter.com",
    "rrtype":"A",
    "ttl":8,
    "rdata": "199.16.156.6"
}
```

Event type: FTP

Fields

- "command": The FTP command.
- "command_data": The data accompanying the command.
- "reply": The command reply, which may contain multiple lines, in array format.
- "completion_code": The 3-digit completion code. The first digit indicates whether the response is good, bad or incomplete. This is also in array format and may contain multiple completion codes matching multiple reply lines.
- "dynamic_port": The dynamic port established for subsequent data transfers, when applicable, with a "PORT" or "EPRT" command.
- "mode": The type of FTP connection. Most connections are "passive" but may be "active".
- "reply_received": Indicates whether a response was matched to the command. In some non-typical cases, a command may lack a response.

Examples

Example of regular FTP logging:

```
"ftp": {
  "command": "RETR",
  "command_data": "100KB.zip",
  "reply": [
    "Opening BINARY mode data connection for 100KB.zip (102400 bytes).",
    "Transfer complete."
  ],
  "completion_code": [
    "150",
    "226"
  ],
```

Example showing all fields:

```
"ftp": {
  "command": "EPRT",
  "command_data": "|2|2a01:e34:ee97:b130:8c3e:45ea:5ac6:e301|41813|",
  "reply": [
    "EPRT command successful. Consider using EPSV."
  ],
  "completion_code": [
    "200"
  ],
  "dynamic_port": 41813,
  "mode": "active",
  "reply_received": "yes"
}
```

Event type: FTP_DATA

Fields

- "command": The FTP command associated with the event.
- "filename": The name of the involved file.

Examples

Example of FTP_DATA logging:

```
"ftp_data": {
  "filename": "temp.txt",
  "command": "RETR"
}
```

Event type: TLS

Fields

- "subject": The subject field from the TLS certificate
- "issuer": The issuer field from the TLS certificate
- "session_resumed": This field has the value of "true" if the TLS session was resumed via a session id. If this field appears, "subject" and "issuer" do not appear, since a TLS certificate is not seen.

If extended logging is enabled the following fields are also included:

- "serial": The serial number of the TLS certificate
- "fingerprint": The (SHA1) fingerprint of the TLS certificate
- "sni": The Server Name Indication (SNI) extension sent by the client
- "version": The SSL/TLS version used
- "notbefore": The NotBefore field from the TLS certificate
- "notafter": The NotAfter field from the TLS certificate
- "ja3": The JA3 fingerprint consisting of both a JA3 hash and a JA3 string
- "ja3s": The JA3S fingerprint consisting of both a JA3 hash and a JA3 string
- "ja4": The JA4 client fingerprint for TLS

JA3 and JA4 must be enabled in the Suricata config file (set 'app-layer.protocols.tls.ja3-fingerprints'/'app-layer.protocols.tls.ja4-fingerprints' to 'yes').

In addition to this, custom logging also allows the following fields:

- "certificate": The TLS certificate base64 encoded
- "chain": The entire TLS certificate chain base64 encoded

Examples

Example of regular TLS logging:

```
"tls": {
    "subject": "C=US, ST=California, L=Mountain View, O=Google Inc, CN=*.google.com",
    "issuerdn": "C=US, O=Google Inc, CN=Google Internet Authority G2"
}
```

Example of regular TLS logging for resumed sessions:

```
"tls": {
    "session_resumed": true
}
```

Example of extended TLS logging:

```
"tls": {
    "subject": "C=US, ST=California, L=Mountain View, O=Google Inc, CN=*.google.com",
    "issuerdn": "C=US, O=Google Inc, CN=Google Internet Authority G2",
    "serial": "0C:00:99:B7:D7:54:C9:F6:77:26:31:7E:BA:EA:7C:1C",
    "fingerprint": "8f:51:12:06:a0:cc:4e:cd:e8:a3:8b:38:f8:87:59:e5:af:95:ca:cd",
    "sni": "calendar.google.com",
    "version": "TLS 1.2",
    "notbefore": "2017-01-04T10:48:43",
    "notafter": "2017-03-29T10:18:00"
}
```

Example of certificate logging using TLS custom logging (subject, sni, certificate):

```
"tls": {
    "subject": "C=US, ST=California, L=Mountain View, O=Google Inc, CN=*.googleapis.com
    "sni": "www.googleapis.com",
    "certificate": "MIIE3TCCA8WgAwIBAgIIQPsvobRZN0gwDQYJKoZIhvcNAQELBQAwSTELMA [...]"
 }
```

Event type: TFTP

Fields

- "packet": The operation code, can be "read" or "write" or "error"
- "file": The filename transported with the tftp protocol
- "mode": The mode field, can be "octet" or "mail" or "netascii" (or any combination of upper and lower case)

Example of TFTP logging:

```
"tftp": {
    "packet": "write",
    "file": "rfc1350.txt",
    "mode": "octet"
 }
```

Event type: KRB5

KRB5 Fields

- "cname" (string): The client PrincipalName
- "encryption" (string): Encryption used (only in AS-REP and TGS-REP)
- "error_code" (string): Error code, if request has failed
- "failed_request" (string): The request type for which the response had an error_code
- "msg_type" (string): The message type: AS-REQ, AS-REP, etc...
- "realm" (string): The server Realm
- "sname" (string): The server PrincipalName
- "ticket_encryption" (string): Encryption used for ticket
- "ticket_weak_encryption" (boolean): Whether the encryption used for ticket is a weak cipher
- "weak_encryption" (boolean): Whether the encryption used in AS-REP or TGS-REP is a weak cipher

Examples of KRB5 logging:

Pipe open:

```
"krb5": {
  "msg_type": "KRB_TGS_REP",
  "cname": "robin",
  "realm": "CYLERA.LAB",
  "sname": "ldap/dc01",
  "encryption": "aes256-cts-hmac-sha1-96",
  "weak_encryption": false,
  "ticket_encryption": "aes256-cts-hmac-sha1-96",
  "ticket_weak_encryption": false
}
```

Event type: SMB

SMB Fields

- "id" (integer): internal transaction id
- "dialect" (string): the negotiated protocol dialect, or "unknown" if missing
- "command" (string): command name. E.g. SMB2_COMMAND_CREATE or SMB1_COMMAND_WRITE_ANDX
- "status" (string): status string. Can be both NT_STATUS or DOS_ERR and other variants
- "status_code" (string): status code as hex string
- "session_id" (integer): SMB2+ session_id. SMB1 user id.
- "tree_id" (integer): Tree ID
- "filename" (string): filename for CREATE and other commands.
- "disposition" (string): requested disposition. E.g. FILE_OPEN, FILE_CREATE and FILE_OVERWRITE. See https://msdn.microsoft.com/en-us/library/ee442175.aspx#Appendix_A_Target_119

- "access" (string): indication of how the file was opened. "normal" or "delete on close" (field is subject to change)
- "created", "accessed", "modified", "changed" (integer): timestamps in seconds since unix epoch
- "size" (integer): size of the requested file
- "fuid" (string): SMB2+ file GUID. SMB1 FID as hex.
- "share" (string): share name.
- "share_type" (string): FILE, PIPE, PRINT or unknown.
- "client_dialects" (array of strings): list of SMB dialects the client speaks.
- "client_guid" (string): client GUID
- "server_guid" (string): server GUID
- "request.native_os" (string): SMB1 native OS string
- "request.native_lm" (string): SMB1 native Lan Manager string
- "response.native_os" (string): SMB1 native OS string
- "response.native_lm" (string): SMB1 native Lan Manager string

Examples of SMB logging:

Pipe open:

```
"smb": {
  "id": 1,
  "dialect": "unknown",
  "command": "SMB2_COMMAND_CREATE",
  "status": "STATUS_SUCCESS",
  "status_code": "0x0",
  "session_id": 4398046511201,
  "tree_id": 1,
  "filename": "atsvc",
  "disposition": "FILE_OPEN",
  "access": "normal",
  "created": 0,
  "accessed": 0,
  "modified": 0,
  "changed": 0,
  "size": 0,
  "fuid": "0000004d-0000-0000-0005-0000ffffffff"
}
```

File/pipe close:

```
"smb": {
  "id": 15,
  "dialect": "2.10",
  "command": "SMB2_COMMAND_CLOSE",
  "status": "STATUS_SUCCESS",
  "status_code": "0x0",
  "session_id": 4398046511121,
  "tree_id": 1,
}
```

Tree connect (share open):

```
"smb": {
  "id": 3,
  "dialect": "2.10",
  "command": "SMB2_COMMAND_TREE_CONNECT",
  "status": "STATUS_SUCCESS",
  "status_code": "0x0",
  "session_id": 4398046511121,
  "tree_id": 1,
  "share": "\\\\admin-pc\\c$",
  "share_type": "FILE"
}
```

Dialect negotiation from SMB1 to SMB2 dialect 2.10:

```
"smb": {
  "id": 1,
  "dialect": "2.??",
  "command": "SMB1_COMMAND_NEGOTIATE_PROTOCOL",
  "status": "STATUS_SUCCESS",
  "status_code": "0x0",
  "session_id": 0,
  "tree_id": 0,
  "client_dialects": [
    "PC NETWORK PROGRAM 1.0",
    "LANMAN1.0",
    "Windows for Workgroups 3.1a",
    "LM1.2X002",
    "LANMAN2.1",
    "NT LM 0.12",
    "SMB 2.002",
    "SMB 2.???"
  ],
  "server_guid": "aec6e793-2b11-4019-2d95-55453a0ad2f1"
}
"smb": {
  "id": 2,
  "dialect": "2.10",
  "command": "SMB2_COMMAND_NEGOTIATE_PROTOCOL",
  "status": "STATUS_SUCCESS",
  "status_code": "0x0",
  "session_id": 0,
  "tree_id": 0,
  "client_dialects": [
    "2.02",
    "2.10"
  ],
  "client_guid": "601985d2-aad9-11e7-8494-00088bb57f27",
  "server_guid": "aec6e793-2b11-4019-2d95-55453a0ad2f1"
}
```

SMB1 partial SMB1_COMMAND_SESSION_SETUP_ANDX:

```
"request": {
  "native_os": "Unix",
  "native_lm": "Samba 3.9.0-SVN-build-11572"
},
"response": {
  "native_os": "Windows (TM) Code Name \"Longhorn\" Ultimate 5231",
  "native_lm": "Windows (TM) Code Name \"Longhorn\" Ultimate 6.0"
}
```

DCERPC fields

- "request" (string): command. E.g. REQUEST, BIND.
- "response" (string): reply. E.g. RESPONSE, BINDACK or FAULT.
- "opnum" (integer): the opnum
- "call_id" (integer): the call id
- "frag_cnt" (integer): the number of fragments for the stub data
- "stub_data_size": total stub data size
- "interfaces" (array): list of interfaces
- "interfaces.uuid" (string): string representation of the UUID
- "interfaces.version" (string): interface version
- "interfaces.ack_result" (integer): ack result
- "interfaces.ack_reason" (integer): ack reason

DCERPC REQUEST/RESPONSE:

```
"smb": {
  "id": 4,
  "dialect": "unknown",
  "command": "SMB2_COMMAND_IOCTL",
  "status": "STATUS_SUCCESS",
  "status_code": "0x0",
  "session_id": 4398046511201,
  "tree_id": 0,
  "dcerpc": {
    "request": "REQUEST",
    "response": "RESPONSE",
    "opnum": 0,
    "req": {
      "frag_cnt": 1,
      "stub_data_size": 136
    },
    "res": {
      "frag_cnt": 1,
      "stub_data_size": 8
    },
    "call_id": 2
```

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```
  }
}
```

DCERPC BIND/BINDACK:

```
"smb": {
  "id": 53,
  "dialect": "2.10",
  "command": "SMB2_COMMAND_WRITE",
  "status": "STATUS_SUCCESS",
  "status_code": "0x0",
  "session_id": 35184439197745,
  "tree_id": 1,
  "dcerpc": {
    "request": "BIND",
    "response": "BINDACK",
    "interfaces": [
      {
        "uuid": "12345778-1234-abcd-ef00-0123456789ac",
        "version": "1.0",
        "ack_result": 2,
        "ack_reason": 0
      },
      {
        "uuid": "12345778-1234-abcd-ef00-0123456789ac",
        "version": "1.0",
        "ack_result": 0,
        "ack_reason": 0
      },
      {
        "uuid": "12345778-1234-abcd-ef00-0123456789ac",
        "version": "1.0",
        "ack_result": 3,
        "ack_reason": 0
      }
    ],
    "call_id": 2
  }
```

NTLMSSP fields

- "domain" (string): the Windows domain.
- "user" (string): the user.
- "host" (string): the host.
- "version" (string): the client version.

Example:

```
"ntlmssp": {
  "domain": "VNET3",
```

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```
  "user": "administrator",
  "host": "BLU",
  "version": "60.230 build 13699 rev 188"
}
```

More complete example:

```
"smb": {
  "id": 3,
  "dialect": "NT LM 0.12",
  "command": "SMB1_COMMAND_SESSION_SETUP_ANDX",
  "status": "STATUS_SUCCESS",
  "status_code": "0x0",
  "session_id": 2048,
  "tree_id": 0,
  "ntlmssp": {
    "domain": "VNET3",
    "user": "administrator",
    "host": "BLU",
    "version": "60.230 build 13699 rev 188"
  },
  "request": {
    "native_os": "Unix",
    "native_lm": "Samba 3.9.0-SVN-build-11572"
  },
  "response": {
    "native_os": "Windows (TM) Code Name \"Longhorn\" Ultimate 5231",
    "native_lm": "Windows (TM) Code Name \"Longhorn\" Ultimate 6.0"
  }
}
```

Kerberos fields

- "kerberos.realm" (string): the Kerberos Realm.
- "kerberos.snames (array of strings): snames.

Example:

```
"smb": {
  "dialect": "2.10",
  "command": "SMB2_COMMAND_SESSION_SETUP",
  "status": "STATUS_SUCCESS",
  "status_code": "0x0",
  "session_id": 35184439197745,
  "tree_id": 0,
  "kerberos": {
    "realm": "CONTOSO.LOCAL",
    "snames": [
      "cifs",
      "DC1.contoso.local"
    ]
```

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```
  }
}
```

Event type: BITTORRENT-DHT

Common fields:

- "transaction_id" (hex): the unique id of the transaction, generated by node making the request (a.k.a the querying node). Same transaction_id is echoed back by responding nodes.
- "client_version" (hex): identifies the type and version of the bittorrent-dht client. Some implementations may be missing this field.

Extra fields:

Packets should also contain one of either the fields:

error

- **"error": details of an error which occurred while processing the request**
  - "error.num" (num): the error code
  - "error.msg" (string): the error message

request_type and request

- "request_type" (string): the type of the request (a.k.a. the query). Included if this packet was a request
- **"request": a request (a.k.a. a query) sent by the bittorrent-dht client**
  - "request.id" (hex): the node ID of the node which sent the request (20 bytes in network byte order)
  - "request.target" (hex): the target node ID. Used by the find_node request_type
  - "request.info_hash" (hex): info hash of target torrent (20 bytes). Used by the get_peers and announce_peer request_types
  - "request.token" (hex): token key received from previous get_peers request. Used by the announce_peer request type
  - "request.implied_port" (num): 0 or 1, if 1 ignore provided port and use source port of UDP packet. Used by the announce_peer request_type
  - "request.port" (num): port on which peer will download torrent. Used by the announce_peer request_type

response

- **"response": a response to the client's request**

- "response.id" (hex): the node ID of the node which sent the response (20 bytes in network byte order)
- "response.nodes" (array): find_node/get_peers - a list of info objects for target node or K(8) closest good nodes in routing table
- "response.nodes6" (array): find_node/get_peers - a list of info objects for target node or K(8) closest good nodes in routing table (ipv6)
- "response.values" (array): list of compact peer info strings. Used by the get_peers request_type
- "response.token" (hex): token key required for sender's future announce_peer query

node object

- "id" (hex): node ID
- "ip" (string): IPv4 or IPv6 address of node
- "port" (integer): node port

peer object (values array)

- "ip" (string): IPv6 or IPv6 address of node
- "port" (integer): node port

Examples:

Ping and response:

```
"bittorrent_dht": {
  "transaction_id": "0c17",
  "client_version": "4c540126",
  "request_type": "ping",
  "request": {
    "id": "41aff1580119f074e2f537f231f12adf684f0d1f"
  }
}

"bittorrent_dht": {
  "transaction_id": "0c17",
  "client_version": "5554b50c",
  "response": {
    "id": "42aeb304a0845b3b9ee089327b48967b8e87b2e2"
  }
}
```

Find_node and response:

```
"bittorrent_dht": {
  "transaction_id": "420f0000",
  "client_version": "5554b50c",
  "request_type": "find_node",
```

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```
  "request": {
    "id": "37579bad1bad166af4329508096fae8c553c6cf4",
    "target": "37579bad1bad166af4329508096fae8c553c6cf4"
  }
}
```

Get_peers and response with values param:

```
"bittorrent_dht": {
  "transaction_id": "05e4",
  "client_version": "4c540126",
  "request_type": "get_peers",
  "request": {
    "id": "41aff1580119f074e2f537f231f12adf684f0d1f",
    "info_hash": "19a6fcfcba6cc2c6d371eb754074d095adb5d291"
  }
}
"bittorrent_dht": {
  "transaction_id": "05e4",
  "client_version": "555462d6",
  "response": {
    "id": "19a6f98be177e32e7b5bd77276d529f03e3ba8a9",
    "values": [
      {
        "ip": "45.238.190.2",
        "port": 6881
      },
      {
        "ip": "185.70.52.245",
        "port": 51215
      },
      {
        "ip": "45.21.238.247",
        "port": 55909
      },
      {
        "ip": "62.28.248.195",
        "port": 6881
      }
    ],
    "token": "c17094641ca8844d711120baecb2b5cf25435614"
  }
}
```

Get_peers and response with nodes param:

```
 "bittorrent_dht": {
  "transaction_id": "44e6",
  "client_version": "4c540126",
  "request_type": "get_peers",
  "request": {
    "id": "41aff1580119f074e2f537f231f12adf684f0d1f",
```

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```
    "info_hash": "19a6fcfcba6cc2c6d371eb754074d095adb5d291"
  }
}

"bittorrent_dht": {
  "transaction_id": "44e6",
  "response": {
    "id": "19a7c8f4f6d14d9f87a67671720633e551f30cb7",
    "values": [
      {
        "ip": "45.22.252.153",
        "port": 36798
      },
      {
        "ip": "94.41.206.37",
        "port": 30850
      },
      {
        "ip": "84.228.120.50",
        "port": 6881
      },
      {
        "ip": "178.81.206.84",
        "port": 12373
      },
      {
        "ip": "110.188.93.186",
        "port": 22223
      }
    ],
    "token": "c897ee539e02a54595b4d7cfb6319ad48e71b282"
  }
}
```

Announce_peer and response:

```
"bittorrent_dht": {
  "transaction_id": "aa",
  "request_type": "announce_peer",
  "request": {
    "id": "abcdefghij0123456789",
    "info_hash": "mnopqrstuvwxyz123456",
    "token": "aoeusnth",
    "port": 6881
  }
}
"bittorrent_dht": {
  "transaction_id": "aa",
  "response": {
    "id": "mnopqrstuvwxyz123456"
  }
}
```

Announce_peer with implied_port param and response:

```
"bittorrent_dht": {
  "transaction_id": "7fe9",
  "client_version": "4c540126",
  "request_type": "announce_peer",
  "request": {
    "id": "51bc83f53417a62a40e8a48170cad369a13fef3c",
    "info_hash": "19a6fcfcba6cc2c6d371eb754074d095adb5d291",
    "token": "cacbef35",
    "implied_port": 1,
    "port": 54892
  }
}

"bittorrent_dht": {
  "transaction_id": "7fe9",
  "client_version": "4c54012f",
  "response": {
    "id": "19a66dece45e0288ab75d141e0255738a1ce8508"
  }
}
```

Sample error responses:

```
"bittorrent_dht": {
  "transaction_id": "aa",
  "error": {
    "num": 201,
    "msg": "A Generic Error Ocurred"
  }
}
"bittorrent_dht": {
  "transaction_id": "aa",
  "error": {
    "num": 203,
    "msg": "Malformed Packet"
  }
}
```

Event type: SSH

Fields

- "proto_version": The protocol version transported with the ssh protocol (1.x, 2.x)
- "software_version": The software version used by end user
- "hassh.hash": MD5 of hassh algorithms of client or server
- "hassh.string": hassh algorithms of client or server

Hassh must be enabled in the Suricata config file (set 'app-layer.protocols.ssh.hassh' to 'yes').

Example of SSH logging:

```
"ssh": {
  "client": {
      "proto_version": "2.0",
      "software_version": "OpenSSH_6.7",
      "hassh": {
          "hash": "ec7378c1a92f5a8dde7e8b7a1ddf33d1",
          "string": "curve25519-sha256,diffie-hellman-group14-sha256,diffie-hellman-
↪group14-sha1,ext-info-c",
      }
   },
  "server": {
      "proto_version": "2.0",
      "software_version": "OpenSSH_6.7",
      "hassh": {
          "hash": "ec7378c1a92f5a8dde7e8b7a1ddf33d1",
          "string": "curve25519-sha256,curve25519-sha256@libssh.org,ecdh-sha2-nistp256",
      }
   }
}
```

Event type: Flow

Fields

- "pkts_toserver": total number of packets to server, include bypassed packets
- "pkts_toclient": total number of packets to client
- "bytes_toserver": total bytes count to server
- "bytes_toclient": total bytes count to client
- "bypassed.pkts_toserver": number of bypassed packets to server
- "bypassed.pkts_toclient": number of bypassed packets to client
- "bypassed.bytes_toserver": bypassed bytes count to server
- "bypassed.bytes_toclient": bypassed bytes count to client
- "start": date of start of the flow
- "end": date of end of flow (last seen packet)
- "age": duration of the flow
- "bypass": if the flow has been bypassed, it is set to "local" (internal bypass) or "capture"
- "state": display state of the flow (include "new", "established", "closed", "bypassed")
- "reason": mechanism that did trigger the end of the flow (include "timeout", "forced" and "shutdown")
- "alerted": "true" or "false" depending if an alert has been seen on flow
- "action": "pass" or "drop" depending if flow was PASS'ed or DROP'ed (no present if none)
- "exception_policy": array consisting of exception policies that have been triggered by the flow:
  - "target": if an exception policy was triggered, what setting exceptions led to this (cf. *Exception Policy - Specific Settings*).

- "policy": if an exception policy was triggered, what policy was applied (to the flow or to any packet(s) from it).

Example

```
"flow": {
  "pkts_toserver": 23,
  "pkts_toclient": 21,
  "bytes_toserver": 4884,
  "bytes_toclient": 7392,
  "bypassed": {
    "pkts_toserver": 10,
    "pkts_toclient": 8,
    "bytes_toserver": 1305,
    "bytes_toclient": 984
  },
  "start": "2019-05-28T23:32:29.025256+0200",
  "end": "2019-05-28T23:35:28.071281+0200",
  "age": 179,
  "bypass": "capture",
  "state": "bypassed",
  "reason": "timeout",
  "alerted": false,
  "action": "pass",
  "exception_policy": [
    {
      "target": "stream_midstream",
      "policy": "pass_flow"
    }
  ]
}
```

Event type: RDP

Initial negotiations between RDP client and server are stored as transactions and logged.

Each RDP record contains a per-flow incrementing "tx_id" field.

The "event_type" field indicates an RDP event subtype. Possible values:

- "initial_request"
- "initial_response"
- "connect_request"
- "connect_response"
- "tls_handshake"

RDP type: Initial Request

The optional "cookie" field is a string identifier the RDP client has chosen to provide.

The optional "flags" field is a list of client directives. Possible values:

- "restricted_admin_mode_required"
- "redirected_authentication_mode_required"
- "correlation_info_present"

RDP type: Initial Response

In the event of a standard initial response:

The "protocol" field is the selected protocol. Possible values:

- "rdp"
- "ssl"
- "hybrid"
- "rds_tls"
- "hybrid_ex"

The optional "flags" field is a list of support server modes. Possible values:

- "extended_client_data"
- "dynvc_gfx"
- "restricted_admin"
- "redirected_authentication"

Alternatively, in the event of an error-indicating initial response:

There will be no "protocol" or "flags" fields.

The "error_code" field will contain the numeric code provided by the RDP server.

The "reason" field will contain a text summary of this code. Possible values:

- "ssl required by server" (error code 0x1)
- "ssl not allowed by server" (error code 0x2)
- "ssl cert not on server" (error code 0x3)
- "inconsistent flags" (error code 0x4)
- "hybrid required by server" (error code 0x5)
- "ssl with user auth required by server" (error code 0x6)

RDP type: Connect Request

The optional "channel" field is a list of requested data channel names.

Common channels:

- "rdpdr" (device redirection)
- "cliprdr" (shared clipboard)
- "rdpsnd" (sound)

The optional "client" field is a sub-object that may contain the following:

- "version": RDP protocol version. Possible values are "v4", "v5", "v10.0", "v10.1", "v10.2", "v10.3", "v10.4", "v10.5", "v10.6", "v10.7", "unknown".
- "desktop_width": Numeric desktop width value.
- "desktop_height": Numeric desktop height value.
- "color_depth": Numeric color depth. Possible values are 4, 8, 15, 16, 24.
- "keyboard_layout": Locale identifier name, e.g., "en-US".
- "build": OS and SP level, e.g., "Windows XP", "Windows 7 SP1".
- "client_name": Client computer name.
- "keyboard_type": Possible values are "xt", "ico", "at", "enhanced", "1050", "9140", "jp".
- "keyboard_subtype": Numeric code for keyboard.
- "function_keys": Number of function keys on client keyboard.
- "ime": Input method editor (IME) file name.
- "product_id": Product id string.
- "serial_number": Numeric value.
- "capabilities": List of any of the following: "support_errinfo_pdf", "want_32bpp_session", "support_statusinfo_pdu", "strong_asymmetric_keys", "valid_connection_type", "support_monitor_layout_pdu", "support_netchar_autodetect", "support_dynvc_gfx_protocol", "support_dynamic_time_zone", "support_heartbeat_pdu".
- "id": Client product id string.
- "connection_hint": Possible values are "modem", "low_broadband", "satellite", "high_broadband", "wan", "lan", "autodetect".
- "physical_width": Numeric physical width of display.
- "physical_height": Numeric physical height of display.
- "desktop_orientation": Numeric angle of orientation.
- "scale_factor": Numeric scale factor of desktop.
- "device_scale_factor": Numeric scale factor of display.

RDP type: Connect Response

With this event, the initial RDP negotiation is complete in terms of tracking and logging.

RDP type: TLS Handshake

With this event, the initial RDP negotiation is complete in terms of tracking and logging.

The session will use TLS encryption.

The "x509_serials" field is a list of observed certificate serial numbers, e.g., "16ed2aa0495f259d4f5d99edada570d1".

Examples

RDP logging:

```
"rdp": {
  "tx_id": 0,
  "event_type": "initial_request",
  "cookie": "A70067"
}

"rdp": {
  "tx_id": 1,
  "event_type": "initial_response"
}

"rdp": {
  "tx_id": 2,
  "event_type": "connect_request",
  "client": {
    "version": "v5",
    "desktop_width": 1152,
    "desktop_height": 864,
    "color_depth": 15,
    "keyboard_layout": "en-US",
    "build": "Windows XP",
    "client_name": "ISD2-KM84178",
    "keyboard_type": "enhanced",
    "function_keys": 12,
    "product_id": 1,
    "capabilities": [
      "support_errinfo_pdf"
    ],
    "id": "55274-OEM-0011903-00107"
  },
  "channels": [
    "rdpdr",
    "cliprdr",
    "rdpsnd"
  ]
}
```

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```
"rdp": {
  "tx_id": 3,
  "event_type": "connect_response"
}
```

RDP logging, with transition to TLS:

```
"rdp": {
  "tx_id": 0,
  "event_type": "initial_request",
  "cookie": "AWAKECODI"
}

"rdp": {
  "tx_id": 1,
  "event_type": "initial_response",
  "server_supports": [
    "extended_client_data"
  ],
  "protocol": "hybrid"
}

"rdp": {
  "tx_id": 2,
  "event_type": "tls_handshake",
  "x509_serials": [
    "16ed2aa0495f259d4f5d99edada570d1"
  ]
}
```

Event type: RFB

Fields

- "server_protocol_version.major", "server_protocol_version.minor": The RFB protocol version offered by the server.
- "client_protocol_version.major", "client_protocol_version.minor": The RFB protocol version agreed by the client.
- "authentication.security_type": Security type agreed upon in the logged transaction, e.g. `2` is VNC auth.
- "authentication.vnc.challenge", "authentication.vnc.response": Only available when security type 2 is used. Contains the challenge and response byte buffers exchanged by the server and client as hex strings.
- "authentication.security_result": Result of the authentication process (`OK`, `FAIL` or `TOOMANY`).
- "screen_shared": Boolean value describing whether the client requested screen sharing.
- "framebuffer": Contains metadata about the initial screen setup process. Only available when the handshake completed this far.
- "framebuffer.width", "framebuffer.height": Screen size as offered by the server.

- "framebuffer.name": Desktop name as advertised by the server.
- "framebuffer.pixel_format": Pixel representation information, such as color depth. See RFC6143 (https://tools.ietf.org/html/rfc6143) for details.

Examples

Example of RFB logging, with full VNC style authentication parameters:

```
"rfb": {
  "server_protocol_version": {
    "major": "003",
    "minor": "007"
  },
  "client_protocol_version": {
    "major": "003",
    "minor": "007"
  },
  "authentication": {
    "security_type": 2,
    "vnc": {
      "challenge": "0805b790b58e967f2b350a0c99de3881",
      "response": "aecb26faeaaa62179636a5934bac1078"
    },
    "security_result": "OK"
  },
  "screen_shared": false,
  "framebuffer": {
    "width": 1280,
    "height": 800,
    "name": "foobar@localhost.localdomain",
    "pixel_format": {
      "bits_per_pixel": 32,
      "depth": 24,
      "big_endian": false,
      "true_color": true,
      "red_max": 255,
      "green_max": 255,
      "blue_max": 255,
      "red_shift": 16,
      "green_shift": 8,
      "blue_shift": 0
    }
  }
```

Event type: MQTT

EVE-JSON output for MQTT consists of one object per MQTT transaction, with some common and various type-specific fields.

Transactions

A single MQTT communication can consist of multiple messages that need to be exchanged between broker and client. For example, some actions at higher QoS levels (> 0) usually involve a combination of requests and acknowledgement messages that are linked by a common identifier:

- `CONNECT` followed by `CONNACK`
- `PUBLISH` followed by `PUBACK` (QoS 1) or `PUBREC/PUBREL/PUBCOMP` (QoS 2)
- `SUBSCRIBE` followed by `SUBACK`
- `UNSUBSCRIBE` followed by `UNSUBACK`

The MQTT parser merges individual messages into one EVE output item if they belong to one transaction. In such cases, the source and destination information (IP/port) reflect the direction of the initial request, but contain messages from both sides.

Example for a PUBLISH at QoS 2:

```
{
  "timestamp": "2020-05-19T18:00:39.016985+0200",
  "flow_id": 1454127794305760,
  "pcap_cnt": 65,
  "event_type": "mqtt",
  "src_ip": "0000:0000:0000:0000:0000:0000:0000:0001",
  "src_port": 60105,
  "dest_ip": "0000:0000:0000:0000:0000:0000:0000:0001",
  "dest_port": 1883,
  "proto": "TCP",
  "mqtt": {
    "publish": {
      "qos": 2,
      "retain": false,
      "dup": false,
      "topic": "house/bulbs/bulb1",
      "message_id": 3,
      "message": "OFF"
    },
    "pubrec": {
      "qos": 0,
      "retain": false,
      "dup": false,
      "message_id": 3
    },
    "pubrel": {
      "qos": 1,
      "retain": false,
      "dup": false,
      "message_id": 3
```

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```
    },
    "pubcomp": {
      "qos": 0,
      "retain": false,
      "dup": false,
      "message_id": 3
    }
  }
}
```

Note that some message types (aka control packet types), such as `PINGREQ` and `PINGRESP`, have no type-specific data, nor do they have information that facilitate grouping into transactions. These will be logged as single items and only contain the common fields listed below.

Common fields

Common fields from the MQTT fixed header:

- "*.qos": Quality of service level for the message, integer between 0 and 2.
- "*.retain": Boolean value of the MQTT 'retain' flag.
- "*.dup": Boolean value of the MQTT 'dup' (duplicate) flag.

MQTT CONNECT fields

- "connect.protocol_string": Protocol string as defined in the spec, e.g. `MQTT` (MQTT 3.1.1 and later) or `MQIsdp` (MQTT 3.1).
- "connect.protocol_version": Protocol version as defined in the specification:
  - protocol version `3`: MQTT 3.1
  - protocol version `4`: MQTT 3.1.1
  - protocol version `5`: MQTT 5.0
- "connect.flags.username", "connect.flags.password": Set to *true* if credentials are submitted with the connect request.
- "connect.flags.will": Set to *true* if a will is set.
- "connect.flags.will_retain": Set to *true* if the will is to be retained on the broker.
- "connect.will.clean_session": Set to *true* if the connection is to made with a clean session.
- "connect.client_id": Client ID string submitted my the connecting client.
- "connect.username", "connect.password": User/password authentication credentials submitted with the connect request. Passwords are only logged when the corresponding configuration setting is enabled (`mqtt.passwords: yes`).
- "connect.will.topic": Topic to publish the will message to.
- "connect.will.message": Message to be published on connection loss.
- "connect.will.properties": (Optional, MQTT 5.0) Will properties set on this request. See 3.1.3.2 in the spec for more information on will properties.

- "connect.properties": (Optional, MQTT 5.0) CONNECT properties set on this request. See 3.1.2.11 in the spec for more information on CONNECT properties.

Example of MQTT CONNECT logging:

```
"connect": {
  "qos": 0,
  "retain": false,
  "dup": false,
  "protocol_string": "MQTT",
  "protocol_version": 5,
  "flags": {
    "username": true,
    "password": true,
    "will_retain": false,
    "will": true,
    "clean_session": true
  },
  "client_id": "client",
  "username": "user",
  "password": "pass",
  "will": {
    "topic": "willtopic",
    "message": "willmessage",
    "properties": {
      "content_type": "mywilltype",
      "correlation_data": "3c32aa4313b3e",
      "message_expiry_interval": 133,
      "payload_format_indicator": 144,
      "response_topic": "response_topic1",
      "userprop": "uservalue",
      "will_delay_interval": 200
    }
  },
  "properties": {
    "maximum_packet_size": 11111,
    "receive_maximum": 222,
    "session_expiry_interval": 555,
    "topic_alias_maximum": 666,
    "userprop1": "uservalue1",
    "userprop2": "uservalue2"
  }
}
```

MQTT CONNACK fields

- "connack.session_present": Set to *true* if a session is continued on connection.
- "connack.return_code": Return code/reason code for this reply. See 3.2.2.2 in the spec for more information on these codes.
- "connect.properties": (Optional, MQTT 5.0) CONNACK properties set on this request. See 3.2.2.3 in the spec for more information on CONNACK properties.

Example of MQTT CONNACK logging:

```
"connack": {
  "qos": 0,
  "retain": false,
  "dup": false,
  "session_present": false,
  "return_code": 0,
  "properties": {
    "topic_alias_maximum": 10
  }
}
```

MQTT PUBLISH fields

- "publish.topic": Topic this message is published to.
- "publish.message_id": (Only present if QOS level > 0) Message ID for this publication.
- "publish.message": Message to be published.
- "publish.properties": (Optional, MQTT 5.0) PUBLISH properties set on this request. See 3.3.2.3 in the spec for more information on PUBLISH properties.

Example of MQTT PUBLISH logging:

```
"publish": {
  "qos": 1,
  "retain": false,
  "dup": false,
  "topic": "topic",
  "message_id": 1,
  "message": "baa baa sheep",
  "properties": {
    "content_type": "mytype",
    "correlation_data": "3c32aa4313b3e",
    "message_expiry_interval": 77,
    "payload_format_indicator": 88,
    "response_topic": "response_topic1",
    "topic_alias": 5,
    "userprop": "userval"
  }
}
```

MQTT PUBACK/PUBREL/PUBREC/PUBCOMP fields

- "[puback|pubrel|pubrec|pubcomp].message_id": Original message ID this message refers to.
- "[puback|pubrel|pubrec|pubcomp].reason_code": Return code/reason code for this reply. See the spec for more information on these codes.
- "[puback|pubrel|pubrec|pubcomp].properties": (Optional, MQTT 5.0) Properties set on this request. See the spec for more information on these properties.

Example of MQTT PUBACK/PUBREL/PUBREC/PUBCOMP logging:

```
"puback": {
  "qos": 0,
  "retain": false,
  "dup": false,
  "message_id": 1,
  "reason_code": 16
}
```

MQTT SUBSCRIBE fields

- "subscribe.message_id": (Only present if QOS level > 0) Message ID for this subscription.
- "subscribe.topics": Array of pairs describing the subscribed topics:
  - "subscribe.topics[].topic": Topic to subscribe to.
  - "subscribe.topics[].qos": QOS level to apply for when subscribing.
- "subscribe.properties": (Optional, MQTT 5.0) SUBSCRIBE properties set on this request. See 3.8.2.1 in the spec for more information on SUBSCRIBE properties.

Example of MQTT SUBSCRIBE logging:

```
"subscribe": {
  "qos": 1,
  "retain": false,
  "dup": false,
  "message_id": 1,
  "topics": [
    {
      "topic": "topicX",
      "qos": 0
    },
    {
      "topic": "topicY",
      "qos": 0
    }
  ]
}
```

MQTT SUBACK fields

- "suback.message_id": Original message ID this message refers to.
- "suback.qos_granted": Array of QOS levels granted for the subscribed topics, in the order of the original request.
- "suback.properties": (Optional, MQTT 5.0) SUBACK properties set on this request. See 3.9.2.1 in the spec for more information on SUBACK properties.

Example of MQTT SUBACK logging:

```
"suback": {
  "qos": 0,
  "retain": false,
  "dup": false,
  "message_id": 1,
  "qos_granted": [
    0,
    0
  ]
}
```

MQTT UNSUBSCRIBE fields

- "unsubscribe.message_id": (Only present if QOS level > 0) Message ID for this unsubscribe action.
- "unsubscribe.topics": Array of topics to be unsubscribed from.
- "unsubscribe.properties": (Optional, MQTT 5.0) UNSUBSCRIBE properties set on this request. See 3.10.2.1 in the spec for more information on UNSUBSCRIBE properties.

Example of MQTT UNSUBSCRIBE logging:

```
"unsubscribe": {
  "qos": 1,
  "retain": false,
  "dup": false,
  "message_id": 1,
  "topics": [
    "topicX",
    "topicY"
  ]
}
```

MQTT UNSUBACK fields

- "unsuback.message_id": Original message ID this message refers to.

Example of MQTT UNSUBACK logging:

```
"unsuback": {
  "qos": 0,
  "retain": false,
  "dup": false,
```

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```
  "message_id": 1
}
```

MQTT AUTH fields (MQTT 5.0)

- "auth.reason_code": Return code/reason code for this message. See 3.15.2.1 in the spec for more information on these codes.
- "auth.properties": (Optional, MQTT 5.0) Properties set on this request. See 3.15.2.2 in the spec for more information on these properties.

Example of MQTT AUTH logging:

```
"auth": {
  "qos": 0,
  "retain": false,
  "dup": false,
  "reason_code": 16
}
```

MQTT DISCONNECT fields

- "auth.reason_code": (Optional) Return code/reason code for this message. See 3.14.2.1 in the spec for more information on these codes.
- "auth.properties": (Optional, MQTT 5.0) Properties set on this request. See 3.14.2.2 in the spec for more information on DISCONNECT properties.

Example of MQTT DISCONNECT logging:

```
"disconnect": {
  "qos": 0,
  "retain": false,
  "dup": false,
  "reason_code": 4,
  "properties": {
    "session_expiry_interval": 122,
  }
}
```

Truncated MQTT data

Messages exceeding the maximum message length limit (config setting `app-layer.protocols.mqtt.max-msg-length`) will not be parsed entirely to reduce the danger of denial of service issues. In such cases, only reduced metadata will be included in the EVE-JSON output. Furthermore, since no message ID is parsed, such messages can not be placed into transactions, hence, they will always appear as a single transaction.

These truncated events will -- besides basic communication metadata -- only contain the following fields:

- "truncated": Set to *true* if the entry is truncated.
- "skipped_length": Size of the original message.

Example of a truncated MQTT PUBLISH message (with 10000 being the maximum length):

```
{
  "timestamp": "2020-06-23T16:25:48.729785+0200",
  "flow_id": 1872904524326406,
  "pcap_cnt": 107,
  "event_type": "mqtt",
  "src_ip": "0000:0000:0000:0000:0000:0000:0000:0001",
  "src_port": 53335,
  "dest_ip": "0000:0000:0000:0000:0000:0000:0000:0001",
  "dest_port": 1883,
  "proto": "TCP",
  "mqtt": {
    "publish": {
      "qos": 0,
      "retain": false,
      "dup": false,
      "truncated": true,
      "skipped_length": 100011
    }
```

Event type: HTTP2

Fields

There are the two fields "request" and "response" which can each contain the same set of fields : * "settings": a list of settings with "name" and "value" * "headers": a list of headers with either "name" and "value", or "table_size_update", or "error" if any * "error_code": the error code from GOAWAY or RST_STREAM, which can be "NO_ERROR" * "priority": the stream priority.

Examples

Example of HTTP2 logging, of a settings frame:

```
"http2": {
  "request": {
    "settings": [
      {
        "settings_id": "SETTINGSMAXCONCURRENTSTREAMS",
        "settings_value": 100
      },
      {
        "settings_id": "SETTINGSINITIALWINDOWSIZE",
        "settings_value": 65535
      }
    ]
  },
  "response": {}
}
```

Example of HTTP2 logging, of a request and response:

```
"http2": {
  "request": {
    "headers": [
      {
        "name": ":authority",
        "value": "localhost:3000"
      },
      {
        "name": ":method",
        "value": "GET"
      },
      {
        "name": ":path",
        "value": "/doc/manual/html/index.html"
      },
      {
        "name": ":scheme",
        "value": "http"
      },
      {
        "name": "accept",
        "value": "*/*"
      },
      {
        "name": "accept-encoding",
        "value": "gzip, deflate"
      },
      {
        "name": "user-agent",
        "value": "nghttp2/0.5.2-DEV"
      }
    ]
  },
  "response": {
    "headers": [
      {
        "name": ":status",
        "value": "200"
      },
      {
        "name": "server",
        "value": "nghttpd nghttp2/0.5.2-DEV"
      },
      {
        "name": "content-length",
        "value": "22617"
      },
      {
        "name": "cache-control",
        "value": "max-age=3600"
      },
      {
        "name": "date",
```


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```
        "value": "Sat, 02 Aug 2014 10:50:25 GMT"
      },
      {
        "name": "last-modified",
        "value": "Sat, 02 Aug 2014 07:58:59 GMT"
      }
    ]
  }
}
```

Event type: PGSQL

PGSQL eve-logs reflect the bidirectional nature of the protocol transactions. Each PGSQL event lists at most one "Request" message field and one or more "Response" messages.

The PGSQL parser merges individual messages into one EVE output item if they belong to the same transaction. In such cases, the source and destination information (IP/port) reflect the direction of the initial request, but contain messages from both sides.

Example of `pgsql` event for a SimpleQuery transaction complete with request with a `SELECT` statement and its response:

```
{
  "timestamp": "2021-11-24T16:56:24.403417+0000",
  "flow_id": 1960113262002448,
  "pcap_cnt": 780,
  "event_type": "pgsql",
  "src_ip": "172.18.0.1",
  "src_port": 54408,
  "dest_ip": "172.18.0.2",
  "dest_port": 5432,
  "proto": "TCP",
  "pgsql": {
    "tx_id": 4,
    "request": {
      "simple_query": "select * from rule limit 5000;"
    },
    "response": {
      "field_count": 7,
      "data_rows": 5000,
      "data_size": 3035751,
      "command_completed": "SELECT 5000"
    }
  }
}
```

While on the wire PGSQL messages follow basically two types (startup messages and regular messages), those may have different subfields and/or meanings, based on the message type. Messages are logged based on their type and relevant fields.

We list a few possible message types and what they mean in Suricata. For more details on message types and formats as well as what each message and field mean for PGSQL, check PostgreSQL's official documentation.

Fields

- "tx_id": internal transaction id.
- "request": each PGSQL transaction may have up to one request message. The possible messages will be described in another section.
- "response": even when there are several "Response" messages, there is one `response` field that summarizes all responses for that transaction. The possible messages will be described in another section.

Request Messages

Requests are sent by the frontend (client), which would be the source of a pgsql flow. Some of the possible request messages are:

- "startup_message": message sent to start a new PostgreSQL connection
- "password_message": if password output for PGSQL is enabled in suricata.yaml, carries the password sent during Authentication phase
- "simple_query": issued SQL command during simple query subprotocol. PostgreSQL identifies specific sets of commands that change the set of expected messages to be exchanged as subprotocols.
- `"message": "cancel_request"`: sent after a query, when the frontend attempts to cancel said query. This message is sent over a different port, thus bring shown as a different flow. It has no direct answer from the backend, but if successful will lead to an `ErrorResponse` in the transaction where the query was sent.
- "message": requests which do not have meaningful payloads are logged like this, where the field value is the message type

There are several different authentication messages possible, based on selected authentication method. (e.g. the SASL authentication will have a set of authentication messages different from when `md5` authentication is chosen).

Response Messages

Responses are sent by the backend (server), which would be the destination of a pgsql flow. Some of the possible request messages are:

- "authentication_sasl_final": final SCRAM `server-final-message`, as explained at https://www.postgresql.org/docs/14/sasl-authentication.html#SASL-SCRAM-SHA-256
- "message": Backend responses which do not have meaningful payloads are logged like this, where the field value is the message type
- "error_response"
- "notice_response"
- "notification_response"
- "authentication_md5_password": a string with the `md5` salt value
- "parameter_status": logged as an array
- "backend_key_data"
- "data_rows": integer. When one or many `DataRow` messages are parsed, the total returned rows
- "data_size": in bytes. When one or many `DataRow` messages are parsed, the total size in bytes of the data returned
- "command_completed": string. Informs the command just completed by the backend

- "ssl_accepted": bool. With this event, the initial PGSQL SSL Handshake negotiation is complete in terms of tracking and logging. The session will be upgraded to use TLS encryption

Examples

The two `pgsql` events in this example represent a rejected `SSL handshake` and a following connection request where the authentication method indicated by the backend was `md5`:

```
{
  "timestamp": "2021-11-24T16:56:19.435242+0000",
  "flow_id": 1960113262002448,
  "pcap_cnt": 21,
  "event_type": "pgsql",
  "src_ip": "172.18.0.1",
  "src_port": 54408,
  "dest_ip": "172.18.0.2",
  "dest_port": 5432,
  "proto": "TCP",
  "pgsql": {
    "tx_id": 1,
    "request": {
      "message": "SSL Request"
    },
    "response": {
      "accepted": false
    }
  }
}
{
  "timestamp": "2021-11-24T16:56:19.436228+0000",
  "flow_id": 1960113262002448,
  "pcap_cnt": 25,
  "event_type": "pgsql",
  "src_ip": "172.18.0.1",
  "src_port": 54408,
  "dest_ip": "172.18.0.2",
  "dest_port": 5432,
  "proto": "TCP",
  "pgsql": {
    "tx_id": 2,
    "request": {
      "protocol_version": "3.0",
      "startup_parameters": {
        "user": "rules",
        "database": "rules",
        "optional_parameters": [
          {
            "application_name": "psql"
          },
          {
            "client_encoding": "UTF8"
          }
```

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```
        ]
      }
    },
    "response": {
      "authentication_md5_password": "Z\\xdc\\xfdf"
    }
  }
}
```

`AuthenticationOk`: a response indicating that the connection was successfully established.:

```
{
  "pgsql": {
    "tx_id": 3,
    "response": {
      "message": "authentication_ok",
      "parameter_status": [
        {
          "application_name": "psql"
        },
        {
          "client_encoding": "UTF8"
        },
        {
          "date_style": "ISO, MDY"
        },
        {
          "integer_datetimes": "on"
        },
        {
          "interval_style": "postgres"
        },
        {
          "is_superuser": "on"
        },
        {
          "server_encoding": "UTF8"
        },
        {
          "server_version": "13.6 (Debian 13.6-1.pgdg110+1)"
        },
        {
          "session_authorization": "rules"
        },
        {
          "standard_conforming_strings": "on"
        },
        {
          "time_zone": "Etc/UTC"
        }
      ],
      "process_id": 28954,
```

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```
      "secret_key": 889887985
    }
  }
}
```

Note: In Suricata, the `AuthenticationOk` message is also where the backend's `process_id` and `secret_key` are logged. These must be sent by the frontend when it issues a `CancelRequest` message (seen below).

A `CancelRequest` message:

```
{
   "timestamp": "2023-12-07T15:46:56.971150+0000",
   "flow_id": 775771889500133,
   "event_type": "pgsql",
   "src_ip": "100.88.2.140",
   "src_port": 39706,
   "dest_ip": "100.96.199.113",
   "dest_port": 5432,
   "proto": "TCP",
   "pkt_src": "stream (flow timeout)",
   "pgsql": {
     "tx_id": 1,
     "request": {
       "message": "cancel_request",
       "process_id": 28954,
       "secret_key": 889887985
     }
   }
}
```

Note: As the `CancelRequest` message is sent over a new connection, the way to correlate it with the proper frontend/flow from which it originates is by querying on `process_id` and `secret_key` seen in the `AuthenticationOk` event.

References:

- PostgreSQL protocol - Canceling Requests in Progress
- PostgreSQL message format - BackendKeyData

Event type: IKE

The parser implementations for IKEv1 and IKEv2 have a slightly different feature set. They can be distinguished using the "version_major" field (which equals either 1 or 2). The unique properties are contained within a separate "ikev1" and "ikev2" sub-object.

Fields

- "init_spi", "resp_spi": The Security Parameter Index (SPI) of the initiator and responder.
- "version_major": Major version of the ISAKMP header.
- "version_minor": Minor version of the ISAKMP header.
- "payload": List of payload types in the current packet.
- "exchange_type": Type of the exchange, as numeric values.
- "exchange_type_verbose": Type of the exchange, in human-readable form. Needs `extended: yes` set in the `ike` EVE output option.
- "alg_enc", "alg_hash", "alg_auth", "alg_dh", "alg_esn": Properties of the chosen security association by the server.
- "ikev1.encrypted_payloads": Set to `true` if the payloads in the packet are encrypted.
- "ikev1.doi": Value of the domain of interpretation (DOI).
- "ikev1.server.key_exchange_payload", "ikev1.client.key_exchange_payload": Public key exchange payloads of the server and client.
- "ikev1.server.key_exchange_payload_length", "ikev1.client.key_exchange_payload_length": Length of the public key exchange payload.
- "ikev1.server.nonce_payload", "ikev1.client.nonce_payload": Nonce payload of the server and client.
- "ikev1.server.nonce_payload_length", "ikev1.client.nonce_payload_length": Length of the nonce payload.
- "ikev1.client.client_proposals": List of the security associations proposed to the server.
- "ikev1.vendor_ids": List of the vendor IDs observed in the communication.
- "server_proposals": List of server proposals with parameters, if there are more than one. This is a non-standard case; this field is only present if such a situation was observed in the inspected traffic.

Examples

Example of IKE logging:

```
"ike": {
  "version_major": 1,
  "version_minor": 0,
  "init_spi": "8511617bfea2f172",
  "resp_spi": "c0fc6bae013de0f5",
  "message_id": 0,
  "exchange_type": 2,
  "exchange_type_verbose": "Identity Protection",
  "sa_life_type": "LifeTypeSeconds",
  "sa_life_type_raw": 1,
  "sa_life_duration": "Unknown",
  "sa_life_duration_raw": 900,
  "alg_enc": "EncAesCbc",
  "alg_enc_raw": 7,
  "alg_hash": "HashSha2_256",
  "alg_hash_raw": 4,
```

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```
  "alg_auth": "AuthPreSharedKey",
  "alg_auth_raw": 1,
  "alg_dh": "GroupModp2048Bit",
  "alg_dh_raw": 14,
  "sa_key_length": "Unknown",
  "sa_key_length_raw": 256,
  "alg_esn": "NoESN",
  "payload": [
    "VendorID",
    "Transform",
    "Proposal",
    "SecurityAssociation"
  ],
  "ikev1": {
    "doi": 1,
    "encrypted_payloads": false,
    "client": {
      "key_exchange_payload": "0bf7907681a656aabed38fb1ba8918b10d707a8e635a...",
      "key_exchange_payload_length": 256,
      "nonce_payload": "1427d158fc1ed6bbbc1bd81e6b74960809c87d18af5f0abef14d5274ac232904
↪",
      "nonce_payload_length": 32,
      "proposals": [
        {
          "sa_life_type": "LifeTypeSeconds",
          "sa_life_type_raw": 1,
          "sa_life_duration": "Unknown",
          "sa_life_duration_raw": 900,
          "alg_enc": "EncAesCbc",
          "alg_enc_raw": 7,
          "alg_hash": "HashSha2_256",
          "alg_hash_raw": 4,
          "alg_auth": "AuthPreSharedKey",
          "alg_auth_raw": 1,
          "alg_dh": "GroupModp2048Bit",
          "alg_dh_raw": 14,
          "sa_key_length": "Unknown",
          "sa_key_length_raw": 256
        }
      ]
    },
    "server": {
      "key_exchange_payload": "1e43be52b088ec840ff81865074b6d459b5ca7813b46...",
      "key_exchange_payload_length": 256,
      "nonce_payload": "04d78293ead007bc1a0f0c6c821a3515286a935af12ca50e08905b15d6c8fcd4
↪",
      "nonce_payload_length": 32
    },
    "vendor_ids": [
      "4048b7d56ebce88525e7de7f00d6c2d3",
      "4a131c81070358455c5728f20e95452f",
      "afcad71368a1f1c96b8696fc77570100",
```


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```
      "7d9419a65310ca6f2c179d9215529d56",
      "cd60464335df21f87cfdb2fc68b6a448",
      "90cb80913ebb696e086381b5ec427b1f"
    ]
  },
}
```

Event type: Modbus

Common fields

- "id": The unique transaction number given by Suricata

Request/Response fields

- "transaction_id": The transaction id found in the packet
- "protocol_id": The modbus version
- "unit_id": ID of the remote server to interact with
- "function_raw": Raw value of the function code byte
- "function_code": Associated name of the raw function value
- "access_type": Type of access requested by the function
- "category": The function code's category
- "error_flags": Errors found in the data while parsing

Exception fields

- "raw": Raw value of the exception code byte
- "code": Associated name of the raw exception value

Diagnostic fields

- "raw": Raw value of the subfunction code bytes
- "code": Associated name of the raw subfunction value
- "data": Bytes following the subfunction code

MEI fields

- "raw": Raw value of the mei function code bytes
- "code": Associated name of the raw mei function value
- "data": Bytes following the mei function code

Read Request fields

- "address": Starting address to read from
- "quantity": Amount to read

Read Response fields

- "data": Data that was read

Multiple Write Request fields

- "address": Starting address to write to
- "quantity": Amount to write
- "data": Data to write

Mask Write fields

- "address": Starting address of content modification
- "and_mask": And mask to modify content with
- "or_mask": Or mask to modify content with

Other Write fields

- "address": Starting address to write to
- "data": Data to write

Generic Data fields

- "data": Data following the function code

Example

Example of Modbus logging of a request and response:

```
"modbus": {
  "id": 1,
  "request": {
    "transaction_id": 0,
    "protocol_id": 0,
    "unit_id": 0,
    "function_raw": 1,
    "function_code": "RdCoils",
    "access_type": "READ | COILS",
    "category": "PUBLIC_ASSIGNED",
    "error_flags": "NONE",
  },
  "response": {
    "transaction_id": 0,
    "protocol_id": 0,
    "unit_id": 0,
    "function_raw": 1,
    "function_code": "RdCoils",
    "access_type": "READ | COILS",
    "category": "PUBLIC_ASSIGNED",
    "error_flags": "DATA_VALUE",
  },
}
```

Event type: QUIC

Fields

- "version": Version of the QUIC packet if contained in the packet, 0 if not
- "cyu": List of found CYUs in the packet
- "cyu[].hash": CYU hash
- "cyu[].string": CYU string
- "ja3": The JA3 fingerprint consisting of both a JA3 hash and a JA3 string
- "ja3s": The JA3S fingerprint consisting of both a JA3 hash and a JA3 string
- "ja4": The JA4 client fingerprint for QUIC

Examples

Example of QUIC logging with CYU, JA3 and JA4 hashes (note that the JA4 hash is only an example to illustrate the format and does not correlate with the others):

```
"quic": {
  "version": 1362113590,
  "cyu": [
      {
          "hash": "7b3ceb1adc974ad360cfa634e8d0a730",
          "string": "46,PAD-SNI-STK-SNO-VER-CCS-NONC-AEAD-UAID-SCID-TCID-PDMD-SMHL-ICSL-
↪NONP-PUBS-MIDS-SCLS-KEXS-XLCT-CSCT-COPT-CCRT-IRTT-CFCW-SFCW"
      }
  ],
  "ja3": {
      "hash": "324f8c50e267adba4b5dd06c964faf67",
      "string": "771,4865-4866-4867,51-43-13-27-17513-16-45-0-10-57,29-23-24,"
  },
  "ja4": "q13d0310h3_55b375c5d22e_cd85d2d88918"
}
```

Event type: DHCP

The default DHCP logging level only logs enough information to map a MAC address to an IP address. Enable extended mode to log all DHCP message types in full detail.

Fields

- "type": message type (e.g. request, reply)
- "id": DHCP transaction id
- "client_mac": client MAC address
- "assigned_ip": IP address given by DHCP server
- "client_ip": client IP address
- "dhcp_type": DHCP message type
- "client_id": DHCP client identifier
- "hostname": DHCP client host name
- "params": DHCP parameter request list
- "requested_ip": DHCP client requesting specific IP address
- "relay_ip": BOOTP relay agent IP address
- "next_server_ip": BOOTP next IP address to use for booting process
- "subnet_mask": subnet mask to use with client IP address
- "routers": IP address(es) to be used as default gateways on DHCP client
- "lease_time": Duration of IP address assignment to client
- "renewal_time": Time in seconds since client began IP address request or renewal process

- "rebinding_time": Time in seconds before the client begins to renew its IP address lease
- "dns_servers": IP address(es) of servers the client will use for DNS queries

Examples

Example of DHCP log entry (default logging level):

```
"dhcp": {
  "type":"reply",
  "id":755466399,
  "client_mac":"54:ee:75:51:e0:66",
  "assigned_ip":"100.78.202.125",
  "dhcp_type":"ack",
  "renewal_time":21600,
  "client_id":"54:ee:75:51:e0:66"
}
```

Example of DHCP log entry (extended logging enabled):

```
"dhcp": {
  "type":"reply",
  "id":2787908432,
  "client_mac":"54:ee:75:51:e0:66",
  "assigned_ip":"192.168.1.120",
  "client_ip":"0.0.0.0",
  "relay_ip":"192.168.1.1",
  "next_server_ip":"0.0.0.0",
  "dhcp_type":"offer",
  "subnet_mask":"255.255.255.0",
  "routers":["192.168.1.100"],
  "hostname":"test",
  "lease_time":86400,
  "renewal_time":21600,
  "rebinding_time":43200,
  "client_id":"54:ee:75:51:e0:66",
  "dns_servers":["192.168.1.50","192.168.1.49"]
}
```

17.1.3 Eve JSON 'jq' Examples

The jq tool is very useful for quickly parsing and filtering JSON files. This page is contains various examples of how it can be used with Suricata's Eve.json.

The basics are discussed here:

- https://www.stamus-networks.com/2015/05/18/looking-at-suricata-json-events-on-command-line/

Colorize output

```
tail -f eve.json | jq -c '.'
```

DNS NXDOMAIN

```
tail -f eve.json|jq -c 'select(.dns.rcode=="NXDOMAIN")'
```

Unique HTTP User Agents

```
cat eve.json | jq -s '[.[]|.http.http_user_agent]|group_by(.)|map({key:.[0],value:(.
↪|length)})|from_entries'
```

Source: https://twitter.com/mattarnao/status/601807374647750657

Data use for a host

```
tail -n500000 eve.json | jq -s 'map(select(.event_type=="netflow" and .dest_ip=="192.168.
↪1.3").netflow.bytes)|add'|numfmt --to=iec
1.3G
```

Note: can use a lot of memory. Source: https://twitter.com/pkt_inspector/status/605524218722148352

Monitor part of the stats

```
$ tail -f eve.json | jq -c 'select(.event_type=="stats")|.stats.decoder'
```

Inspect Alert Data

```
cat eve.json | jq -r -c 'select(.event_type=="alert")|.payload'|base64 --decode
```

Top 10 Destination Ports

```
cat eve.json | jq -c 'select(.event_type=="flow")|[.proto, .dest_port]'|sort |uniq -
↪c|sort -nr|head -n10
```

17.2 Lua Output

Suricata offers the possibility to get more detailed output on specific kinds of network traffic via pluggable lua scripts. You can write these scripts yourself and only need to define four hook functions.

For lua output scripts suricata offers a wide range of lua functions. They all return information on specific engine internals and aspects of the network traffic. They are described in the following sections, grouped by the event/traffic type. But let's start with an example explaining the four hook functions, and how to make suricata load a lua output script.

17.2.1 Script structure

A lua output script needs to define 4 hook functions: init(), setup(), log(), deinit()

- init() -- registers where the script hooks into the output engine
- setup() -- does per output thread setup
- log() -- logging function
- deinit() -- clean up function

Example:

```
function init (args)
    local needs = {}
    needs["protocol"] = "http"
    return needs
end

function setup (args)
    filename = SCLogPath() .. "/" .. name
    file = assert(io.open(filename, "a"))
    SCLogInfo("HTTP Log Filename " .. filename)
    http = 0
end

function log(args)
    http_uri = HttpGetRequestUriRaw()
    if http_uri == nil then
        http_uri = "<unknown>"
    end
    http_uri = string.gsub(http_uri, "%c", ".")

    http_host = HttpGetRequestHost()
    if http_host == nil then
        http_host = "<hostname unknown>"
    end
    http_host = string.gsub(http_host, "%c", ".")

    http_ua = HttpGetRequestHeader("User-Agent")
    if http_ua == nil then
        http_ua = "<useragent unknown>"
    end
    http_ua = string.gsub(http_ua, "%g", ".")
```

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```
    timestring = SCPacketTimeString()
    ip_version, src_ip, dst_ip, protocol, src_port, dst_port = SCFlowTuple()

    file:write (timestring .. " " .. http_host .. " [**] " .. http_uri .. " [**] " ..
           http_ua .. " [**] " .. src_ip .. ":" .. src_port .. " -> " ..
           dst_ip .. ":" .. dst_port .. "\n")
    file:flush()

    http = http + 1
end

function deinit (args)
    SCLogInfo ("HTTP transactions logged: " .. http);
    file:close(file)
end
```

17.2.2 YAML

To enable the lua output, add the 'lua' output and add one or more scripts like so:

```
outputs:
  - lua:
      enabled: yes
      scripts-dir: /etc/suricata/lua-output/
      scripts:
        - tcp-data.lua
        - flow.lua
```

The scripts-dir option is optional. It makes Suricata load the scripts from this directory. Otherwise scripts will be loaded from the current workdir.

17.2.3 Developing lua output script

You can use functions described in *Lua Functions*

17.3 Syslog Alerting Compatibility

Suricata can alert via syslog which is a very handy feature for central log collection, compliance, and reporting to a SIEM. Instructions on setting this up can be found in the .yaml file in the section where you can configure what type of alert (and other) logging you would like.

However, there are different syslog daemons and there can be parsing issues with the syslog format a SIEM expects and what syslog format Suricata sends. The syslog format from Suricata is dependent on the syslog daemon running on the Suricata sensor but often the format it sends is not the format the SIEM expects and cannot parse it properly.

17.3.1 Popular syslog daemons

- **syslogd** - logs system messages
- **syslog-ng** - logs system messages but also supports TCP, TLS, and other enhanced enterprise features
- **rsyslogd** - logs system messages but also support TCP, TLS, multi-threading, and other enhanced features
- **klogd** - logs kernel messages
- **sysklogd** - basically a bundle of syslogd and klogd

If the syslog format the Suricata sensor is sending is not compatible with what your SIEM or syslog collector expects, you will need to fix this. You can do this on your SIEM if it is capable of being able to be configured to interpret the message, or by configuring the syslog daemon on the Suricata sensor itself to send in a format you SIEM can parse. The latter can be done by applying a template to your syslog config file.

17.3.2 Finding what syslog daemon you are using

There are many ways to find out what syslog daemon you are using but here is one way:

```
cd /etc/init.d
ls | grep syslog
```

You should see a file with the word syslog in it, e.g. "syslog", "rsyslogd", etc. Obviously if the name is "rsyslogd" you can be fairly confident you are running rsyslogd. If unsure or the filename is just "syslog", take a look at that file. For example, if it was "rsyslogd", run:

```
less rsyslogd
```

At the top you should see a comment line that looks something like this:

```
# rsyslog        Starts rsyslogd/rklogd.
```

Locate those files and look at them to give you clues as to what syslog daemon you are running. Also look in the *start()* section of the file you ran "less" on and see what binaries get started because that can give you clues as well.

17.3.3 Example

Here is an example where the Suricata sensor is sending syslog messages in rsyslogd format but the SIEM is expecting and parsing them in a sysklogd format. In the syslog configuration file (usually in /etc with a filename like rsyslog.conf or syslog.conf), first add the template:

```
$template sysklogd, "<%PRI%>%syslogtag:1:32%%msg:::sp-if-no-1st-sp%%msg%"
```

Then send it to the syslog server with the template applied:

```
user.alert @10.8.75.24:514;sysklogd
```

Of course this is just one example and it will probably be different in your environment depending on what syslog daemons and SIEM you use but hopefully this will point you in the right direction.

17.4 Custom http logging

In your Suricata.yaml, find the http-log section and edit as follows:

```
- http-log:
      enabled: yes
      filename: http.log
      custom: yes # enable the custom logging format (defined by custom format)
      customformat: "%{%D-%H:%M:%S}t.%z %{X-Forwarded-For}i %{User-agent}i %H %m %h %u
↪%s %B %a:%p -> %A:%P"
      append: no
      #extended: yes     # enable this for extended logging information
      #filetype: regular # 'regular', 'unix_stream' or 'unix_dgram'
```

And in your http.log file you would get the following, for example:

```
8/28/12-22:14:21.101619 - Mozilla/5.0 (X11; Ubuntu; Linux i686; rv:11.0) Gecko/20100101␣
↪Firefox/11.0  HTTP/1.1 GET us.cnn.com /video/data/3.0/video/world/2012/08/28/hancocks-
↪korea-typhoon-bolavan.cnn/index.xml 200 16856 192.168.1.91:45111 -> 157.166.255.18:80
```

```
08/28/12-22:14:30.693856 - Mozilla/5.0 (X11; Ubuntu; Linux i686; rv:11.0) Gecko/20100101␣
↪Firefox/11.0  HTTP/1.1 GET us.cnn.com /video/data/3.0/video/showbiz/2012/08/28/conan-
↪reports-from-rnc-convention.teamcoco/index.xml 200 15789 192.168.1.91:45108 -> 157.166.
↪255.18:80
```

The list of supported format strings is the following:

- %h - Host HTTP Header (remote host name). ie: google.com
- %H - Request Protocol. ie: HTTP/1.1
- %m - Request Method. ie: GET
- %u - URL including query string. ie: /search?q=suricata
- %{header_name}i - contents of the defined HTTP Request Header name. ie:
- %{User-agent}i: Mozilla/5.0 (X11; Ubuntu; Linux i686; rv:11.0) Gecko/20100101 Firefox/11.0
- %{X-Forwarded-For}i: outputs the IP address contained in the X-Forwarded-For HTTP header (inserted by a reverse proxy)
- %s - return status code. In the case of 301 and 302 it will print the url in brackets. ie: 200
- %B - response size in bytes. ie: 15789
- %{header_name}o - contents of the defined HTTP Response Header name
- %{strftime_format]t - timestamp of the HTTP transaction in the selected strftime format. ie: 08/28/12-22:14:30
- %z - precision time in useconds. ie: 693856
- %a - client IP address
- %p - client port number
- %A - server IP address
- %P - server port number

Any non printable character will be represented by its byte value in hexadecimal format (|XX|, where XX is the hex code)

17.5 Custom tls logging

In your Suricata.yaml, find the tls-log section and edit as follows:

```
- tls-log:
    enabled: yes      # Log TLS connections.
    filename: tls.log # File to store TLS logs.
    append: yes
    custom: yes       # enabled the custom logging format (defined by customformat)
    customformat: "%{%D-%H:%M:%S}t.%z %a:%p -> %A:%P %v %n %d %D"
```

And in your tls.log file you would get the following, for example:

```
12/03/16-19:20:14.85859 10.10.10.4:58274 -> 192.0.78.24:443 VERSION='TLS 1.2' suricata.
↪io NOTBEFORE='2016-10-27T20:36:00' NOTAFTER='2017-01-25T20:36:00'
```

The list of supported format strings is the following:

- %n - client SNI
- %v - TLS/SSL version
- %d - certificate date not before
- %D - certificate date not after
- %f - certificate fingerprint SHA1
- %s - certificate subject
- %i - certificate issuer dn
- %E - extended format
- %{strftime_format}t - timestamp of the TLS transaction in the selected strftime format. ie: 08/28/12-22:14:30
- %z - precision time in useconds. ie: 693856
- %a - client IP address
- %p - client port number
- %A - server IP address
- %P - server port number

Any non printable character will be represented by its byte value in hexadecimal format (|XX|, where XX is the hex code)

17.6 Log Rotation

All outputs in the *outputs* section of the configuration file can be subject to log rotation.

For most outputs an external tool like *logrotate* is required to rotate the log files in combination with sending a SIGHUP to Suricata to notify it that the log files have been rotated.

On receipt of a SIGHUP, Suricata simply closes all open log files and then re-opens them in append mode. If the external tool has renamed any of the log files, new files will be created, otherwise the files will be re-opened and new data will be appended to them with no noticeable affect.

The following is an example *logrotate* configuration file that will rotate Suricata log files then send Suricata a SIGHUP triggering Suricata to open new files:

```
/var/log/suricata/*.log /var/log/suricata/*.json
{
    rotate 3
    missingok
    nocompress
    create
    sharedscripts
    postrotate
            /bin/kill -HUP `cat /var/run/suricata.pid 2>/dev/null` 2>/dev/null || true
    endscript
}
```

Note: The above *logrotate* configuration file depends on the existence of a Suricata PID file. If running in daemon mode a PID file will be created by default, otherwise the `--pidfile` option should be used to create a PID file.

In addition to the SIGHUP style rotation discussed above, some outputs support their own time and date based rotation, however removal of old log files is still the responsibility of external tools. These outputs include:

- *Eve*
- *PCAP log*

CHAPTER

EIGHTEEN

LUA SUPPORT

18.1 Lua usage in Suricata

Lua scripting can be used in two components of Suricata. The first is in output and the second one in rules in the detection engine.

Both features are using a list of functions to access the data extracted by Suricata. You can get the list of functions in the *Lua functions* page.

Note: Currently, there is a difference in the `needs` key in the `init` function, depending on what is the usage: `output` or `detection`. The list of available functions may also differ.

18.1.1 Lua output

Lua can be used to write arbitrary output. See *Lua Output* for more information.

18.1.2 Lua detection

Lua script can be used as a filter condition in signatures. See *Lua Scripting for Detection* for more information.

18.2 Lua functions

18.2.1 Differences between *output* and *detect*:

Currently, the `needs` key initialization varies, depending on what is the goal of the script: output or detection.

If the script is for detection, the `needs` initialization should be as seen in the example below (see *Lua Scripting for Detection* for a complete example of a detection script):

```
function init (args)
    local needs = {}
    needs["packet"] = tostring(true)
    return needs
end
```

For output logs, follow the pattern below. (The complete script structure can be seen at *Lua Output*:)

```
function init (args)
    local needs = {}
    needs["protocol"] = "http"
    return needs
end
```

Do notice that the functions and protocols available for `log` and `match` may also vary. DNP3, for instance, is not available for logging.

18.2.2 packet

Initialize with:

```
function init (args)
    local needs = {}
    needs["type"] = "packet"
    return needs
end
```

SCPacketTimestamp

Get packets timestamp as 2 numbers: seconds & microseconds elapsed since 1970-01-01 00:00:00 UTC.

```
function log(args)
    local sec, usec = SCPacketTimestamp()
end
```

SCPacketTimeString

Use `SCPacketTimeString` to get the packet's time string in the format: 11/24/2009-18:57:25.179869

```
function log(args)
    ts = SCPacketTimeString()
```

SCPacketTuple

```
ipver, srcip, dstip, proto, sp, dp = SCPacketTuple()
```

SCPacketPayload

```
p = SCPacketPayload()
```

18.2.3 flow

```
function init (args)
    local needs = {}
    needs["type"] = "flow"
    return needs
end
```

SCFlowTimestamps

Get timestamps (seconds and microseconds) of the first and the last packet from the flow.

```
startts, lastts = SCFlowTimestamps()
startts_s, lastts_s, startts_us, lastts_us = SCFlowTimestamps()
```

SCFlowTimeString

```
startts = SCFlowTimeString()
```

SCFlowTuple

```
ipver, srcip, dstip, proto, sp, dp = SCFlowTuple()
```

SCFlowAppLayerProto

Get alproto as a string from the flow. If a alproto is not (yet) known, it returns "unknown".

Example:

```
function log(args)
    alproto = SCFlowAppLayerProto()
    if alproto ~= nil then
        print (alproto)
    end
end
```

Returns 5 values: <alproto> <alproto_ts> <alproto_tc> <alproto_orig> <alproto_expect>

Orig and expect are used when changing and upgrading protocols. In a SMTP STARTTLS case, orig would normally be set to "smtp" and expect to "tls".

SCFlowHasAlerts

Returns true if flow has alerts.

Example:

```
function log(args)
    has_alerts = SCFlowHasAlerts()
    if has_alerts then
        -- do something
    end
end
```

SCFlowStats

Gets the packet and byte counts per flow.

```
tscnt, tsbytes, tccnt, tcbytes = SCFlowStats()
```

SCFlowId

Gets the flow id.

```
id = SCFlowId()
```

Note that simply printing 'id' will likely result in printing a scientific notation. To avoid that, simply do:

```
id = SCFlowId()
idstr = string.format("%.0f",id)
print ("Flow ID: " .. idstr .. "\n")
```

18.2.4 http

For output, init with:

```
function init (args)
    local needs = {}
    needs["protocol"] = "http"
    return needs
end
```

For detection, use the specific buffer (cf *Lua Scripting for Detection* for a complete list), as with:

```
function init (args)
    local needs = {}
    needs["http.uri"] = tostring(true)
    return needs
end
```

HttpGetRequestBody and HttpGetResponseBody.

Make normalized body data available to the script through HttpGetRequestBody and HttpGetResponseBody.

There no guarantees that all of the body will be available.

Example:

```
function log(args)
    a, o, e = HttpGetResponseBody();
    --print("offset " .. o .. " end " .. e)
    for n, v in ipairs(a) do
        print(v)
    end
end
```

HttpGetRequestHost

Get the host from libhtp's tx->request_hostname, which can either be the host portion of the url or the host portion of the Host header.

Example:

```
http_host = HttpGetRequestHost()
if http_host == nil then
    http_host = "<hostname unknown>"
end
```

HttpGetRequestHeader

```
http_ua = HttpGetRequestHeader("User-Agent")
if http_ua == nil then
    http_ua = "<useragent unknown>"
end
```

HttpGetResponseHeader

```
server = HttpGetResponseHeader("Server");
print ("Server: " .. server);
```

HttpGetRequestLine

```
rl = HttpGetRequestLine();
print ("Request Line: " .. rl);
```

HttpGetResponseLine

```
rsl = HttpGetResponseLine();
print ("Response Line: " .. rsl);
```

HttpGetRawRequestHeaders

```
rh = HttpGetRawRequestHeaders();
print ("Raw Request Headers: " .. rh);
```

HttpGetRawResponseHeaders

```
rh = HttpGetRawResponseHeaders();
print ("Raw Response Headers: " .. rh);
```

HttpGetRequestUriRaw

```
http_uri = HttpGetRequestUriRaw()
if http_uri == nil then
    http_uri = "<unknown>"
end
```

HttpGetRequestUriNormalized

```
http_uri = HttpGetRequestUriNormalized()
if http_uri == nil then
    http_uri = "<unknown>"
end
```

HttpGetRequestHeaders

```
a = HttpGetRequestHeaders();
for n, v in pairs(a) do
    print(n,v)
end
```

HttpGetResponseHeaders

```
a = HttpGetResponseHeaders();
for n, v in pairs(a) do
    print(n,v)
end
```

18.2.5 DNS

If your purpose is to create a logging script, initialize the buffer as:

```
function init (args)
   local needs = {}
   needs["protocol"] = "dns"
   return needs
end
```

If you are going to use the script for rule matching, choose one of the available DNS buffers listed in *Lua Scripting for Detection* and follow the pattern:

```
function init (args)
   local needs = {}
   needs["dns.rrname"] = tostring(true)
   return needs
end
```

DnsGetQueries

```
dns_query = DnsGetQueries();
if dns_query ~= nil then
    for n, t in pairs(dns_query) do
        rrname = t["rrname"]
        rrtype = t["type"]

        print ("QUERY: " .. ts .. " " .. rrname .. " [**] " .. rrtype .. " [**] " ..
               "TODO" .. " [**] " .. srcip .. ":" .. sp .. " -> " ..
               dstip .. ":" .. dp)
    end
end
```

returns a table of tables

DnsGetAnswers

```
dns_answers = DnsGetAnswers();
if dns_answers ~= nil then
    for n, t in pairs(dns_answers) do
        rrname = t["rrname"]
        rrtype = t["type"]
        ttl = t["ttl"]

        print ("ANSWER: " .. ts .. " " .. rrname .. " [**] " .. rrtype .. " [**] " ..
               ttl .. " [**] " .. srcip .. ":" .. sp .. " -> " ..
               dstip .. ":" .. dp)
    end
end
```

returns a table of tables

DnsGetAuthorities

```
dns_auth = DnsGetAuthorities();
if dns_auth ~= nil then
    for n, t in pairs(dns_auth) do
        rrname = t["rrname"]
        rrtype = t["type"]
        ttl = t["ttl"]

        print ("AUTHORITY: " .. ts .. " " .. rrname .. " [**] " .. rrtype .. " [**] " ..
               ttl .. " [**] " .. srcip .. ":" .. sp .. " -> " ..
               dstip .. ":" .. dp)
    end
end
```

returns a table of tables

DnsGetRcode

```
rcode = DnsGetRcode();
if rcode == nil then
    return 0
end
print (rcode)
```

returns a lua string with the error message, or nil

DnsGetRecursionDesired

```
if DnsGetRecursionDesired() == true then
    print ("RECURSION DESIRED")
end
```

returns a bool

18.2.6 TLS

For log output, initialize with:

```
function init (args)
    local needs = {}
    needs["protocol"] = "tls"
    return needs
end
```

For detection, initialization is as follows:

```
function init (args)
    local needs = {}
    needs["tls"] = tostring(true)
    return needs
end
```

TlsGetVersion

Get the negotiated version in a TLS session as a string through TlsGetVersion.

Example:

```
function log (args)
    version = TlsGetVersion()
    if version then
        -- do something
    end
end
```

TlsGetCertInfo

Make certificate information available to the script through TlsGetCertInfo.

Example:

```
function log (args)
    version, subject, issuer, fingerprint = TlsGetCertInfo()
    if version == nil then
        return 0
    end
end
```

TlsGetCertChain

Make certificate chain available to the script through TlsGetCertChain.

The output is an array of certificate with each certificate being an hash with *data* and *length* keys.

Example:

```
-- Use debian lua-luaossl coming from https://github.com/wahern/luaossl
local x509 = require"openssl.x509"

   chain = TlsGetCertChain()
   for k, v in pairs(chain) do
      -- v.length is length of data
      -- v.data is raw binary data of certificate
      cert = x509.new(v["data"], "DER")
      print(cert:text() .. "\n")
   end
```

TlsGetCertNotAfter

Get the Unix timestamp of end of validity of certificate.

Example:

```
function log (args)
    notafter = TlsGetCertNotAfter()
    if notafter < os.time() then
        -- expired certificate
    end
end
```

TlsGetCertNotBefore

Get the Unix timestamp of beginning of validity of certificate.

Example:

```
function log (args)
    notbefore = TlsGetCertNotBefore()
    if notbefore > os.time() then
        -- not yet valid certificate
    end
end
```

TlsGetCertSerial

Get TLS certificate serial number through TlsGetCertSerial.

Example:

```
function log (args)
    serial = TlsGetCertSerial()
    if serial then
        -- do something
    end
end
```

TlsGetSNI

Get the Server name Indication from a TLS connection.

Example:

```
function log (args)
    asked_domain = TlsGetSNI()
    if string.find(asked_domain, "badguys") then
        -- ok connection to bad guys let's do something
    end
end
```

18.2.7 JA3

JA3 must be enabled in the Suricata config file (set 'app-layer.protocols.tls.ja3-fingerprints' to 'yes').

For log output, initialize with:

```
function init (args)
    local needs = {}
    needs["protocol"] = "tls"
    return needs
end
```

For detection, initialization is as follows:

```
function init (args)
    local needs = {}
    needs["tls"] = tostring(true)
    return needs
end
```

Ja3GetHash

Get the JA3 hash (md5sum of JA3 string) through Ja3GetHash.

Example:

```
function log (args)
    hash = Ja3GetHash()
    if hash == nil then
        return
    end
end
```

Ja3GetString

Get the JA3 string through Ja3GetString.

Example:

```
function log (args)
    str = Ja3GetString()
    if str == nil then
        return
    end
end
```

Ja3SGetHash

Get the JA3S hash (md5sum of JA3S string) through JA3SGetHash.

Examples:

```
function log (args)
    hash = Ja3SGetHash()
    if hash == nil then
        return
    end
end
```

Or, for detection:

```
function match (args)
    hash = Ja3SGetHash()
    if hash == nil then
      return 0
    end

    // matching code

    return 0
end
```

JA3SGetString

Get the JA3S string through Ja3SGetString.

Examples:

```
function log (args)
    str = Ja3SGetString()
    if str == nil then
        return
    end
end
```

Or, for detection:

```
function match (args)
  str = Ja3SGetString()
  if str == nil then
    return 0
  end

  // matching code

  return 0
end
```

18.2.8 SSH

Initialize with:

```
function init (args)
    local needs = {}
    needs["protocol"] = "ssh"
    return needs
end
```

SshGetServerProtoVersion

Get SSH protocol version used by the server through SshGetServerProtoVersion.

Example:

```
function log (args)
    version = SshGetServerProtoVersion()
    if version == nil then
        return 0
    end
end
```

SshGetServerSoftwareVersion

Get SSH software used by the server through SshGetServerSoftwareVersion.

Example:

```
function log (args)
    software = SshGetServerSoftwareVersion()
    if software == nil then
        return 0
    end
end
```

SshGetClientProtoVersion

Get SSH protocol version used by the client through SshGetClientProtoVersion.

Example:

```
function log (args)
    version = SshGetClientProtoVersion()
    if version == nil then
        return 0
    end
end
```

SshGetClientSoftwareVersion

Get SSH software used by the client through SshGetClientSoftwareVersion.

Example:

```
function log (args)
    software = SshGetClientSoftwareVersion()
    if software == nil then
        return 0
    end
end
```

HasshGet

Get MD5 of hassh algorithms used by the client through HasshGet.

Example:

```
function log (args)
    hassh = HasshGet()
    if hassh == nil then
        return 0
    end
end
```

HasshGetString

Get hassh algorithms used by the client through HasshGetString.

Example:

```
function log (args)
    hassh_string = HasshGetString()
    if hassh == nil then
        return 0
    end
end
```

HasshServerGet

Get MD5 of hassh algorithms used by the server through HasshServerGet.

Example:

```
function log (args)
    hassh_string = HasshServerGet()
    if hassh == nil then
        return 0
    end
end
```

HasshServerGetString

Get hassh algorithms used by the server through HasshServerGetString.

Example:

```
function log (args)
    hassh_string = HasshServerGetString()
    if hassh == nil then
        return 0
    end
end
```

18.2.9 Files

To use the file logging API, the script's init() function needs to look like:

```
function init (args)
    local needs = {}
    needs['type'] = 'file'
    return needs
end
```

SCFileInfo

```
fileid, txid, name, size, magic, md5, sha1, sha256 = SCFileInfo()
```

returns fileid (number), txid (number), name (string), size (number), magic (string), md5 in hex (string), sha1 (string), sha256 (string)

SCFileState

```
state, stored = SCFileState()
```

returns state (string), stored (bool)

18.2.10 Alerts

Alerts are a subset of the 'packet' logger:

```
function init (args)
    local needs = {}
    needs["type"] = "packet"
    needs["filter"] = "alerts"
    return needs
end
```

SCRuleIds

```
sid, rev, gid = SCRuleIds()
```

SCRuleAction

```
action = SCRuleAction()
```

returns one of 'pass', 'reject', 'drop' or 'alert'

SCRuleMsg

```
msg = SCRuleMsg()
```

SCRuleClass

```
class, prio = SCRuleClass()
```

18.2.11 Streaming Data

Streaming data can currently log out reassembled TCP data and normalized HTTP data. The script will be invoked for each consecutive data chunk.

In case of TCP reassembled data, all possible overlaps are removed according to the host OS settings.

```
function init (args)
    local needs = {}
    needs["type"] = "streaming"
    needs["filter"] = "tcp"
    return needs
end
```

In case of HTTP body data, the bodies are unzipped and dechunked if applicable.

```
function init (args)
    local needs = {}
    needs["type"] = "streaming"
    needs["protocol"] = "http"
    return needs
end
```

SCStreamingBuffer

```
function log(args)
    -- sb_ts and sb_tc are bools indicating the direction of the data
    data, sb_open, sb_close, sb_ts, sb_tc = SCStreamingBuffer()
    if sb_ts then
      print("->")
    else
      print("<-")
    end
    hex_dump(data)
end
```

18.2.12 Flow variables

It is possible to access, define and modify Flow variables from Lua. To do so, you must use the functions described in this section and declare the counter in init function:

```
function init(args)
    local needs = {}
    needs["tls"] tostring(true)
    needs["flowint"] = {"tls-cnt"}
```

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```
    return needs
end
```

Here we define a *tls-cnt* Flowint that can now be used in output or in a signature via dedicated functions. The access to the Flow variable is done by index so in our case we need to use 0.

```
function match(args)
    a = SCFlowintGet(0);
    if a then
        SCFlowintSet(0, a + 1)
    else
        SCFlowintSet(0, 1)
    end
```

SCFlowintGet

Get the Flowint at index given by the parameter.

SCFlowintSet

Set the Flowint at index given by the first parameter. The second parameter is the value.

SCFlowintIncr

Increment Flowint at index given by the first parameter.

SCFlowintDecr

Decrement Flowint at index given by the first parameter.

SCFlowvarGet

Get the Flowvar at index given by the parameter.

SCFlowvarSet

Set a Flowvar. First parameter is the index, second is the data and third is the length of data.

You can use it to set string

```
function init (args)
    local needs = {}
    needs["http.request_headers"] = tostring(true)
    needs["flowvar"] = {"cnt"}
    return needs
end

function match(args)
```

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```
    a = SCFlowvarGet(0);
    if a then
        a = tostring(tonumber(a)+1)
        SCFlowvarSet(0, a, #a)
    else
        a = tostring(1)
        SCFlowvarSet(0, a, #a)
    end
```

18.2.13 Misc

SCThreadInfo

```
tid, tname, tgroup = SCThreadInfo()
```

It gives: tid (integer), tname (string), tgroup (string)

SCLogError, SCLogWarning, SCLogNotice, SCLogInfo, SCLogDebug

Print a message. It will go into the outputs defined in the yaml. Whether it will be printed depends on the log level.

Example:

```
SCLogError("some error message")
```

SCLogPath

Expose the log path.

```
name = "fast_lua.log"
function setup (args)
    filename = SCLogPath() .. "/" .. name
    file = assert(io.open(filename, "a"))
end
```

SCByteVarGet

Get the ByteVar at index given by the parameter. These variables are defined by *byte_extract* or *byte_math* in Suricata rules. Only callable from match scripts.

```
function init(args)
    local needs = {}
    needs["bytevar"] = {"var1", "var2"}
    return needs
end
```

Here we define a register that we will be using variables *var1* and *var2*. The access to the Byte variables is done by index.

```
function match(args)
    var1 = SCByteVarGet(0)
    var2 = SCByteVarGet(1)
```

CHAPTER

NINETEEN

FILE EXTRACTION

19.1 Architecture

The file extraction code works on top of selected protocol parsers (see supported protocols below). The application layer parsers run on top of the stream reassembly engine and the UDP flow tracking.

In case of HTTP, the parser takes care of dechunking and unzipping the request and/or response data if necessary.

This means that settings in the stream engine, reassembly engine and the application layer parsers all affect the workings of the file extraction.

The rule language controls which files are extracted and stored on disk.

Supported protocols are:

- HTTP
- SMTP
- FTP
- NFS
- SMB
- HTTP2

19.2 Settings

stream.checksum_validation controls whether or not the stream engine rejects packets with invalid checksums. A good idea normally, but the network interface performs checksum offloading a lot of packets may seem to be broken. This setting is enabled by default, and can be disabled by setting to "no". Note that the checksum handling can be controlled per interface, see "checksum_checks" in example configuration.

file-store.stream-depth controls how far into a stream reassembly is done. Beyond this value no reassembly will be done. This means that after this value the HTTP session will no longer be tracked. By default a setting of 1 Megabyte is used. 0 sets it to unlimited. If set to no, it is disabled and stream.reassembly.depth is considered. Non-zero values must be greater than `stream.stream-depth` to be used.

libhtp.default-config.request-body-limit / *libhtp.server-config.<config>.request-body-limit* controls how much of the HTTP request body is tracked for inspection by the *http_client_body* keyword, but also used to limit file inspection. A value of 0 means unlimited.

libhtp.default-config.response-body-limit / *libhtp.server-config.<config>.response-body-limit* is like the request body limit, only it applies to the HTTP response body.

19.3 Output

19.3.1 File-Store and Eve Fileinfo

There are two output modules for logging information about extracted files. The first is `eve.files` which is an `eve` sub-logger that logs `fileinfo` records. These `fileinfo` records provide metadata about the file, but not the actual file contents.

This must be enabled in the `eve` output:

```
- outputs:
    - eve-log:
      types:
          - files:
              force-magic: no
              force-hash: [md5,sha256]
```

See *Eve (Extensible Event Format)* for more details on working with the *eve* output.

The other output module, `file-store` stores the actual files to disk.

The `file-store` module uses its own log directory (default: *filestore* in the default logging directory) and logs files using the SHA256 of the contents as the filename. Each file is then placed in a directory named *00* to *ff* where the directory shares the first 2 characters of the filename. For example, if the SHA256 hex string of an extracted file starts with "f9bc6d..." the file we be placed in the directory *filestore/f9*.

The size of a file that can be stored depends on `file-store.stream-depth`, if this value is reached a file can be truncated and might not be stored completely. If not enabled, `stream.reassembly.depth` will be considered.

Setting `file-store.stream-depth` to 0 permits store of the entire file; here, 0 means "unlimited."

`file-store.stream-depth` will always override `stream.reassembly.depth` when filestore keyword is used. However, it is not possible to set `file-store.stream-depth` to a value less than `stream.reassembly.depth`. Values less than this amount are ignored and a warning message will be displayed.

A protocol parser, like modbus, could permit to set a different store-depth value and use it rather than `file-store.stream-depth`.

Using the SHA256 for file names allows for automatic de-duplication of extracted files. However, the timestamp of a preexisting file will be updated if the same files is extracted again, similar to the *touch* command.

Optionally a `fileinfo` record can be written to its own file sharing the same SHA256 as the file it references. To handle recording the metadata of each occurrence of an extracted file, these filenames include some extra fields to ensure uniqueness. Currently the format is:

```
<SHA256>.<SECONDS>.<ID>.json
```

where `<SECONDS>` is the seconds from the packet that triggered the stored file to be closed and `<ID>` is a unique ID for the runtime of the Suricata instance. These values should not be depended on, and are simply used to ensure uniqueness.

These `fileinfo` records are identical to the `fileinfo` records logged to the `eve` output.

See *File-store (File Extraction)* for more information on configuring the file-store output.

Note: This section documents version 2 of the `file-store`. Version 1 of the file-store has been removed as of Suricata version 6.

19.4 Rules

Without rules in place no extraction will happen. The simplest rule would be:

```
alert http any any -> any any (msg:"FILE store all"; filestore; sid:1; rev:1;)
```

This will simply store all files to disk.

Want to store all files with a pdf extension?

```
alert http any any -> any any (msg:"FILE PDF file claimed"; fileext:"pdf"; filestore;␣
↪sid:2; rev:1;)
```

Or rather all actual pdf files?

```
alert http any any -> any any (msg:"FILE pdf detected"; filemagic:"PDF document";␣
↪filestore; sid:3; rev:1;)
```

Or rather only store files from black list checksum md5 ?

```
alert http any any -> any any (msg:"Black list checksum match and extract MD5";␣
↪filemd5:fileextraction-chksum.list; filestore; sid:4; rev:1;)
```

Or only store files from black list checksum sha1 ?

```
alert http any any -> any any (msg:"Black list checksum match and extract SHA1";␣
↪filesha1:fileextraction-chksum.list; filestore; sid:5; rev:1;)
```

Or finally store files from black list checksum sha256 ?

::

alert http any any -> any any (msg:"Black list checksum match and extract SHA256"; filesha256:fileextraction-chksum.list; filestore; sid:6; rev:1;)

Bundled with the Suricata download, is a file with more example rules. In the archive, go to the *rules* directory and check the `files.rules` file.

19.5 MD5

Suricata can calculate MD5 checksums of files on the fly and log them. See *Storing MD5s checksums* for an explanation on how to enable this.

19.5.1 Storing MD5s checksums

Configuration

In the Suricata config file:

```
- file-store:
    enabled: yes       # set to yes to enable
    dir: filestore     # directory to store the files
    force-hash: [md5]  # force logging of md5 checksums
```

For JSON output:

```
outputs:
  - eve-log:
    enabled: yes
    filetype: regular #regular|syslog|unix_dgram|unix_stream|redis
    filename: eve.json
    types:
      - files:
        force-magic: no   # force logging magic on all logged files
        # force logging of checksums, available hash functions are md5,
        # sha1 and sha256
        #force-hash: [md5]
```

Other settings affecting *File Extraction*

```
stream:
  memcap: 64mb
  checksum-validation: yes      # reject wrong csums
  inline: no                    # no inline mode
  reassembly:
    memcap: 32mb
    depth: 0                     # reassemble all of a stream
    toserver-chunk-size: 2560
    toclient-chunk-size: 2560
```

Make sure we have *depth: 0* so all files can be tracked fully.

```
libhtp:
  default-config:
    personality: IDS
    # Can be specified in kb, mb, gb.  Just a number indicates
    # it's in bytes.
    request-body-limit: 0
    response-body-limit: 0
```

Make sure we have *request-body-limit: 0* and *response-body-limit: 0*

Testing

For the purpose of testing we use this rule only in a file.rules (a test/example file):

```
alert http any any -> any any (msg:"FILE store all"; filestore; sid:1; rev:1;)
```

This rule above will save all the file data for files that are opened/downloaded through HTTP

Start Suricata (`-S` option *ONLY loads* the specified rule file and disregards any other rules that are enabled in suricata.yaml):

```
suricata -c /etc/suricata/suricata.yaml -S file.rules -i eth0
```

Meta data:

```
TIME:              05/01/2012-11:09:52.425751
SRC IP:            2.23.144.170
DST IP:            192.168.1.91
PROTO:             6
SRC PORT:          80
DST PORT:          51598
HTTP URI:          /en/US/prod/collateral/routers/ps5855/prod_brochure0900aecd8019dc1f.
↪pdf
HTTP HOST:         www.cisco.com
HTTP REFERER:      http://www.cisco.com/c/en/us/products/routers/3800-series-integrated-
↪services-routers-isr/index.html
FILENAME:          /en/US/prod/collateral/routers/ps5855/prod_brochure0900aecd8019dc1f.
↪pdf
MAGIC:             PDF document, version 1.6
STATE:             CLOSED
MD5:               59eba188e52467adc11bf2442ee5bf57
SIZE:              9485123
```

and in files-json.log (or eve.json) :

```
{ "id": 1, "timestamp": "05\/01\/2012-11:10:27.693583", "ipver": 4, "srcip": "2.23.144.
↪170", "dstip": "192.168.1.91", "protocol": 6, "sp": 80, "dp": 51598, "http_uri": "\/en\
↪/US\/prod\/collateral\/routers\/ps5855\/prod_brochure0900aecd8019dc1f.pdf", "http_host
↪": "www.cisco.com", "http_referer": "http:\/\/www.google.com\/url?sa=t&rct=j&q=&esrc=s&
↪source=web&cd=1&ved=0CDAQFjAA&url=http%3A%2F%2Fwww.cisco.com%2Fen%2FUS%2Fprod
↪%2Fcollateral%2Frouters%2Fps5855%2Fprod_brochure0900aecd8019dc1f.pdf&
↪ei=OqyfT9eoJubi4QTyiamhAw&usg=AFQjCNGdjDBpBDfQv2r3VogSH41V6T5x9Q", "filename": "\/en\/
↪US\/prod\/collateral\/routers\/ps5855\/prod_brochure0900aecd8019dc1f.pdf", "magic":
↪"PDF document, version 1.6", "state": "CLOSED", "md5":
↪"59eba188e52467adc11bf2442ee5bf57", "stored": true, "size": 9485123 }
{ "id": 12, "timestamp": "05\/01\/2012-11:12:57.421420", "ipver": 4, "srcip": "2.23.144.
↪170", "dstip": "192.168.1.91", "protocol": 6, "sp": 80, "dp": 51598, "http_uri": "\/en\
↪/US\/prod\/collateral\/routers\/ps5855\/prod_brochure0900aecd8019dc1f.pdf", "http_host
↪": "www.cisco.com", "http_referer": "http:\/\/www.google.com\/url?sa=t&rct=j&q=&esrc=s&
↪source=web&cd=1&ved=0CDAQFjAA&url=http%3A%2F%2Fwww.cisco.com%2Fen%2FUS%2Fprod
↪%2Fcollateral%2Frouters%2Fps5855%2Fprod_brochure0900aecd8019dc1f.pdf&
↪ei=OqyfT9eoJubi4QTyiamhAw&usg=AFQjCNGdjDBpBDfQv2r3VogSH41V6T5x9Q", "filename": "\/en\/
↪US\/prod\/collateral\/routers\/ps5855\/prod_brochure0900aecd8019dc1f.pdf", "magic":
↪"PDF document, version 1.6", "state": "CLOSED", "md5":
↪"59eba188e52467adc11bf2442ee5bf57", "stored": true, "size": 9485123 }
```

Log all MD5s without any rules

If you would like to log MD5s for everything and anything that passes through the traffic that you are inspecting with Suricata, but not log the files themselves, all you have to do is disable file-store and enable only the JSON output with forced MD5s - in suricata.yaml like so:

```
- file-store:
    version: 2
    enabled: no       # set to yes to enable
    log-dir: files    # directory to store the files
```

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```
    force-filestore: no
    force-hash: [md5]  # force logging of md5 checksums
```

19.5.2 Public SHA1 MD5 data sets

National Software Reference Library - http://www.nsrl.nist.gov/Downloads.html

19.6 Updating Filestore Configuration

19.6.1 Update File-store v1 Configuration to V2

Given a file-store configuration like:

```
- file-store:
    enabled: yes        # set to yes to enable
    log-dir: files      # directory to store the files
    force-magic: no     # force logging magic on all stored files
    force-hash: [md5]   # force logging of md5 checksums
    force-filestore: no # force storing of all files
    stream-depth: 1mb   # reassemble 1mb into a stream, set to no to disable
    waldo: file.waldo   # waldo file to store the file_id across runs
    max-open-files: 0   # how many files to keep open (0 means none)
    write-meta: yes     # write a .meta file if set to yes
    include-pid: yes    # include the pid in filenames if set to yes.
```

The following changes will need to be made to convert to a v2 style configuration:

- The `version` field must be set to 2.
- The `log-dir` field should be renamed to `dir`. It is recommended to use a new directory instead of an existing v1 directory.
- Remove the `waldo` option. It is no longer used.
- Remove the `write-meta` option.
- Optionally set `write-fileinfo` to enable writing of a metadata file along side the extracted file. Not that this option is disabled by default as a `fileinfo` event can be written to the Eve log file.
- Remove the `include-pid` option. There is no equivalent to this option in file-store v2.

Example converted configuration:

```
- file-store:
    version: 2
    enabled: yes
    dir: filestore
    force-hash: [md5]
    file-filestore: no
    stream-depth: 1mb
    max-open-files: 0
    write-fileinfo: yes
```

Refer to the *File Extraction* section of the manual for information about the format of the file-store directory for file-store v2.

CHAPTER

TWENTY

PUBLIC DATA SETS

Collections of pcaps for testing and profiling.

DARPA sets: https://www.ll.mit.edu/r-d/datasets?author=All&rdarea=All&rdgroup=All&keywords=cyber&tag=All&items_per_page=10

MAWI sets (pkt headers only, no payloads): http://mawi.wide.ad.jp/mawi/samplepoint-F/2012/

MACCDC: http://www.netresec.com/?page=MACCDC

Netresec: http://www.netresec.com/?page=PcapFiles

Wireshark: https://gitlab.com/wireshark/wireshark/-/wikis/SampleCaptures

Security Onion collection: https://securityonion.net/docs/Pcaps

Stratosphere IPS. Malware Capture Facility Project: https://stratosphereips.org/category/dataset.html

CHAPTER

TWENTYONE

USING CAPTURE HARDWARE

21.1 AF_PACKET

21.1.1 Introduction

AF_PACKET is a capture interface to the Linux Kernel.

21.1.2 Config Options

disable-hwtimestamp

Boolean option to disable hardware timestamping on an interface.

By default the hardware timestamping support is enabled if the system support it.

Hardware timestamping can lead to issue of the NIC and kernel getting out of sync. See ticket 7585.

```
af-packet:
  - interface: eth0
    cluster-id: 99
    disable-hwtimestamp: true
    cluster-type: cluster_flow
```

21.2 Endace DAG

Suricata comes with native Endace DAG card support. This means Suricata can use the *libdag* interface directly, instead of a libpcap wrapper (which should also work).

Steps:

Configure with DAG support:

```
./configure --enable-dag --prefix=/usr --sysconfdir=/etc --localstatedir=/var
make
sudo make install
```

Results in:

```
Suricata Configuration:
  AF_PACKET support:                       no
  PF_RING support:                         no
  NFQueue support:                         no
  IPFW support:                            no
  DAG enabled:                             yes
  Napatech enabled:                        no
```

Start with:

```
suricata -c suricata.yaml --dag 0:0
```

Started up!

```
[5570] 10/7/2012 -- 13:52:30 - (source-erf-dag.c:262) <Info> (ReceiveErfDagThreadInit) --
↪ Attached and started stream: 0 on DAG: /dev/dag0
[5570] 10/7/2012 -- 13:52:30 - (source-erf-dag.c:288) <Info> (ReceiveErfDagThreadInit) --
↪ Starting processing packets from stream: 0 on DAG: /dev/dag0
```

21.3 Napatech

21.3.1 Contents

- Introduction
- Package Installation
- Basic Configuration
- Advanced Multithreaded Configuration

21.3.2 Introduction

Napatech packet capture accelerator cards can greatly improve the performance of your Suricata deployment using these hardware based features:

- On board burst buffering (up to 12GB)
- Zero-copy kernel bypass DMA
- Non-blocking PCIe performance
- Port merging
- Load distribution to up 128 host buffers
- Precise timestamping
- Accurate time synchronization

The package uses a proprietary shell script to handle the installation process. In either case, gcc, make and the kernel header files are required to compile the kernel module and install the software.

21.3.3 Package Installation

Note that make, gcc, and the kernel headers are required for installation

Root privileges are also required

The latest driver and tools installation package can be downloaded from: https://www.napatech.com/downloads.

Note that you will be prompted to install the Napatech libpcap library. Answer "yes" if you would like to use the Napatech card to capture packets in Wireshark, tcpdump, or another pcap based application. Libpcap is not needed for Suricata as native Napatech API support is included

Red Hat Based Distros:

```
$ yum install kernel-devel-$(uname -r) gcc make
       $ ./package_install_3gd.sh
```

Debian Based Distros:

```
$ apt-get install linux-headers-$(uname .r) gcc make
       $ ./package_install_3gd.sh
```

To complete installation for all distros `ntservice`:

```
$ /opt/napatech3/bin/ntstart.sh -m
```

21.3.4 Suricata Installation

After downloading and extracting the Suricata tarball, you need to run configure to enable Napatech support and prepare for compilation:

```
$ ./configure --enable-napatech --with-napatech-includes=/opt/napatech3/include --with-
↪napatech-libraries=/opt/napatech3/lib
$ make
$ make install-full
```

21.3.5 Suricata configuration

Now edit the suricata.yaml file to configure the system. There are three ways the system can be configured:

1. Auto-config without cpu-affinity: In this mode you specify the stream configuration in suricata.yaml file and allow the threads to roam freely. This is good for single processor systems where NUMA node configuration is not a performance concern.

2. Auto-config with cpu-affinity: In this mode you use the cpu-affinity of the worker threads to control the creation and configuration of streams. One stream and one worker thread will be created for each cpu identified in suricata.yaml. This is best in systems with multiple NUMA nodes (i.e. multi-processor systems) as the NUMA node of the host buffers is matched to the core on which the thread is running.

3. Manual-config (legacy): In this mode the underlying Napatech streams are configured by issuing NTPL commands prior to running Suricata. Suricata then connects to the existing streams on startup.

21.3.6 Example Configuration - Auto-config without cpu-affinity:

If cpu-affinity is not used it is necessary to explicitly define the streams in the Suricata configuration file. To use this option the following options should be set in the Suricata configuration file:

1. Turn off cpu-affinity
2. Enable the Napatech "auto-config" option
3. Specify the streams that should be created on startup
4. Specify the ports that will provide traffic to Suricata
5. Specify the hashmode used to distribute traffic to the streams

Below are the options to set:

```
threading:
  set-cpu-affinity: no
    .
    .
    .
napatech:
    auto-config: yes
    streams: ["0-3"]
    ports: [all]
    hashmode: hash5tuplesorted
```

Now modify `ntservice.ini`. You also need make sure that you have allocated enough host buffers in `ntservice.ini` for the streams. It's a good idea to also set the `TimeSyncReferencePriority`. To do this make the following changes to ntservice.ini:

> HostBuffersRx = [4,16,-1] # [number of host buffers, Size(MB), NUMA node] TimeSyncReferencePriority = OSTime # Timestamp clock synchronized to the OS

Stop and restart `ntservice` after making changes to ntservice:

```
$ /opt/napatech3/bin/ntstop.sh
$ /opt/napatech3/bin/ntstart.sh
```

Now you are ready to start Suricata:

```
$ suricata -c /usr/local/etc/suricata/suricata.yaml --napatech --runmode workers
```

21.3.7 Example Configuration - Auto-config with cpu-affinity:

This option will create a single worker-thread and stream for each CPU defined in the `worker-cpu-set`. To use this option make the following changes to suricata.yaml:

1. Turn on cpu-affinity
2. Specify the worker-cpu-set
3. Enable the Napatech "auto-config" option
4. Specify the ports that will provide traffic to Suricata
5. Specify the hashmode that will be used to control the distribution of traffic to the different streams/cpus.

When you are done it should look similar to this:

```
threading:
  set-cpu-affinity: yes
  cpu-affinity:
    management-cpu-set:
      cpu: [ 0 ]
    receive-cpu-set:
      cpu: [ 0 ]
    worker-cpu-set:
      cpu: [ all ]
      .
      .
      .
napatech:
  auto-config: yes
  ports: [all]
  hashmode: hash5tuplesorted
```

Prior to running Suricata in this mode you also need to configure a sufficient number of host buffers on each NUMA node. So, for example, if you have a two processor server with 32 total cores and you plan to use all of the cores you will need to allocate 16 host buffers on each NUMA node. It is also desirable to set the Napatech cards time source to the OS.

To do this make the following changes to ntservice.ini:

```
TimeSyncReferencePriority = OSTime  # Timestamp clock synchronized to the OS
HostBuffersRx = [16,16,0],[16,16,1] # [number of host buffers, Size(MB), NUMA node]
```

Stop and restart `ntservice` after making changes to ntservice:

```
$ /opt/napatech3/bin/ntstop.sh -m
$ /opt/napatech3/bin/ntstart.sh -m
```

Now you are ready to start Suricata:

```
$ suricata -c /usr/local/etc/suricata/suricata.yaml --napatech --runmode workers
```

21.3.8 Example Configuration - Manual Configuration

For Manual Configuration the Napatech streams are created by running NTPL commands prior to running Suricata.

Note that this option is provided primarily for legacy configurations as previously this was the only way to configure Napatech products. Newer capabilities such as flow-awareness and inline processing cannot be configured manually.

In this example we will setup the Napatech capture accelerator to merge all physical ports, and then distribute the merged traffic to four streams that Suricata will ingest.

The steps for this configuration are:

1. Disable the Napatech auto-config option in suricata.yaml
2. Specify the streams that Suricata is to use in suricata.yaml
3. Create a file with NTPL commands to create the underlying Napatech streams.

First suricata.yaml should be configured similar to the following:

```
napatech:
  auto-config: no
  streams: ["0-3"]
```

Next you need to make sure you have enough host buffers defined in ntservice.ini. As it's also a good idea to set up the TimeSync. Here are the lines to change:

```
TimeSyncReferencePriority = OSTime      # Timestamp clock synchronized to the OS
HostBuffersRx = [4,16,-1]               # [number of host buffers, Size(MB), NUMA node]
```

Stop and restart ntservice after making changes to ntservice:

```
$ /opt/napatech3/bin/ntstop.sh
$ /opt/napatech3/bin/ntstart.sh
```

Now that ntservice is running we need to execute a few NTPL (Napatech Programming Language) commands to complete the setup. Create a file will the following commands:

```
Delete=All                              # Delete any existing filters
Assign[streamid=(0..3)]= all    # Assign all physical ports to stream ID 0
```

Next execute those command using the `ntpl` tool:

```
$ /opt/napatech3/bin/ntpl -f <my_ntpl_file>
```

Now you are ready to start Suricata:

```
$ suricata -c /usr/local/etc/suricata/suricata.yaml --napatech --runmode workers
```

It is possible to specify much more elaborate configurations using this option. Simply by creating the appropriate NTPL file and attaching Suricata to the streams.

21.3.9 Bypassing Flows

On flow-aware Napatech products, traffic from individual flows can be automatically dropped or, in the case of inline configurations, forwarded by the hardware after an inspection of the initial packet(s) of the flow by Suricata. This will save CPU cycles since Suricata does not process packets for a flow that has already been adjudicated. This is enabled via the hardware-bypass option in the Napatech section of the configuration file.

When hardware bypass is used it is important that the ports accepting upstream and downstream traffic from the network are configured with information on which port the two sides of the connection will arrive. This is needed for the hardware to properly process traffic in both directions. This is indicated in the "ports" section as a hyphen separated list of port-pairs that will be receiving upstream and downstream traffic E.g.:

```
napatech:
  hardware-bypass: true
  ports[0-1,2-3]
```

Note that these "port-pairings" are also required for IDS configurations as the hardware needs to know on which port(s) two sides of the connection will arrive.

For configurations relying on optical taps the two sides of the pairing will typically be different ports. For SPAN port configurations where both upstream and downstream traffic are delivered to a single port both sides of the "port-pair" will reference the same port.

For example tap configurations have a form similar to this:

```
ports[0-1,2-3]
```

Whereas SPAN port configurations it would look similar to this:

```
ports[0-0,1-1,2-2,3-3]
```

Note that SPAN and tap configurations may be combined on the same adapter.

There are multiple ways that Suricata can be configured to bypass traffic. One way is to enable stream.bypass in the configuration file. E.g.:

```
stream:
  bypass: true
```

When enabled once Suricata has evaluated the first chunk of the stream (the size of which is also configurable) it will indicate that the rest of the packets in the flow can be bypassed. In IDS mode this means that the subsequent packets of the flow will be dropped and not delivered to Suricata. In inline operation the packets will be transmitted on the output port but not delivered to Suricata.

Another way is by specifying the "bypass" keyword in a rule. When a rule is triggered with this keyword then the "pass" or "drop" action will be applied to subsequent packets of the flow automatically without further analysis by Suricata. For example given the rule:

```
drop tcp any 443 <> any any (msg: "SURICATA Test rule"; bypass; sid:1000001; rev:2;)
```

Once Suricata initially evaluates the fist packet(s) and identifies the flow, all subsequent packets from the flow will be dropped by the hardware; thus saving CPU cycles for more important tasks.

The timeout value for how long to wait before evicting stale flows from the hardware flow table can be specified via the FlowTimeout attribute in ntservice.ini.

21.3.10 Inline Operation

Napatech flow-aware products can be configured for inline operation. This is specified in the configuration file. When enabled, ports are specified as port-pairs. With traffic received from one port it is transmitted out the the peer port after inspection by Suricata. E.g. the configuration:

```
napatech:
 inline: enabled
 ports[0-1, 2-3]
```

Will pair ports 0 and 1; and 2 and 3 as peers. Rules can be defined to pass traffic matching a given signature. For example, given the rule:

```
pass tcp any 443 <> any any (msg: "SURICATA Test rule";  bypass; sid:1000001; rev:2;)
```

Suricata will evaluate the initial packet(s) of the flow and program the flow into the hardware. Subsequent packets from the flow will be automatically be shunted from one port to it's peer.

21.3.11 Counters

The following counters are available:

- napa_total.pkts - The total of packets received by the card.
- napa_total.byte - The total count of bytes received by the card.
- napa_total.overflow_drop_pkts - The number of packets that were dropped because the host buffers were full. (I.e. the application is not able to process packets quickly enough.)
- napa_total.overflow_drop_byte - The number of bytes that were dropped because the host buffers were full. (I.e. the application is not able to process packets quickly enough.)

On flow-aware products the following counters are also available:

- napa_dispatch_host.pkts, napa_dispatch_host.byte:

  The total number of packets/bytes that were dispatched to a host buffer for processing by Suricata. (Note: this count includes packets that may be subsequently dropped if there is no room in the host buffer.)

- napa_dispatch_drop.pkts, napa_dispatch_drop.byte:

  The total number of packets/bytes that were dropped at the hardware as a result of a Suricata "drop" bypass rule or other adjudication by Suricata that the flow packets should be dropped. These packets are not delivered to the application.

- napa_dispatch_fwd.pkts, napa_dispatch_fwd.byte:

  When inline operation is configured this is the total number of packets/bytes that were forwarded as result of a Suricata "pass" bypass rule or as a result of stream or encryption bypass being enabled in the configuration file. These packets were not delivered to the application.

- napa_bypass.active_flows:

  The number of flows actively programmed on the hardware to be forwarded or dropped.

- napa_bypass.total_flows:

  The total count of flows programmed since the application started.

If enable-stream-stats is enabled in the configuration file then, for each stream that is being processed, the following counters will be output in stats.log:

- napa<streamid>.pkts: The number of packets received by the stream.
- napa<streamid>.bytes: The total bytes received by the stream.
- napa<streamid>.drop_pkts: The number of packets dropped from this stream due to buffer overflow conditions.
- napa<streamid>.drop_byte: The number of bytes dropped from this stream due to buffer overflow conditions.

This is useful for fine-grain debugging to determine if a specific CPU core or thread is falling behind resulting in dropped packets.

If hba is enabled the following counter will also be provided:

- napa<streamid>.hba_drop: the number of packets dropped because the host buffer allowance high-water mark was reached.

In addition to counters host buffer utilization is tracked and logged. This is also useful for debugging. Log messages are output for both Host and On-Board buffers when reach 25, 50, 75 percent of utilization. Corresponding messages are output when utilization decreases.

Debugging:

For debugging configurations it is useful to see what traffic is flowing as well as what streams are created and receiving traffic. There are two tools in /opt/napatech3/bin that are useful for this:

- monitoring: this tool will, among other things, show what traffic is arriving at the port interfaces.
- profiling: this will show host-buffers, streams and traffic flow to the streams.

If Suricata terminates abnormally stream definitions, which are normally removed at shutdown, may remain in effect. If this happens they can be cleared by issuing the "delete=all" NTPL command as follows:

```
# /opt/napatech3/bin/ntpl -e "delete=all"
```

21.3.12 Napatech configuration options:

These are the Napatech options available in the Suricata configuration file:

```
napatech:
  # The Host Buffer Allowance for all streams
  # (-1 = OFF, 1 - 100 = percentage of the host buffer that can be held back)
  # This may be enabled when sharing streams with another application.
  # Otherwise, it should be turned off.
  #
  # Note: hba will be deprecated in Suricata 7
  #
  #hba: -1

  # When use_all_streams is set to "yes" the initialization code will query
  # the Napatech service for all configured streams and listen on all of them.
  # When set to "no" the streams config array will be used.
  #
  # This option necessitates running the appropriate NTPL commands to create
  # the desired streams prior to running Suricata.
  #use-all-streams: no

  # The streams to listen on when auto-config is disabled or when threading
  # cpu-affinity is disabled. This can be either:
  #   an individual stream (e.g. streams: [0])
  # or
  #   a range of streams (e.g. streams: ["0-3"])
  #
  streams: ["0-3"]

  # Stream stats can be enabled to provide fine grain packet and byte counters
  # for each thread/stream that is configured.
  #
  enable-stream-stats: no

  # When auto-config is enabled the streams will be created and assigned
  # automatically to the NUMA node where the thread resides. If cpu-affinity
  # is enabled in the threading section, then the streams will be created
  # according to the number of worker threads specified in the worker cpu set.
  # Otherwise, the streams array is used to define the streams.
  #
  # This option cannot be used simultaneous with "use-all-streams".
```

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```
#
auto-config: yes

# Enable hardware level flow bypass.
#
hardware-bypass: yes

# Enable inline operation. When enabled traffic arriving on a given port is
# automatically forwarded out it's peer port after analysis by Suricata.
# hardware-bypass must be enabled when this is enabled.
#
inline: no

# Ports indicates which napatech ports are to be used in auto-config mode.
# these are the port ID's of the ports that will be merged prior to the
# traffic being distributed to the streams.
#
# When hardware-bypass is enabled the ports must be configured as a segment
# specify the port(s) on which upstream and downstream traffic will arrive.
# This information is necessary for the hardware to properly process flows.
#
# When using a tap configuration one of the ports will receive inbound traffic
# for the network and the other will receive outbound traffic. The two ports on a
# given segment must reside on the same network adapter.
#
# When using a SPAN-port configuration the upstream and downstream traffic
# arrives on a single port. This is configured by setting the two sides of the
# segment to reference the same port.  (e.g. 0-0 to configure a SPAN port on
# port 0).
#
# port segments are specified in the form:
#    ports: [0-1,2-3,4-5,6-6,7-7]
#
# For legacy systems when hardware-bypass is disabled this can be specified in any
# of the following ways:
#
#   a list of individual ports (e.g. ports: [0,1,2,3])
#
#   a range of ports (e.g. ports: [0-3])
#
#   "all" to indicate that all ports are to be merged together
#   (e.g. ports: [all])
#
# This parameter has no effect if auto-config is disabled.
#
ports: [0-1,2-3]

# When auto-config is enabled the hashmode specifies the algorithm for
# determining to which stream a given packet is to be delivered.
# This can be any valid Napatech NTPL hashmode command.
#
# The most common hashmode commands are: hash2tuple, hash2tuplesorted,
```

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```
  # hash5tuple, hash5tuplesorted and roundrobin.
  #
  # See Napatech NTPL documentation other hashmodes and details on their use.
  #
  # This parameter has no effect if auto-config is disabled.
  #
  hashmode: hash5tuplesorted
```

Note: hba is useful only when a stream is shared with another application. When hba is enabled packets will be dropped (i.e. not delivered to Suricata) when the host-buffer utilization reaches the high-water mark indicated by the hba value. This insures that, should Suricata get behind in its packet processing, the other application will still receive all of the packets. If this is enabled without another application sharing the stream it will result in sub-optimal packet buffering.

Make sure that there are enough host-buffers declared in `ntservice.ini` to accommodate the number of cores/streams being used.

21.3.13 Support

Contact a support engineer at: ntsupport@napatech.com

Napatech Documentation can be found at: https://docs.napatech.com (Click the search icon, with no search text, to see all documents in the portal.)

21.4 Myricom

From: https://blog.inliniac.net/2012/07/10/suricata-on-myricom-capture-cards/

In this guide I'll describe using the Myricom libpcap support. I'm going to assume you installed the card properly, installed the Sniffer driver and made sure that all works. Make sure `dmesg` shows that the card is in sniffer mode:

```
[ 2102.860241] myri_snf INFO: eth4: Link0 is UP
[ 2101.341965] myri_snf INFO: eth5: Link0 is UP
```

I have installed the Myricom runtime and libraries in `/opt/snf`

Compile Suricata against Myricom's libpcap:

```
./configure --with-libpcap-includes=/opt/snf/include/ --with-libpcap-libraries=/opt/snf/
↪lib/ --prefix=/usr --sysconfdir=/etc --localstatedir=/var
make
sudo make install
```

Next, configure the amount of ringbuffers. I'm going to work with 8 here, as my quad core + hyper threading has 8 logical CPUs. *See below* for additional information about the buffer-size parameter.

```
pcap:
  - interface: eth5
    threads: 8
    buffer-size: 512kb
    checksum-checks: no
```

The 8 threads setting causes Suricata to create 8 reader threads for eth5. The Myricom driver makes sure each of those is attached to its own ringbuffer.

Then start Suricata as follows:

```
SNF_NUM_RINGS=8 SNF_FLAGS=0x1 suricata -c suricata.yaml -i eth5 --runmode=workers
```

If you want 16 ringbuffers, update the "threads" variable in the Suricata configuration file to *16* and start Suricata:

```
SNF_NUM_RINGS=16 SNF_FLAGS=0x1 suricata -c suricata.yaml -i eth5 --runmode=workers
```

Note that the `pcap.buffer-size` configuration setting shown above is currently ignored when using Myricom cards. The value is passed through to the `pcap_set_buffer_size` libpcap API within the Suricata source code. From Myricom support:

```
"The libpcap interface to Sniffer10G ignores the pcap_set_buffer_size() value.  The call␣
↪to snf_open() uses zero as the dataring_size which informs the Sniffer library to use␣
↪a default value or the value from the SNF_DATARING_SIZE environment variable."
```

The following pull request opened by Myricom in the libpcap project indicates that a future SNF software release could provide support for setting the SNF_DATARING_SIZE via the pcap.buffer-size yaml setting:

- https://github.com/the-tcpdump-group/libpcap/pull/435

Until then, the data ring and descriptor ring values can be explicitly set using the SNF_DATARING_SIZE and SNF_DESCRING_SIZE environment variables, respectively.

The SNF_DATARING_SIZE is the total amount of memory to be used for storing incoming packet data. This size is shared across all rings. The SNF_DESCRING_SIZE is the total amount of memory to be used for storing meta information about the packets (packet lengths, offsets, timestamps). This size is also shared across all rings.

Myricom recommends that the descriptor ring be 1/4 the size of the data ring, but the ratio can be modified based on your traffic profile. If not set explicitly, Myricom uses the following default values: SNF_DATARING_SIZE = 256MB, and SNF_DESCRING_SIZE = 64MB

Expanding on the 16 thread example above, you can start Suricata with a 16GB Data Ring and a 4GB Descriptor Ring using the following command:

```
SNF_NUM_RINGS=16 SNF_DATARING_SIZE=17179869184 SNF_DESCRING_SIZE=4294967296 SNF_
↪FLAGS=0x1 suricata -c suricata.yaml -i eth5 --runmode=workers
```

21.4.1 Debug Info

Myricom also provides a means for obtaining debug information. This can be useful for verifying your configuration and gathering additional information. Setting SNF_DEBUG_MASK=3 enables debug information, and optionally setting the SNF_DEBUG_FILENAME allows you to specify the location of the output file.

Following through with the example:

```
SNF_NUM_RINGS=16 SNF_DATARING_SIZE=17179869184 SNF_DESCRING_SIZE=4294967296 SNF_
↪FLAGS=0x1 SNF_DEBUG_MASK=3 SNF_DEBUG_FILENAME="/tmp/snf.out" suricata -c suricata.yaml␣
↪-i eth5 --runmode=workers
```

21.4.2 Additional Info

- http://www.40gbe.net/index_files/be59da7f2ab5bf0a299ab99ef441bb2e-28.html
- https://www.broadcom.com/support/knowledgebase/1211161394432/how-to-use-emulex-oneconnect-oce12000-d-adapters-with

21.5 eBPF and XDP

21.5.1 Introduction

eBPF stands for extended BPF. This is an extended version of Berkeley Packet Filter available in recent Linux kernel versions.

It provides more advanced features with eBPF programs developed in C and capability to use structured data shared between kernel and userspace.

eBPF is used for three things in Suricata:

- eBPF filter: any BPF like filter can be developed. An example of filter accepting only packet for some VLANs is provided. A bypass implementation is also provided.
- eBPF load balancing: provide programmable load balancing. Simple ippair load balancing is provided.
- XDP programs: Suricata can load XDP programs. A bypass program is provided.

Bypass can be implemented in eBPF and XDP. The advantage of XDP is that the packets are dropped at the earliest stage possible. So performance is better. But bypassed packets don't reach the network so you can't use this on regular traffic but only on duplicated/sniffed traffic.

The bypass implementation relies on one of the most powerful concept of eBPF: maps. A map is a data structure shared between user space and kernel space/hardware. It allows user space and kernel space to interact, pass information. Maps are often implemented as arrays or hash tables that can contain arbitrary key, value pairs.

XDP

XDP provides another Linux native way of optimising Suricata's performance on sniffing high speed networks:

> XDP or eXpress Data Path provides a high performance, programmable network data path in the Linux kernel as part of the IO Visor Project. XDP provides bare metal packet processing at the lowest point in the software stack which makes it ideal for speed without compromising programmability. Furthermore, new functions can be implemented dynamically with the integrated fast path without kernel modification.

More info about XDP:

- IOVisor's XDP page
- Cilium's BPF and XDP reference guide

21.5.2 Requirements

You will need a kernel that supports XDP and, for the most performance improvement, a network card that support XDP in the driver.

Suricata XDP code has been tested with 4.13.10 but 4.15 or later is necessary to use all features like the CPU redirect map.

If you are using an Intel network card, you will need to stay with in tree kernel NIC drivers. The out of tree drivers do not contain the XDP support.

Having a network card with support for RSS symmetric hashing is a good point or you will have to use the XDP CPU redirect map feature.

21.5.3 Prerequisites

This guide has been confirmed on Debian/Ubuntu "LTS" Linux.

Disable irqbalance

`irqbalance` may cause issues in most setups described here, so it is recommended to deactivate it

```
systemctl stop irqbalance
systemctl disable irqbalance
```

Kernel

You need to run a kernel 4.13 or newer.

Clang and dependencies

Make sure you have `clang` (>=3.9) installed on the system

```
sudo apt install clang
```

libbpf

Suricata uses libbpf to interact with eBPF and XDP

```
sudo apt install libbpf-dev
```

If the libbpf package is unavailable, it can be cloned from the repository

```
git clone https://github.com/libbpf/libbpf.git
```

Now, you can build and install the library

```
cd libbpf/src/
make && sudo make install

sudo make install_headers
sudo ldconfig
```

In some cases your system will not find the libbpf library that is installed under `/usr/lib64` so you may need to modify your ldconfig configuration.

21.5.4 Compile and install Suricata

To get Suricata source, you can use the usual

```
git clone https://github.com/OISF/suricata.git
cd suricata && ./scripts/bundle.sh

./autogen.sh
```

Then you need to add the eBPF flags to configure and specify the Clang compiler for building all C sources, including the eBPF programs

```
CC=clang ./configure --prefix=/usr/ --sysconfdir=/etc/ --localstatedir=/var/ \
--enable-ebpf --enable-ebpf-build

make clean && make
sudo make install-full
sudo ldconfig
sudo mkdir /usr/libexec/suricata/ebpf/
```

The `clang` compiler is needed if you want to build eBPF files as the build is done via a specific eBPF backend available only in llvm/clang suite. If you don't want to use Clang for building Suricata itself, you can still specify it separately, using the `--with-clang` parameter

```
./configure --prefix=/usr/ --sysconfdir=/etc/ --localstatedir=/var/ \
--enable-ebpf --enable-ebpf-build --with-clang=/usr/bin/clang
```

21.5.5 Setup bypass

If you plan to use eBPF or XDP for a kernel/hardware level bypass, you need to enable some of the following features:

First, enable *bypass* in the *stream* section in `suricata.yaml`

```
stream:
  bypass: true
```

This will bypass flows as soon as the stream depth will be reached.

If you want, you can also bypass encrypted flows by setting *encryption-handling* to *bypass* in the app-layer tls section

```
app-layer:
  protocols:
    tls:
      enabled: yes
      detection-ports:
        dp: 443

      encryption-handling: bypass
```

Another solution is to use a set of signatures using the `bypass` keyword to obtain a selective bypass. Suricata traffic ID defines flowbits that can be used in other signatures. For instance one could use

```
alert any any -> any any (msg:"bypass video"; flowbits:isset,traffic/label/video;␣
↪noalert; bypass; sid:1000000; rev:1;)
alert any any -> any any (msg:"bypass Skype"; flowbits:isset,traffic/id/skype; noalert;␣
↪bypass; sid:1000001; rev:1;)
```

21.5.6 Setup eBPF filter

The file *ebpf/vlan_filter.c* contains a list of VLAN id in a switch that you need to edit to get something adapted to your network. Another filter dropping packets from or to a set of IPv4 address is also available in *ebpf/filter.c*. See *Pinned maps usage* for more information.

Suricata can load as eBPF filter any eBPF code exposing a `filter` section.

Once modifications and build via `make` are complete, you can copy the resulting eBPF filter as needed

```
cp ebpf/vlan_filter.bpf /usr/libexec/suricata/ebpf/
```

Then setup the *ebpf-filter-file* variable in af-packet section in `suricata.yaml`

```
- interface: eth3
  threads: 16
  cluster-id: 97
  cluster-type: cluster_flow # choose any type suitable
  defrag: yes
  # eBPF file containing a 'filter' function that will be inserted into the
  # kernel and used as load balancing function
  ebpf-filter-file:  /usr/libexec/suricata/ebpf/vlan_filter.bpf
  use-mmap: yes
  ring-size: 200000
```

You can then run Suricata normally

```
/usr/bin/suricata --pidfile /var/run/suricata.pid  --af-packet=eth3 -vvv
```

21.5.7 Setup eBPF bypass

You can also use eBPF bypass. To do that load the *bypass_filter.bpf* file and update af-packet configuration in `suricata.yaml` to set bypass to *yes*

```
- interface: eth3
  threads: 16
  cluster-id: 97
  cluster-type: cluster_qm # symmetric RSS hashing is mandatory to use this mode
  # eBPF file containing a 'filter' function that will be inserted into the
  # kernel and used as packet filter function
  ebpf-filter-file:  /usr/libexec/suricata/ebpf/bypass_filter.bpf
  bypass: yes
  use-mmap: yes
  ring-size: 200000
```

Constraints on eBPF code to have a bypass compliant code are stronger than for regular filters. The filter must expose *flow_table_v4* and *flow_table_v6* per CPU array maps with similar definitions as the one available in *bypass_filter.c*. These two maps will be accessed and maintained by Suricata to handle the lists of flows to bypass.

If you are not using VLAN tracking (`vlan.use-for-tracking` set to *false* in suricata.yaml) then you also have to set the `VLAN_TRACKING` define to *0* in `bypass_filter.c`.

21.5.8 Setup eBPF load balancing

eBPF load balancing allows to load balance the traffic on the listening sockets With any logic implemented in the eBPF filter. The value returned by the function tagged with the `loadbalancer` section is used with a modulo on the CPU count to know in which socket the packet has to be send.

An implementation of a simple symmetric IP pair hashing function is provided in the `lb.bpf` file.

Copy the resulting eBPF filter as needed

```
cp ebpf/lb.bpf /usr/libexec/suricata/ebpf/
```

Then use `cluster_ebpf` as load balancing method in the interface section of af-packet and point the `ebpf-lb-file` variable to the `lb.bpf` file

```
- interface: eth3
  threads: 16
  cluster-id: 97
  cluster-type: cluster_ebpf
  defrag: yes
  # eBPF file containing a 'loadbalancer' function that will be inserted into the
  # kernel and used as load balancing function
  ebpf-lb-file:  /usr/libexec/suricata/ebpf/lb.bpf
  use-mmap: yes
  ring-size: 200000
```

21.5.9 Setup XDP bypass

XDP bypass allows Suricata to tell the kernel that packets for some flows have to be dropped via the XDP mechanism. This is an early drop that occurs before the datagram reaches the Linux kernel network stack.

Linux 4.15 or newer are recommended to use that feature. You can use it on older kernel if you set `BUILD_CPUMAP` to *0* in `ebpf/xdp_filter.c`.

Copy the resulting XDP filter as needed:

```
cp ebpf/xdp_filter.bpf /usr/libexec/suricata/ebpf/
```

Setup af-packet section/interface in `suricata.yaml`.

We will use `cluster_qm` as we have symmetric hashing on the NIC, `xdp-mode: driver` and we will also use the `/usr/libexec/suricata/ebpf/xdp_filter.bpf` (in our example TCP offloading/bypass)

```
- interface: eth3
  threads: 16
  cluster-id: 97
  cluster-type: cluster_qm # symmetric hashing is a must!
  defrag: yes
  # Xdp mode, "soft" for skb based version, "driver" for network card based
  # and "hw" for card supporting eBPF.
  xdp-mode: driver
```

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```
  xdp-filter-file:  /usr/libexec/suricata/ebpf/xdp_filter.bpf
  # if the ebpf filter implements a bypass function, you can set 'bypass' to
  # yes and benefit from these feature
  bypass: yes
  use-mmap: yes
  ring-size: 200000
  # Uncomment the following if you are using hardware XDP with
  # a card like Netronome (default value is yes)
  # use-percpu-hash: no
```

XDP bypass is compatible with AF_PACKET IPS mode. Packets from bypassed flows will be send directly from one card to the second card without going by the kernel network stack.

If you are using hardware XDP offload you may have to set `use-percpu-hash` to false and build and install the XDP filter file after setting `USE_PERCPU_HASH` to 0.

In the XDP filter file, you can set `ENCRYPTED_TLS_BYPASS` to 1 if you want to bypass the encrypted TLS 1.2 packets in the eBPF code. Be aware that this will mean that Suricata will be blind on packets on port 443 with the correct pattern.

If you are not using VLAN tracking (`vlan.use-for-tracking` set to false in suricata.yaml) then you also have to set the VLAN_TRACKING define to 0 in `xdp_filter.c`.

Intel NIC setup

Intel network card don't support symmetric hashing but it is possible to emulate it by using a specific hashing function.

Follow these instructions closely for desired result:

```
ifconfig eth3 down
```

Use in tree kernel drivers: XDP support is not available in Intel drivers available on Intel website.

Enable symmetric hashing

```
ifconfig eth3 down
ethtool -L eth3 combined 16 # if you have at least 16 cores
ethtool -K eth3 rxhash on
ethtool -K eth3 ntuple on
ifconfig eth3 up
./set_irq_affinity 0-15 eth3
ethtool -X eth3 hkey␣
↪6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A
↪equal 16
ethtool -x eth3
ethtool -n eth3
```

In the above setup you are free to use any recent `set_irq_affinity` script. It is available in any Intel x520/710 NIC sources driver download.

NOTE: We use a special low entropy key for the symmetric hashing. More info about the research for symmetric hashing set up

Disable any NIC offloading

Run the following command to disable offloading

```
for i in rx tx tso ufo gso gro lro tx nocache copy sg txvlan rxvlan; do
       /sbin/ethtool -K eth3 $i off 2>&1 > /dev/null;
done
```

Balance as much as you can

Try to use the network card's flow balancing as much as possible

```
for proto in tcp4 udp4 ah4 esp4 sctp4 tcp6 udp6 ah6 esp6 sctp6; do
   /sbin/ethtool -N eth3 rx-flow-hash $proto sd
done
```

This command triggers load balancing using only source and destination IPs. This may be not optimal in term of load balancing fairness but this ensures all packets of a flow will reach the same thread even in the case of IP fragmentation (where source and destination port will not be available for some fragmented packets).

The XDP CPU redirect case

If ever your hardware is not able to do a symmetric load balancing but support XDP in driver mode, you can then use the CPU redirect map support available in the *xdp_filter.bpf* and *xdp_lb.bpf* file. In this mode, the load balancing will be done by the XDP filter and each CPU will handle the whole packet treatment including the creation of the skb structure in kernel.

You will need Linux 4.15 or newer to use that feature.

To do so set the *xdp-cpu-redirect* variable in af-packet interface configuration to a set of CPUs. Then use the *cluster_cpu* as load balancing function. You will also need to set the affinity to be certain that CPU cores that have the skb assigned are used by Suricata.

Also to avoid out of order packets, you need to set the RSS queue number to 1. So if our interface is *eth3*

```
/sbin/ethtool -L eth3 combined 1
```

In case your system has more then 64 core, you need to set *CPUMAP_MAX_CPUS* to a value greater than this number in *xdp_lb.c* and *xdp_filter.c*.

A sample configuration for pure XDP load balancing could look like

```
- interface: eth3
  threads: 16
  cluster-id: 97
  cluster-type: cluster_cpu
  xdp-mode: driver
  xdp-filter-file:  /usr/libexec/suricata/ebpf/xdp_lb.bpf
  xdp-cpu-redirect: ["1-17"] # or ["all"] to load balance on all CPUs
  use-mmap: yes
  ring-size: 200000
```

It is possible to use *xdp_monitor* to have information about the behavior of CPU redirect. This program is available in Linux tree under the *samples/bpf* directory and will be build by the make command. Sample output is the following

```
sudo ./xdp_monitor --stats
XDP-event       CPU:to  pps          drop-pps     extra-info
XDP_REDIRECT    11      2,880,212    0            Success
XDP_REDIRECT    total   2,880,212    0            Success
XDP_REDIRECT    total   0            0            Error
cpumap-enqueue   11:0   575,954      0            5.27       bulk-average
cpumap-enqueue  sum:0   575,954      0            5.27       bulk-average
cpumap-kthread  0       575,990      0            56,409     sched
cpumap-kthread  1       576,090      0            54,897     sched
```

Start Suricata with XDP

You can now start Suricata with XDP bypass activated

```
/usr/bin/suricata -c /etc/suricata/xdp-suricata.yaml --pidfile /var/run/suricata.pid  --
↪af-packet=eth3 -vvv
```

Confirm you have the XDP filter engaged in the output (example):

```
...
...
(runmode-af-packet.c:220) <Config> (ParseAFPConfig) -- Enabling locked memory for mmap␣
↪on iface eth3
(runmode-af-packet.c:231) <Config> (ParseAFPConfig) -- Enabling tpacket v3 capture on␣
↪iface eth3
(runmode-af-packet.c:326) <Config> (ParseAFPConfig) -- Using queue based cluster mode␣
↪for AF_PACKET (iface eth3)
(runmode-af-packet.c:424) <Info> (ParseAFPConfig) -- af-packet will use '/usr/libexec/
↪suricata/ebpf/xdp_filter.bpf' as XDP filter file
(runmode-af-packet.c:429) <Config> (ParseAFPConfig) -- Using bypass kernel functionality␣
↪for AF_PACKET (iface eth3)
(runmode-af-packet.c:609) <Config> (ParseAFPConfig) -- eth3: enabling zero copy mode by␣
↪using data release call
(util-runmodes.c:296) <Info> (RunModeSetLiveCaptureWorkersForDevice) -- Going to use 8␣
↪thread(s)
...
...
```

21.5.10 Pinned maps usage

Pinned maps stay attached to the system if the creating process disappears and they can also be accessed by external tools. In Suricata bypass case, this can be used to keep bypassed flow tables active, so Suricata is not hit by previously bypassed flows when restarting. In the socket filter case, this can be used to maintain a map from tools outside of Suricata.

To use pinned maps, you first have to mount the *bpf* pseudo filesystem

```
sudo mount -t bpf none /sys/fs/bpf
```

You can also add to your */etc/fstab*

```
bpffs                       /sys/fs/bpf             bpf     defaults 0 0
```

and run *sudo mount -a*.

Pinned maps will be accessible as file from the */sys/fs/bpf* directory. Suricata will pin them under the name *suricata-$IFACE_NAME-$MAP_NAME*.

To activate pinned maps for a interface, set *pinned-maps* to *true* in the *af-packet* configuration of this interface

```
- interface: eth3
  pinned-maps: true
```

21.5.11 XDP and pinned-maps

This option can be used to expose the maps of a socket filter to other processes. This allows for example, the external handling of a accept list or block list of IP addresses. See bpfctrl for an example of external list handling.

In the case of XDP, the eBPF filter is attached to the interface so if you activate *pinned-maps* the eBPF will remain attached to the interface and the maps will remain accessible upon Suricata start. If XDP bypass is activated, Suricata will try at start to open the pinned maps *flow_v4_table* and *flow_v6_table*. If they are present, this means the XDP filter is still there and Suricata will just use them instead of attaching the XDP file to the interface.

So if you want to reload the XDP filter, you need to remove the files from */sys/fs/bpf/* before starting Suricata.

In case, you are not using bypass, this means that the used maps are managed from outside Suricata. As their names are not known by Suricata, you need to specify a name of a map to look for, that will be used to check for the presence of the XDP filter

```
- interface: eth3
  pinned-maps: true
  pinned-maps-name: ipv4_drop
  xdp-filter-file: /usr/libexec/suricata/ebpf/xdp_filter.bpf
```

If XDP bypass is used in IPS mode stopping Suricata will trigger an interruption in the traffic. To fix that, the provided XDP filter *xdp_filter.bpf* is containing a map that will trigger a global bypass if set to 1. You need to use *pinned-maps* to benefit from this feature.

To use it you need to set *#define USE_GLOBAL_BYPASS 1* (instead of 0) in the *xdp_filter.c* file and rebuild the eBPF code and install the eBPF file in the correct place. If you write *1* as key *0* then the XDP filter will switch to global bypass mode. Set key *0* to value *0* to send traffic to Suricata.

The switch must be activated on all sniffing interfaces. For an interface named *eth0* the global switch map will be */sys/fs/bpf/suricata-eth0-global_bypass*.

Pinned maps and eBPF filter

Pinned maps can also be used with regular eBPF filters. The main difference is that the map will not persist after Suricata is stopped because it is attached to a socket and not an interface which is persistent.

The eBPF filter *filter.bpf* uses a *ipv4_drop* map that contains the set of IPv4 addresses to drop. If *pinned-maps* is set to *true* in the interface configuration then the map will be pinned under */sys/fs/bpf/suricata-eth3-ipv4_drop*.

You can then use a tool like *bpfctrl* to manage the IPv4 addresses in the map.

21.5.12 Hardware bypass with Netronome

Netronome cards support hardware bypass. In this case the eBPF code is running in the card itself. This introduces some architectural differences compared to driver mode and the configuration and eBPF filter need to be updated.

On eBPF side, as of Linux 4.19 CPU maps and interfaces redirect are not supported and these features need to be disabled. By architecture, per CPU hash should not be used and has to be disabled. To achieve this, edit the beginning of *ebpf/xdp_filter.c* and do

```
#define BUILD_CPUMAP        0
/* Increase CPUMAP_MAX_CPUS if ever you have more than 64 CPUs */
#define CPUMAP_MAX_CPUS     64

#define USE_PERCPU_HASH    0
#define GOT_TX_PEER    0
```

Then build the bpf file with *make* and install it in the expected place.

The Suricata configuration is rather simple as you need to activate hardware mode and the *use-percpu-hash* option in the *af-packet* configuration of the interface

```
xdp-mode: hw
use-percpu-hash: no
```

The load balancing will be done on IP pairs inside the eBPF code, so using *cluster_qm* as cluster type is a good idea

```
cluster-type: cluster_qm
```

As of Linux 4.19, the number of threads must be a power of 2. So set *threads* variable of the *af-packet* interface to a power of 2 and in the eBPF filter set the following variable accordingly

```
#define RSS_QUEUE_NUMBERS   32
```

21.5.13 Getting live info about bypass

You can get information about bypass via the stats event and through the unix socket. `iface-stat` will return the number of bypassed packets (adding packets for a flow when it timeout)

```
suricatasc -c "iface-stat enp94s0np0" | jq
{
  "message": {
    "pkts": 56529854964,
    "drop": 932328611,
    "bypassed": 1569467248,
    "invalid-checksums": 0
  },
  "return": "OK"
}
```

`iface-bypassed-stats` command will return the number of elements in IPv4 and IPv6 flow tables for each interface

```
# suricatasc
>>> iface-bypassed-stats
Success:
```

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```
{
    "enp94s0np0": {
       "ipv4_fail": 0,
       "ipv4_maps_count": 2303,
       "ipv4_success": 4232,
       "ipv6_fail": 0,
       "ipv6_maps_count": 13131,
       "ipv6_success": 13500

    }
}
```

The stats entry also contains a *stats.flow_bypassed* object that has local and capture bytes and packets counters as well as a bypassed and closed flow counter

```
{
  "local_pkts": 0,
  "local_bytes": 0,
  "local_capture_pkts": 20,
  "local_capture_bytes": 25000,
  "closed": 84,
  "pkts": 4799,
  "bytes": 2975133
}
```

local_pkts and *local_bytes* are for Suricata bypassed flows. This can be because local bypass is used or because the capture method can not bypass more flows. *pkts* and *bytes* are counters coming from the capture method. They can take some time to appear due to the accounting at timeout. *local_capture_pkts* and *local_capture_bytes* are counters for packets that are seen by Suricata before the capture method efficiently bypass the traffic. There is almost always some for each flow because of the buffer in front of Suricata reading threads.

21.6 Netmap

Netmap is a high speed capture framework for Linux and FreeBSD. In Linux it is available as an external module, while in FreeBSD 11+ it is available by default.

21.6.1 Compiling Suricata

FreeBSD

On FreeBSD 11 and up, NETMAP is included and enabled by default in the kernel.

To build Suricata with NETMAP, add `--enable-netmap` to the configure line. The location of the NETMAP includes (/usr/src/sys/net/) does not have to be specified.

Linux

On Linux, NETMAP is not included by default. It can be pulled from github. Follow the instructions on installation included in the NETMAP repository.

When NETMAP is installed, add `--enable-netmap` to the configure line. If the includes are not added to a standard location, the location can be specified when configuring Suricata.

Example:

```
./configure --enable-netmap --with-netmap-includes=/usr/local/include/netmap/
```

21.6.2 Starting Suricata

When opening an interface, netmap can take various special characters as options in the interface string.

> **Warning:** the interface that netmap reads from will become unavailable for normal network operations. You can lock yourself out of your system.

IDS

Suricata can be started in 2 ways to use netmap:

```
suricata --netmap=<interface>
suricata --netmap=igb0
```

In the above example Suricata will start reading from the *igb0* network interface. The number of threads created depends on the number of RSS queues available on the NIC.

```
suricata --netmap
```

In the above example Suricata will take the `netmap` block from the Suricata configuration and open each of the interfaces listed.

```
netmap:
  - interface: igb0
    threads: 2
  - interface: igb1
    threads: 4
```

For the above configuration, both `igb0` and `igb1` would be opened. With 2 threads for `igb0` and 4 capture threads for `igb1`.

> **Warning:** This multi threaded setup only works correctly if the NIC has symmetric RSS hashing. If this is not the case, consider using the 'lb' method below.

IPS

Suricata's Netmap based IPS mode is based on the concept of creating a layer 2 software bridge between 2 interfaces. Suricata reads packets on one interface and transmits them on another.

Packets that are blocked by the IPS policy, are simply not transmitted.

```
netmap:
  - interface: igb0
    copy-mode: ips
    copy-iface: igb1
  - interface: igb1
    copy-mode: ips
    copy-iface: igb0
```

21.6.3 Advanced setups

21.6.4 lb (load balance)

"lb" is a tool written by Seth Hall to allow for load balancing for single or multiple tools. One common use case is being able to run Suricata and Zeek together on the same traffic.

starting lb:

```
lb -i eth0 -p suricata:6 -p zeek:6
```

Note: On FreeBSD 11, the named prefix doesn't work.

yaml:

```
netmap:
  - interface: netmap:suricata
    threads: 6
```

startup:

```
suricata --netmap=netmap:suricata
```

The interface name as passed to Suricata includes a 'netmap:' prefix. This tells Suricata that it's going to read from netmap pipes instead of a real interface.

Then Zeek (formerly Bro) can be configured to load 6 instances. Both will get a copy of the same traffic. The number of netmap pipes does not have to be equal for both tools.

FreeBSD 11

On FreeBSD 11 the named pipe is not available.

starting lb:

```
lb -i eth0 -p 6
```

yaml:

```
netmap:
  - interface: netmap:eth0
    threads: 6
```

startup:

```
suricata --netmap
```

Note: "lb" is bundled with netmap.

Single NIC

When an interface enters NETMAP mode, it is no longer available to the OS for other operations. This can be undesirable in certain cases, but there is a workaround.

By running Suricata in a special inline mode, the interface will show it's traffic to the OS.

```
netmap:
  - interface: igb0
    copy-mode: tap
    copy-iface: igb0^
  - interface: igb0^
    copy-mode: tap
    copy-iface: igb0
```

The copy-mode can be both 'tap' and 'ips', where the former never drops packets based on the policies in use, and the latter may drop packets.

Warning: Misconfiguration can lead to connectivity loss. Use with care.

Note: This set up can also be used to mix NETMAP with firewall setups like pf or ipfw.

VALE switches

VALE is a virtual switch that can be used to create an all virtual network or a mix of virtual and real nics.

A simple all virtual setup:

```
vale-ctl -n vi0
vale-ctl -a vale0:vi0
vale-ctl -n vi1
vale-ctl -a vale0:vi1
```

We now have a virtual switch "vale0" with 2 ports "vi0" and "vi1".

We can start Suricata to listen on one of the ports:

```
suricata --netmap=vale0:vi1
```

Then we can

21.6.5 Inline IDS

The inline IDS is almost the same as the IPS setup above, but it will not enforce `drop` policies.

```
netmap:
  - interface: igb0
    copy-mode: tap
    copy-iface: igb1
  - interface: igb1
    copy-mode: tap
    copy-iface: igb0
```

The only difference with the IPS mode is that the `copy-mode` setting is set to `tap`.

21.7 AF_XDP

AF_XDP (eXpress Data Path) is a high speed capture framework for Linux that was introduced in Linux v4.18. AF_XDP aims at improving capture performance by redirecting ingress frames to user-space memory rings, thus bypassing the network stack.

Note that during `af_xdp` operation the selected interface cannot be used for regular network usage.

Further reading:

- https://www.kernel.org/doc/html/latest/networking/af_xdp.html

21.7.1 Compiling Suricata

Linux

libxdp and libpbf are required for this feature. When building from source the development files will also be required.

Example:

```
dnf -y install libxdp-devel libbpf-devel
```

This feature is enabled provided the libraries above are installed, the user does not need to add any additional command line options.

The command line option `--disable-af-xdp` can be used to disable this feature.

Example:

```
./configure --disable-af-xdp
```

21.7.2 Starting Suricata

IDS

Suricata can be started as follows to use af-xdp:

```
af-xdp:
  suricata --af-xdp=<interface>
  suricata --af-xdp=igb0
```

In the above example Suricata will start reading from the *igb0* network interface.

21.7.3 AF_XDP Configuration

Each of these settings can be configured under `af-xdp` within the "Configure common capture settings" section of suricata.yaml configuration file.

The number of threads created can be configured in the suricata.yaml configuration file. It is recommended to use threads equal to NIC queues/CPU cores.

Another option is to select `auto` which will allow Suricata to configure the number of threads based on the number of RSS queues available on the NIC.

With `auto` selected, Suricata spawns receive threads equal to the number of configured RSS queues on the interface.

```
af-xdp:
  threads: <number>
  threads: auto
  threads: 8
```

21.7.4 Advanced setup

af-xdp capture source will operate using the default configuration settings. However, these settings are available in the suricata.yaml configuration file.

Available configuration options are:

force-xdp-mode

There are two operating modes employed when loading the XDP program, these are:

- XDP_DRV: Mode chosen when the driver supports AF_XDP
- XDP_SKB: Mode chosen when no AF_XDP support is unavailable

XDP_DRV mode is the preferred mode, used to ensure best performance.

```
af-xdp:
  force-xdp-mode: <value> where: value = <skb|drv|none>
  force-xdp-mode: drv
```

force-bind-mode

During binding the kernel will first attempt to use zero-copy (preferred). If zero-copy support is unavailable it will fallback to copy mode, copying all packets out to user space.

```
af-xdp:
  force-bind-mode: <value> where: value = <copy|zero|none>
  force-bind-mode: zero
```

For both options, the kernel will attempt the 'preferred' option first and fallback upon failure. Therefore the default (none) means the kernel has control of which option to apply. By configuring these options the user is forcing said option. Note that if enabled, the bind will only attempt this option, upon failure the bind will fail i.e. no fallback.

mem-unaligned

AF_XDP can operate in two memory alignment modes, these are:

- Aligned chunk mode
- Unaligned chunk mode

Aligned chunk mode is the default option which ensures alignment of the data within the UMEM.

Unaligned chunk mode uses hugepages for the UMEM. Hugepages start at the size of 2MB but they can be as large as 1GB. Lower count of pages (memory chunks) allows faster lookup of page entries. The hugepages need to be allocated on the NUMA node where the NIC and CPU resides. Otherwise, if the hugepages are allocated only on NUMA node 0 and the NIC is connected to NUMA node 1, then the application will fail to start. Therefore, it is recommended to first find out to which NUMA node the NIC is connected to and only then allocate hugepages and set CPU cores affinity to the given NUMA node.

Memory assigned per socket/thread is 16MB, so each worker thread requires at least 16MB of free space. As stated above hugepages can be of various sizes, consult the OS to confirm with `cat /proc/meminfo`.

Example

```
8 worker threads * 16Mb = 128Mb
hugepages = 2048 kB
so: pages required = 62.5 (63) pages
```

See https://www.kernel.org/doc/Documentation/vm/hugetlbpage.txt for detailed description.

To enable unaligned chunk mode:

```
af-xdp:
  mem-unaligned: <yes/no>
  mem-unaligned: yes
```

Introduced from Linux v5.11 a `SO_PREFER_BUSY_POLL` option has been added to AF_XDP that allows a true polling of the socket queues. This feature has been introduced to reduce context switching and improve CPU reaction time during traffic reception.

Enabled by default, this feature will apply the following options, unless disabled (see below). The following options are used to configure this feature.

enable-busy-poll

Enables or disables busy polling.

```
af-xdp:
  enable-busy-poll: <yes/no>
  enable-busy-poll: yes
```

busy-poll-time

Sets the approximate time in microseconds to busy poll on a `blocking receive` when there is no data.

```
af-xdp:
  busy-poll-time: <time>
  busy-poll-time: 20
```

busy-poll-budget

Budget allowed for batching of ingress frames. Larger values means more frames can be stored/read. It is recommended to test this for performance.

```
af-xdp:
  busy-poll-budget: <budget>
  busy-poll-budget: 64
```

Linux tunables

The SO_PREFER_BUSY_POLL option works in concert with the following two Linux knobs to ensure best capture performance. These are not socket options:

- gro-flush-timeout
- napi-defer-hard-irq

The purpose of these two knobs is to defer interrupts and to allow the NAPI context to be scheduled from a watchdog timer instead.

The `gro-flush-timeout` indicates the timeout period for the watchdog timer. When no traffic is received for `gro-flush-timeout` the timer will exit and softirq handling will resume.

The `napi-defer-hard-irq` indicates the number of queue scan attempts before exiting to interrupt context. When enabled, the softirq NAPI context will exit early, allowing busy polling.

```
af-xdp:
  gro-flush-timeout: 2000000
  napi-defer-hard-irq: 2
```

21.7.5 Hardware setup

Intel NIC setup

Intel network cards don't support symmetric hashing but it is possible to emulate it by using a specific hashing function.

Follow these instructions closely for desired result:

```
ifconfig eth3 down
```

Enable symmetric hashing

```
ifconfig eth3 down
ethtool -L eth3 combined 16 # if you have at least 16 cores
ethtool -K eth3 rxhash on
ethtool -K eth3 ntuple on
ifconfig eth3 up
./set_irq_affinity 0-15 eth3
ethtool -X eth3 hkey␣
↪6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A:6D:5A
↪equal 16
ethtool -x eth3
ethtool -n eth3
```

In the above setup you are free to use any recent `set_irq_affinity` script. It is available in any Intel x520/710 NIC sources driver download.

NOTE: We use a special low entropy key for the symmetric hashing. More info about the research for symmetric hashing set up

Disable any NIC offloading

Suricata shall disable NIC offloading based on configuration parameter `disable-offloading`, which is enabled by default. See `capture` section of yaml file.

```
capture:
  # disable NIC offloading. It's restored when Suricata exits.
  # Enabled by default.
  #disable-offloading: false
```

Balance as much as you can

Try to use the network card's flow balancing as much as possible

```
for proto in tcp4 udp4 ah4 esp4 sctp4 tcp6 udp6 ah6 esp6 sctp6; do
   /sbin/ethtool -N eth3 rx-flow-hash $proto sd
done
```

This command triggers load balancing using only source and destination IPs. This may be not optimal in terms of load balancing fairness but this ensures all packets of a flow will reach the same thread even in the case of IP fragmentation (where source and destination port will not be available for some fragmented packets).

21.8 DPDK

21.8.1 Introduction

The Data Plane Development Kit (DPDK) is a set of libraries and drivers that enhance and speed up packet processing in the data plane. Its primary use is to provide faster packet processing by bypassing the kernel network stack, which can provide significant performance improvements. For detailed instructions on how to setup DPDK, please refer to *Suricata.yaml* to learn more about the basic setup for DPDK. The following sections contain examples of how to set up DPDK and Suricata for more obscure use-cases.

21.8.2 Hugepage analysis

Suricata can analyse utilized hugepages on the system. This can be particularly beneficial when there's a potential overallocation of hugepages. The hugepage analysis is designed to examine the hugepages in use and provide recommendations on an adequate number of hugepages. This then ensures Suricata operates optimally while leaving sufficient memory for other applications on the system. The analysis works by comparing snapshots of the hugepages before and after Suricata is initialized. After the initialization, no more hugepages are allocated by Suricata. The hugepage analysis can be seen in the Perf log level and is printed out during the Suricata start. It is only printed when Suricata detects some disrepancies in the system related to hugepage allocation.

It's recommended to perform this analysis from a "clean" state - that is a state when all your hugepages are free. It is especially recommended when no other hugepage-dependent applications are running on your system. This can be checked in one of two ways:

```
# global check
cat /proc/meminfo

HugePages_Total:    1024
```

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```
HugePages_Free:     1024

# per-numa check depends on NUMA node ID, hugepage size,
# and nr_hugepages/free_hugepages - e.g.:
cat /sys/devices/system/node/node0/hugepages/hugepages-2048kB/free_hugepages
```

After the termination of Suricata and other hugepage-related applications, if the count of free hugepages is not equal with the total number of hugepages, it indicates some hugepages were not freed completely. This can be fixed by removing DPDK-related files from the hugepage-mounted directory (filesystem). It's important to exercise caution while removing hugepages, especially when other hugepage-dependent applications are in operation, as this action will disrupt their memory functionality. Removing the DPDK files from the hugepage directory can often be done as:

```
sudo rm -rf /dev/hugepages/rtemap_*

# To check where hugepages are mounted:
dpdk-hugepages.py -s
# or
mount | grep huge
```

21.8.3 Bond interface

Link Bonding Poll Mode Driver (Bond PMD), is a software mechanism provided by the Data Plane Development Kit (DPDK) for aggregating multiple physical network interfaces into a single logical interface. Bonding can be e.g. used to:

- deliver bidirectional flows of tapped interfaces to the same worker,
- establish redundancy by monitoring multiple links,
- improve network performance by load-balancing traffic across multiple links.

Bond PMD is essentially a virtual driver that manipulates with multiple physical network interfaces. It can operate in multiple modes as described in the DPDK docs The individual bonding modes can accustom user needs. DPDK Bond PMD has a requirement that the aggregated interfaces must be the same device types - e.g. both physical ports run on mlx5 PMD. Bond PMD supports multiple queues and therefore can work in workers runmode. It should have no effect on traffic distribution of the individual ports and flows should be distributed by physical ports according to the RSS configuration the same way as if they would be configured independently.

As an example of Bond PMD, we can setup Suricata to monitor 2 interfaces that receive TAP traffic from optical interfaces. This means that Suricata receive one direction of the communication on one interface and the other direction is received on the other interface.

```
...
dpdk:
  eal-params:
    proc-type: primary
    vdev: 'net_bonding0,mode=0,slave=0000:04:00.0,slave=0000:04:00.1'

  # DPDK capture support
  # RX queues (and TX queues in IPS mode) are assigned to cores in 1:1 ratio
  interfaces:
    - interface: net_bonding0 # PCIe address of the NIC port
      # Threading: possible values are either "auto" or number of threads
```

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```
      # - auto takes all cores
      # in IPS mode it is required to specify the number of cores and the
      # numbers on both interfaces must match
      threads: 4
...
```

In the DPDK part of suricata.yaml we have added a new parameter to the eal-params section for virtual devices - *vdev*. DPDK Environment Abstraction Layer (EAL) can initialize some virtual devices during the initialization of EAL. In this case, EAL creates a new device of type *net_bonding*. Suffix of *net_bonding* signifies the name of the interface (in this case the zero). Extra arguments are passed after the device name, such as the bonding mode (*mode=0*). This is the round-robin mode as is described in the DPDK documentation of Bond PMD. Members (slaves) of the *net_bonding0* interface are appended after the bonding mode parameter.

When the device is specified within EAL parameters, it can be used within Suricata *interfaces* list. Note that the list doesn't contain PCIe addresses of the physical ports but instead the *net_bonding0* interface. Threading section is also adjusted according to the items in the interfaces list by enablign set-cpu-affinity and listing CPUs that should be used in management and worker CPU set.

```
...
threading:
  set-cpu-affinity: yes
  cpu-affinity:
    - management-cpu-set:
        cpu: [ 0 ]  # include only these CPUs in affinity settings
    - receive-cpu-set:
        cpu: [ 0 ]  # include only these CPUs in affinity settings
    - worker-cpu-set:
        cpu: [ 2,4,6,8 ]
...
```

21.8.4 Interrupt (power-saving) mode

The DPDK is traditionally recognized for its polling mode operation. In this mode, CPU cores are continuously querying for packets from the Network Interface Card (NIC). While this approach offers benefits like reduced latency and improved performance, it might not be the most efficient in scenarios with sporadic or low traffic. The constant polling can lead to unnecessary CPU consumption. To address this, DPDK offers an *interrupt* mode.

The obvious advantage that interrupt mode brings is power efficiency. So far in our tests, we haven't observed a decrease in performance. Suricata's performance has actually seen a slight improvement. The (IPS runmode) users should be aware that interrupts can introduce non-deterministic latency. However, the latency should never be higher than in other (e.g. AF_PACKET/AF_XDP/...) capture methods.

Interrupt mode in DPDK can be configured on a per-interface basis. This allows for a hybrid setup where some workers operate in polling mode, while others utilize the interrupt mode. The configuration for the interrupt mode can be found and modified in the DPDK section of the suricata.yaml file.

Below is a sample configuration that demonstrates how to enable the interrupt mode for a specific interface:

```
...
dpdk:
    eal-params:
      proc-type: primary
```

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```
    interfaces:
      - interface: 0000:3b:00.0
        interrupt-mode: true
        threads: 4
```

21.9 PCAP File Reading

Suricata offers a `pcap-file` capture method to process PCAP files and directories of PCAP files in an offline or live-feed manner.

21.9.1 Configuration

```
pcap-file:
  checksum-checks: auto
  # tenant-id: none
  # delete-when-done: false
  # recursive: false
  # continuous: false
  # delay: 30
  # poll-interval: 5
```

21.9.2 Directory-related options

The **recursive** option enables Suricata to traverse subdirectories within the specified directory, up to a maximum depth of 255. This allows for processing of PCAP files located in nested folders. Note that the recursive option cannot be used together with the `continuous` option. The command-line option is *--pcap-file-recursive*.

The **continuous** option allows Suricata to monitor the specified directory for new files, processing them as they appear. This is useful for live environments where new PCAP files are continuously added. The continuous option cannot be combined with the `recursive` option. The command-line option is *--pcap-file-continuous*..

The **delay** option specifies the amount of time, in seconds, that Suricata waits before processing newly detected files. This helps prevent the processing of incomplete files that are still being written. The delay option is applicable with the `continuous` mode.

The **poll-interval** option determines how frequently, in seconds, Suricata checks the directory for new files. Adjusting this interval can help balance responsiveness and resource usage.

Note: `continuous` and `recursive` cannot be enabled simultaneously.

Note: Symlinks are ignored during recursive traversal.

21.9.3 Other options

checksum-checks

- **auto** (default): Suricata detects checksum offloading statistically.
- **yes**: Forces checksum validation.
- **no**: Disables checksum validation.
- The command-line option is *-k*

tenant-id

- Specifies the tenant for multi-tenant setups with direct select.
- The PCAP is processed by the detection engine assigned to the specified tenant.

delete-when-done

- If `true`, Suricata deletes the PCAP file after processing.
- The command-line option is *--pcap-file-delete*

BPF filter

- Suricata supports BPF filters for packet capture that is also applicable to the `pcap-file` capture method.
- The BPF filter is specified in the file with the *-F* command-line option.

CHAPTER

TWENTYTWO

INTERACTING VIA UNIX SOCKET

22.1 Introduction

Suricata can listen to a unix socket and accept commands from the user. The exchange protocol is JSON-based and the format of the message is generic.

An example script called `suricatasc` is provided in the source and installed automatically when installing/updating Suricata.

The unix socket is always enabled by default.

You'll need to have JSON support in Python:

- python-simplejson - simple, fast, extensible JSON encoder/decoder for Python

Debian/Ubuntu:

```
apt-get install python-simplejson
```

The creation of the socket is managed by setting enabled to 'yes' or 'auto' under unix-command in Suricata YAML configuration file:

```
unix-command:
  enabled: yes
  #filename: custom.socket # use this to specify an alternate file
```

The `filename` variable can be used to set an alternate socket filename. The filename is always relative to the local state base directory.

Clients are implemented for some programming languages and can be used as code example to write custom scripts:

- Python: https://github.com/OISF/suricata/blob/main/python/suricata/sc/suricatasc.py (provided with Suricata and used in this document)
- Perl: https://github.com/aflab/suricatac (a simple Perl client with interactive mode)
- C: https://github.com/regit/SuricataC (a Unix socket mode client in C without interactive mode)

22.2 Commands in standard running mode

Runnable script for suricatasc is available in *python/bin* directory of suricata. You can run it with the following commands.

```
cd python
sudo ./bin/suricatasc
```

The set of existing commands is the following:

- command-list: list available commands
- shutdown: shutdown Suricata
- iface-list: list interfaces where Suricata is sniffing packets
- iface-stat: list statistics for an interface
- help: alias of command-list
- version: display Suricata's version
- uptime: display Suricata's uptime
- running-mode: display running mode (workers, autofp, simple)
- capture-mode: display capture system used
- conf-get: get configuration item (see example below)
- dump-counters: dump Suricata's performance counters
- reopen-log-files: reopen log files (to be run after external log rotation)
- ruleset-reload-rules: reload ruleset and wait for completion
- ruleset-reload-nonblocking: reload ruleset and proceed without waiting
- ruleset-reload-time: return time of last reload
- ruleset-stats: display the number of rules loaded and failed
- ruleset-failed-rules: display the list of failed rules
- memcap-set: update memcap value of the specified item
- memcap-show: show memcap value of the specified item
- memcap-list: list all memcap values available
- reload-rules: alias of ruleset-reload-rules
- register-tenant-handler: register a tenant handler with the specified mapping
- unregister-tenant-handler: unregister a tenant handler with the specified mapping
- register-tenant: register tenant with a particular ID and filename
- unregister-tenant: unregister tenant with a particular ID
- reload-tenant: reload a tenant with specified ID and filename
- add-hostbit: add hostbit on a host IP with a particular bit name and time of expiry
- remove-hostbit: remove hostbit on a host IP with specified bit name
- list-hostbit: list hostbit for a particular host IP

You can access these commands with the provided example `suricatasc` script. A typical session with `suricatasc` looks like:

```
# suricatasc
Command list: shutdown, command-list, help, version, uptime, running-mode, capture-mode,␣
↪conf-get, dump-counters, iface-stat, iface-list, quit
>>> iface-list
Success: {'count': 2, 'ifaces': ['eth0', 'eth1']}
>>> iface-stat eth0
Success: {'pkts': 378, 'drop': 0, 'invalid-checksums': 0}
>>> conf-get unix-command.enabled
Success:
"yes"
```

22.3 Commands on the cmd prompt

You can use `suricatasc` directly on the command prompt:

```
root@debian64:~# suricatasc -c version
{'message': '5.0.3 RELEASE', 'return': 'OK'}
root@debian64:~#
root@debian64:~# suricatasc -c uptime
{'message': 35264, 'return': 'OK'}
root@debian64:~#
```

NOTE: You need to quote commands with more than one argument:

```
root@debian64:~# suricatasc -c "iface-stat eth0"
{'message': {'pkts': 5110429, 'drop': 0, 'invalid-checksums': 0}, 'return': 'OK'}
root@debian64:~#
```

22.4 PCAP processing mode

This mode is one of main motivations behind this code. The idea is to be able to provide different pcap files to Suricata without having to restart Suricata for each file. This saves time since you don't need to wait for the signature engine to initialize.

To use this mode, start Suricata with your preferred configuration YAML file and provide the option `--unix-socket` as argument:

```
suricata -c /etc/suricata-full-sigs.yaml --unix-socket
```

It is also possible to specify the socket filename as an argument:

```
suricata --unix-socket=custom.socket
```

In this last case, you will need to provide the complete path to the socket to `suricatasc`. To do so, you need to pass the filename as first argument of `suricatasc`:

```
suricatasc custom.socket
```

Once Suricata is started, you can use `suricatasc` to connect to the command socket and provide different pcap files:

```
root@tiger:~# suricatasc
>>> pcap-file /home/benches/file1.pcap /tmp/file1
Success: Successfully added file to list
>>> pcap-file /home/benches/file2.pcap /tmp/file2
Success: Successfully added file to list
>>> pcap-file-continuous /home/pcaps /tmp/dirout
Success: Successfully added file to list
```

You can add multiple files without waiting for each to be processed; they will be sequentially processed and the generated log/alert files will be put into the directory specified as second argument of the pcap-file command. You need to provide an absolute path to the files and directory as Suricata doesn't know from where the script has been run. If you pass a directory instead of a file, all files in the directory will be processed. If using `pcap-file-continuous` and passing in a directory, the directory will be monitored for new files being added until you use `pcap-interrupt` or delete/move the directory.

To display how many files are waiting to get processed, you can do:

```
>>> pcap-file-number
Success: 3
```

To display the list of queued files, do:

```
>>> pcap-file-list
Success: {'count': 2, 'files': ['/home/benches/file1.pcap', '/home/benches/file2.pcap']}
```

To display current processed file:

```
>>> pcap-current
Success:
"/tmp/test.pcap"
```

When passing in a directory, you can see last processed time (modified time of last file) in milliseconds since epoch:

```
>>> pcap-last-processed
Success:
1509138964000
```

To interrupt directory processing which terminates the current state:

```
>>> pcap-interrupt
Success:
"Interrupted"
```

22.5 Build your own client

The protocol is documented in the following page https://redmine.openinfosecfoundation.org/projects/suricata/wiki/Unix_Socket#Protocol

The following session show what is sent (SND) and received (RCV) by the server. Initial negotiation is the following:

```
# suricatasc
SND: {"version": "0.1"}
RCV: {"return": "OK"}
```

Once this is done, commands can be issued:

```
>>> iface-list
SND: {"command": "iface-list"}
RCV: {"message": {"count": 1, "ifaces": ["wlan0"]}, "return": "OK"}
Success: {'count': 1, 'ifaces': ['wlan0']}
>>> iface-stat wlan0
SND: {"command": "iface-stat", "arguments": {"iface": "wlan0"}}
RCV: {"message": {"pkts": 41508, "drop": 0, "invalid-checksums": 0}, "return": "OK"}
Success: {'pkts': 41508, 'drop': 0, 'invalid-checksums': 0}
```

In pcap-file mode, this gives:

```
>>> pcap-file /home/eric/git/oisf/benches/sandnet.pcap /tmp/bench
SND: {"command": "pcap-file", "arguments": {"output-dir": "/tmp/bench", "filename": "/
↪home/eric/git/oisf/benches/sandnet.pcap"}}
RCV: {"message": "Successfully added file to list", "return": "OK"}
Success: Successfully added file to list
>>> pcap-file-number
SND: {"command": "pcap-file-number"}
RCV: {"message": 1, "return": "OK"}
>>> pcap-file-list
SND: {"command": "pcap-file-list"}
RCV: {"message": {"count": 1, "files": ["/home/eric/git/oisf/benches/sandnet.pcap"]},
↪"return": "OK"}
Success: {'count': 1, 'files': ['/home/eric/git/oisf/benches/sandnet.pcap']}
>>> pcap-file-continuous /home/eric/git/oisf/benches /tmp/bench 0 true
SND: {"command": "pcap-file", "arguments": {"output-dir": "/tmp/bench", "filename": "/
↪home/eric/git/oisf/benches/sandnet.pcap", "tenant": 0, "delete-when-done": true}}
RCV: {"message": "Successfully added file to list", "return": "OK"}
Success: Successfully added file to list
```

There is one thing to be careful about: a Suricata message is sent in multiple send operations. This result in possible incomplete read on client side. The worse workaround is to sleep a bit before trying a recv call. An other solution is to use non blocking socket and retry a recv if the previous one has failed.

Pcap-file json format is:

```
{
  "command": "pcap-file",
  "arguments": {
    "output-dir": "path to output dir",
    "filename": "path to file or directory to run",
```

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```
    "tenant": 0,
    "continuous": false,
    "delete-when-done": false
  }
}
```

output-dir and *filename* are required. *tenant* is optional and should be a number, indicating which tenant the file or directory should run under. *continuous* is optional and should be true/false, indicating that file or directory should be run until *pcap-interrupt* is sent or ctrl-c is invoked. *delete-when-done* is optional and should be true/false, indicating that the file or files under the directory specified by *filename* should be deleted when processing is complete. *delete-when-done* defaults to false, indicating files will be kept after processing.

CHAPTER

TWENTYTHREE

3RD PARTY INTEGRATION

23.1 Symantec SSL Visibility (BlueCoat)

As Suricata itself cannot decrypt SSL/TLS traffic, some organizations use a decryption product to handle this. This document will offer some advice on using Suricata with the Symantec SSL Visibility appliance (formerly known as BlueCoat).

23.1.1 Appliance Software Version

The appliance comes with two major software version options. The 3.x and 4.x series. Suricata works best with the 4.x series.

TLS1.3 is only properly supported in the 4.x version of the appliance software.

23.1.2 Magic Markers

The appliance has an indicator that data is decrypted. This is done using a special magic source MAC address, or using a special VLAN header. Since Suricata can use VLANs as part of flow tracking, it is recommended to use the source MAC method.

In the 3.x version of the software these markers are always there, the config just allows setting which type will be used. In the 4.x software the markers are optional.

23.1.3 TCP handling

In the 3.x software, a bit of care is required in TCP stream reassembly handling in Suricata. The decrypted traffic is presented to the IDS as TCP data packets, that are not ack'd as regularly as would be expected in a regular TCP session. A large TCP window is used to not violate the TCP specs. Since in IDS mode Suricata waits for ACKs for much of its processing, this can lead to delays in detection and logging, as well as increased resource usage due to increased data buffering.

To avoid this, enable the 'stream.inline' mode, which processed data segments as they come in without waiting for the ACKs.

The 4.x software sends more regular ACKs and does not need any special handling on the Suricata side.

23.1.4 TLS matching in Suricata

The appliance takes care of the TLS handling and decryption, presenting only the decrypted data to Suricata. This means that Suricata will not see the TLS handshake. As a consequence of this, Suricata cannot inspect the TLS handshake or otherwise process it. This means that for decrypted TLS sessions, Suricata will not do any TLS keyword inspection (such as fingerprint matching and ja3), TLS logging or TLS certificate extraction.

If it is important to match on and/or log such information as well, the appliance facilities for matching and logging themselves will have to be used.

For TLS traffic where the appliance security policy does not lead to decryption of the traffic, the TLS handshake is presented to Suricata for analysis and logging.

23.1.5 IPS

When using Suricata in IPS mode with the appliance, some things will have to be considered:

- if Suricata DROPs a packet in the decrypted traffic, this will be seen by the appliance after which it will trigger a RST session teardown.
- if a packet takes more than one second to process, it will automatically be considered a DROP by the appliance. This should not happen in normal traffic, but with very inefficient Lua scripts this could perhaps happen. The appliance can also be configured to wait for 5 seconds.
- When using the Suricata 'replace' keyword to modify data, be aware that the 3.x appliance software will not pass the modification on to the destination so this will not have any effect. The 4.x appliance software does support passing on modifications that were made to the unencrypted text, by default this feature is disabled but you can enable it if you want modifications to be passed on to the destination in the re-encrypted stream. Due to how Suricata works, the size of the payloads cannot be changed.

CHAPTER

TWENTYFOUR

MAN PAGES

24.1 Suricata

24.1.1 SYNOPSIS

suricata [OPTIONS] [BPF FILTER]

24.1.2 DESCRIPTION

suricata is a high performance Network IDS, IPS and Network Security Monitoring engine. Open Source and owned by a community run non-profit foundation, the Open Information Security Foundation (OISF).

suricata can be used to analyze live traffic and pcap files. It can generate alerts based on rules. **suricata** will generate traffic logs.

When used with live traffic **suricata** can be passive or active. Active modes are: inline in a L2 bridge setup, inline with L3 integration with host firewall (NFQ, IPFW, WinDivert), or out of band using active responses.

24.1.3 OPTIONS

-h

Display a brief usage overview.

-V

Displays the version of Suricata.

-c <path>

Path to configuration file.

--include <path>

Additional configuration files to include. Multiple additional configuration files can be provided and will be included in the order specified on the command line. These additional configuration files are loaded as if they existed at the end of the main configuration file.

Example including one additional file:

```
--include /etc/suricata/other.yaml
```

Example including more than one additional file:

```
--include /etc/suricata/other.yaml --include /etc/suricata/extra.yaml
```

-T

Test configuration.

-v

Increase the verbosity of the Suricata application logging by increasing the log level from the default. This option can be passed multiple times to further increase the verbosity.

- -v: INFO
- -vv: PERF
- -vvv: CONFIG
- -vvvv: DEBUG

This option will not decrease the log level set in the configuration file if it is already more verbose than the level requested with this option.

-r <path>

Run in pcap offline mode (replay mode) reading files from pcap file. If <path> specifies a directory, all files in that directory will be processed in order of modified time maintaining flow state between files.

--pcap-file-continuous

Used with the -r option to indicate that the mode should stay alive until interrupted. This is useful with directories to add new files and not reset flow state between files.

--pcap-file-recursive

Used with the -r option when the path provided is a directory. This option enables recursive traversal into subdirectories to a maximum depth of 255. This option cannot be combined with --pcap-file-continuous. Symlinks are ignored.

--pcap-file-delete

Used with the -r option to indicate that the mode should delete pcap files after they have been processed. This is useful with pcap-file-continuous to continuously feed files to a directory and have them cleaned up when done. If this option is not set, pcap files will not be deleted after processing.

-i <interface>

After the -i option you can enter the interface card you would like to use to sniff packets from. This option will try to use the best capture method available. Can be used several times to sniff packets from several interfaces.

--pcap[=<device>]

Run in PCAP mode. If no device is provided the interfaces provided in the *pcap* section of the configuration file will be used.

--af-packet[=<device>]

Enable capture of packet using AF_PACKET on Linux. If no device is supplied, the list of devices from the af-packet section in the yaml is used.

--af-xdp[=<device>]

Enable capture of packet using AF_XDP on Linux. If no device is supplied, the list of devices from the af-xdp section in the yaml is used.

-q <queue id>

Run inline of the NFQUEUE queue ID provided. May be provided multiple times.

-s <filename.rules>

With the -s option you can set a file with signatures, which will be loaded together with the rules set in the yaml.

It is possible to use globbing when specifying rules files. For example, `-s '/path/to/rules/*.rules'`

-S <filename.rules>

With the -S option you can set a file with signatures, which will be loaded exclusively, regardless of the rules set in the yaml.

It is possible to use globbing when specifying rules files. For example, `-S '/path/to/rules/*.rules'`

-l <directory>

With the -l option you can set the default log directory. If you already have the default-log-dir set in yaml, it will not be used by Suricata if you use the -l option. It will use the log dir that is set with the -l option. If you do not set a directory with the -l option, Suricata will use the directory that is set in yaml.

-D

Normally if you run Suricata on your console, it keeps your console occupied. You can not use it for other purposes, and when you close the window, Suricata stops running. If you run Suricata as daemon (using the -D option), it runs at the background and you will be able to use the console for other tasks without disturbing the engine running.

--runmode <runmode>

With the *--runmode* option you can set the runmode that you would like to use. This command line option can override the yaml runmode option.

Runmodes are: *workers*, *autofp* and *single*.

For more information about runmodes see *Runmodes* in the user guide.

-F <bpf filter file>

Use BPF filter from file.

-k [all|none]

Force (all) the checksum check or disable (none) all checksum checks.

--user=<user>

Set the process user after initialization. Overrides the user provided in the *run-as* section of the configuration file.

--group=<group>

Set the process group to group after initialization. Overrides the group provided in the *run-as* section of the configuration file.

--pidfile <file>

Write the process ID to file. Overrides the *pid-file* option in the configuration file and forces the file to be written when not running as a daemon.

--init-errors-fatal

Exit with a failure when errors are encountered loading signatures.

--strict-rule-keywords[=all|<keyword>|<keywords(csv)]

Applies to: classtype, reference and app-layer-event.

By default missing reference or classtype values are warnings and not errors. Additionally, loading outdated app-layer-event events are also not treated as errors, but as warnings instead.

If this option is enabled these warnings are considered errors.

If no value, or the value 'all', is specified, the option applies to all of the keywords above. Alternatively, a comma separated list can be supplied with the keyword names it should apply to.

--disable-detection

Disable the detection engine.

--disable-hashing

Disable support for hash algorithms such as md5, sha1 and sha256.

By default hashing is enabled. Disabling hashing will also disable some Suricata features such as the filestore, ja3, and rule keywords that use hash algorithms.

--dump-config

Dump the configuration loaded from the configuration file to the terminal and exit.

--dump-features

Dump the features provided by Suricata modules and exit. Features list (a subset of) the configuration values and are intended to assist with comparing provided features with those required by one or more rules.

--build-info

Display the build information the Suricata was built with.

--list-app-layer-protos

List all supported application layer protocols.

--list-keywords=[all|csv|<kword>]

List all supported rule keywords.

--list-runmodes

List all supported run modes.

--set <key>=<value>

Set a configuration value. Useful for overriding basic configuration parameters. For example, to change the default log directory:

```
--set default-log-dir=/var/tmp
```

This option cannot be used to add new entries to a list in the configuration file, such as a new output. It can only be used to modify a value in a list that already exists.

For example, to disable the `eve-log` in the default configuration file:

```
--set outputs.1.eve-log.enabled=no
```

Also note that the index values may change as the `suricata.yaml` is updated.

See the output of `--dump-config` for existing values that could be modified with their index.

--engine-analysis

Print reports on analysis of different sections in the engine and exit. Please have a look at the conf parameter engine-analysis on what reports can be printed

--unix-socket=<file>

Use file as the Suricata unix control socket. Overrides the *filename* provided in the *unix-command* section of the configuration file.

--reject-dev=<device>

Use *device* to send out RST / ICMP error packets with the *reject* keyword.

--pcap-buffer-size=<size>

Set the size of the PCAP buffer (0 - 2147483647).

--netmap[=<device>]

Enable capture of packet using NETMAP on FreeBSD or Linux. If no device is supplied, the list of devices from the netmap section in the yaml is used.

--pfring[=<device>]

Enable PF_RING packet capture. If no device provided, the devices in the Suricata configuration will be used.

--pfring-cluster-id <id>

Set the PF_RING cluster ID.

--pfring-cluster-type <type>

Set the PF_RING cluster type (cluster_round_robin, cluster_flow).

-d <divert-port>

Run inline using IPFW divert mode.

--dag <device>

Enable packet capture off a DAG card. If capturing off a specific stream the stream can be select using a device name like "dag0:4". This option may be provided multiple times read off multiple devices and/or streams.

--napatech

Enable packet capture using the Napatech Streams API.

--erf-in=<file>

Run in offline mode reading the specific ERF file (Endace extensible record format).

--simulate-ips

Simulate IPS mode when running in a non-IPS mode.

24.1.4 OPTIONS FOR DEVELOPERS

-u

Run the unit tests and exit. Requires that Suricata be configured with *--enable-unittests*.

-U, --unittest-filter=REGEX

With the -U option you can select which of the unit tests you want to run. This option uses REGEX. Example of use: suricata -u -U http

--list-unittests

Lists available unit tests.

--fatal-unittests

Enables fatal failure on a unit test error. Suricata will exit instead of continuing more tests.

--unittests-coverage

Display unit test coverage report.

24.1.5 SIGNALS

Suricata will respond to the following signals:

SIGUSR2

Causes Suricata to perform a live rule reload.

SIGHUP

Causes Suricata to close and re-open all log files. This can be used to re-open log files after they may have been moved away by log rotation utilities.

24.1.6 FILES AND DIRECTORIES

/usr/local/etc/suricata/suricata.yaml
Default location of the Suricata configuration file.

/usr/local/var/log/suricata
Default Suricata log directory.

24.1.7 EXAMPLES

To capture live traffic from interface *eno1*:

```
suricata -i eno1
```

To analyze a pcap file and output logs to the CWD:

```
suricata -r /path/to/capture.pcap
```

To capture using *AF_PACKET* and override the flow memcap setting from the *suricata.yaml*:

```
suricata --af-packet --set flow.memcap=1gb
```

To analyze a pcap file with a custom rule file:

```
suricata -r /pcap/to/capture.pcap -S /path/to/custom.rules
```

24.1.8 BUGS

Please visit Suricata's support page for information about submitting bugs or feature requests.

24.1.9 NOTES

- Suricata Home Page

  https://suricata.io/

- Suricata Support Page

  https://suricata.io/support/

24.2 Suricata Socket Control

24.2.1 SYNOPSIS

suricatasc

24.2.2 DESCRIPTION

Suricata socket control tool

24.2.3 COMMANDS

`shutdown`
: Shut Suricata instance down.

`command-list`
: List available commands.

`help`
: Get help about the available commands.

`version`
: Print the version of Suricata instance.

`uptime`
: Display the uptime of Suricata.

`running-mode`
: Display running mode. This can either be *workers*, *autofp* or *single*.

`capture-mode`
: Display the capture mode. This can be either of *PCAP_DEV*, *PCAP_FILE*, *PFRING(DISABLED)*, *NFQ*, *NFLOG*, *IPFW*, *ERF_FILE*, *ERF_DAG*, *AF_PACKET_DEV*, *NETMAP(DISABLED)*, *UNIX_SOCKET* or *WINDIVERT(DISABLED)*.

`conf-get <variable>`
: Get configuration value for a given variable. Variable to be provided can be either of the configuration parameters that are written in suricata.yaml.

`dump-counters`
: Dump Suricata's performance counters.

`ruleset-reload-rules`
: Reload the ruleset and wait for completion.

`reload-rules`
: Alias .. describe *ruleset-reload-rules*.

`ruleset-reload-nonblocking`
: Reload ruleset and proceed without waiting.

`ruleset-reload-time`
: Return time of last reload.

ruleset-stats

Display the number of rules loaded and failed.

ruleset-failed-rules

Display the list of failed rules.

register-tenant-handler <id> <htype> [hargs]

Register a tenant handler with the specified mapping.

unregister-tenant-handler <id> <htype> [hargs]

Unregister a tenant handler with the specified mapping.

register-tenant <id> <filename>

Register tenant with a particular ID and filename.

reload-tenant <id> [filename]

Reload a tenant with specified ID. A filename to a tenant yaml can be specified. If it is omitted, the original yaml that was used to load / last reload the tenant is used.

reload-tenants

Reload all registered tenants by reloading their yaml.

unregister-tenant <id>

Unregister tenant with a particular ID.

add-hostbit <ipaddress> <hostbit> <expire>

Add hostbit on a host IP with a particular bit name and time of expiry.

remove-hostbit <ipaddress> <hostbit>

Remove hostbit on a host IP with specified IP address and bit name.

list-hostbit <ipaddress>

List hostbit for a particular host IP.

reopen-log-files

Reopen log files to be run after external log rotation.

memcap-set <config> <memcap>

Update memcap value of a specified item.

memcap-show <config>

Show memcap value of a specified item.

memcap-list

List all memcap values available.

24.2.4 PCAP MODE COMMANDS

pcap-file <file> <dir> [tenant] [continuous] [delete-when-done]

Add pcap files to Suricata for sequential processing. The generated log/alert files will be put into the directory specified as second argument. Make sure to provide absolute path to the files and directory. It is acceptable to add multiple files without waiting the result.

pcap-file-continuous <file> <dir> [tenant] [delete-when-done]

Add pcap files to Suricata for sequential processing. Directory will be monitored for new files being added until there is a use of **pcap-interrupt** or directory is moved or deleted.

pcap-file-number
Number of pcap files waiting to get processed.

pcap-file-list
List of queued pcap files.

pcap-last-processed
Processed time of last file in milliseconds since epoch.

pcap-interrupt
Terminate the current state by interrupting directory processing.

pcap-current
Currently processed file.

24.2.5 BUGS

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24.2.6 NOTES

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24.3 Suricata Control

24.3.1 SYNOPSIS

suricatactl [-h] <command> [<args>]

24.3.2 DESCRIPTION

This tool helps control Suricata's features.

24.3.3 OPTIONS

-h

Get help about the available commands.

24.3.4 COMMANDS

suricatactl-filestore(1)

24.3.5 BUGS

Please visit Suricata's support page for information about submitting bugs or feature requests.

24.3.6 NOTES

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24.4 Suricata Control Filestore

24.4.1 SYNOPSIS

suricatactl filestore [-h] <command> [<args>]

24.4.2 DESCRIPTION

This command lets you perform certain operations on Suricata filestore.

24.4.3 OPTIONS

-h

Get help about the available commands.

24.4.4 COMMANDS

prune [-h|--help] [-n|--dry-run] [-v|verbose] [-q|--quiet] -d <DIRECTORY> --age <AGE>

Prune files older than a given age.

-d <DIRECTORY> | --directory <DIRECTORY> is a required argument which tells that user must provide the suricata filestore directory on which all the specified operations are to be performed.

--age <AGE> is a required argument asking the age of the files. Files older than the age mentioned with this option shall be pruned.

-h | --help is an optional argument with which you can ask for help about the command usage.

-n | --dry-run is an optional argument which makes the utility print only what would happen

-v | --verbose is an optional argument to increase the verbosity of command.

-q | --quiet is an optional argument that helps log errors and warnings only and keep silent about everything else.

24.4.5 BUGS

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24.4.6 NOTES

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CHAPTER

TWENTYFIVE

ACKNOWLEDGEMENTS

Thank you to the following for their Wiki and documentation contributions that have made this user guide possible:

- Andreas Herz
- Andreas Moe
- Anne-Fleur Koolstra
- Christophe Vandeplas
- Darren Spruell
- David Cannings
- David Diallo
- David Wharton
- Eric Leblond
- god lol
- Haris Haq
- Ignacio Sanchez
- Jason Ish
- Jason Taylor
- Josh Smith
- Juliana Fajardini
- Ken Steele
- Les Syv
- Lukas Sismis
- Mark Solaris
- Martin Holste
- Mats Klepsland
- Matt Jonkman
- Michael Bentley
- Michael Hrishenko
- Nathan Jimerson

- Nicolas Merle
- Peter Manev
- Philipp Buehler
- Philippe Antoine
- Ralph Broenink
- Rob MacGregor
- Russel Fulton
- Shivani Bhardwaj
- Victor Julien
- Vincent Fang
- Zach Rasmor

CHAPTER

TWENTYSIX

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CHAPTER

TWENTYSEVEN

SURICATA DEVELOPER GUIDE

27.1 Working with the Codebase

27.1.1 Contributing

Contributing to Suricata

This guide describes what steps to take if you want to contribute a patch or patchset to Suricata.

Essentially, these are:

1. Agree to and sign our *Contribution Agreement*
2. Communicate early, and use the *preferred channels*
3. *Claim (or open) a ticket*
4. *Fork from main*
5. Follow our *Coding Style*
6. Use our *Documentation Style*
7. Stick to our *commit guidelines*
8. Add version numbers to your *Pull Requests*
9. Incorporate *Feedback* into new PRs
10. [Work merged] *Wrap up!*

The rest of this document will cover those in detail.

Note: Important!

Before contributing, please review and sign our Contribution Agreement.

Communication is Key!

To clarify questions, discuss or suggest new features, talk about bugs and optimizations, and/or ask for help, it is important to communicate.

These are our main channels:

- Suricata's issue tracker
- Suricata's forum
- Suricata's Discord server

Claim (or open) a ticket

For features and bugs we need tickets. Tickets help us keep track of the work done, indicate when changes need backports etc.

They are also important if you would like to see your new feature officially added to our tool: the ticket documents your ideas so we can analyze how do they fit in our plans for Suricata, and, if the feature is accepted, we can properly track progress etc.

Note: If you want to add new functionalities (e.g. a new application layer protocol), please ask us first whether we see that being merged into Suricata or not. This helps both sides understand how the new feature will fit in our roadmap, and prevents wasting time and motivation with contributions that we may not accept. Therefore, *before* starting any code related to a new feature, do request comments from the team about it.

For really trivial fixes or cleanups we won't need that.

Once work on the issue has been agreed upon:

Assign the ticket to yourself. For this, you will need to have the "developer" role. You can ask for that directly on the ticket you want to claim or mention that you are interested in working on *ticket number* on our Developer's channel on Discord.

If a ticket is already assigned to someone, please reach out on the ticket or ask the person first.

You can reach out to other community members via Suricata's Discord server.

Expectations

If you submit a new feature that is not part of Suricata's core functionalities, it will have the *community supported* status. This means we would expect some commitment from you, or the organization who is sponsoring your work, before we could approve the new feature, as the Suricata development team is pretty lean (and many times overworked).

This means we expect that:

- the new contribution comes with a set of Suricata-verify tests (and possibly unit tests, where those apply), before we can approve it;
- proof of compatibility with existing keywords/features is provided, when the contribution is for replacing an existing feature;
- you would maintain the feature once it is approved - or some other community member would do that, in case you cannot.

Note: Regardless of contribution size or complexity, we expect that you respect our guidelines and processes. We appreciate community contributors: Suricata wouldn't be what it is without them; and the value of our tool and community also comes from how seriously we take all this, so we ask that our contributors do the same!

What does "community supported" and "supporting a feature" mean?

If a feature is *community supported*, the Suricata team will try to spend minimal time on it - to be able to focus on the core functionalities. If for any reason you're not willing or able to commit to supporting a feature, please indicate this.

The team and/or community members can then consider offering help. It is best to indicate this prior to doing the actual work, because we will reject features if no one steps up.

It is also important to note that *community supported* features will be disabled by default, and if it brings in new dependencies (libraries or Rust crates) those will also be optional and disabled by default.

Supporting a feature means to actually *maintain* it:

- fixing bugs
- writing documentation
- keeping it up to date
- offering end-user support via forum and/or Discord chat

Stale tickets policy

We understand that people's availability and interested to volunteer their time to our project may change. Therefore, to prevent tickets going stale (not worked on), and issues going unsolved for a long time, we have a policy to unclaim tickets if there are no contribution updates within 6 months.

If you claim a ticket and later on find out that you won't be able to work on it, it is also appreciated if you inform that to us in the ticket and unclaim it, so everyone knows that work is still open and waiting to be done.

What branch to work on

There are 2 or 3 active branches:

- main-x.x.x (e.g. main-7.0.x)
- main-x.x.x (e.g. main-8.0.x)
- main

The first two are stable branches. The latter is the development branch.

Stable branches should only be worked on for important bug fixes. Those are mainly expected from more experienced contributors.

Development of new features or large scale redesign is done in the development branch. New development and new contributors should work with `main` except in very special cases - which should and would be discussed with us first.

If in doubt, please reach out to us via *Redmine, Discord or forum*.

Create your own branch

It's useful to create descriptive branch names. You're working on ticket 123 to improve GeoIP? Name your branch "geoip-feature-123-v1". The "-v1" addition is for feedback. When incorporating feedback you will have to create a new branch for each pull request. So, when you address the first feedback, you will work in "geoip-feature-123-v2" and so on.

For more details check: Creating a branch to do your changes

Coding Style

We have a *Coding Style* that must be followed.

Documentation Style

For documenting *code*, please follow Rust documentation and/or Doxygen guidelines, according to what your contribution is using (Rust or C).

If you are writing or updating *documentation pages*, please:

- wrap up lines at 79 (80 at most) characters;
- when adding diagrams or images, we prefer alternatives that can be generated automatically, if possible;
- bear in mind that our documentation is published on Read the Docs and can also be built to pdf, so it is important that it looks good in such formats.

Commit History matters

Please consider our *Commit guidelines* before submitting your PR.

Send a Pull Request

The pull request is used to request inclusion of your patches into the main repository. Before it is merged, it will be reviewed and pushed through a QA process.

Please consider our *Pull Requests Criteria* when submitting.

We have 'GitHub-CI' integration enabled. This means some automated build check, suricata-verity and unit tests are performed on the pull request. Generally, this is ready after a few minutes. If the test fails, the pull request won't be considered. So please, when you submit something, keep an eye on the checks, and address any failures - if you do not understand what they are, it is fine to ask about them on the failing PR itself.

Before merge, we also perform other integration tests in our private QA-lab. If those fail, we may request further changes, even if the GitHub-CI has passed.

Feedback

You'll likely get some feedback. Even our most experienced devs do, so don't feel bad about it.

After discussing what needs to be changed (usually on the PR itself), it's time to go back to "*Create your own branch*" and do it all again. This process can iterate quite a few times, as the contribution is refined.

Wrapping up

Merged! Cleanup

Congrats! Your change has been merged into the main repository. Many thanks!

We strongly suggest cleaning up: delete your related branches, both locally and on GitHub - this helps you in keeping things organized when you want to make new contributions.

Update ticket

You can now put the URL of the *merged* pull request in the Redmine ticket. Next, mark the ticket as "Closed" or "Resolved".

Well done! You are all set now.

Suricata Backports Guide

This document describes the processes used to backport content to current stable Suricata releases. Most often, this means security and/or bug fixes; however, in some cases, features may be backported to previous Suricata releases.

There are multiple versions of Suricata at any given time:

- Main
- Major stable release
- Old stable release

For example, at the moment, there are 3 releases based on these Suricata branches:

- main: 9.0.0-dev, current development branch
- main-8.0.x: major stable release
- main-7.0.x: old stable release

For Suricata's release cadence and *end of life* policies, please check https://suricata.io/our-story/eol-policy/.

The next sections discuss when and what to backport, and some guidelines when doing so.

What should be backported?

Usually, when the team creates a ticket, we'll add the *Needs backport* related labels, so necessary backporting tickets will be automatically created. If you are working on a ticket that doesn't have such labels, nor backporting tasks associated, it probably doesn't need backporting. If you understand that the issue should be backported, please let us know in the ticket or related PR. But sometimes we'll miss those.

The general principle used to determine what will be backported is:

- security fixes (please see our Security Policy)
- bug fixes
- in some cases, new features are backported if there are sufficient reasons to backport a new feature.

Note: 7.0.x backports

With the release of Suricata 8.0, Suricata 7 has reached a mature stage of its release cycle. Thus, as a rule, only critical issues (bugs and security), should be considered for backporting.

Note: Exceptions

There can be cases where backports may be "missed" -- some issues may not be labeled as needing backports and some PRs may be merged without an issue.

This guide may be insufficient for some situations. When in doubt, please reach out to the team on the backport ticket or PR.

Selection overview

All items considered for backports should be reviewed with the following:

- risk estimate: will the change introduce new bugs? Consider the scope and items affected by the change.
- behavioral change: how much will the behavior of the system be changed by the backport. For example, a small change to decode additional encapsulation protocols may result in more traffic being presented to Suricata.
- default settings: if the issue alters behavior, can it be made optional, and at what cost?

Creating backport tickets -- new issues

Redmine: for security and bug fixes, when creating a new Redmine issue, label the Redmine issue with "Needs backport to x.0", where x.0 is a supported Suricata release, e.g, 8.0.x.

Creating backport tickets -- existing issues/PRs

We want to minimize the occurrence of "missed backports" -- that is, work that should be backported but wasn't. Sometimes this happens when there is no Redmine issue, or the Redmine issue wasn't labeled as needing a backport.

Therefore, we will be periodically reviewing:

- Redmine issues without backport labels, including recently closed issues, to see which require backport labels.
- PRs without associated Redmine issues. Those requiring backports should be labeled with *needs backport*.

Then, also periodically, we will create backport issues from those items identified in the previous steps. When doing so, we will evaluate what are the relevant target backport releases. Some issues reported against main or the current Suricata release may not apply to older releases.

Git Backport Workflow

If you are working on a task that needs to be backported, only start the backporting process once the PR for main has been merged. Then:

- *Identify the commit(s) needed* for the backport. Start with the PR that merged the commits into main and select only the commits from the issue being backported.
- *Bring each commit into the new branch,* one at a time -- starting with the oldest commit. Use `git cherry-pick -x commit-hash`, where `commit-hash` is the hash to the commit already in main or main-8.0x that is being backported, as it maintains the linkage with said cherry-picked commit.
- *Resolve conflicts:* Some of the cherry-picked commits may contain merge conflicts. If the conflicts are small, include the corrections in the cherry-picked commit.
- *Add additional commits*, if any are needed (e.g., to adjust cherry-picked code to old behavior).

Note: Commit hashes

We have a CI check that ensures the validity of the cherry-pick line.

Note: Exceptions

Sometimes, the fix for main will not work for the stable or old releases. In such cases, the backporting process won't be through cherry-picking, but through actually implementing a fix for the specific version.

Create a PR:

Please indicate in the title that this is a backport PR, with something like *(8.0.x-backport)*, and add the related milestone label.

In the PR description, indicate the backport ticket.

QA

Add suricata-verify PRs when needed. Some existing suricata-verify tests may require version specification changes.

Code Submission Process

Commits

1. Commits need to be logically separated. Don't fix unrelated things in one commit.
2. Don't add unnecessary commits, if commit 2 fixes commit 1 merge them together (squash)
3. Commits need to have proper messages, explaining anything that is non-trivial
4. Commits should not at the same time change, rename and/or move code. Use separate commits for each of this, e.g, a commit to rename files, then a commit to change the code.
5. Documentation updates should be in their own commit (not mixed with code commits)
6. **Commit messages need to be properly formatted:**
   - Meaningful and short (50 chars max) subject line followed by an empty line
   - Naming convention: prefix message with sub-system ("rule parsing: fixing foobar"). If you're not sure what to use, look at past commits to the file(s) in your PR.
   - Description, wrapped at ~72 characters
7. Commits should be individually compilable, starting with the oldest commit. Make sure that each commit can be built if it and the preceding commits in the PR are used.
8. Commits should be authored with the format: "FirstName LastName <name@example.com>"

Information that needs to be part of a commit (if applicable):

1. Ticket it fixes. E.g. "Fixes Bug #123."
2. Compiler warnings addressed.
3. Coverity Scan issues addressed.
4. Static analyzer error it fixes (cppcheck/scan-build/etc)

When in doubt, check our git history for other messages or changes done to the same module your're working on. This is a good example of a commit message:

```
pcap/file: normalize file timestamps

Normalize the timestamps that are too far in the past to epoch.

Bug: #6240.
```

Pull Requests

A github pull request is actually just a pointer to a branch in your tree. GitHub provides a review interface that we use.

1. A branch can only be used in for an individual PR.
2. A branch should not be updated after the pull request
3. A pull request always needs a good description (link to issue tracker if related to a ticket).
4. Incremental pull requests need to link to the prior iteration
5. Incremental pull requests need to describe changes since the last PR
6. Link to the ticket(s) that are addressed to it.
7. When fixing an issue, update the issue status to `In Review` after submitting the PR.
8. Pull requests are automatically tested using github actions (https://github.com/OISF/suricata/blob/main/.github/workflows/builds.yml). Failing builds won't be considered and should be closed immediately.
9. Pull requests that change, or add a feature should include a documentation update commit

Tests and QA

As much as possible, new functionality should be easy to QA.

1. Add `suricata-verify` tests for verification. See https://github.com/OISF/suricata-verify
2. Add unittests if a `suricata-verify` test isn't possible.
3. Provide pcaps that reproduce the problem. Try to trim as much as possible to the pcap includes the minimal set of packets that demonstrate the problem.
4. Provide example rules if the code added new keywords or new options to existing keywords

GitHub Pull Request Workflow

Draft Pull Requests

A Pull Request (PR) should be marked as *draft* if it is not intended to be merged as is, but is waiting for some sort of feedback. The author of the PR should be explicit with what kind of feedback is expected (CI/QA run, discussion on the code, etc...)

GitHub filter is `is:pr is:open draft:true sort:updated-asc`

A draft may be closed if it has not been updated in two months.

Mergeable Pull Requests

When a Pull Request is intended to be merged as is, the workflow is the following:

1. get reviewed, and either request changes or get approved
2. if approved, get staged in a next branch (with other PRs), wait for CI validation (and eventually request changes if CI finds anything)
3. get merged and closed

A newly created PR should match the filter `is:pr is:open draft:false review:none sort:updated-asc no:assignee` The whole team is responsible to assign a PR to someone precise within 2 weeks.

When someone gets assigned a PR, the PR should get a review status within 2 weeks: either changes requested, approved, or assigned to someone else if more expertise is needed.

GitHub filter for changes-requested PRs is `is:pr is:open draft:false sort: updated-asc review:changes-requested`

Such a PR may be closed if it has not been updated in two months. It is expected that the author creates a new PR with a new version of the patch as described in *Pull Requests Criteria*.

Command to get approved PRs is `gh pr list --json number,reviewDecision --search "state:open type:pr -review:none" | jq '.[] | select(.reviewDecision==="")'`

Web UI filter does not work cf https://github.com/orgs/community/discussions/55826

Once in approved state, the PRs are in the responsibility of the merger, along with the next branches/PRs.

27.1.2 Installation from GIT

Ubuntu Installation from GIT

This document will explain how to install and use the most recent code of Suricata on Ubuntu. Installing from GIT on other operating systems is basically the same, except that some commands are Ubuntu-specific (like sudo and apt-get). In case you are using another operating system, you should replace those commands with your OS-specific commands.

Note: These instructions were tested on Ubuntu 22.04.

Pre-installation requirements

Before you can build Suricata for your system, run the following command to ensure that you have everything you need for the installation.

```
sudo apt-get -y install libpcre2-dev build-essential autoconf \
automake libtool libpcap-dev libnet1-dev libyaml-0-2 libyaml-dev \
pkg-config zlib1g zlib1g-dev libcap-ng-dev libcap-ng0 make \
libmagic-dev libjansson-dev rustc cargo jq git-core
```

Add `${HOME}/.cargo/bin` to your path:

```
export PATH=$PATH:${HOME}/.cargo/bin
cargo install --force cbindgen
```

Depending on the current status of your system, it may take a while to complete this process.

IPS

By default, Suricata works as an IDS. If you want to use it as an IDS and IPS program, enter:

```
sudo apt-get -y install libnetfilter-queue-dev libnetfilter-queue1 \
libnfnetlink-dev libnfnetlink0
```

Suricata

First, it is convenient to create a directory for Suricata. Name it 'suricata' or 'oisf', for example. Open the terminal and enter:

```
mkdir suricata  # mkdir oisf
```

Followed by:

```
cd suricata  # cd oisf
```

Next, enter the following line in the terminal:

```
git clone https://github.com/OISF/suricata.git
cd suricata
```

Libhtp and suricata-update are not bundled. Get them by doing:

```
./scripts/bundle.sh
```

Followed by:

```
./autogen.sh
```

To configure, please enter:

```
./configure
```

To compile, please enter:

```
make
```

To install Suricata, enter:

```
sudo make install
sudo ldconfig
```

Auto-setup

You can also use the available auto-setup features of Suricata. Ex:

```
./configure && make && sudo make install-conf
```

make install-conf would do the regular "make install" and then it would automatically create/setup all the necessary directories and `suricata.yaml` for you.

```
./configure && make && make install-rules
```

make install-rules would do the regular "make install" and then it would automatically download and set-up the latest ruleset from Emerging Threats available for Suricata.

```
./configure && make && make install-full
```

make install-full would combine everything mentioned above (install-conf and install-rules) - and will present you with a ready to run (configured and set-up) Suricata.

Post installation

Please continue with *Basic setup*.

In case you have already created your Suricata directory and cloned the repository in it, if you want to update your local repository with the most recent code, please run:

```
cd suricata/suricata
```

next, enter:

```
git pull
```

After that, you should run *./autogen.sh* again.

27.1.3 Coding Style

Suricata uses a fairly strict coding style. This document describes it.

Formatting

clang-format

`clang-format` is configured to help you with formatting C code.

Note: The `.clang-format` script requires clang 9 or newer.

Format your Changes

Before opening a pull request, please also try to ensure it is formatted properly. We use `clang-format` for this, which has git integration through the `git-clang-format` script to only format your changes.

On some systems, it may already be installed (or be installable via your package manager). If so, you can simply run it.

It is recommended to format each commit as you go. However, you can always reformat your whole branch after the fact.

Note: Depending on your installation, you might have to use the version-specific `git clang-format` in the commands below, e.g. `git clang-format-9`, and possibly even provide the `clang-format` binary with `--binary clang-format-9`.

As an alternative, you can use the provided `scripts/clang-format.sh` that isolates you from the different versions.

Formatting the most recent commit only

The following command will format only the code changed in the most recent commit:

```
$ git clang-format HEAD^
# Or with script:
$ scripts/clang-format.sh commit
```

Note that this modifies the files, but doesn't commit them. If the changes are trivial, you'll likely want to run

```
$ git commit --amend -a
```

in order to update the last commit with all pending changes.

For bigger formatting changes, we do ask you to add them to separate, dedicated commits.

Formatting code in staging

The following command will format the changes in staging, i.e. files you `git add`-ed:

```
$ git clang-format
# Or with script:
$ scripts/clang-format.sh cached
```

If you also want to change the unstaged changes, do:

```
$ git clang-format --force
# Or with script:
$ scripts/clang-format.sh cached --force
```

Formatting your branch's commits

In case you have multiple commits on your branch already and forgot to format them you can fix that up as well.

The following command will format every commit in your branch off main and rewrite history using the existing commit metadata.

Tip: Create a new version of your branch first and run this off the new version.

```
# In a new version of your pull request:
$ scripts/clang-format.sh rewrite-branch
```

Note that the above should only be used for rather minimal formatting changes. As mentioned, we prefer that you add such changes to a dedicated commit for formatting changes:

```
# Format all changes by commits on your branch:
$ git clang-format first_commit_on_your_branch^
# Or with script:
$ scripts/clang-format.sh branch
```

Note the usage of `first_commit_on_your_branch^`, not `main`, to avoid picking up new commits on `main` in case you've updated main since you've branched.

Check formatting

Check if your branch changes' formatting is correct with:

```
$ scripts/clang-format.sh check-branch
```

Add the `--diffstat` parameter if you want to see the files needing formatting. Add the `--diff` parameter if you want to see the actual diff of the formatting change.

Formatting a whole file

> **Note**
> Do not reformat whole files by default, i.e. do not use `clang-format` proper in general.

If you were ever to do so, formatting changes of existing code with clang-format shall be a different commit and must not be mixed with actual code changes.

```
$ clang-format -i {file}
```

Disabling clang-format

There might be times, where the clang-format's formatting might not please. This might mostly happen with macros, arrays (single or multi-dimensional ones), struct initialization, or where one manually formatted code.

You can always disable clang-format.

```
/* clang-format off */
#define APP_LAYER_INCOMPLETE(c, n) (AppLayerResult){1, (c), (n)}
/* clang-format on */
```

Installing clang-format and git-clang-format

clang-format 9 or newer is required.

On ubuntu 18.04:

- It is sufficient to only install clang-format, e.g.

  ```
  $ sudo apt-get install clang-format-9
  ```

- See http://apt.llvm.org for other releases in case the clang-format version is not found in the default repos.

On fedora:

- Install the `clang` and `git-clang-format` packages with

  ```
  $ sudo dnf install clang git-clang-format
  ```

Line length

Limit line lengths to 100 characters.

When wrapping lines that are too long, they should be indented at least 8 spaces from previous line. You should attempt to wrap the minimal portion of the line to meet the 100 character limit.

clang-format:

- ColumnLimit: 100
- ContinuationIndentWidth: 8
- ReflowComments: true

Indent

We use 4 space indentation.

```
int DecodeEthernet(ThreadVars *tv, DecodeThreadVars *dtv, Packet *p,
        uint8_t *pkt, uint16_t len, PacketQueue *pq)
{
    SCPerfCounterIncr(dtv->counter_eth, tv->sc_perf_pca);

    if (unlikely(len < ETHERNET_HEADER_LEN)) {
        ENGINE_SET_INVALID_EVENT(p, ETHERNET_PKT_TOO_SMALL);
        return TM_ECODE_FAILED;
    }

    ...

    DecodeNetworkLayer(tv, dtv, SCNtohs(p->ethh->eth_type), p,
            pkt + ETHERNET_HEADER_LEN, len - ETHERNET_HEADER_LEN);

    return TM_ECODE_OK;
}
```

Use 8 space indentation when wrapping function parameters, loops and if statements.

Use 4 space indentation when wrapping variable definitions.

```
const SCPlugin PluginSpec = {
    .name = OUTPUT_NAME,
    .author = "Some Developer",
    .license = "GPLv2",
    .Init = TemplateInit,
};
```

clang-format:

- AlignAfterOpenBracket: DontAlign
- Cpp11BracedListStyle: false
- IndentWidth: 4
- TabWidth: 8 [llvm]
- UseTab: Never [llvm]

Braces

Functions should have the opening brace on a newline:

```
int SomeFunction(void)
{
    DoSomething();
}
```

Note: you may encounter non-compliant code.

Control and loop statements should have the opening brace on the same line:

```
if (unlikely(len < ETHERNET_HEADER_LEN)) {
    ENGINE_SET_INVALID_EVENT(p, ETHERNET_PKT_TOO_SMALL);
    return TM_ECODE_FAILED;
}

for (ascii_code = 0; ascii_code < 256; ascii_code++) {
    ctx->goto_table[ctx->state_count][ascii_code] = SC_AC_FAIL;
}

while (funcs != NULL) {
    temp = funcs;
    funcs = funcs->next;
    SCFree(temp);
}
```

Opening and closing braces go on the same line as as the _else_ (also known as a "cuddled else").

```
if (this) {
    DoThis();
} else {
    DoThat();
}
```

Structs, unions and enums should have the opening brace on the same line:

```
union {
    TCPVars tcpvars;
    ICMPV4Vars icmpv4vars;
    ICMPV6Vars icmpv6vars;
} l4vars;

struct {
    uint8_t type;
    uint8_t code;
} icmp_s;

enum {
    DETECT_TAG_TYPE_SESSION,
    DETECT_TAG_TYPE_HOST,
    DETECT_TAG_TYPE_MAX
};
```

clang-format:

- BreakBeforeBraces: Custom [breakbeforebraces]
- BraceWrapping:
  - AfterClass: true
  - AfterControlStatement: false
  - AfterEnum: false
  - AfterFunction: true
  - AfterStruct: false
  - AfterUnion: false
  - AfterExternBlock: true
  - BeforeElse: false
  - IndentBraces: false

Flow

Don't use conditions and statements on the same line. E.g.

```
if (a) b = a; // <- wrong

if (a)
    b = a; // <- right

for (int i = 0; i < 32; ++i) f(i); // <- wrong

for (int i = 0; i < 32; ++i)
    f(i); // <- right
```

Don't put short or empty functions and structs on one line.

```
void empty_function(void)
{
}

int short_function(void)
{
    return 1;
}
```

Don't use unnecessary branching. E.g.:

```
if (error) {
    goto error;
} else {
    a = b;
}
```

Can be written as:

```
if (error) {
    goto error;
}
a = b;
```

clang-format:

- AllowShortBlocksOnASingleLine: false [llvm]
- AllowShortBlocksOnASingleLine: Never [llvm] (breaking change in clang 10!) [clang10]
- AllowShortEnumsOnASingleLine: false [clang11]
- AllowShortFunctionsOnASingleLine: None
- AllowShortIfStatementsOnASingleLine: Never [llvm]
- AllowShortLoopsOnASingleLine: false [llvm]
- BreakBeforeBraces: Custom [breakbeforebraces]
- BraceWrapping:
  - SplitEmptyFunction: true
  - SplitEmptyRecord: true

Alignment

Pointers

Pointers shall be right aligned.

```
void *ptr;
void f(int *a, const char *b);
void (*foo)(int *);
```

clang-format:

- PointerAlignment: Right
- DerivePointerAlignment: false

Declarations and Comments

Trailing comments should be aligned for consecutive lines.

```
struct bla {
    int a;       /* comment */
    unsigned bb; /* comment */
    int *ccc;    /* comment */
};

void alignment()
{
    // multiple consecutive vars
    int a = 13;           /* comment */
```

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```
    int32_t abc = 1312;   /* comment */
    int abcdefghikl = 13; /* comment */
}
```

clang-format:

- AlignConsecutiveAssignments: false
- AlignConsecutiveDeclarations: false
- AlignTrailingComments: true

Functions

parameter names

TODO

Function names

Function names are NamedLikeThis().

```
static ConfNode *ConfGetNodeOrCreate(char *name, int final)
```

static vs non-static

Functions should be declared static whenever possible.

inline

The inlining of functions should be used only in critical paths.

Variables

Names

A variable is `named_like_this` in all lowercase.

```
ConfNode *parent_node = root;
```

Generally, use descriptive variable names.

In loop vars, make sure `i` is a signed int type.

Scope

TODO

Macros

Macro names are ALL_CAPS_WITH_UNDERSCORES. Enclose parameters in parens on each usage inside the macro.

Align macro values on consecutive lines.

```
#define ACTION_ALERT       0x01
#define ACTION_DROP        0x02
#define ACTION_REJECT      0x04
#define ACTION_REJECT_DST  0x08
#define ACTION_REJECT_BOTH 0x10
#define ACTION_PASS        0x20
```

Align escape for multi-line macros right-most at ColumnLimit.

```
#define MULTILINE_DEF(a, b)                                          \
    if ((a) > 2) {                                                   \
        auto temp = (b) / 2;                                         \
        (b) += 10;                                                   \
        someFunctionCall((a), (b));                                  \
    }
```

clang-format:

- AlignConsecutiveMacros: true [clang9]
- AlignEscapedNewlines: Right

Comments

TODO

Function comments

We use Doxygen, functions are documented using Doxygen notation:

```
/**
 * \brief Helper function to get a node, creating it if it does not
 * exist.
 *
 * This function exits on memory failure as creating configuration
 * nodes is usually part of application initialization.
 *
 * \param name The name of the configuration node to get.
 * \param final Flag to set created nodes as final or not.
 *
 * \retval The existing configuration node if it exists, or a newly
 * created node for the provided name. On error, NULL will be returned.
```

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```
 */
static ConfNode *ConfGetNodeOrCreate(char *name, int final)
```

General comments

We use `/* foobar */` style and try to avoid `//` style.

File names

File names are all lowercase and have a .c. .h or .rs (Rust) extension.

Most files have a _subsystem_ prefix, e.g. `detect-dsize.c, util-ip.c`

Some cases have a multi-layer prefix, e.g. `util-mpm-ac.c`

Enums

Use a common prefix for all enum values. Value names are ALL_CAPS_WITH_UNDERSCORES.

Put each enum values on a separate line. Tip: Add a trailing comma to the last element to force "one-value-per-line" formatting in clang-format.

```
enum { VALUE_ONE, VALUE_TWO };  // <- wrong

// right
enum {
    VALUE_ONE,
    VALUE_TWO, // <- force one-value-per-line
};
```

clang-format:

- AllowShortEnumsOnASingleLine: false [clang11]

Structures and typedefs

TODO

switch statements

Switch statements are indented like in the following example, so the 'case' is indented from the switch:

```
switch (ntohs(p->ethh->eth_type)) {
    case ETHERNET_TYPE_IP:
        DecodeIPV4(tv, dtv, p, pkt + ETHERNET_HEADER_LEN,
                   len - ETHERNET_HEADER_LEN, pq);
        break;
```

Fall through cases will be commented with `/* fall through */`. E.g.:

```
switch (suri->run_mode) {
    case RUNMODE_PCAP_DEV:
    case RUNMODE_AFP_DEV:
    case RUNMODE_PFRING:
        /* find payload for interface and use it */
        default_packet_size = GetIfaceMaxPacketSize(suri->pcap_dev);
        if (default_packet_size)
            break;
        /* fall through */
    default:
        default_packet_size = DEFAULT_PACKET_SIZE;
```

Do not put short case labels on one line. Put opening brace on same line as case statement.

```
switch (a) {
    case 13: {
        int a = bla();
        break;
    }
    case 15:
        blu();
        break;
    default:
        gugus();
}
```

clang-format:

- IndentCaseLabels: true
- IndentCaseBlocks: false [clang11]
- AllowShortCaseLabelsOnASingleLine: false [llvm]
- BreakBeforeBraces: Custom [breakbeforebraces]
- BraceWrapping:
  - AfterCaseLabel: false (default)

const

TODO

goto

Goto statements should be used with care. Generally, we use it primarily for error handling. E.g.:

```
static DetectFileextData *DetectFileextParse (char *str)
{
    DetectFileextData *fileext = NULL;

    fileext = SCMalloc(sizeof(DetectFileextData));
    if (unlikely(fileext == NULL))
        goto error;
```

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```
    memset(fileext, 0x00, sizeof(DetectFileextData));

    if (DetectContentDataParse("fileext", str, &fileext->ext, &fileext->len, &fileext->
↪flags) == -1) {
        goto error;
    }

    return fileext;

error:
    if (fileext != NULL)
        DetectFileextFree(fileext);
    return NULL;
}
```

Put goto labels at brace level.

```
int goto_style_nested()
{
    if (foo()) {
    label1:
        bar();
    }

label2:
    return 1;
}
```

clang-format:

- IndentGotoLabels: true (default) [clang10]

Includes

TODO

A .c file shall include it's own header first.

clang-format:

- SortIncludes: false

Unittests

When writing unittests that use a data array containing a protocol message, please put an explanatory comment that contain the readable content of the message

So instead of:

```
int SMTPProcessDataChunkTest02(void)
{
    char mimemsg[] = {0x4D, 0x49, 0x4D, 0x45, 0x2D, 0x56, 0x65, 0x72,
```

you should have something like:

```
int SMTPParserTest14(void)
{
    /* 220 mx.google.com ESMTP d15sm986283wfl.6<CR><LF> */
    static uint8_t welcome_reply[] = { 0x32, 0x32, 0x30, 0x20,
```

Banned functions

function	replacement	reason
strtok	strtok_r	
sprintf	snprintf	unsafe
strcat	strlcat	unsafe
strcpy	strlcpy	unsafe
strncpy	strlcat	
strncat	strlcpy	
strndup		OS specific
strchrnul		
rand		
rand_r		
index		
rindex		
bzero	memset	

Also, check the existing code. If yours is wildly different, it's wrong. Example: https://github.com/oisf/suricata/blob/main/src/decode-ethernet.c

27.1.4 Fuzz Testing

To enable fuzz targets compilation, add *--enable-fuzztargets* to configure.

Note: This changes various parts of Suricata making the *suricata* binary unsafe for production use.

The targets can be used with libFuzzer, AFL and other fuzz platforms.

Running the Fuzzers

TODO. For now see src/tests/fuzz/README

Reproducing issues

Extending Coverage

Adding Fuzz Targets

Oss-Fuzz

Suricata is continuously fuzz tested in Oss-Fuzz. See https://github.com/google/oss-fuzz/tree/master/projects/suricata

27.1.5 Testing Suricata

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    - *Crafting input samples with Scapy*
    - *Other examples from our Suricata-Verify tests:*
    - *Finding Capture Samples*

General Concepts

There are a few ways of testing Suricata:

- **Unit tests**: for independently checking specific functions or portions of code. This guide has specific sections to further explain those, for C and Rust;
- Suricata-Verify: those are used to check more complex behavior, like the log output or the alert counts for a given input, where that input is usually comprised of several packets;
- **Static and dynamic analysis tools**: to help in finding bugs, memory leaks and other issues (like scan-build, from *clang*, which is also used for our C formatting checks; or ASAN, which checks for memory issues);
- **Fuzz testing**: especially good for uncovering existing, often non-trivial bugs. For more on how to fuzz test Suricata, check *Fuzz Testing*;
- **CI checks**: each PR submitted to the project's public repositories will be run against a suit of Continuous Integration workflows, as part of our QA process. Those cover: formatting and commit checks; fuzz tests (CI Fuzz), and several builds. See our github workflows for details and those in action at https://github.com/OISF/suricata/actions.

Note: If you can run unit tests or other checks and report failures in our issue tracker, that is rather useful and appreciated!

The focus of this document are Unit tests and Suricata-Verify tests, especially on offering some guidance regarding when to use each type of test, and how to prepare input for them.

Unit tests

Use these to check that specific functions behave as expected, in success and in failure scenarios. Specially useful during development, for nom parsers in the Rust codebase, for instance, or for checking that messages or message parts of a protocol/stream are processed as they should.

To execute all unit tests (both from C and Rust code), as well as `libhtp` ones, from the Suricata main directory, run:

```
make check
```

Check the Suricata Devguide on *Unit Tests - C* or *Unit tests - Rust* for more on how to write and run unit tests, given that the way to do so differs, depending on the language.

Code Examples

An example from the DNS parser. This checks that the given raw input (note the comments indicating what it means), once processed by `dns_parse_name` yields the expected result, including the unparsed portion.

```
/// Parse a simple name with no pointers.
#[test]
fn test_dns_parse_name() {
    let buf: &[u8] = &[
                                            0x09, 0x63, /* .......c */
        0x6c, 0x69, 0x65, 0x6e, 0x74, 0x2d, 0x63, 0x66, /* lient-cf */
        0x07, 0x64, 0x72, 0x6f, 0x70, 0x62, 0x6f, 0x78, /* .dropbox */
        0x03, 0x63, 0x6f, 0x6d, 0x00, 0x00, 0x01, 0x00, /* .com.... */
    ];
    let expected_remainder: &[u8] = &[0x00, 0x01, 0x00];
    let (remainder,name) = dns_parse_name(buf, buf).unwrap();
    assert_eq!("client-cf.dropbox.com".as_bytes(), &name[..]);
    assert_eq!(remainder, expected_remainder);
}
```

From the C side, `decode-ethernet.c` offers an good example:

```
/**
 * Test a DCE ethernet frame that is too small.
 */
static int DecodeEthernetTestDceTooSmall(void)
{
    uint8_t raw_eth[] = {
        0x00, 0x10, 0x94, 0x55, 0x00, 0x01, 0x00, 0x10,
        0x94, 0x56, 0x00, 0x01, 0x89, 0x03,
    };
```

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```
    Packet *p = PacketGetFromAlloc();
    FAIL_IF_NULL(p);
    ThreadVars tv;
    DecodeThreadVars dtv;

    memset(&dtv, 0, sizeof(DecodeThreadVars));
    memset(&tv,  0, sizeof(ThreadVars));

    DecodeEthernet(&tv, &dtv, p, raw_eth, sizeof(raw_eth));

    FAIL_IF_NOT(ENGINE_ISSET_EVENT(p, DCE_PKT_TOO_SMALL));

    PacketFree(p);
    PASS;
}
```

Suricata-Verify

As mentioned above, these tests are used to check more complex behavior that involve a complete flow, with exchange of requests and responses. This can be done in an easier and more straightforward way, since one doesn't have to simulate the network traffic and Suricata engine mechanics - one simply runs it, with the desired input packet capture, configuration and checks.

A Suricata-verify test can help to ensure that code refactoring doesn't affect protocol logs, or signature detection, for instance, as this could have a major impact to Suricata users and integrators.

For simpler tests, providing the pcap input is enough. But it is also possible to provide Suricata rules to be inspected, and have Suricata Verify match for alerts and specific events.

Refer to the Suricata Verify readme for details on how to create this type of test. It suffices to have a packet capture representative of the behavior one wants to test, and then follow the steps described there.

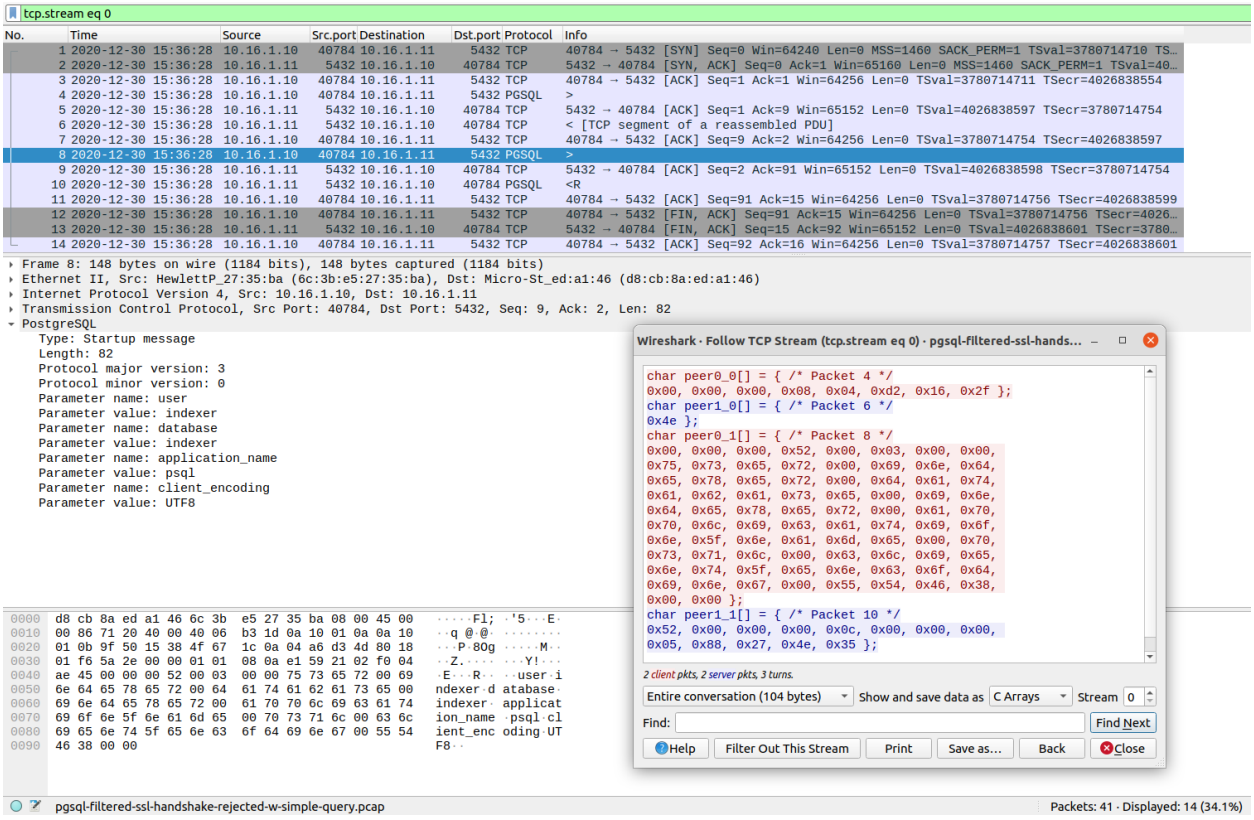
The Git repository for the Suricata Verify tests is a great source for examples, like the app-layer-template one.

Generating Input

Using real traffic

Having a packet capture for the desired protocol you want to test, open it in Wireshark, and select the specific packet chosen for the test input, then use the Wireshark option `Follow [TCP/UDP/HTTP/HTTP2/QUIC] Stream`. This allows for inspecting the whole network traffic stream in a different window. There, it's possible to choose to `Show and save data as C Arrays`, as well as to select if one wants to see the whole conversation or just **client** or **server** packets. It is also possible to reach the same effect by accessing the **Analyze->Follow->TCP Stream** top menu in Wireshark. (There are other stream options, the available one will depend on the type of network traffic captured).

This option will show the packet data as hexadecimal compatible with C-array style, and easily adapted for Rust, as well. As shown in the image:



Wireshark can be also used to capture sample network traffic and generate pcap files.

Crafting input samples with Scapy

It is also possible to use Scapy to create specific traffic: Scapy usage

Suricata-verify tests have several examples of pcaps generated in such a way. Look for Python scripts like the one used for the dce-udp-scapy.

Other examples from our Suricata-Verify tests:

Going through Suricata-Verify tests *readme* files it is also possible to find an assorted collection of pcap generation possibilities, some with explanation on the how-tos. To list a few:

- http2-range
- http-range
- smb2-delete
- smtp-rset
- http-auth-unrecognized

Finding Capture Samples

If you can't capture traffic for the desired protocol from live traffic, or craft something up, you can try finding the type of traffic you are interested in in public data sets. There's a thread for Sharing good sources of sample captures in our forum.

27.1.6 Unit Tests - C

Unit tests are a great way to create tests that can check the internal state of parsers, structures and other objects.

Tests should:

- use `FAIL`/`PASS` macros
- be deterministic
- not leak memory on `PASS`
- not use conditions

Unit tests are used by developers of Suricata and advanced users who would like to contribute by debugging and testing the engine. Unit tests are small pieces (units) of code which check certain code functionalities in Suricata. If Suricata's code is modified, developers can run unit tests to see if there are any unforeseen effects on other parts of the engine's code. Unit tests will not be compiled with Suricata by default. If you would like to compile Suricata with unit tests, enter the following during the configure-stage:

```
./configure --enable-unittests
```

The unit tests specific command line options can be found at Command Line Options.

Example: You can run tests specifically on flowbits. This is how you should do that:

```
suricata -u -U flowbit
```

It is highly appreciated if you would run unit tests and report failing tests in our issue tracker.

If you want more info about the unittests, regular debug mode can help. This is enabled by adding the configure option:

```
--enable-debug
```

Then, set the debug level from the command-line:

```
SC_LOG_LEVEL=Debug suricata -u
```

This will be very verbose. You can also add the `SC_LOG_OP_FILTER` to limit the output, it is grep-like:

```
SC_LOG_LEVEL=Debug SC_LOG_OP_FILTER="(something|somethingelse)" suricata -u
```

This example will show all lines (debug, info, and all other levels) that contain either something or something else. Keep in mind the log level precedence: if you choose *Info* level, for instance, Suricata won't show messages from the other levels.

Writing Unit Tests - C codebase

Suricata unit tests are somewhat different in C and in Rust. In C, they are comprised of a function with no arguments and returning 0 for failure or 1 for success. Instead of explicitly returning a value, FAIL_* and PASS macros should be used. For example:

```
void MyUnitTest(void)
{
    int n = 1;
    void *p = NULL;

    FAIL_IF(n != 1);
    FAIL_IF_NOT(n == 1);
    FAIL_IF_NOT_NULL(p);
    FAIL_IF_NULL(p);

    PASS;
}
```

Each unit test needs to be registered with `UtRegisterTest()`. Example:

```
UtRegisterTest("MyUnitTest", MyUnitTest);
```

where the first argument is the name of the test, and the second argument is the function. Existing modules should already have a function that registers its unit tests. Otherwise the unit tests will need to be registered. Look for a module similar to your new module to see how best to register the unit tests or ask the development team for help.

Examples

From `conf-yaml-loader.c`:

```
/**
 * Test that a configuration section is overridden but subsequent
 * occurrences.
 */
static int
ConfYamlOverrideTest(void)
{
    char config[] =
        "%YAML 1.1\n"
        "---\n"
        "some-log-dir: /var/log\n"
        "some-log-dir: /tmp\n"
        "\n"
        "parent:\n"
        "  child0:\n"
        "    key: value\n"
        "parent:\n"
        "  child1:\n"
        "    key: value\n"
        ;
    const char *value;
```

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```
    ConfCreateContextBackup();
    ConfInit();

    FAIL_IF(ConfYamlLoadString(config, strlen(config)) != 0);
    FAIL_IF_NOT(ConfGet("some-log-dir", &value));
    FAIL_IF(strcmp(value, "/tmp") != 0);

    /* Test that parent.child0 does not exist, but child1 does. */
    FAIL_IF_NOT_NULL(ConfGetNode("parent.child0"));
    FAIL_IF_NOT(ConfGet("parent.child1.key", &value));
    FAIL_IF(strcmp(value, "value") != 0);

    ConfDeInit();
    ConfRestoreContextBackup();

    PASS;
}
```

In `detect-ike-chosen-sa.c`, it is possible to see the freeing of resources (`DetectIkeChosenSaFree`) and the function that should group all the `UtRegisterTest` calls:

```
#ifdef UNITTESTS
.
.
.
static int IKEChosenSaParserTest(void)
{
    DetectIkeChosenSaData *de = NULL;
    de = DetectIkeChosenSaParse("alg_hash=2");

    FAIL_IF_NULL(de);
    FAIL_IF(de->sa_value != 2);
    FAIL_IF(strcmp(de->sa_type, "alg_hash") != 0);

    DetectIkeChosenSaFree(NULL, de);
    PASS;
}

#endif /* UNITTESTS */

void IKEChosenSaRegisterTests(void)
{
#ifdef UNITTESTS
    UtRegisterTest("IKEChosenSaParserTest", IKEChosenSaParserTest);
#endif /* UNITTESTS */
```

27.1.7 Unit tests - Rust

Rust tests with Cargo check

Rust offers a built-in tool for running unit and integration tests. To do so, one makes usage of:

```
cargo test [options][testname][-- test-options]
```

The Cargo Book explains all options in more detail.

For testing a specific Rust module from Suricata, it suffices to go to the `rust` directory and run the above command, specifying the desired module (like `http2`).

```
cargo test http2
```

The line above will make *rustc* compile the Rust side of Suricata and run unit tests in the `http2` rust module.

For running all Suricata unit tests from our Rust codebase, just run `cargo test`.

Adding unit tests

> **Note:** If you want to understand *when* to use a unit test, please read the devguide section on *Testing Suricata*.

In general, it is preferable to have the unit tests in the same file that they test. At the end of the file, after all other functions. Add a `tests` module, if there isn't one yet, and add the `#[test]` attribute before the unit test function. It is also necessary to import (`use`) the module to test, as well as any other modules used. As seen in the example below:

Example

From `nfs > rpc_records.rs`:

```
mod tests {
     use crate::nfs::rpc_records::*;
     use nom::Err::Incomplete;
     use nom::Needed::Size;

     #[test]
     fn test_partial_input_ok() {
         let buf: &[u8] = &[
             0x80, 0x00, 0x00, 0x9c, // flags
             0x8e, 0x28, 0x02, 0x7e, // xid
             0x00, 0x00, 0x00, 0x01, // msgtype
             0x00, 0x00, 0x00, 0x02, // rpcver
             0x00, 0x00, 0x00, 0x03, // program
             0x00, 0x00, 0x00, 0x04, // progver
             0x00, 0x00, 0x00, 0x05, // procedure
         ];
         let expected = RpcRequestPacketPartial {
             hdr: RpcPacketHeader {
                     frag_is_last: true,
```

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```
                    frag_len: 156,
                    xid: 2384986750,
                    msgtype: 1
                },
            rpcver: 2,
            program: 3,
            progver: 4,
            procedure: 5
        };
        let r = parse_rpc_request_partial(buf);
        match r {
            Ok((rem, hdr)) => {
                assert_eq!(rem.len(), 0);
                assert_eq!(hdr, expected);
            },
            _ => { panic!("failed {:?}",r); }
        }
    }
}
```

Once that is done, Rust should recognize the new test. If you want to check a single test, run:

```
cargo test module::file_name::tests::test_name
```

Where `tests` refers to `mod tests`. If you know the test name is unique, you can even run:

```
cargo test test_name
```

Following the same idea, it is also possible to test specific modules or submodules. For instance:

```
cargo test nfs::rpc_records
```

27.2 Suricata Internals

27.2.1 Packet Pipeline

27.2.2 Threading

27.2.3 Important Data Structures

Introduction

This section explains the most important Suricata Data structures.

For a complete overview, see the doxygen: https://doxygen.openinfosecfoundation.org

27.2.4 Engines

Flow

Stream

Defrag

27.3 Extending Suricata

27.3.1 Packet Capture

27.3.2 Packet Decoder

27.3.3 App-Layer

Application Layer Frame Support

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  - *Adding Frame Support to a Parser*
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Baseline

- Suricata rules format

General Concepts

Frame support was introduced with Suricata 7.0. Up until 6.0.x, Suricata's architecture and state of parsers meant that the network traffic available to the detection engine was just a stream of data, without detail about higher level parsers.

Note: For Suricata, *Frame* is a generic term that can represent any unit of network data we are interested in, which could be comprised of one or several records of other, lower level protocol(s). Frames work as "stream annotations", allowing Suricata to tell the detection engine what type of record exists at a specific offset in the stream.

The normal pipeline of detection in Suricata implied that:

- Certain rules could be quite costly performance-wise. This happened because the same stream could be inspected several times for different rules, since for certain signatures the detection is done when Suricata is still inspecting a lower level stream, not the application layer protocol (e.g., *TCP* traffic, in place of *SMB* one);
- Rules could be difficult and tedious to write (and read), requiring that writers went in byte-detail to express matching on specific payload patterns.

What the Frame support offers is the ability to "point" to a specific portion of stream and identify what type of traffic Suricata is looking at. Then, as the engine reassembles the stream, one can have "read access" to that portion of the stream, aggregating concepts like what type of application layer protocol that is, and differentiating between `header`, `data` or even protocol versions (*SMB1*, *SMB2*...).

The goal of the stream *Frame* is to expose application layer protocol PDUs and other such arbitrary elements to the detection engine directly, instead of relying on Transactions. The main purpose is to bring *TCP data* processing times down by specialising/ filtering down traffic detection.

Adding Frame Support to a Parser

The application layer parser exposes frames it supports to the detect engine, by tagging them as they're parsed. The rest works automatically.

In order to allow the engine to identify frames for records of a given application layer parser, thought must be given as to which frames make sense for the specific protocol you are handling. Some parsers may have clear `header` and `data` fields that form its *protocol data unit* (pdu). For others, the distinction might be between `request` and `response`, only. Whereas for others it may make sense to have specific types of data. This is better understood by seeing the different types of frame keywords, which vary on a per-protocol basis.

It is also important to keep follow naming conventions when defining Frame Types. While a protocol may have strong naming standards for certain structures, do compare those with what Suricata already has registered:

- `hdr`: used for the record header portion
- `data`: is used for the record data portion
- `pdu`: unless documented otherwise, means the whole record, comprising `hdr` and `data`
- `request`: a message from a client to a server
- `response`: a message from a server to a client

Basic steps

Once the frame types that make sense for a given protocol are defined, the basic steps for adding them are:

- create an enum with the frame types;
- identify the parsing function(s) where application layer records are parsed;
- identify the correct moment to register the frames;
- use the Frame API calls directly or build upon them and use your functions to register the frames;
- register the relevant frame callbacks when registering the parser.

Once these are done, you can enable frame eve-output to confirm that your frames are being properly registered. It is important to notice that some hard coded limits could influence what you see on the logs (max size of log output; type of logging for the payload, cf. https://redmine.openinfosecfoundation.org/issues/4988).

If all the steps are successfully followed, you should be able to write a rule using the *frame* keyword and the frame types you have registered with the application layer parser.

Using the *SMB* parser as example, before frame support, a rule would look like:

```
alert tcp ... flow:to_server; content:"|ff|SMB"; content:"some smb 1 issue";
```

With frame support, one is able to do:

```
alert smb ... flow:to_server; frame:smb1.data; content:"some smb 1 issue";
```

Implementation Examples & API Callbacks

Though the steps are the same, there are a few differences when implementing frame support in Rust or in C. The following sections elaborate on that, as well as on the process itself. (Note that the code snippets have omitted portions of code that weren't so relevant to this document).

Rust

This section shows how Frame support is added in Rust, using examples from the SIP parser, and the telnet parser.

Define the frame types. The frame types are defined as an enum. In Rust, make sure to derive from the `AppLayerFrameType`:

Listing 1: rust/src/sip/sip.rs

```rust
#[derive(AppLayerFrameType)]
pub enum SIPFrameType {
    Pdu,
    RequestLine,
    ResponseLine,
    RequestHeaders,
    ResponseHeaders,
    RequestBody,
    ResponseBody,
}
```

Frame registering. Some understanding of the parser will be needed in order to find where the frames should be registered. It makes sense that it will happen when the input stream is being parsed into records. See when some pdu and request frames are created for SIP:

Listing 2: rust/src/sip/sip.rs

```rust
fn parse_request(&mut self, flow: *const core::Flow, stream_slice: StreamSlice) -> bool {
    let input = stream_slice.as_slice();
    let _pdu = Frame::new(
        flow,
        &stream_slice,
        input,
        input.len() as i64,
        SIPFrameType::Pdu as u8,
    );
    SCLogDebug!("ts: pdu {:?}", _pdu);
```

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```
    match sip_parse_request(input) {
        Ok((_, request)) => {
            sip_frames_ts(flow, &stream_slice, &request);
            let mut tx = self.new_tx(crate::core::Direction::ToServer);
            tx.request = Some(request);
            if let Ok((_, req_line)) = sip_take_line(input) {
                tx.request_line = req_line;
            }
            self.transactions.push(tx);
            return true;
        }
```

Note: when to create PDU frames

The standard approach we follow for frame registration is that a frame `pdu` will always be created, regardless of parser status (in practice, before the parser is called). The other frames are then created when and if only the parser succeeds.

Use the Frame API or build upon them as needed. These are the frame registration functions highlighted above:

Listing 3: rust/src/sip/sip.rs

```
fn sip_frames_ts(flow: *const core::Flow, stream_slice: &StreamSlice, r: &Request) {
    let oi = stream_slice.as_slice();
    let _f = Frame::new(
        flow,
        stream_slice,
        oi,
        r.request_line_len as i64,
        SIPFrameType::RequestLine as u8,
    );
    SCLogDebug!("ts: request_line {:?}", _f);
    let hi = &oi[r.request_line_len as usize..];
    let _f = Frame::new(
        flow,
        stream_slice,
        hi,
        r.headers_len as i64,
        SIPFrameType::RequestHeaders as u8,
    );
    SCLogDebug!("ts: request_headers {:?}", _f);
    if r.body_len > 0 {
        let bi = &oi[r.body_offset as usize..];
        let _f = Frame::new(
            flow,
            stream_slice,
            bi,
            r.body_len as i64,
            SIPFrameType::RequestBody as u8,
        );
        SCLogDebug!("ts: request_body {:?}", _f);
```

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```
    }
}
```

Register relevant frame callbacks. As these are inferred from the `#[derive(AppLayerFrameType)]` statement, all that is needed is:

Listing 4: rust/src/sip/sip.rs

```
get_frame_id_by_name: Some(SIPFrameType::ffi_id_from_name),
get_frame_name_by_id: Some(SIPFrameType::ffi_name_from_id),
```

Note: on frame_len

For protocols which search for an end of frame char, like telnet, indicate unknown length by passing `-1`. Once the length is known, it must be updated. For those where length is a field in the record (e.g. *SIP*), the frame is set to match said length, even if that is bigger than the current input

The telnet parser has examples of using the Frame API directly for registering telnet frames, and also illustrates how that is done when length is not yet known:

Listing 5: rust/src/telnet/telnet.rs

```
fn parse_request(
    &mut self, flow: *const Flow, stream_slice: &StreamSlice, input: &[u8],
) -> AppLayerResult {
    let mut start = input;
    while !start.is_empty() {
        if self.request_frame.is_none() {
            self.request_frame = Frame::new(
                flow,
                stream_slice,
                start,
                -1_i64,
                TelnetFrameType::Pdu as u8,
            );
        }
        if self.request_specific_frame.is_none() {
            if let Ok((_, is_ctl)) = parser::peek_message_is_ctl(start) {
                let f = if is_ctl {
                    Frame::new(
                        flow,
                        stream_slice,
                        start,
                        -1_i64,
                        TelnetFrameType::Ctl as u8,
                    )
                } else {
                    Frame::new(
                        flow,
                        stream_slice,
                        start,
                        -1_i64,
```

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```
                        TelnetFrameType::Data as u8,
```

We then update length later on (note especially lines 3 and 10):

Listing 6: rust/src/telnet/telnet.rs

```
1  match parser::parse_message(start) {
2      Ok((rem, request)) => {
3          let consumed = start.len() - rem.len();
4          if rem.len() == start.len() {
5              panic!("lockup");
6          }
7          start = rem;
8
9          if let Some(frame) = &self.request_frame {
10             frame.set_len(flow, consumed as i64);
```

The Frame API calls parameters represent:

- `flow`: dedicated data type, carries specific flow-related data
- `stream_slice`: dedicated data type, carries stream data, shown further bellow
- `frame_start`: a pointer to the start of the frame buffer in the stream (`cur_i` in the SMB code snippet)
- `frame_len`: what we expect the frame length to be (the engine may need to wait until it has enough data. See what is done in the telnet snippet request frames registering)
- `frame_type`: type of frame it's being registering (defined in an enum, as shown further above)

`StreamSlice` contains the input data to the parser, alongside other Stream-related data important in parsing context. Definition is found in *applayer.rs*:

Listing 7: rust/src/applayer.rs

```
pub struct StreamSlice {
    input: *const u8,
    input_len: u32,
    /// STREAM_* flags
    flags: u8,
    offset: u64,
}
```

C code

Implementing Frame support in C involves a bit more manual work, as one cannot make use of the Rust derives. Code snippets from the *HTTP* parser:

Defining the frame types with the enum means:

Listing 8: src/app-layer-htp.c

```
enum HttpFrameTypes {
    HTTP_FRAME_REQUEST,
    HTTP_FRAME_RESPONSE,
```

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```
};

SCEnumCharMap http_frame_table[] = {
    {
            "request",
            HTTP_FRAME_REQUEST,
    },
    {
            "response",
            HTTP_FRAME_RESPONSE,
    },
    { NULL, -1 },
};
```

The HTTP parser uses the Frame registration functions from the C API (`app-layer-frames.c`) directly for registering request Frames. Here we also don't know the length yet. The `0` indicates flow direction: `toserver`, and `1` would be used for `toclient`:

Listing 9: src/app-layer-htp.c

```
Frame *frame = AppLayerFrameNewByAbsoluteOffset(
        hstate->f, hstate->slice, consumed, -1, 0, HTTP_FRAME_REQUEST);
if (frame) {
    SCLogDebug("frame %p/%" PRIi64, frame, frame->id);
    hstate->request_frame_id = frame->id;
    AppLayerFrameSetTxId(frame, HtpGetActiveRequestTxID(hstate));
}
```

Updating `frame->len` later:

Listing 10: src/app-layer-htp.c

```
if (hstate->request_frame_id > 0) {
    Frame *frame = AppLayerFrameGetById(hstate->f, 0, hstate->request_frame_id);
    if (frame) {
        const uint64_t request_size = abs_right_edge - hstate->last_request_data_stamp;

        SCLogDebug("HTTP request complete: data offset %" PRIu64 ", request_size %"␣
↪PRIu64,
                hstate->last_request_data_stamp, request_size);
        SCLogDebug("frame %p/%" PRIi64 " setting len to  %" PRIu64, frame, frame->id,
                request_size);
        frame->len = (int64_t)request_size;
```

Register relevant callbacks (note that the actual functions will also have to be written, for C):

Listing 11: src/app-layer-htp.c

```
AppLayerParserRegisterGetFrameFuncs(
        IPPROTO_TCP, ALPROTO_HTTP1, HTTPGetFrameIdByName, HTTPGetFrameNameById);
```

Note: The `GetFrameIdByName` functions can be "probed", so they should not generate any output or that could be misleading (for instance, Suricata generating a log message stating that a valid frame type is unknown).

Visual context

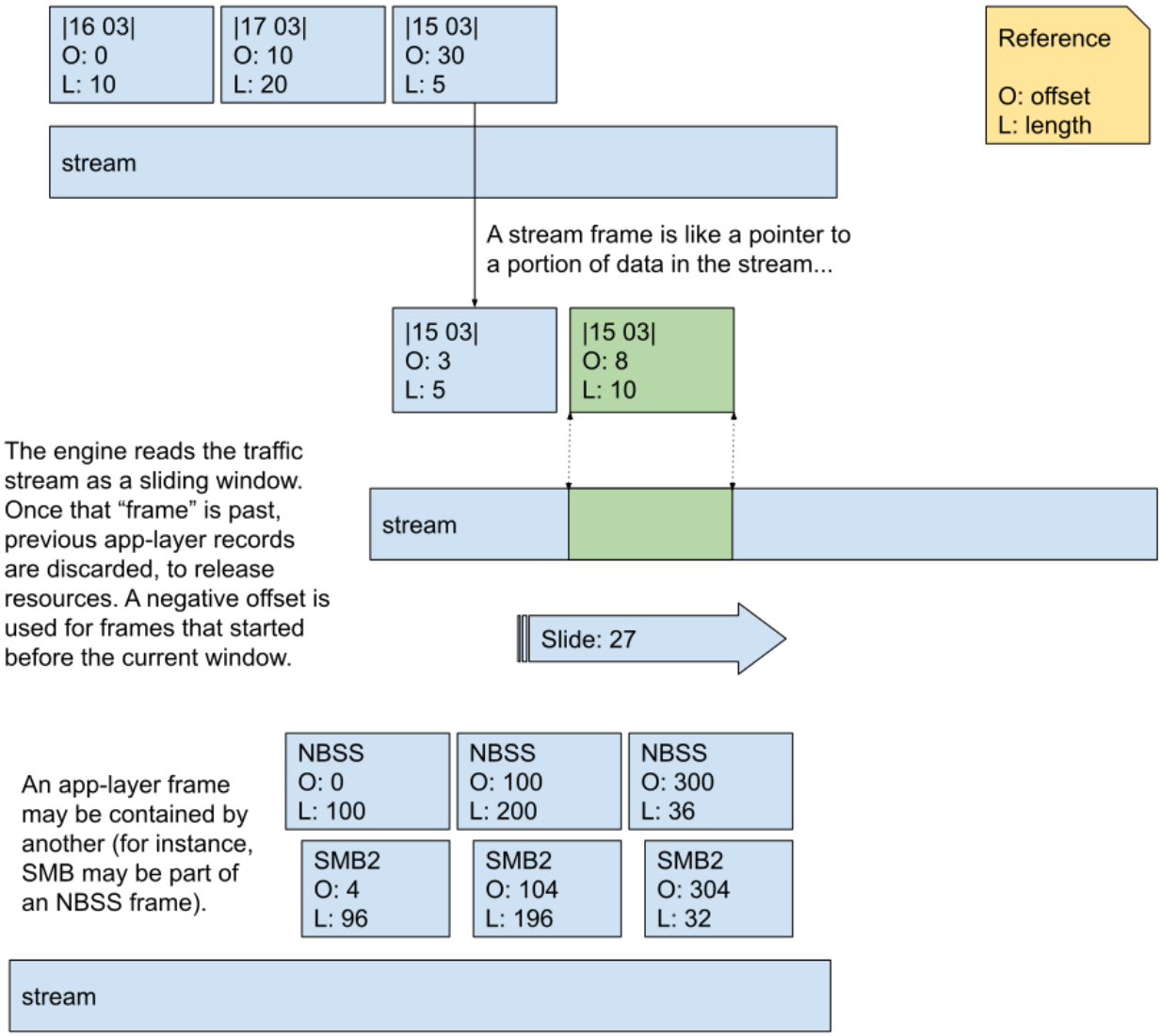
`input` and `input_len` are used to calculate the proper offset, for storing the frame. The stream buffer slides forward, so frame offsets/frames have to be updated. The *relative offset* (`rel_offset`) reflects that:

```
Start:
[ stream ]
  [ frame   ...........]
   rel_offset: 2
   len: 19

Slide:
     [ stream ]
[ frame ....          .]
 rel_offset: -10
 len: 19

Slide:
            [ stream ]
[ frame ...........    ]
 rel_offset: -16
 len: 19
```

The way the engine handles stream frames can be illustrated as follows:



Parsers

Callbacks

The API calls callbacks that are registered at the start of the program.

The function prototype is:

```
typedef AppLayerResult (*AppLayerParserFPtr)(Flow *f, void *protocol_state,
        AppLayerParserState *pstate,
        const uint8_t *buf, uint32_t buf_len,
        void *local_storage, const uint8_t flags);
```

Examples

A C example:

```
static AppLayerResult HTPHandleRequestData(Flow *f, void *htp_state,
        AppLayerParserState *pstate,
        const uint8_t *input, uint32_t input_len,
        void *local_data, const uint8_t flags);
```

In Rust, the callbacks are similar.

```
#[no_mangle]
pub extern "C" fn rs_dns_parse_response_tcp(_flow: *const core::Flow,
        state: *mut std::os::raw::c_void,
        _pstate: *mut std::os::raw::c_void,
        input: *const u8,
        input_len: u32,
        _data: *const std::os::raw::c_void,
        _flags: u8)
-> AppLayerResult
```

Return Types

Parsers return the type *AppLayerResult*.

There are 3 possible results:

- *APP_LAYER_OK* - parser consumed the data successfully
- *APP_LAYER_ERROR* - parser encountered a unrecoverable error
- *APP_LAYER_INCOMPLETE(c,n)* - parser consumed *c* bytes, and needs *n* more before being called again

Rust parsers follow the same logic, but can return

- *AppLayerResult::ok()*
- *AppLayerResult::err()*
- *AppLayerResult::incomplete(c,n)*

For *i32* and *bool*, Rust parsers can also use *.into()*.

APP_LAYER_OK / AppLayerResult::ok()

When a parser returns "OK", it signals to the API that all data has been consumed. The parser will be called again when more data is available.

APP_LAYER_ERROR / AppLayerResult::err()

Returning "ERROR" from the parser indicates to the API that the parser encountered an unrecoverable error and the processing of the protocol should stop for the rest of this flow.

Note: This should not be used for recoverable errors. For those events should be set.

APP_LAYER_INCOMPLETE / AppLayerResult::incomplete()

Using "INCOMPLETE" a parser can indicate how much more data is needed. Many protocols use records that have the size as one of the first parameters. When the parser receives a partial record, it can read this value and then tell the API to only call the parser again when enough data is available.

consumed is used how much of the current data has been processed *needed* is the number of bytes that the parser needs on top of what was consumed.

Example:

```
[ 32 record 1 ][ 32 record 2 ][ 32 r.. ]
 0          31  32         63  64    72
                            ^   ^
consumed: 64 ---------------/   |
needed:   32 --------------------/
```

Note: "INCOMPLETE" is only supported for TCP

The parser will be called again when the *needed* data is available OR when the stream ends. In the latter case the data will be incomplete. It's up to the parser to decide what to do with it in this case.

Supporting incomplete data

In some cases it may be preferable to actually support dealing with incomplete records. For example protocols like SMB and NFS can use very large records during file transfers. Completely queuing these before processing could be a waste of resources. In such cases the "INCOMPLETE" logic could be used for just the record header, while the record data is streamed into the parser.

Transactions

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    - *Rule Matching*

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General Concepts

For Suricata, transactions are an abstraction that help with detecting and logging. An example of a complete transaction is a pair of messages in the form of a request (from client to server) and a response (from server to client) in HTTP.

In order to know when to log an event for a given protocol, the engine tracks the progress of each transaction - that is, when is it complete, or when it reaches a key intermediate state. They aid during the detection phase, when dealing with protocols that can have large PDUs (protocol data units), like TCP, in controlling state for partial rule matching -- in case of rules that mention more than one field.

Transactions are implemented and stored in the per-flow state. The engine interacts with them using a set of callbacks the parser registers.

How the engine uses transactions

Logging

Suricata controls when logging should happen based on transaction completeness. For simpler protocols, such as `dns` or `ntp`, that will most likely happen once per transaction, by the time of its completion. In other cases, like with HTTP, this may happen at intermediary states.

In `OutputTxLog`, the engine will compare current state with the value defined for the logging to happen, per flow direction (`logger->tc_log_progress`, `logger->ts_log_progress`). If state is less than that value, the engine skips to the next logger. Code snippet from: suricata/src/output-tx.c:

```
static TmEcode OutputTxLog(ThreadVars *tv, Packet *p, void *thread_data)
{
    .
    .
    .
        if ((ts_eof && tc_eof) || last_pseudo) {
            SCLogDebug("EOF, so log now");
        } else {
            if (logger->LogCondition) {
                int r = logger->LogCondition(tv, p, alstate, tx, tx_id);
                if (r == FALSE) {
                    SCLogDebug("conditions not met, not logging");
                    goto next_logger;
```

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```
                }
            } else {
                if (tx_progress_tc < logger->tc_log_progress) {
                    SCLogDebug("progress not far enough, not logging");
                    goto next_logger;
                }

                if (tx_progress_ts < logger->ts_log_progress) {
                    SCLogDebug("progress not far enough, not logging");
                    goto next_logger;
                }
            }
        }
    .
    .
    .
}
```

Rule Matching

Transaction progress is also used for certain keywords to know what is the minimum state before we can expect a match: until that, Suricata won't even try to look for the patterns.

As seen in `DetectAppLayerMpmRegister2` that has `int progress` as parameter, and `DetectAppLayerInspectEngineRegister2`, which expects `int tx_min_progress`, for instance. In the code snippet, `HTTP2StateDataClient`, `HTTP2StateDataServer` and `0` are the values passed to the functions - in the last example, for `FTPDATA`, the existence of a transaction implies that a file is being transferred. Hence the `0` value.

```
void DetectFiledataRegister(void)
{
    .
    .
    DetectAppLayerMpmRegister2("file_data", SIG_FLAG_TOSERVER, 2,
            PrefilterMpmFiledataRegister, NULL,
            ALPROTO_HTTP2, HTTP2StateDataClient);
    DetectAppLayerMpmRegister2("file_data", SIG_FLAG_TOCLIENT, 2,
            PrefilterMpmFiledataRegister, NULL,
            ALPROTO_HTTP2, HTTP2StateDataServer);
    .
    .
    DetectAppLayerInspectEngineRegister2("file_data",
        ALPROTO_HTTP2, SIG_FLAG_TOCLIENT, HTTP2StateDataServer,
        DetectEngineInspectFiledata, NULL);
    DetectAppLayerInspectEngineRegister2(
            "file_data", ALPROTO_FTPDATA, SIG_FLAG_TOSERVER, 0,␣
↪DetectEngineInspectFiledata, NULL);
    .
    .
}
```

Progress Tracking

As a rule of thumb, transactions will follow a request-response model: if a transaction has had a request and a response, it is complete.

But if a protocol has situations where a request or response won't expect or generate a message from its counterpart, it is also possible to have uni-directional transactions. In such cases, transaction is set to complete at the moment of creation.

For example, DNS responses may be considered as completed transactions, because they also contain the request data, so all information needed for logging and detection can be found in the response.

In addition, for file transfer protocols, or similar ones where there may be several messages before the file exchange is completed (NFS, SMB), it is possible to create a level of abstraction to handle such complexity. This could be achieved by adding phases to the model implemented by the protocol (e.g., protocol negotiation phase (SMB), request parsed (HTTP), and so on).

This is controlled by implementing progress states. In Suricata, those will be enums that are incremented as the parsing progresses. A state will start at 0. The higher its value, the closer the transaction would be to completion. Due to how the engine tracks detection across states, there is an upper limit of 48 to the state progress (it must be < 48).

The engine interacts with transactions' state using a set of callbacks the parser registers. State is defined per flow direction (`STREAM_TOSERVER` / `STREAM_TOCLIENT`).

In Summary - Transactions and State

- Initial State value: `0`.
- Simpler scenarios: State is simply a bool. `1` represents transaction completion, per direction.
- Complex Transaction State in Suricata: `enum` (Rust: `i32`). Completion is indicated by the highest enum value (some examples are: SSH, HTTP, HTTP2, DNS, SMB).

Examples

This section shares some examples from Suricata codebase, to help visualize how Transactions work and are handled by the engine.

Enums

Code snippet from: rust/src/ssh/ssh.rs:

```
pub enum SSHConnectionState {
    SshStateInProgress = 0,
    SshStateBannerWaitEol = 1,
    SshStateBannerDone = 2,
    SshStateFinished = 3,
}
```

From src/app-layer-ftp.h:

```
enum {
    FTP_STATE_IN_PROGRESS,
    FTP_STATE_PORT_DONE,
```

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```
    FTP_STATE_FINISHED,
};
```

From src/app-layer-ssl.h:

```
enum {
    TLS_STATE_IN_PROGRESS = 0,
    TLS_STATE_CERT_READY = 1,
    TLS_HANDSHAKE_DONE = 2,
    TLS_STATE_FINISHED = 3
};
```

API Callbacks

In Rust, this is done via the RustParser struct. As seen in rust/src/applayer.rs:

```
/// Rust parser declaration
pub struct RustParser {
        .
        .
        .
    /// Progress values at which the tx is considered complete in a direction
    pub tx_comp_st_ts:      c_int,
    pub tx_comp_st_tc:      c_int,
    .
    .
    .
}
```

In C, the callback API is:

```
void AppLayerParserRegisterStateProgressCompletionStatus(
    AppProto alproto, const int ts, const int tc)
```

Simple scenario described, in Rust:

rust/src/dhcp/dhcp.rs:

```
tx_comp_st_ts: 1,
tx_comp_st_tc: 1,
```

For SSH, this looks like this:

rust/src/ssh/ssh.rs:

```
tx_comp_st_ts: SSHConnectionState::SshStateFinished as i32,
tx_comp_st_tc: SSHConnectionState::SshStateFinished as i32,
```

In C, callback usage would be as follows:

src/app-layer-dcerpc.c:

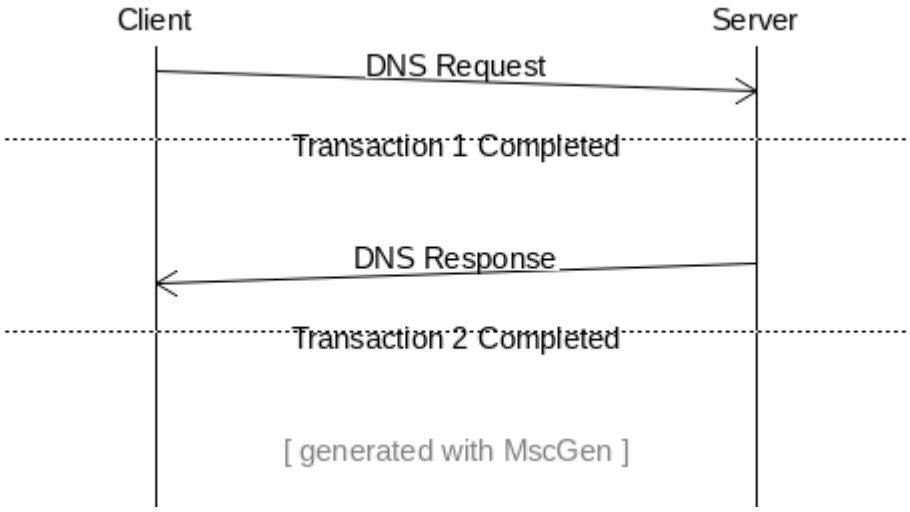
```
AppLayerParserRegisterStateProgressCompletionStatus(ALPROTO_DCERPC, 1, 1);
```

src/app-layer-ftp.c:

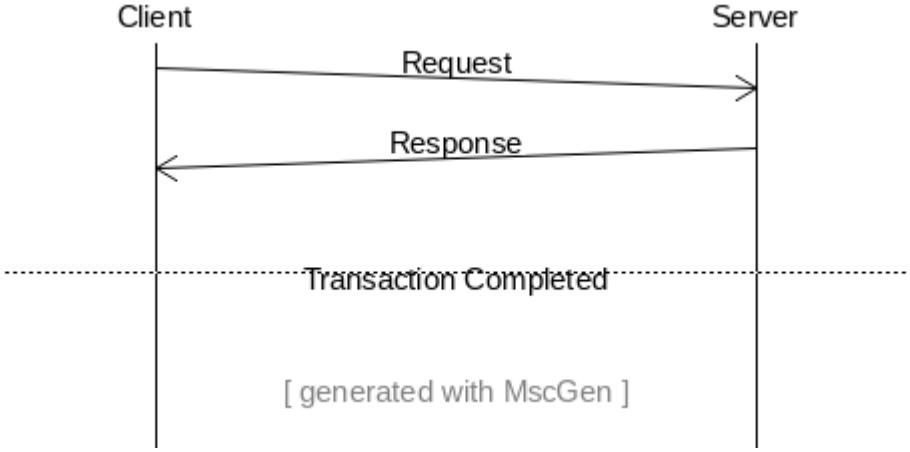
```
AppLayerParserRegisterStateProgressCompletionStatus(
    ALPROTO_FTP, FTP_STATE_FINISHED, FTP_STATE_FINISHED);
```

Sequence Diagrams

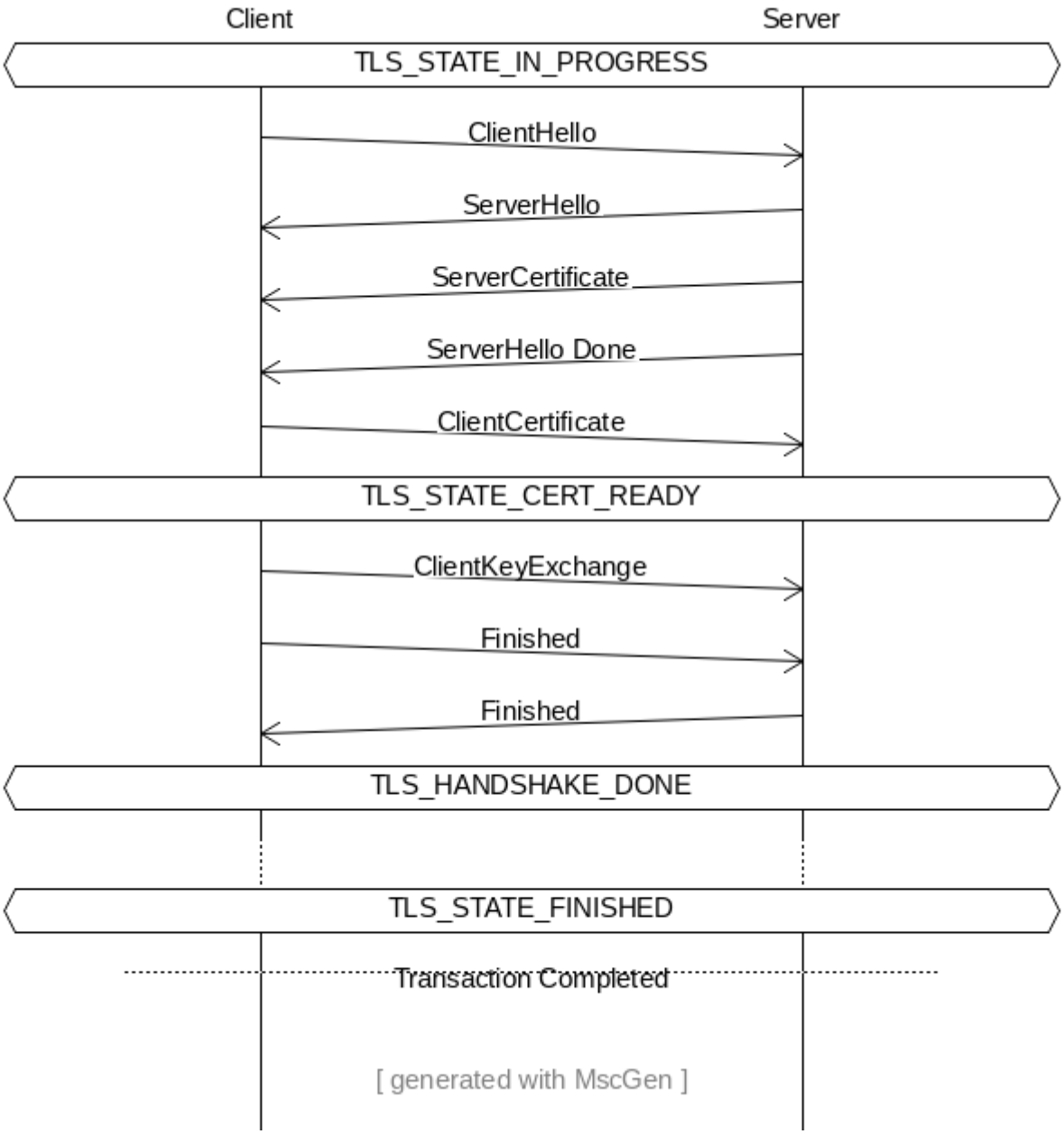
A DNS transaction in Suricata can be considered unidirectional:



An HTTP2 transaction is an example of a bidirectional transaction, in Suricata (note that, while HTTP2 may have multiple streams, those are mapped to transactions in Suricata. They run in parallel, scenario not shown in this Sequence Diagram - which shows one transaction, only):



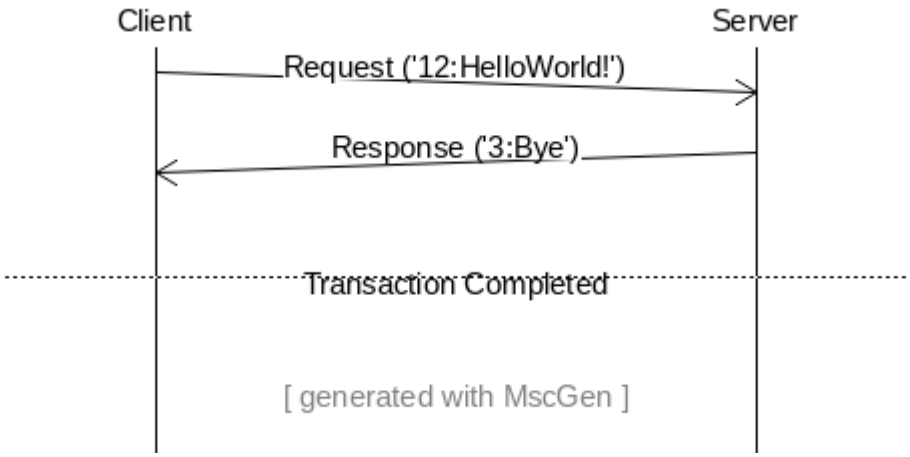
A TLS Handshake is a more complex example, where several messages are exchanged before the transaction is considered completed:



Template Protocol

Suricata has a template protocol for educational purposes, which has simple bidirectional transactions.

A completed transaction for the template looks like this:



Following are the functions that check whether a transaction is considered completed, for the Template Protocol. Those are called by the Suricata API. Similar functions exist for each protocol, and may present implementation differences, based on what is considered a transaction for that given protocol.

In C:

```
static int TemplateGetStateProgress(void *txv, uint8_t direction)
{
    TemplateTransaction *tx = txv;

    SCLogNotice("Transaction progress requested for tx ID %"PRIu64
        ", direction=0x%02x", tx->tx_id, direction);

    if (direction & STREAM_TOCLIENT && tx->response_done) {
        return 1;
    }
    else if (direction & STREAM_TOSERVER) {
        /* For the template, just the existence of the transaction means the
         * request is done. */
        return 1;
    }

    return 0;
}
```

And in Rust:

```
pub extern "C" fn rs_template_tx_get_alstate_progress(
    tx: *mut std::os::raw::c_void,
    _direction: u8,
) -> std::os::raw::c_int {
    let tx = cast_pointer!(tx, TemplateTransaction);

    // Transaction is done if we have a response.
    if tx.response.is_some() {
        return 1;
    }
    return 0;
}
```

Work In Progress changes

Currently we are working to have files be part of the transaction instead of the per-flow state, as seen in https://redmine.openinfosecfoundation.org/issues/4444.

Another work in progress is to limit the number of transactions per flow, to prevent Denial of Service (DoS) by quadratic complexity - a type of attack that may happen to protocols which can have multiple transactions at the same time - such as HTTP2 so-called streams (see https://redmine.openinfosecfoundation.org/issues/4530).

Common words and abbreviations

- al, applayer: application layer
- alproto: application layer protocol
- alstate: application layer state
- engine: refers to Suricata core detection logic
- flow: a bidirectional flow of packets with the same 5-tuple elements (protocol, source ip, destination ip, source port, destination port. Vlans can be added as well)
- PDU: Protocol Data Unit
- rs: rust
- tc: to client
- ts: to server
- tx: transaction

27.3.4 Detection

27.3.5 Output

Introduction

Extending Suricata's alert and event output.

CHAPTER

TWENTYEIGHT

VERIFYING SURICATA SOURCE DISTRIBUTION FILES

Once the Suricata release distribution file has been downloaded, the PGP signature should be verified. This can be done using the GPG application and is usually available on Linux/BSD systems without having to manually install any additional packages. For Mac or Windows systems installation packages can be found at https://gnupg.org/.

28.1 Verification Steps

These verification steps are for general guidance, the exact process and commands may vary between operating systems.

28.1.1 Downloading the Signature File

The signature file needs to be downloaded as well as the distribution file. Both files can be found at https://suricata.io/download/.

28.1.2 Importing the OISF Signing Key

Once both the signature file and Suricata distribution files are obtained, the OISF signing key should be imported to the local gpg keyring. This can be done by running the following command:

```
$ gpg --receive-keys 2BA9C98CCDF1E93A
```

The above command should produce output similar to the following:

```
gpg: key 2BA9C98CCDF1E93A: public key "Open Information Security Foundation
(OISF) <releases@openinfosecfoundation.org>" imported
gpg: Total number processed: 1
gpg:               imported: 1
```

28.1.3 Verifying the Suricata Distribution File

To verify the contents of the Suricata distribution file the following command could be ran on the Suricata 7.0.5 distribution file:

```
$ gpg --verify suricata-7.0.5.tar.gz.sig suricata-7.0.5.tar.gz
```

Depending on the trust level assigned to the OISF signing keys, something similar to the following output should be seen:

```
$ gpg --verify suricata-7.0.5.tar.gz.sig suricata-7.0.5.tar.gz
gpg: Signature made Tue 23 Apr 2024 11:58:56 AM UTC
gpg:                using RSA key B36FDAF2607E10E8FFA89E5E2BA9C98CCDF1E93A
gpg: checking the trustdb
gpg: marginals needed: 3  completes needed: 1  trust model: pgp
gpg: depth: 0  valid:   1  signed:   0  trust: 0-, 0q, 0n, 0m, 0f, 1u
gpg: next trustdb check due at 2025-08-06
gpg: Good signature from "Open Information Security Foundation (OISF)
<releases@openinfosecfoundation.org>" [ultimate]
```

This indicates a valid signature and that the signing key is trusted.

Note: If output from the *--verify* command is similar to the following:

```
gpg: Signature made Tue 23 Apr 2024 11:58:56 AM UTC
gpg:                using RSA key B36FDAF2607E10E8FFA89E5E2BA9C98CCDF1E93A
gpg: Can't check signature: No public key
```

This indicates that the OISF signing key was not imported to the local GPG keyring.

Note: If output from the *--verify* command is similar to the following:

```
gpg: Signature made Tue 23 Apr 2024 11:58:56 AM UTC
gpg:                using RSA key B36FDAF2607E10E8FFA89E5E2BA9C98CCDF1E93A
gpg: Good signature from "Open Information Security Foundation (OISF)
<releases@openinfosecfoundation.org>" [unknown]
gpg: WARNING: This key is not certified with a trusted signature!
gpg:          There is no indication that the signature belongs to the owner.
Primary key fingerprint: B36F DAF2 607E 10E8 FFA8  9E5E 2BA9 C98C CDF1 E93A
```

This indicates that the OISF signing key was imported and the signatures are valid, but either the keys have not been marked as trusted OR the keys are possibly a forgery.

If there are questions regarding the validity of the downloaded file, the OISF team can be reached at *security @ oisf.net* (remove the spaces between the @ before sending).

CHAPTER

TWENTYNINE

KNOWN ISSUES

The following is a list of known issues in Suricata 7.0.

- When an IKE message contains multiple attributes with the same key, only the first will be logged to avoid producing invalid JSON, or introducing a logging format change. See https://redmine.openinfosecfoundation.org/issues/7923.

BIBLIOGRAPHY

[llvm] Default LLVM clang-format Style

[clang9] Requires clang 9

[clang10] Requires clang 10

[clang11] Requires clang 11

[breakbeforebraces] BreakBeforeBraces: Mozilla is closest, but does not split empty functions/structs

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