SNORT® Users Manual
2.8.5

The Snort Project

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Contents

Chapter 1

Snort Overview

This manual is based on *Writing Snort Rules* by Martin Roesch and further work from Chris Green <cmg@snort.org>. It was then maintained by Brian Caswell <bmc@snort.org> and now is maintained by the Snort Team. If you have a better way to say something or find that something in the documentation is outdated, drop us a line and we will update it. If you would like to submit patches for this document, you can find the latest version of the documentation in LaTeX format in the Snort CVS repository at `/doc/snort_manual.tex`. Small documentation updates are the easiest way to help out the Snort Project.

1.1 Getting Started

Snort really isn't very hard to use, but there are a lot of command line options to play with, and it's not always obvious which ones go together well. This file aims to make using Snort easier for new users.

Before we proceed, there are a few basic concepts you should understand about Snort. Snort can be configured to run in three modes:

- *Sniffer mode,* which simply reads the packets off of the network and displays them for you in a continuous stream on the console (screen).
- *Packet Logger mode,* which logs the packets to disk.
- *Network Intrusion Detection System (NIDS) mode,* the most complex and configurable configuration, which allows Snort to analyze network traffic for matches against a user-defined rule set and performs several actions based upon what it sees.
- *Inline mode,* which obtains packets from iptables instead of from libpcap and then causes iptables to drop or pass packets based on Snort rules that use inline-specific rule types.

1.2 Sniffer Mode

First, let's start with the basics. If you just want to print out the TCP/IP packet headers to the screen (i.e. sniffer mode), try this:

```
./snort -v
```

This command will run Snort and just show the IP and TCP/UDP/ICMP headers, nothing else. If you want to see the application data in transit, try the following:

```
./snort -vd
```

This instructs Snort to display the packet data as well as the headers. If you want an even more descriptive display, showing the data link layer headers, do this:

```
./snort -vde
```

(As an aside, these switches may be divided up or smashed together in any combination. The last command could also be typed out as:

```
./snort -d -v -e
```

and it would do the same thing.)

1.3 Packet Logger Mode

OK, all of these commands are pretty cool, but if you want to record the packets to the disk, you need to specify a logging directory and Snort will automatically know to go into packet logger mode:

```
./snort -dev -l ./log
```

Of course, this assumes you have a directory named `log` in the current directory. If you don't, Snort will exit with an error message. When Snort runs in this mode, it collects every packet it sees and places it in a directory hierarchy based upon the IP address of one of the hosts in the datagram.

If you just specify a plain -l switch, you may notice that Snort sometimes uses the address of the remote computer as the directory in which it places packets and sometimes it uses the local host address. In order to log relative to the home network, you need to tell Snort which network is the home network:

```
./snort -dev -l ./log -h 192.168.1.0/24
```

This rule tells Snort that you want to print out the data link and TCP/IP headers as well as application data into the directory `./log`, and you want to log the packets relative to the 192.168.1.0 class C network. All incoming packets will be recorded into subdirectories of the log directory, with the directory names being based on the address of the remote (non-192.168.1) host.

Note that if both the source and destination hosts are on the home network, they are logged to a directory with a name based on the higher of the two port numbers or, in the case of a tie, the source address.

If you're on a high speed network or you want to log the packets into a more compact form for later analysis, you should consider logging in binary mode. Binary mode logs the packets in tcpdump format to a single binary file in the logging directory:

```
./snort -l ./log -b
```

Note the command line changes here. We don't need to specify a home network any longer because binary mode logs everything into a single file, which eliminates the need to tell it how to format the output directory structure. Additionally, you don't need to run in verbose mode or specify the -d or -e switches because in binary mode the entire packet is logged, not just sections of it. All you really need to do to place Snort into logger mode is to specify a logging directory at the command line using the -l switch—the -b binary logging switch merely provides a modifier that tells Snort to log the packets in something other than the default output format of plain ASCII text.

Once the packets have been logged to the binary file, you can read the packets back out of the file with any sniffer that supports the tcpdump binary format (such as tcpdump or Ethereal). Snort can also read the packets back by using the

-r switch, which puts it into playback mode. Packets from any tcpdump formatted file can be processed through Snort in any of its run modes. For example, if you wanted to run a binary log file through Snort in sniffer mode to dump the packets to the screen, you can try something like this:

```
./snort -dv -r packet.log
```

You can manipulate the data in the file in a number of ways through Snort's packet logging and intrusion detection modes, as well as with the BPF interface that's available from the command line. For example, if you only wanted to see the ICMP packets from the log file, simply specify a BPF filter at the command line and Snort will only see the ICMP packets in the file:

```
./snort -dvr packet.log icmp
```

For more info on how to use the BPF interface, read the Snort and tcpdump man pages.

1.4 Network Intrusion Detection System Mode

To enable Network Intrusion Detection System (NIDS) mode so that you don't record every single packet sent down the wire, try this:

```
./snort -dev -l ./log -h 192.168.1.0/24 -c snort.conf
```

where `snort.conf` is the name of your rules file. This will apply the rules configured in the `snort.conf` file to each packet to decide if an action based upon the rule type in the file should be taken. If you don't specify an output directory for the program, it will default to `/var/log/snort`.

One thing to note about the last command line is that if Snort is going to be used in a long term way as an IDS, the -v switch should be left off the command line for the sake of speed. The screen is a slow place to write data to, and packets can be dropped while writing to the display.

It's also not necessary to record the data link headers for most applications, so you can usually omit the -e switch, too.

```
./snort -d -h 192.168.1.0/24 -l ./log -c snort.conf
```

This will configure Snort to run in its most basic NIDS form, logging packets that trigger rules specified in the `snort.conf` in plain ASCII to disk using a hierarchical directory structure (just like packet logger mode).

1.4.1 NIDS Mode Output Options

There are a number of ways to configure the output of Snort in NIDS mode. The default logging and alerting mechanisms are to log in decoded ASCII format and use full alerts. The full alert mechanism prints out the alert message in addition to the full packet headers. There are several other alert output modes available at the command line, as well as two logging facilities.

Alert modes are somewhat more complex. There are seven alert modes available at the command line: full, fast, socket, syslog, console, cmg, and none. Six of these modes are accessed with the -A command line switch. These options are:

Option	Description
`-A fast`	Fast alert mode. Writes the alert in a simple format with a timestamp, alert message, source and destination IPs/ports.
`-A full`	Full alert mode. This is the default alert mode and will be used automatically if you do not specify a mode.
`-A unsock`	Sends alerts to a UNIX socket that another program can listen on.
`-A none`	Turns off alerting.
`-A console`	Sends "fast-style" alerts to the console (screen).
`-A cmg`	Generates "cmg style" alerts.

Packets can be logged to their default decoded ASCII format or to a binary log file via the -b command line switch. To disable packet logging altogether, use the -N command line switch.

For output modes available through the configuration file, see Section 2.6.

Command line logging options override any output options specified in the configuration file. This allows debugging of configuration issues quickly via the command line.

To send alerts to syslog, use the -s switch. The default facilities for the syslog alerting mechanism are LOG_AUTHPRIV and LOG_ALERT. If you want to configure other facilities for syslog output, use the output plugin directives in the rules files. See Section 2.6.1 for more details on configuring syslog output.

For example, use the following command line to log to default (decoded ASCII) facility and send alerts to syslog:

```
./snort -c snort.conf -l ./log -h 192.168.1.0/24 -s
```

As another example, use the following command line to log to the default facility in /var/log/snort and send alerts to a fast alert file:

```
./snort -c snort.conf -A fast -h 192.168.1.0/24
```

1.4.2 Understanding Standard Alert Output

When Snort generates an alert message, it will usually look like the following:

```
[**] [116:56:1] (snort_decoder): T/TCP Detected [**]
```

The first number is the Generator ID, this tells the user what component of Snort generated this alert. For a list of GIDs, please read etc/generators in the Snort source. In this case, we know that this event came from the “decode” (116) component of Snort.

The second number is the Snort ID (sometimes referred to as Signature ID). For a list of preprocessor SIDs, please see etc/gen-msg.map. Rule-based SIDs are written directly into the rules with the *sid* option. In this case, *56* represents a T/TCP event.

The third number is the revision ID. This number is primarily used when writing signatures, as each rendition of the rule should increment this number with the *rev* option.

1.4.3 High Performance Configuration

If you want Snort to go *fast* (like keep up with a 1000 Mbps connection), you need to use unified logging and a unified log reader such as *barnyard*. This allows Snort to log alerts in a binary form as fast as possible while another program performs the slow actions, such as writing to a database.

If you want a text file that’s easily parsable, but still somewhat fast, try using binary logging with the “fast” output mechanism.

This will log packets in tcpdump format and produce minimal alerts. For example:

```
./snort -b -A fast -c snort.conf
```

1.4.4 Changing Alert Order

The default way in which Snort applies its rules to packets may not be appropriate for all installations. The Pass rules are applied first, then the Drop rules, then the Alert rules and finally, Log rules are applied.

Sometimes an errant pass rule could cause alerts to not show up, in which case you can change the default ordering to allow Alert rules to be applied before Pass rules. For more information, please refer to the `--alert-before-pass` option.

Several command line options are available to change the order in which rule actions are taken.

- `--alert-before-pass` option forces alert rules to take affect in favor of a pass rule.
- `--treat-drop-as-alert` causes drop, sdrop, and reject rules and any associated alerts to be logged as alerts, rather then the normal action. This allows use of an inline policy with passive/IDS mode.
- `--process-all-events` option causes Snort to process every event associated with a packet, while taking the actions based on the rules ordering. Without this option (default case), only the events for the first action based on rules ordering are processed.

Pass rules are special cases here, in that the event processing is terminated when a pass rule is encountered, regardless of the use of `--process-all-events`.

1.5 Inline Mode

Snort 2.3.0 RC1 integrated the intrusion prevention system (IPS) capability of `Snort Inline` into the official Snort project. `Snort Inline` obtains packets from iptables instead of libpcap and then uses new rule types to help iptables pass or drop packets based on Snort rules.

In order for `Snort Inline` to work properly, you must download and compile the iptables code to include "make install-devel" (`http://www.iptables.org`). This will install the `libipq` library that allows `Snort Inline` to interface with iptables. Also, you must build and install LibNet, which is available from `http://www.packetfactory.net`.

There are three rule types you can use when running Snort with `Snort Inline`:

- **drop** - The drop rule type will tell iptables to drop the packet and log it via usual Snort means.
- **reject** - The reject rule type will tell iptables to drop the packet, log it via usual Snort means, and send a TCP reset if the protocol is TCP or an icmp port unreachable if the protocol is UDP.
- **sdrop** - The sdrop rule type will tell iptables to drop the packet. Nothing is logged.

You can also replace sections of the packet payload when using `Snort Inline`. See Section 1.5.2 for more information.

When using a `reject` rule, there are two options you can use to send TCP resets:

- You can use a RAW socket (the default behavior for `Snort Inline`), in which case you must have an interface that has an IP address assigned to it. If there is not an interface with an IP address assigned with access to the source of the packet, the packet will be logged and the reset packet will never make it onto the network.
- You can also now perform resets via a physical device when using iptables. We take the indev name from ip_queue and use this as the interface on which to send resets. We no longer need an IP loaded on the bridge, and can remain pretty stealthy as the `config layer2_resets` in snort.conf takes a source MAC address which we substitue for the MAC of the bridge. For example:

  ```
  config layer2resets
  ```

  tells `Snort Inline` to use layer2 resets and uses the MAC address of the bridge as the source MAC in the packet, and:

  ```
  config layer2resets: 00:06:76:DD:5F:E3
  ```

  will tell Snort Inline to use layer2 resets and uses the source MAC of 00:06:76:DD:5F:E3 in the reset packet.
- The command-line option `--disable-inline-initialization` can be used to not initialize IPTables when in inline mode. It should be used with command-line option `-T` to test for a valid configuration without requiring opening inline devices and adversely affecting traffic flow.

1.5.1 Snort Inline Rule Application Order

The current rule application order is:

```
->activation->dynamic->pass->drop->sdrop->reject->alert->log
```

This will ensure that a drop rule has precedence over an alert or log rule.

1.5.2 Replacing Packets with Snort Inline

Additionally, Jed Haile's content replace code allows you to modify packets before they leave the network. For example:

```
alert tcp any any <> any 80 ( \
    msg: "tcp replace"; content:"GET"; replace:"BET";)

alert udp any any <> any 53 ( \
    msg: "udp replace"; content: "yahoo"; replace: "xxxxx";)
```

These rules will comb TCP port 80 traffic looking for GET, and UDP port 53 traffic looking for yahoo. Once they are found, they are replaced with BET and xxxxx, respectively. The only catch is that the replace must be the same length as the content.

1.5.3 Installing Snort Inline

To install Snort inline, use the following command:

```
./configure --enable-inline
make
make install
```

1.5.4 Running Snort Inline

First, you need to ensure that the ip_queue module is loaded. Then, you need to send traffic to Snort Inline using the QUEUE target. For example:

```
iptables -A OUTPUT -p tcp --dport 80 -j QUEUE
```

sends all TCP traffic leaving the firewall going to port 80 to the QUEUE target. This is what sends the packet from kernel space to user space (`Snort Inline`). A quick way to get all outbound traffic going to the QUEUE is to use the rc.firewall script created and maintained by the Honeynet Project (`http://www.honeynet.org/papers/honeynet/tools/`) This script is well-documented and allows you to direct packets to `Snort Inline` by simply changing the QUEUE variable to yes.

Finally, start Snort Inline:

```
snort -QDc ../etc/drop.conf -l /var/log/snort
```

You can use the following command line options:

- `-Q` - Gets packets from iptables.
- `-D` - Runs `Snort Inline` in daemon mode. The process ID is stored at `/var/run/snort.pid`
- `-c` - Reads the following configuration file.
- `-l` - Logs to the following directory.

Ideally, Snort Inline will be run using only its own drop.rules. If you want to use Snort for just alerting, a separate process should be running with its own rule set.

1.5.5 Using the Honeynet Snort Inline Toolkit

The Honeynet Snort Inline Toolkit is a statically compiled `Snort Inline` binary put together by the Honeynet Project for the Linux operating system. It comes with a set of drop.rules, the `Snort Inline` binary, a snort-inline rotation shell script, and a good README. It can be found at:

`http://www.honeynet.org/papers/honeynet/tools/`

1.5.6 Troubleshooting Snort Inline

If you run Snort Inline and see something like this:

```
Initializing Output Plugins!
Reading from iptables
Log directory = /var/log/snort
Initializing Inline mode
InlineInit: : Failed to send netlink message: Connection refused
```

More than likely, the ip_queue module is not loaded or ip_queue support is not compiled into your kernel. Either recompile your kernel to support ip_queue, or load the module.

The ip_queue module is loaded by executing:

```
insmod ip_queue
```

Also, if you want to ensure Snort Inline is getting packets, you can start it in the following manner:

```
snort -Qvc <configuration file>
```

This will display the header of every packet that Snort Inline sees.

1.6 Miscellaneous

1.6.1 Running Snort as a Daemon

If you want to run Snort as a daemon, you can the add -D switch to any combination described in the previous sections. Please notice that if you want to be able to restart Snort by sending a SIGHUP signal to the daemon, you *must* specify the full path to the Snort binary when you start it, for example:

```
/usr/local/bin/snort -d -h 192.168.1.0/24 \
    -l /var/log/snortlogs -c /usr/local/etc/snort.conf -s -D
```

Relative paths are not supported due to security concerns.

Snort PID File

When Snort is run as a daemon , the daemon creates a PID file in the log directory. In Snort 2.6, the `--pid-path` command line switch causes Snort to write the PID file in the directory specified.

Additionally, the `--create-pidfile` switch can be used to force creation of a PID file even when not running in daemon mode.

The PID file will be locked so that other snort processes cannot start. Use the `--nolock-pidfile` switch to not lock the PID file.

1.6.2 Running in Rule Stub Creation Mode

If you need to dump the shared object rules stub to a directory, you might need to use the –dump-dynamic-rules option. These rule stub files are used in conjunction with the shared object rules. The path can be relative or absolute.

```
/usr/local/bin/snort -c /usr/local/etc/snort.conf \
    --dump-dynamic-rules=/tmp
```

This path can also be configured in the snort.conf using the config option dump-dynamic-rules-path as follows:

```
config dump-dynamic-rules-path: /tmp/sorules
```

The path configured by command line has precedence over the one configured using dump-dynamic-rules-path.

```
/usr/local/bin/snort -c /usr/local/etc/snort.conf \
    --dump-dynamic-rules

snort.conf:
config dump-dynamic-rules-path: /tmp/sorules
```

In the above mentioned scenario the dump path is set to /tmp/sorules.

1.6.3 Obfuscating IP Address Printouts

If you need to post packet logs to public mailing lists, you might want to use the -O switch. This switch obfuscates your IP addresses in packet printouts. This is handy if you don't want people on the mailing list to know the IP addresses involved. You can also combine the -O switch with the -h switch to only obfuscate the IP addresses of hosts on the home network. This is useful if you don't care who sees the address of the attacking host. For example, you could use the following command to read the packets from a log file and dump them to the screen, obfuscating only the addresses from the 192.168.1.0/24 class C network:

```
./snort -d -v -r snort.log -O -h 192.168.1.0/24
```

1.6.4 Specifying Multiple-Instance Identifiers

In Snort v2.4, the `-G` command line option was added that specifies an instance identifier for the event logs. This option can be used when running multiple instances of snort, either on different CPUs, or on the same CPU but a different interface. Each Snort instance will use the value specified to generate unique event IDs. Users can specify either a decimal value (`-G 1`) or hex value preceded by 0x (`-G 0x11`). This is also supported via a long option `--logid`.

1.7 Reading Pcaps

Instead of having Snort listen on an interface, you can give it a packet capture to read. Snort will read and analyze the packets as if they came off the wire. This can be useful for testing and debugging Snort.

1.7.1 Command line arguments

Any of the below can be specified multiple times on the command line (`-r` included) and in addition to other Snort command line options. Note, however, that specifying `--pcap-reset` and `--pcap-show` multiple times has the same effect as specifying them once.

Option	Description
`-r <file>`	Read a single pcap.
`--pcap-single=<file>`	Same as -r. Added for completeness.
`--pcap-file=<file>`	File that contains a list of pcaps to read. Can specifiy path to pcap or directory to recurse to get pcaps.
`--pcap-list="<list>"`	A space separated list of pcaps to read.
`--pcap-dir=<dir>`	A directory to recurse to look for pcaps. Sorted in ascii order.
`--pcap-filter=<filter>`	Shell style filter to apply when getting pcaps from file or directory. This filter will apply to any `--pcap-file` or `--pcap-dir` arguments following. Use `--pcap-no-filter` to delete filter for following `--pcap-file` or `--pcap-dir` arguments or specifiy `--pcap-filter` again to forget previous filter and to apply to following `--pcap-file` or `--pcap-dir` arguments.
`--pcap-no-filter`	Reset to use no filter when getting pcaps from file or directory.
`--pcap-reset`	If reading multiple pcaps, reset snort to post-configuration state before reading next pcap. The default, i.e. without this option, is not to reset state.
`--pcap-show`	Print a line saying what pcap is currently being read.

1.7.2 Examples

Read a single pcap

```
$ snort -r foo.pcap
$ snort --pcap-single=foo.pcap
```

Read pcaps from a file

```
$ cat foo.txt
foo1.pcap
foo2.pcap
/home/foo/pcaps

$ snort --pcap-file=foo.txt
```

This will read foo1.pcap, foo2.pcap and all files under /home/foo/pcaps. Note that Snort will not try to determine whether the files under that directory are really pcap files or not.

Read pcaps from a command line list

```
$ snort --pcap-list="foo1.pcap foo2.pcap foo3.pcap"
```

This will read foo1.pcap, foo2.pcap and foo3.pcap.

Read pcaps under a directory

```
$ snort --pcap-dir="/home/foo/pcaps"
```

This will include all of the files under /home/foo/pcaps.

Using filters

```
$ cat foo.txt
foo1.pcap
foo2.pcap
/home/foo/pcaps

$ snort --pcap-filter="*.pcap" --pcap-file=foo.txt
$ snort --pcap-filter="*.pcap" --pcap-dir=/home/foo/pcaps
```

The above will only include files that match the shell pattern ”*.pcap”, in other words, any file ending in ”.pcap”.

```
$ snort --pcap-filter="*.pcap --pcap-file=foo.txt \
> --pcap-filter="*.cap" --pcap-dir=/home/foo/pcaps
```

In the above, the first filter ”*.pcap” will only be applied to the pcaps in the file ”foo.txt” (and any directories that are recursed in that file). The addition of the second filter ”*.cap” will cause the first filter to be forgotten and then applied to the directory /home/foo/pcaps, so only files ending in ”.cap” will be included from that directory.

```
$ snort --pcap-filter="*.pcap --pcap-file=foo.txt \
> --pcap-no-filter --pcap-dir=/home/foo/pcaps
```

In this example, the first filter will be applied to foo.txt, then no filter will be applied to the files found under /home/foo/pcaps, so all files found under /home/foo/pcaps will be included.

```
$ snort --pcap-filter="*.pcap --pcap-file=foo.txt \
> --pcap-no-filter --pcap-dir=/home/foo/pcaps \
> --pcap-filter="*.cap" --pcap-dir=/home/foo/pcaps2
```

In this example, the first filter will be applied to foo.txt, then no filter will be applied to the files found under /home/foo/pcaps, so all files found under /home/foo/pcaps will be included, then the filter ”*.cap” will be applied to files found under /home/foo/pcaps2.

Resetting state

```
$ snort --pcap-dir=/home/foo/pcaps --pcap-reset
```

The above example will read all of the files under /home/foo/pcaps, but after each pcap is read, Snort will be reset to a post-configuration state, meaning all buffers will be flushed, statistics reset, etc. For each pcap, it will be like Snort is seeing traffic for the first time.

Printing the pcap

```
$ snort --pcap-dir=/home/foo/pcaps --pcap-show
```

The above example will read all of the files under /home/foo/pcaps and will print a line indicating which pcap is currently being read.

1.8 Tunneling Protocol Support

Snort supports decoding of GRE, IP in IP and PPTP. To enable support, an extra configuration option is necessary:

```
$ ./configure --enable-gre
```

To enable IPv6 support, one still needs to use the configuration option:

```
$ ./configure --enable-ipv6
```

1.8.1 Multiple Encapsulations

Snort will not decode more than one encapsulation. Scenarios such as

```
Eth IPv4 GRE IPv4 GRE IPv4 TCP Payload
```

or

```
Eth IPv4 IPv6 IPv4 TCP Payload
```

will not be handled and will generate a decoder alert.

1.8.2 Logging

Currently, only the encapsulated part of the packet is logged, e.g.

```
Eth IP1 GRE IP2 TCP Payload
```

gets logged as

```
Eth IP2 TCP Payload
```

and

```
Eth IP1 IP2 TCP Payload
```

gets logged as

```
Eth IP2 TCP Payload
```

Decoding of PPTP, which utilizes GRE and PPP, is not currently supported on architectures that require word alignment such as SPARC.

1.9 More Information

Chapter 2 contains much information about many configuration options available in the configuration file. The Snort manual page and the output of `snort -?` or `snort --help` contain information that can help you get Snort running in several different modes.

In many shells, a backslash (\) is needed to escape the ?, so you may have to type `snort -\?` instead of `snort -?` for a list of Snort command line options.

The Snort web page (`http://www.snort.org`) and the Snort Users mailing list:

`http://marc.theaimsgroup.com/?l=snort-users`

at `snort-users@lists.sourceforge.net` provide informative announcements as well as a venue for community discussion and support. There's a lot to Snort, so sit back with a beverage of your choosing and read the documentation and mailing list archives.

Chapter 2

Configuring Snort

2.1 Includes

The `include` keyword allows other rules files to be included within the rules file indicated on the Snort command line. It works much like an #include from the C programming language, reading the contents of the named file and adding the contents in the place where the include statement appears in the file.

2.1.1 Format

```
include <include file path/name>
```

Note that there is no semicolon at the end of this line.

Included files will substitute any predefined variable values into their own variable references. See Section 2.1.2 for more information on defining and using variables in Snort rules files.

2.1.2 Variables

Three types of variables may be defined in Snort:

- var
- portvar
- ipvar

Note: 'ipvar's are only enabled with IPv6 support. Without IPv6 support, use a regular 'var'.

These are simple substitution variables set with the `var`, `ipvar`, or `portvar` keywords as follows:

```
var RULES_PATH rules/
portvar MY_PORTS [22,80,1024:1050]
ipvar MY_NET [192.168.1.0/24,10.1.1.0/24]
alert tcp any any -> $MY_NET $MY_PORTS (flags:S; msg:"SYN packet";)
include $RULE_PATH/example.rule
```

IP Variables and IP Lists

IPs may be specified individually, in a list, as a CIDR block, or any combination of the three. If IPv6 support is enabled, IP variables should be specified using 'ipvar' instead of 'var'. Using 'var' for an IP variable is still allowed for backward compatibility, but it will be deprecated in a future release.

IPs, IP lists, and CIDR blocks may be negated with '!'. Negation is handled differently compared with Snort versions 2.7.x and earlier. Previously, each element in a list was logically OR'ed together. IP lists now OR non-negated elements and AND the result with the OR'ed negated elements.

The following example list will match the IP 1.1.1.1 and IP from 2.2.2.0 to 2.2.2.255, with the exception of IPs 2.2.2.2 and 2.2.2.3.

```
[1.1.1.1,2.2.2.0/24,![2.2.2.2,2.2.2.3]]
```

The order of the elements in the list does not matter. The element 'any' can be used to match all IPs, although '!any' is not allowed. Also, negated IP ranges that are more general than non-negated IP ranges are not allowed.

See below for some valid examples if IP variables and IP lists.

```
ipvar EXAMPLE [1.1.1.1,2.2.2.0/24,![2.2.2.2,2.2.2.3]]

alert tcp $EXAMPLE any -> any any (msg:"Example"; sid:1;)

alert tcp [1.0.0.0/8,!1.1.1.0/24] any -> any any (msg:"Example";sid:2;)
```

The following examples demonstrate some invalid uses of IP variables and IP lists.

Use of !any:

```
ipvar EXAMPLE any
alert tcp !$EXAMPLE any -> any any (msg:"Example";sid:3;)
```

Different use of !any:

```
ipvar EXAMPLE !any
alert tcp $EXAMPLE any -> any any (msg:"Example";sid:3;)
```

Logical contradictions:

```
ipvar EXAMPLE [1.1.1.1,!1.1.1.1]
```

Nonsensical negations:

```
ipvar EXAMPLE [1.1.1.0/24,!1.1.0.0/16]
```

Port Variables and Port Lists

Portlists supports the declaration and lookup of ports and the representation of lists and ranges of ports. Variables, ranges, or lists may all be negated with '!'. Also, 'any' will specify any ports, but '!any' is not allowed. Valid port ranges are from 0 to 65535.

Lists of ports must be enclosed in brackets and port ranges may be specified with a ':', such as in:

```
[10:50,888:900]
```

Port variables should be specified using 'portvar'. The use of 'var' to declare a port variable will be deprecated in a future release. For backwards compatibility, a 'var' can still be used to declare a port variable, provided the variable name either ends with '_PORT' or begins with 'PORT_'.

The following examples demonstrate several valid usages of both port variables and port lists.

```
portvar EXAMPLE1 80

var EXAMPLE2_PORT [80:90]

var PORT_EXAMPLE2 [1]

portvar EXAMPLE3 any

portvar EXAMPLE4 [!70:90]

portvar EXAMPLE5 [80,91:95,100:200]

alert tcp any $EXAMPLE1 -> any $EXAMPLE2_PORT (msg:"Example"; sid:1;)

alert tcp any $PORT_EXAMPLE2 -> any any (msg:"Example"; sid:2;)

alert tcp any 90 -> any [100:1000,9999:20000] (msg:"Example"; sid:3;)
```

Several invalid examples of port variables and port lists are demonstrated below:

Use of !any:

```
portvar EXAMPLE5 !any
var EXAMPLE5 !any
```

Logical contradictions:

```
portvar EXAMPLE6 [80,!80]
```

Ports out of range:

```
portvar EXAMPLE7 [65536]
```

Incorrect declaration and use of a port variable:

```
var EXAMPLE8 80
alert tcp any $EXAMPLE8 -> any any (msg:"Example"; sid:4;)
```

Port variable used as an IP:

```
alert tcp $EXAMPLE1 any -> any any (msg:"Example"; sid:5;)
```

Variable Modifiers

Rule variable names can be modified in several ways. You can define meta-variables using the $ operator. These can be used with the variable modifier operators ? and -, as described in the following table:

Variable Syntax	Description
var	Defines a meta-variable.
$(var) or $var	Replaces with the contents of variable var.
$(var:-default)	Replaces the contents of the variable var with “default” if var is undefined.
$(var:?message)	Replaces with the contents of variable var or prints out the error message and exits.

Here is an example of advanced variable usage in action:

```
ipvar MY_NET 192.168.1.0/24
log tcp any any -> $(MY_NET:?MY_NET is undefined!) 23
```

Limitations

When embedding variables, types can not be mixed. For instance, port variables can be defined in terms of other port variables, but old-style variables (with the ’var’ keyword) can not be embedded inside a ’portvar’.

Valid embedded variable:

```
portvar pvar1 80
portvar pvar2 [$pvar1,90]
```

Invalid embedded variable:

```
var pvar1 80
portvar pvar2 [$pvar1,90]
```

Likewise, variables can not be redefined if they were previously defined as a different type. They should be renamed instead:

Invalid redefinition:

```
var pvar 80
portvar pvar 90
```

2.1.3 Config

Many configuration and command line options of Snort can be specified in the configuration file.

Format

```
config <directive> [: <value>]
```

Config Directive	Description
config alert_with_interface_name	Appends interface name to alert (snort -I).
config alertfile: <filename>	Sets the alerts output file.
config asn1: <max-nodes>	Specifies the maximum number of nodes to track when doing ASN1 decoding. See Section 3.5.21 for more information and examples.
config autogenerate_preprocessor _decoder_rules	If Snort was configured to enable decoder and preprocessor rules, this option will cause Snort to revert back to it's original behavior of alerting if the decoder or preprocessor generates an event.
config bpf_file: <filename>	Specifies BPF filters (snort -F).
config checksum_drop: <types>	Types of packets to drop if invalid checksums. Values: none, noip, notcp, noicmp, noudp, ip, tcp, udp, icmp or all (only applicable in inline mode and for packets checked per checksum_mode config option).
config checksum_mode: <types>	Types of packets to calculate checksums. Values: none, noip, notcp, noicmp, noudp, ip, tcp, udp, icmp or all.
config chroot: <dir>	Chroots to specified dir (snort -t).
config classification: <class>	See Table 3.2 for a list of classifications.
config daemon	Forks as a daemon (snort -D).
config decode_data_link	Decodes Layer2 headers (snort -e).
config default_rule_state: <state>	Global configuration directive to enable or disable the loading of rules into the detection engine. Default (with or without directive) is enabled. Specify disabled to disable loading rules.
config detection: <search-method> [lowmem] [no_stream_inserts] [max_queue_events <num>]	Makes changes to the detection engine. The following options can be used: • search-method <ac | ac-std | ac-bnfa | acs | ac-banded | ac-sparsebands | lowmem > – ac Aho-Corasick Full (high memory, best performance) – ac-std Aho-Corasick Standard (moderate memory, high performance) – ac-bnfa Aho-Corasick NFA (low memory, high performance) – acs Aho-Corasick Sparse (small memory, moderate performance) – ac-banded Aho-Corasick Banded (small memory, moderate performance) – ac-sparsebands Aho-Corasick Sparse-Banded (small memory, high performance) – lowmem Low Memory Keyword Trie (small memory, low performance) • no_stream_inserts • max_queue_events<integer>
config disable_decode_alerts	Turns off the alerts generated by the decode phase of Snort.
config disable_inline_init_failopen	Disables failopen thread that allows inline traffic to pass while Snort is starting up. Only useful if Snort was configured with –enable-inline-init-failopen. (snort --disable-inline-init-failopen)
config disable_ipopt_alerts	Disables IP option length validation alerts.

config disable_tcpopt_alerts	Disables option length validation alerts.
config disable_tcpopt_experimental_alerts	Turns off alerts generated by experimental TCP options.
config disable_tcpopt_obsolete_alerts	Turns off alerts generated by obsolete TCP options.
config disable_tcpopt_ttcp_alerts	Turns off alerts generated by T/TCP options.
config disable_ttcp_alerts	Turns off alerts generated by T/TCP options.
config dump_chars_only	Turns on character dumps (snort -C).
config dump_payload	Dumps application layer (snort -d).
config dump_payload_verbose	Dumps raw packet starting at link layer (snort -X).
config enable_decode_drops	Enables the dropping of bad packets identified by decoder (only applicable in inline mode).
config enable_decode_oversized_alerts	Enable alerting on packets that have headers containing length fields for which the value is greater than the length of the packet.
config enable_decode_oversized_drops	Enable dropping packets that have headers containing length fields for which the value is greater than the length of the packet. enable_decode_oversized_alerts must also be enabled for this to be effective (only applicable in inline mode).
config enable_ipopt_drops	Enables the dropping of bad packets with bad/truncated IP options (only applicable in inline mode).
config enable_mpls_multicast	Enables support for MPLS multicast. This option is needed when the network allows MPLS multicast traffic. When this option is off and MPLS multicast traffic is detected, Snort will generate an alert. By default, it is off.
config enable_mpls_overlapping_ip	Enables support for overlapping IP addresses in an MPLS network. In a normal situation, where there are no overlapping IP addresses, this configuration option should not be turned on. However, there could be situations where two private networks share the same IP space and different MPLS labels are used to differentiate traffic from the two VPNs. In such a situation, this configuration option should be turned on. By default, it is off.
config enable_tcpopt_drops	Enables the dropping of bad packets with bad/truncated TCP option (only applicable in inline mode).
config enable_tcpopt_experimental_drops	Enables the dropping of bad packets with experimental TCP option. (only applicable in inline mode).
config enable_tcpopt_obsolete_drops	Enables the dropping of bad packets with obsolete TCP option. (only applicable in inline mode).
enable_tcpopt_ttcp_drops	Enables the dropping of bad packets with T/TCP option. (only applicable in inline mode).
enable_ttcp_drops	Enables the dropping of bad packets with T/TCP option. (only applicable in inline mode).
config event_filter: memcap <bytes>	Set global memcap in bytes for thresholding. Default is 1048576 bytes (1 megabyte).
config event_queue: [max_queue <num>] [log <num>] [order_events <order>]	Specifies conditions about Snort's event queue. You can use the following options: • max_queue <integer> (max events supported) • log <integer> (number of events to log) • order_events [priority|content_length] (how to order events within the queue) See Section 2.4.4 for more information and examples.

config flexresp2_attempts: <num-resets>	Specify the number of TCP reset packets to send to the source of the attack. Valid values are 0 to 20, however values less than 4 will default to 4. The default value without this option is 4. (Snort must be compiled with –enable-flexresp2)
config flexresp2_interface: <iface>	Specify the response interface to use. In Windows this can also be the interface number. (Snort must be compiled with –enable-flexresp2)
config flexresp2_memcap: <bytes>	Specify the memcap for the hash table used to track the time of responses. The times (hashed on a socket pair plus protocol) are used to limit sending a response to the same half of a socket pair every couple of seconds. Default is 1048576 bytes. (Snort must be compiled with –enable-flexresp2)
config flexresp2_rows: <num-rows>	Specify the number of rows for the hash table used to track the time of responses. Default is 1024 rows. (Snort must be compiled with –enable-flexresp2)
config flowbits_size: <num-bits>	Specifies the maximum number of flowbit tags that can be used within a rule set.
config ignore_ports: <proto> <port-list>	Specifies ports to ignore (useful for ignoring noisy NFS traffic). Specify the protocol (TCP, UDP, IP, or ICMP), followed by a list of ports. Port ranges are supported.
config interface: <iface>	Sets the network interface (`snort -i`).
config ipv6_frag: [bsd_icmp_frag_alert on|off] [, bad_ipv6_frag_alert on|off] [, frag_timeout <secs>] [, max_frag_sessions <max-track>]	The following options can be used: • `bsd_icmp_frag_alert on|off` (Specify whether or not to alert. Default is on) • `bad_ipv6_frag_alert on|off` (Specify whether or not to alert. Default is on) • `frag_timeout` <integer> (Specify amount of time in seconds to timeout first frag in hash table) • `max_frag_sessions` <integer> (Specify the number of fragments to track in the hash table)
config layer2resets: <mac-addr>	This option is only available when running in inline mode. See Section 1.5.
config logdir: <dir>	Sets the logdir (`snort -l`).
config max_attribute_hosts: <hosts>	Sets a limit on the maximum number of hosts to read from the attribute table. Minimum value is 32 and the maximum is 524288 (512k). The default is 10000. If the number of hosts in the attribute table exceeds this value, an error is logged and the remainder of the hosts are ignored. This option is only supported with a Host Attribute Table (see section 2.7).
config max_mpls_labelchain_len: <num-hdrs>	Sets a Snort-wide limit on the number of MPLS headers a packet can have. Its default value is -1, which means that there is no limit on label chain length.
config min_ttl: <ttl>	Sets a Snort-wide minimum ttl to ignore all traffic.
config mpls_payload_type: ipv4|ipv6|ethernet	Sets a Snort-wide MPLS payload type. In addition to ipv4, ipv6 and ethernet are also valid options. The default MPLS payload type is ipv4
config no_promisc	Disables promiscuous mode (`snort -p`).
config nolog	Disables logging. Note: Alerts will still occur. (`snort -N`).
config nopcre	Disables pcre pattern matching.
config obfuscate	Obfuscates IP Addresses (`snort -O`).

config order: <order>	Changes the order that rules are evaluated, eg: pass alert log activation.
config pcre_match_limit: <integer>	Restricts the amount of backtracking a given PCRE option. For example, it will limit the number of nested repeats within a pattern. A value of -1 allows for unlimited PCRE, up to the PCRE library compiled limit (around 10 million). A value of 0 results in no PCRE evaluation. The snort default value is 1500.
config pcre_match_limit_recursion: <integer>	Restricts the amount of stack used by a given PCRE option. A value of -1 allows for unlimited PCRE, up to the PCRE library compiled limit (around 10 million). A value of 0 results in no PCRE evaluation. The snort default value is 1500. This option is only useful if the value is less than the pcre_match_limit
config pkt_count: <N>	Exits after N packets (snort -n).
config policy_version: <base-version-string> [<binding-version-string>]	Supply versioning information to configuration files. Base version should be a string in all configuration files including included ones. In addition, binding version must be in any file configured with config binding. This option is used to avoid race conditions when modifying and loading a configuration within a short time span - before Snort has had a chance to load a previous configuration.
config profile_preprocs	Print statistics on preprocessor performance. See Section 2.5.2 for more details.
config profile_rules	Print statistics on rule performance. See Section 2.5.1 for more details.
config quiet	Disables banner and status reports (snort -q).
config read_bin_file: <pcap>	Specifies a pcap file to use (instead of reading from network), same effect as -r <tf> option.
config reference: <ref>	Adds a new reference system to Snort, eg: myref http://myurl.com/?id=
config reference_net <cidr>	For IP obfuscation, the obfuscated net will be used if the packet contains an IP address in the reference net. Also used to determine how to set up the logging directory structure for the session post detection rule option and ascii output plugin - an attempt is made to name the log directories after the IP address that is not in the reference net.
config set_gid: <gid>	Changes GID to specified GID (snort -g).
set_uid: <uid>	Sets UID to <id> (snort -u).
config show_year	Shows year in timestamps (snort -y).
config snaplen: <bytes>	Set the snaplength of packet, same effect as -P <snaplen> or --snaplen <snaplen> options.
config stateful	Sets assurance mode for stream (stream is established).
config tagged_packet_limit: <max-tag>	When a metric other than packets is used in a tag option in a rule, this option sets the maximum number of packets to be tagged regardless of the amount defined by the other metric. See Section 3.7.5 on using the tag option when writing rules for more details. The default value when this option is not configured is 256 packets. Setting this option to a value of 0 will disable the packet limit.
config threshold: memcap <bytes>	Set global memcap in bytes for thresholding. Default is 1048576 bytes (1 megabyte). (This is deprecated. Use config event_filter instead.)
config timestats_interval: <secs>	Set the amount of time in seconds between logging time stats. Default is 3600 (1 hour). Note this option is only available if Snort was built to use time stats with --enable-timestats.
config umask: <umask>	Sets umask when running (snort -m).

`config utc`	Uses UTC instead of local time for timestamps (`snort -U`).
`config verbose`	Uses verbose logging to STDOUT (`snort -v`).

2.2 Preprocessors

Preprocessors were introduced in version 1.5 of Snort. They allow the functionality of Snort to be extended by allowing users and programmers to drop modular plugins into Snort fairly easily. Preprocessor code is run before the detection engine is called, but after the packet has been decoded. The packet can be modified or analyzed in an out-of-band manner using this mechanism.

Preprocessors are loaded and configured using the `preprocessor` keyword. The format of the preprocessor directive in the Snort rules file is:

```
preprocessor <name>: <options>
```

2.2.1 Frag3

The frag3 preprocessor is a target-based IP defragmentation module for Snort. Frag3 is intended as a replacement for the frag2 defragmentation module and was designed with the following goals:

1. Faster execution than frag2 with less complex data management.
2. Target-based host modeling anti-evasion techniques.

The frag2 preprocessor used splay trees extensively for managing the data structures associated with defragmenting packets. Splay trees are excellent data structures to use when you have some assurance of locality of reference for the data that you are handling but in high speed, heavily fragmented environments the nature of the splay trees worked against the system and actually hindered performance. Frag3 uses the sfxhash data structure and linked lists for data handling internally which allows it to have much more predictable and deterministic performance in any environment which should aid us in managing heavily fragmented environments.

Target-based analysis is a relatively new concept in network-based intrusion detection. The idea of a target-based system is to model the actual targets on the network instead of merely modeling the protocols and looking for attacks within them. When IP stacks are written for different operating systems, they are usually implemented by people who read the RFCs and then write their interpretation of what the RFC outlines into code. Unfortunately, there are ambiguities in the way that the RFCs define some of the edge conditions that may occurr and when this happens different people implement certain aspects of their IP stacks differently. For an IDS this is a big problem.

In an environment where the attacker can determine what style of IP defragmentation is being used on a particular target, the attacker can try to fragment packets such that the target will put them back together in a specific manner while any passive systems trying to model the host traffic have to guess which way the target OS is going to handle the overlaps and retransmits. As I like to say, if the attacker has more information about the targets on a network than the IDS does, it is possible to evade the IDS. This is where the idea for "target-based IDS" came from. For more detail on this issue and how it affects IDS, check out the famous Ptacek & Newsham paper at `http://www.snort.org/docs/idspaper/`.

The basic idea behind target-based IDS is that we tell the IDS information about hosts on the network so that it can avoid Ptacek & Newsham style evasion attacks based on information about how an individual target IP stack operates. Vern Paxson and Umesh Shankar did a great paper on this very topic in 2003 that detailed mapping the hosts on a network and determining how their various IP stack implementations handled the types of problems seen in IP defragmentation and TCP stream reassembly. Check it out at `http://www.icir.org/vern/papers/activemap-oak03.pdf`.

We can also present the IDS with topology information to avoid TTL-based evasions and a variety of other issues, but that's a topic for another day. Once we have this information we can start to really change the game for these complex modeling problems.

Frag3 was implemented to showcase and prototype a target-based module within Snort to test this idea.

Frag 3 Configuration

Frag3 configuration is somewhat more complex than frag2. There are at least two preprocessor directives required to activate frag3, a global configuration directive and an engine instantiation. There can be an arbitrary number of engines defined at startup with their own configuration, but only one global configuration.

Global Configuration

- Preprocessor name: `frag3_global`
- Available options: NOTE: Global configuration options are comma separated.
  - `max_frags <number>` - Maximum simultaneous fragments to track. Default is 8192.
  - `memcap <bytes>` - Memory cap for self preservation. Default is 4MB.
  - `prealloc_frags <number>` - Alternate memory management mode. Use preallocated fragment nodes (faster in some situations).

Engine Configuration

- Preprocessor name: `frag3_engine`
- Available options: NOTE: Engine configuration options are space separated.
  - `timeout <seconds>` - Timeout for fragments. Fragments in the engine for longer than this period will be automatically dropped. Default is 60 seconds.
  - `min_ttl <value>` - Minimum acceptable TTL value for a fragment packet. Default is 1.
  - `detect_anomalies` - Detect fragment anomalies.
  - `bind_to <ip_list>` - IP List to bind this engine to. This engine will only run for packets with destination addresses contained within the IP List. Default value is `all`.
  - `overlap_limit <number>` - Limits the number of overlapping fragments per packet. The default is "0" (unlimited), the minimum is "0", and the maximum is "255". This is an optional parameter. detect_anomalies option must be configured for this option to take effect.
  - `min_fragment_length <number>` - Defines smallest fragment size (payload size) that should be considered valid. Fragments smaller than or equal to this limit are considered malicious and an event is raised, if detect_anomalies is also configured. The default is "0" (unlimited), the minimum is "0", and the maximum is "255". This is an optional parameter. detect_anomalies option must be configured for this option to take effect.
  - `policy <type>` - Select a target-based defragmentation mode. Available types are first, last, bsd, bsd-right, linux. Default type is bsd.

    The Paxson Active Mapping paper introduced the terminology frag3 is using to describe policy types. The known mappings are as follows. Anyone who develops more mappings and would like to add to this list please feel free to send us an email!

Platform	Type
AIX 2	BSD
AIX 4.3 8.9.3	BSD
Cisco IOS	Last
FreeBSD	BSD
HP JetDirect (printer)	BSD-right
HP-UX B.10.20	BSD
HP-UX 11.00	First
IRIX 4.0.5F	BSD
IRIX 6.2	BSD
IRIX 6.3	BSD
IRIX64 6.4	BSD
Linux 2.2.10	linux
Linux 2.2.14-5.0	linux
Linux 2.2.16-3	linux
Linux 2.2.19-6.2.10smp	linux
Linux 2.4.7-10	linux
Linux 2.4.9-31SGI 1.0.2smp	linux
Linux 2.4 (RedHat 7.1-7.3)	linux
MacOS (version unknown)	First
NCD Thin Clients	BSD
OpenBSD (version unknown)	linux
OpenBSD (version unknown)	linux
OpenVMS 7.1	BSD
OS/2 (version unknown)	BSD
OSF1 V3.0	BSD
OSF1 V3.2	BSD
OSF1 V4.0,5.0,5.1	BSD
SunOS 4.1.4	BSD
SunOS 5.5.1,5.6,5.7,5.8	First
Tru64 Unix V5.0A,V5.1	BSD
Vax/VMS	BSD
Windows (95/98/NT4/W2K/XP)	First

Format

Note in the advanced configuration below that there are three engines specified running with *Linux*, `first` and `last` policies assigned. The first two engines are bound to specific IP address ranges and the last one applies to all other traffic. Packets that don't fall within the address requirements of the first two engines automatically fall through to the third one.

Basic Configuration

```
preprocessor frag3_global
preprocessor frag3_engine
```

Advanced Configuration

```
preprocessor frag3_global: prealloc_nodes 8192
preprocessor frag3_engine: policy linux, bind_to 192.168.1.0/24
preprocessor frag3_engine: policy first, bind_to [10.1.47.0/24,172.16.8.0/24]
preprocessor frag3_engine: policy last, detect_anomalies
```

Frag 3 Alert Output

Frag3 is capable of detecting eight different types of anomalies. Its event output is packet-based so it will work with all output modes of Snort. Read the documentation in the `doc/signatures` directory with filenames that begin with "123-" for information on the different event types.

2.2.2 Stream5

The Stream5 preprocessor is a target-based TCP reassembly module for Snort. It is capable of tracking sessions for both TCP and UDP. With Stream5, the rule 'flow' and 'flowbits' keywords are usable with TCP as well as UDP traffic.

Transport Protocols

TCP sessions are identified via the classic TCP "connection". UDP sessions are established as the result of a series of UDP packets from two end points via the same set of ports. ICMP messages are tracked for the purposes of checking for unreachable and service unavailable messages, which effectively terminate a TCP or UDP session.

Target-Based

Stream5, like Frag3, introduces target-based actions for handling of overlapping data and other TCP anomalies. The methods for handling overlapping data, TCP Timestamps, Data on SYN, FIN and Reset sequence numbers, etc. and the policies supported by Stream5 are the results of extensive research with many target operating systems.

Stream API

Stream5 fully supports the Stream API, other protocol normalizers/preprocessors to dynamically configure reassembly behavior as required by the application layer protocol, identify sessions that may be ignored (large data transfers, etc), and update the identifying information about the session (application protocol, direction, etc) that can later be used by rules.

Anomaly Detection

TCP protocol anomalies, such as data on SYN packets, data received outside the TCP window, etc are configured via the `detect_anomalies` option to the TCP configuration. Some of these anomalies are detected on a per-target basis. For example, a few operating systems allow data in TCP SYN packets, while others do not.

Stream5 Global Configuration

Global settings for the Stream5 preprocessor.

```
preprocessor stream5_global: \
    [track_tcp <yes|no>], [max_tcp <number>], \
    [memcap <number bytes>], \
    [track_udp <yes|no>], [max_udp <number>], \
    [track_icmp <yes|no>], [max_icmp <number>], \
    [flush_on_alert], [show_rebuilt_packets], \
    [prune_log_max <bytes>]
```

Option	Description
track_tcp <yes|no>	Track sessions for TCP. The default is ”yes”.
max_tcp <num sessions>	Maximum simultaneous TCP sessions tracked. The default is ”256000”, maximum is ”1052672”, minimum is ”1”.
memcap <num bytes>	Memcap for TCP packet storage. The default is ”8388608” (8MB), maximum is ”1073741824” (1GB), minimum is ”32768” (32KB).
track_udp <yes|no>	Track sessions for UDP. The default is ”yes”.
max_udp <num sessions>	Maximum simultaneous UDP sessions tracked. The default is ”128000”, maximum is ”1052672”, minimum is ”1”.
track_icmp <yes|no>	Track sessions for ICMP. The default is ”yes”.
max_icmp <num sessions>	Maximum simultaneous ICMP sessions tracked. The default is ”64000”, maximum is ”1052672”, minimum is ”1”.
flush_on_alert	Backwards compatibilty. Flush a TCP stream when an alert is generated on that stream. The default is set to off.
show_rebuilt_packets	Print/display packet after rebuilt (for debugging). The default is set to off.
prune_log_max <num bytes>	Print a message when a session terminates that was consuming more than the specified number of bytes. The default is ”1048576” (1MB), minimum is ”0” (unlimited), maximum is not bounded, other than by the memcap.

Stream5 TCP Configuration

Provides a means on a per IP address target to configure TCP policy. This can have multiple occurances, per policy that is bound to an IP address or network. One default policy must be specified, and that policy is not bound to an IP address or network.

```
preprocessor stream5_tcp: \
    [bind_to <ip_addr>], [timeout <number secs>], \
    [policy <policy_id>], [min_ttl <number>], \
    [overlap_limit <number>], [max_window <number>], \
    [require_3whs [<number secs>]], [detect_anomalies], \
    [check_session_hijacking], [use_static_footprint_sizes], \
    [dont_store_large_packets], [dont_reassemble_async], \
    [max_queued_bytes <bytes>], [max_queued_segs <number segs>], \
    [ports <client|server|both> <all|number [number]*>], \
    [ignore_any_rules]
```

Option	Description
bind_to <ip_addr>	IP address or network for this policy. The default is set to any.
timeout <num seconds>	Session timeout. The default is ”30”, the minimum is ”1”, and the maximum is ”86400” (approximately 1 day).

<table>
<tr><td>policy <policy_id></td><td>The Operating System policy for the target OS. The policy_id can be one of the following:
<table>
<tr><th>Policy Name</th><th>Operating Systems.</th></tr>
<tr><td>first</td><td>Favor first overlapped segment.</td></tr>
<tr><td>last</td><td>Favor first overlapped segment.</td></tr>
<tr><td>bsd</td><td>FresBSD 4.x and newer, NetBSD 2.x and newer, OpenBSD 3.x and newer</td></tr>
<tr><td>linux</td><td>Linux 2.4 and newer</td></tr>
<tr><td>old-linux</td><td>Linux 2.2 and earlier</td></tr>
<tr><td>windows</td><td>Windows 2000, Windows XP, Windows 95/98/ME</td></tr>
<tr><td>win2003</td><td>Windows 2003 Server</td></tr>
<tr><td>vista</td><td>Windows Vista</td></tr>
<tr><td>solaris</td><td>Solaris 9.x and newer</td></tr>
<tr><td>hpux</td><td>HPUX 11 and newer</td></tr>
<tr><td>hpux10</td><td>HPUX 10</td></tr>
<tr><td>irix</td><td>IRIX 6 and newer</td></tr>
<tr><td>macos</td><td>MacOS 10.3 and newer</td></tr>
</table></td></tr>
<tr><td>min_ttl <number></td><td>Minimum TTL. The default is ”1”, the minimum is ”1” and the maximum is ”255”.</td></tr>
<tr><td>overlap_limit <number></td><td>Limits the number of overlapping packets per session. The default is ”0” (unlimited), the minimum is ”0”, and the maximum is ”255”.</td></tr>
<tr><td>max_window <number></td><td>Maximum TCP window allowed. The default is ”0” (unlimited), the minimum is ”0”, and the maximum is ”1073725440” (65535 left shift 14). That is the highest possible TCP window per RFCs. This option is intended to prevent a DoS against Stream5 by an attacker using an abnormally large window, so using a value near the maximum is discouraged.</td></tr>
<tr><td>require_3whs [<number seconds>]</td><td>Establish sessions only on completion of a SYN/SYN-ACK/ACK handshake. The default is set to off. The optional number of seconds specifies a startup timeout. This allows a grace period for existing sessions to be considered established during that interval immediately after Snort is started. The default is ”0” (don’t consider existing sessions established), the minimum is ”0”, and the maximum is ”86400” (approximately 1 day).</td></tr>
<tr><td>detect_anomalies</td><td>Detect and alert on TCP protocol anomalies. The default is set to off.</td></tr>
<tr><td>check_session_hijacking</td><td>Check for TCP session hijacking. This check validates the hardware (MAC) address from both sides of the connect – as established on the 3-way handshake against subsequent packets received on the session. If an ethernet layer is not part of the protocol stack received by Snort, there are no checks performed. Alerts are generated (per ’detect_anomalies’ option) for either the client or server when the MAC address for one side or the other does not match. The default is set to off.</td></tr>
<tr><td>use_static_footprint_sizes</td><td>Use static values for determining when to build a reassembled packet to allow for repeatable tests. This option should not be used production environments. The default is set to off.</td></tr>
<tr><td>dont_store_large_packets</td><td>Performance improvement to not queue large packets in reassembly buffer. The default is set to off. Using this option may result in missed attacks.</td></tr>
<tr><td>dont_reassemble_async</td><td>Don’t queue packets for reassembly if traffic has not been seen in both directions. The default is set to queue packets.</td></tr>
<tr><td>max_queued_bytes <bytes></td><td>Limit the number of bytes queued for reassembly on a given TCP session to bytes. Default is ”1048576” (1MB). A value of ”0” means unlimited, with a non-zero minimum of ”1024”, and a maximum of ”1073741824” (1GB). A message is written to console/syslog when this limit is enforced.</td></tr>
</table>

max_queued_segs <num>	Limit the number of segments queued for reassembly on a given TCP session. The default is ”2621”, derived based on an average size of 400 bytes. A value of ”0” means unlimited, with a non-zero minimum of ”2”, and a maximum of ”1073741824” (1GB). A message is written to console/syslog when this limit is enforced.
ports <client|server|both> <all|number(s)>	Specify the client, server, or both and list of ports in which to perform reassembly. This can appear more than once in a given config. The default settings are ports client 21 23 25 42 53 80 110 111 135 136 137 139 143 445 513 514 1433 1521 2401 3306. The minimum port allowed is ”1” and the maximum allowed is ”65535”.
ignore_any_rules	Don’t process any -> any (ports) rules for TCP that attempt to match payload if there are no port specific rules for the src or destination port. Rules that have flow or flowbits will never be ignored. This is a performance improvement and may result in missed attacks. Using this does not affect rules that look at protocol headers, only those with content, PCRE, or byte test options. The default is ”off”. This option can be used only in default policy.

⚠NOTE

If no options are specified for a given TCP policy, that is the default TCP policy. If only a bind_to option is used with no other options that TCP policy uses all of the default values.

Stream5 UDP Configuration

Configuration for UDP session tracking. Since there is no target based binding, there should be only one occurance of the UDP configuration.

```
preprocessor stream5_udp: [timeout <number secs>], [ignore_any_rules]
```

Option	Description
timeout <num seconds>	Session timeout. The default is ”30”, the minimum is ”1”, and the maximum is ”86400” (approximately 1 day).
ignore_any_rules	Don’t process any -> any (ports) rules for UDP that attempt to match payload if there are no port specific rules for the src or destination port. Rules that have flow or flowbits will never be ignored. This is a performance improvement and may result in missed attacks. Using this does not affect rules that look at protocol headers, only those with content, PCRE, or byte test options. The default is ”off”.

⚠NOTE

With the ignore_any_rules option, a UDP rule will be ignored except when there is another port specific rule that may be applied to the traffic. For example, if a UDP rule specifies destination port 53, the ’ignored’ any -> any rule will be applied to traffic to/from port 53, but NOT to any other source or destination port. A list of rule SIDs affected by this option are printed at Snort’s startup.

⚠NOTE

With the ignore_any_rules option, if a UDP rule that uses any -> any ports includes either flow or flowbits, the ignore_any_rules option is effectively pointless. Because of the potential impact of disabling a flowbits rule, the ignore_any_rules option will be disabled in this case.

Stream5 ICMP Configuration

Configuration for ICMP session tracking. Since there is no target based binding, there should be only one occurance of the ICMP configuration.

ICMP is currently untested, in minimal code form and is NOT ready for use in production networks. It is not turned on by default.

```
preprocessor stream5_icmp: [timeout <number secs>]
```

Option	Description
`timeout <num seconds>`	Session timeout. The default is ”30”, the minimum is ”1”, and the maximum is ”86400” (approximately 1 day).

Example Configurations

1. This example configuration is the default configuration in snort.conf and can be used for repeatable tests of stream reassembly in readback mode.

```
preprocessor stream5_global: \
    max_tcp 8192, track_tcp yes, track_udp yes, track_icmp no

preprocessor stream5_tcp: \
    policy first, use_static_footprint_sizes

preprocessor stream5_udp: \
    ignore_any_rules
```

2. This configuration maps two network segments to different OS policies, one for Windows and one for Linux, with all other traffic going to the default policy of Solaris.

```
preprocessor stream5_global: track_tcp yes
preprocessor stream5_tcp: bind_to 192.168.1.0/24, policy windows
preprocessor stream5_tcp: bind_to 10.1.1.0/24, policy linux
preprocessor stream5_tcp: policy solaris
```

Alerts

Stream5 uses generator ID 129. It is capable of alerting on 8 (eight) anomalies, all of which relate to TCP anomalies. There are no anomalies detected relating to UDP or ICMP.

The list of SIDs is as follows:

1. SYN on established session
2. Data on SYN packet
3. Data sent on stream not accepting data
4. TCP Timestamp is outside of PAWS window
5. Bad segment, overlap adjusted size less than/equal 0
6. Window size (after scaling) larger than policy allows
7. Limit on number of overlapping TCP packets reached
8. Data after Reset packet

2.2.3 sfPortscan

The sfPortscan module, developed by Sourcefire, is designed to detect the first phase in a network attack: Reconnaissance. In the Reconnaissance phase, an attacker determines what types of network protocols or services a host supports. This is the traditional place where a portscan takes place. This phase assumes the attacking host has no prior knowledge of what protocols or services are supported by the target; otherwise, this phase would not be necessary.

As the attacker has no beforehand knowledge of its intended target, most queries sent by the attacker will be negative (meaning that the service ports are closed). In the nature of legitimate network communications, negative responses from hosts are rare, and rarer still are multiple negative responses within a given amount of time. Our primary objective in detecting portscans is to detect and track these negative responses.

One of the most common portscanning tools in use today is Nmap. Nmap encompasses many, if not all, of the current portscanning techniques. sfPortscan was designed to be able to detect the different types of scans Nmap can produce.

sfPortscan will currently alert for the following types of Nmap scans:

- TCP Portscan
- UDP Portscan
- IP Portscan

These alerts are for one→one portscans, which are the traditional types of scans; one host scans multiple ports on another host. Most of the port queries will be negative, since most hosts have relatively few services available.

sfPortscan also alerts for the following types of decoy portscans:

- TCP Decoy Portscan
- UDP Decoy Portscan
- IP Decoy Portscan

Decoy portscans are much like the Nmap portscans described above, only the attacker has a spoofed source address inter-mixed with the real scanning address. This tactic helps hide the true identity of the attacker.

sfPortscan alerts for the following types of distributed portscans:

- TCP Distributed Portscan
- UDP Distributed Portscan
- IP Distributed Portscan

These are many→one portscans. Distributed portscans occur when multiple hosts query one host for open services. This is used to evade an IDS and obfuscate command and control hosts.

Negative queries will be distributed among scanning hosts, so we track this type of scan through the scanned host.

sfPortscan alerts for the following types of portsweeps:

- TCP Portsweep
- UDP Portsweep
- IP Portsweep

- ICMP Portsweep

These alerts are for one→many portsweeps. One host scans a single port on multiple hosts. This usually occurs when a new exploit comes out and the attacker is looking for a specific service.

The characteristics of a portsweep scan may not result in many negative responses. For example, if an attacker portsweeps a web farm for port 80, we will most likely not see many negative responses.

sfPortscan alerts on the following filtered portscans and portsweeps:

- TCP Filtered Portscan
- UDP Filtered Portscan
- IP Filtered Portscan
- TCP Filtered Decoy Portscan
- UDP Filtered Decoy Portscan
- IP Filtered Decoy Portscan
- TCP Filtered Portsweep
- UDP Filtered Portsweep
- IP Filtered Portsweep
- ICMP Filtered Portsweep
- TCP Filtered Distributed Portscan
- UDP Filtered Distributed Portscan
- IP Filtered Distributed Portscan

"Filtered" alerts indicate that there were no network errors (ICMP unreachables or TCP RSTs) or responses on closed ports have been suppressed. It's also a good indicator of whether the alert is just a very active legitimate host. Active hosts, such as NATs, can trigger these alerts because they can send out many connection attempts within a very small amount of time. A filtered alert may go off before responses from the remote hosts are received.

sfPortscan only generates one alert for each host pair in question during the time window (more on windows below). On TCP scan alerts, sfPortscan will also display any open ports that were scanned. On TCP sweep alerts however, sfPortscan will only track open ports after the alert has been triggered. Open port events are not individual alerts, but tags based on the orginal scan alert.

sfPortscan Configuration

Use of the Stream5 preprocessor is required for sfPortscan. Stream gives portscan direction in the case of connectionless protocols like ICMP and UDP. You should enable the Stream preprocessor in your `snort.conf`, as described in Section 2.2.2.

The parameters you can use to configure the portscan module are:

1. **proto** <**protocol**>
   Available options:
   - `TCP`

- UDP
- IGMP
- ip_proto
- all

2. **scan_type** <**scan_type**>

   Available options:

   - portscan
   - portsweep
   - decoy_portscan
   - distributed_portscan
   - all

3. **sense_level** <**level**>

   Available options:

   - low - "Low" alerts are only generated on error packets sent from the target host, and because of the nature of error responses, this setting should see very few false postives. However, this setting will never trigger a Filtered Scan alert because of a lack of error responses. This setting is based on a static time window of 60 seconds, afterwhich this window is reset.
   - medium - "Medium" alerts track connection counts, and so will generate filtered scan alerts. This setting may false positive on active hosts (NATs, proxies, DNS caches, etc), so the user may need to deploy the use of Ignore directives to properly tune this directive.
   - high - "High" alerts continuously track hosts on a network using a time window to evaluate portscan statistics for that host. A "High" setting will catch some slow scans because of the continuous monitoring, but is very sensitive to active hosts. This most definitely will require the user to tune sfPortscan.

4. **watch_ip** <**ip1**|**ip2/cidr[[port**|**port2-port3]]**>

   Defines which IPs, networks, and specific ports on those hosts to watch. The list is a comma separated list of IP addresses, IP address using CIDR notation. Optionally, ports are specified after the IP address/CIDR using a space and can be either a single port or a range denoted by a dash. IPs or networks not falling into this range are ignored if this option is used.

5. **ignore_scanners** <**ip1**|**ip2/cidr[[port**|**port2-port3]]**>

   Ignores the source of scan alerts. The parameter is the same format as that of watch_ip.

6. **ignore_scanned** <**ip1**|**ip2/cidr[[port**|**port2-port3]]**>

   Ignores the destination of scan alerts. The parameter is the same format as that of watch_ip.

7. **logfile** <**file**>

   This option will output portscan events to the file specified. If file does not contain a leading slash, this file will be placed in the Snort config dir.

8. **include_midstream**

   This option will include sessions picked up in midstream by Stream5. This can lead to false alerts, especially under heavy load with dropped packets; which is why the option is off by default.

9. **detect_ack_scans**

   This option will include sessions picked up in midstream by the stream module, which is necessary to detect ACK scans. However, this can lead to false alerts, especially under heavy load with dropped packets; which is why the option is off by default.

Format

```
preprocessor sfportscan: proto <protocols> \
    scan_type <portscan|portsweep|decoy_portscan|distributed_portscan|all> \
    sense_level <low|medium|high> \
    watch_ip <IP or IP/CIDR> \
    ignore_scanners <IP list> \
    ignore_scanned <IP list> \
    logfile <path and filename>
```

Example

```
preprocessor flow: stats_interval 0 hash 2
preprocessor sfportscan:\
    proto { all } \
    scan_type { all } \
    sense_level { low }
```

sfPortscan Alert Output

Unified Output In order to get all the portscan information logged with the alert, snort generates a pseudo-packet and uses the payload portion to store the additional portscan information of priority count, connection count, IP count, port count, IP range, and port range. The characteristics of the packet are:

```
Src/Dst MAC Addr == MACDAD
IP Protocol == 255
IP TTL == 0
```

Other than that, the packet looks like the IP portion of the packet that caused the portscan alert to be generated. This includes any IP options, etc. The payload and payload size of the packet are equal to the length of the additional portscan information that is logged. The size tends to be around 100 - 200 bytes.

Open port alerts differ from the other portscan alerts, because open port alerts utilize the tagged packet output system. This means that if an output system that doesn't print tagged packets is used, then the user won't see open port alerts. The open port information is stored in the IP payload and contains the port that is open.

The sfPortscan alert output was designed to work with unified packet logging, so it is possible to extend favorite Snort GUIs to display portscan alerts and the additional information in the IP payload using the above packet characteristics.

Log File Output Log file output is displayed in the following format, and explained further below:

```
Time: 09/08-15:07:31.603880
event_id: 2
192.168.169.3 -> 192.168.169.5 (portscan) TCP Filtered Portscan
Priority Count: 0
Connection Count: 200
IP Count: 2
Scanner IP Range: 192.168.169.3:192.168.169.4
Port/Proto Count: 200
Port/Proto Range: 20:47557
```

If there are open ports on the target, one or more additional tagged packet(s) will be appended:

```
Time: 09/08-15:07:31.603881
event_ref: 2
```

```
192.168.169.3 -> 192.168.169.5 (portscan) Open Port
Open Port: 38458
```

1. **Event_id/Event_ref**

   These fields are used to link an alert with the corresponding `Open Port` tagged packet

2. **Priority Count**

   `Priority Count` keeps track of bad responses (resets, unreachables). The higher the priority count, the more bad responses have been received.

3. **Connection Count**

   `Connection Count` lists how many connections are active on the hosts (src or dst). This is accurate for connection-based protocols, and is more of an estimate for others. Whether or not a portscan was filtered is determined here. High connection count and low priority count would indicate filtered (no response received from target).

4. **IP Count**

   IP Count keeps track of the last IP to contact a host, and increments the count if the next IP is different. For one-to-one scans, this is a low number. For active hosts this number will be high regardless, and one-to-one scans may appear as a distributed scan.

5. **Scanned/Scanner IP Range**

   This field changes depending on the type of alert. Portsweep (one-to-many) scans display the scanned IP range; Portscans (one-to-one) display the scanner IP.

6. **Port Count**

   Port Count keeps track of the last port contacted and increments this number when that changes. We use this count (along with IP Count) to determine the difference between one-to-one portscans and one-to-one decoys.

Tuning sfPortscan

The most important aspect in detecting portscans is tuning the detection engine for your network(s). Here are some tuning tips:

1. **Use the watch_ip, ignore_scanners, and ignore_scanned options.**

   It's important to correctly set these options. The `watch_ip` option is easy to understand. The analyst should set this option to the list of Cidr blocks and IPs that they want to watch. If no `watch_ip` is defined, sfPortscan will watch all network traffic.

   The `ignore_scanners` and `ignore_scanned` options come into play in weeding out legitimate hosts that are very active on your network. Some of the most common examples are NAT IPs, DNS cache servers, syslog servers, and nfs servers. sfPortscan may not generate false positives for these types of hosts, but be aware when first tuning sfPortscan for these IPs. Depending on the type of alert that the host generates, the analyst will know which to ignore it as. If the host is generating portsweep events, then add it to the `ignore_scanners` option. If the host is generating portscan alerts (and is the host that is being scanned), add it to the `ignore_scanned` option.

2. **Filtered scan alerts are much more prone to false positives.**

   When determining false positives, the alert type is very important. Most of the false positives that sfPortscan may generate are of the filtered scan alert type. So be much more suspicious of filtered portscans. Many times this just indicates that a host was very active during the time period in question. If the host continually generates these types of alerts, add it to the `ignore_scanners` list or use a lower sensitivity level.

3. **Make use of the Priority Count, Connection Count, IP Count, Port Count, IP Range, and Port Range to determine false positives.**

The portscan alert details are vital in determining the scope of a portscan and also the confidence of the portscan. In the future, we hope to automate much of this analysis in assigning a scope level and confidence level, but for now the user must manually do this. The easiest way to determine false positives is through simple ratio estimations. The following is a list of ratios to estimate and the associated values that indicate a legimite scan and not a false positive.

Connection Count / IP Count: This ratio indicates an estimated average of connections per IP. For portscans, this ratio should be high, the higher the better. For portsweeps, this ratio should be low.

Port Count / IP Count: This ratio indicates an estimated average of ports connected to per IP. For portscans, this ratio should be high and indicates that the scanned host's ports were connected to by fewer IPs. For portsweeps, this ratio should be low, indicating that the scanning host connected to few ports but on many hosts.

Connection Count / Port Count: This ratio indicates an estimated average of connections per port. For portscans, this ratio should be low. This indicates that each connection was to a different port. For portsweeps, this ratio should be high. This indicates that there were many connections to the same port.

The reason that `Priority Count` is not included, is because the priority count is included in the connection count and the above comparisons take that into consideration. The Priority Count play an important role in tuning because the higher the priority count the more likely it is a real portscan or portsweep (unless the host is firewalled).

4. **If all else fails, lower the sensitivity level.**

   If none of these other tuning techniques work or the analyst doesn't have the time for tuning, lower the sensitivity level. You get the best protection the higher the sensitivity level, but it's also important that the portscan detection engine generate alerts that the analyst will find informative. The low sensitivity level only generates alerts based on error responses. These responses indicate a portscan and the alerts generated by the low sensitivity level are highly accurate and require the least tuning. The low sensitivity level does not catch filtered scans; since these are more prone to false positives.

2.2.4 RPC Decode

The rpc_decode preprocessor normalizes RPC multiple fragmented records into a single un-fragmented record. It does this by normalizing the packet into the packet buffer. If stream5 is enabled, it will only process client-side traffic. By default, it runs against traffic on ports 111 and 32771.

Format

```
preprocessor rpc_decode: \
    <ports> [ alert_fragments ] \
    [no_alert_multiple_requests] \
    [no_alert_large_fragments] \
    [no_alert_incomplete]
```

Option	Description
`alert_fragments`	Alert on any fragmented RPC record.
`no_alert_multiple_requests`	Don't alert when there are multiple records in one packet.
`no_alert_large_fragments`	Don't alert when the sum of fragmented records exceeds one packet.
`no_alert_incomplete`	Don't alert when a single fragment record exceeds the size of one packet.

2.2.5 Performance Monitor

This preprocessor measures Snort's real-time and theoretical maximum performance. Whenever this preprocessor is turned on, it should have an output mode enabled, either "console" which prints statistics to the console window or "file" with a file name, where statistics get printed to the specified file name. By default, Snort's real-time statistics are processed. This includes:

- Time Stamp
- Drop Rate
- Mbits/Sec (wire) [duplicated below for easy comparison with other rates]
- Alerts/Sec
- K-Pkts/Sec (wire) [duplicated below for easy comparison with other rates]
- Avg Bytes/Pkt (wire) [duplicated below for easy comparison with other rates]
- Pat-Matched [percent of data received that Snort processes in pattern matching]
- Syns/Sec
- SynAcks/Sec
- New Sessions Cached/Sec
- Sessions Del fr Cache/Sec
- Current Cached Sessions
- Max Cached Sessions
- Stream Flushes/Sec
- Stream Session Cache Faults
- Stream Session Cache Timeouts
- New Frag Trackers/Sec
- Frag-Completes/Sec
- Frag-Inserts/Sec
- Frag-Deletes/Sec
- Frag-Auto Deletes/Sec [memory DoS protection]
- Frag-Flushes/Sec
- Frag-Current [number of current Frag Trackers]
- Frag-Max [max number of Frag Trackers at any time]
- Frag-Timeouts
- Frag-Faults
- Number of CPUs [*** Only if compiled with LINUX_SMP ***, the next three appear for each CPU]
- CPU usage (user)
- CPU usage (sys)
- CPU usage (Idle)
- Mbits/Sec (wire) [average mbits of total traffic]
- Mbits/Sec (ipfrag) [average mbits of IP fragmented traffic]
- Mbits/Sec (ipreass) [average mbits Snort injects after IP reassembly]
- Mbits/Sec (tcprebuilt) [average mbits Snort injects after TCP reassembly]
- Mbits/Sec (applayer) [average mbits seen by rules and protocol decoders]

- Avg Bytes/Pkt (wire)
- Avg Bytes/Pkt (ipfrag)
- Avg Bytes/Pkt (ipreass)
- Avg Bytes/Pkt (tcprebuilt)
- Avg Bytes/Pkt (applayer)
- K-Pkts/Sec (wire)
- K-Pkts/Sec (ipfrag)
- K-Pkts/Sec (ipreass)
- K-Pkts/Sec (tcprebuilt)
- K-Pkts/Sec (applayer)
- Total Packets Received
- Total Packets Dropped (not processed)
- Total Packets Blocked (inline)
- Percentage of Packets Dropped
- Total Filtered TCP Packets
- Total Filtered UDP Packets
- Midstream TCP Sessions/Sec
- Closed TCP Sessions/Sec
- Pruned TCP Sessions/Sec
- TimedOut TCP Sessions/Sec
- Dropped Async TCP Sessions/Sec
- TCP Sessions Initializing
- TCP Sessions Established
- TCP Sessions Closing
- Max TCP Sessions (interval)
- New Cached UDP Sessions/Sec
- Cached UDP Ssns Del/Sec
- Current Cached UDP Sessions
- Max Cached UDP Sessions
- Current Attribute Table Hosts (Target Based)
- Attribute Table Reloads (Target Based)
- Mbits/Sec (Snort)
- Mbits/Sec (sniffing)
- Mbits/Sec (combined)
- uSeconds/Pkt (Snort)

- uSeconds/Pkt (sniffing)
- uSeconds/Pkt (combined)
- KPkts/Sec (Snort)
- KPkts/Sec (sniffing)
- KPkts/Sec (combined)

The following options can be used with the performance monitor:

- `flow` - Prints out statistics about the type of traffic and protocol distributions that Snort is seeing. This option can produce large amounts of output.
- `events` - Turns on event reporting. This prints out statistics as to the number of signatures that were matched by the setwise pattern matcher (*non-qualified events*) and the number of those matches that were verified with the signature flags (*qualified events*). This shows the user if there is a problem with the rule set that they are running.
- `max` - Turns on the theoretical maximum performance that Snort calculates given the processor speed and current performance. This is only valid for uniprocessor machines, since many operating systems don't keep accurate kernel statistics for multiple CPUs.
- `console` - Prints statistics at the console.
- `file` - Prints statistics in a comma-delimited format to the file that is specified. Not all statistics are output to this file. You may also use `snortfile` which will output into your defined Snort log directory. Both of these directives can be overridden on the command line with the `-Z` or `--perfmon-file` options.
- `pktcnt` - Adjusts the number of packets to process before checking for the time sample. This boosts performance, since checking the time sample reduces Snort's performance. By default, this is 10000.
- `time` - Represents the number of seconds between intervals.
- `accumulate` or `reset` - Defines which type of drop statistics are kept by the operating system. By default, `reset` is used.
- `atexitonly` - Dump stats for entire life of Snort.
- `max_file_size` - Defines the maximum size of the comma-delimited file. Before the file exceeds this size, it will be rolled into a new date stamped file of the format YYYY-MM-DD, followed by YYYY-MM-DD.x, where x will be incremented each time the comma delimiated file is rolled over. The minimum is 4096 bytes and the maximum is 2147483648 bytes (2GB). The default is the same as the maximum.

Examples

```
preprocessor perfmonitor: \
    time 30 events flow file stats.profile max console pktcnt 10000

preprocessor perfmonitor: \
    time 300 file /var/tmp/snortstat pktcnt 10000
```

2.2.6 HTTP Inspect

HTTP Inspect is a generic HTTP decoder for user applications. Given a data buffer, HTTP Inspect will decode the buffer, find HTTP fields, and normalize the fields. HTTP Inspect works on both client requests and server responses.

The current version of HTTP Inspect only handles stateless processing. This means that HTTP Inspect looks for HTTP fields on a packet-by-packet basis, and will be fooled if packets are not reassembled. This works fine when there is

another module handling the reassembly, but there are limitations in analyzing the protocol. Future versions will have a stateful processing mode which will hook into various reassembly modules.

HTTP Inspect has a very "rich" user configuration. Users can configure individual HTTP servers with a variety of options, which should allow the user to emulate any type of web server. Within HTTP Inspect, there are two areas of configuration: global and server.

Global Configuration

The global configuration deals with configuration options that determine the global functioning of HTTP Inspect. The following example gives the generic global configuration format:

Format

```
preprocessor http_inspect: \
    global \
    iis_unicode_map <map_filename> \
    codemap <integer> \
    [detect_anomalous_servers] \
    [proxy_alert]
```

You can only have a single global configuration, you'll get an error if you try otherwise.

Configuration

1. `iis_unicode_map <map_filename> [codemap <integer>]`

   This is the global `iis_unicode_map` file. The `iis_unicode_map` is a required configuration parameter. The map file can reside in the same directory as `snort.conf` or be specified via a fully-qualified path to the map file.

   The `iis_unicode_map` file is a Unicode codepoint map which tells HTTP Inspect which codepage to use when decoding Unicode characters. For US servers, the codemap is usually 1252.

   A Microsoft US Unicode codepoint map is provided in the Snort source `etc` directory by default. It is called `unicode.map` and should be used if no other codepoint map is available. A tool is supplied with Snort to generate custom Unicode `maps--ms_unicode_generator.c`, which is available at `http://www.snort.org/dl/contrib/`.

   Remember that this configuration is for the global IIS Unicode map, individual servers can reference their own IIS Unicode map.

2. `detect_anomalous_servers`

   This global configuration option enables generic HTTP server traffic inspection on non-HTTP configured ports, and alerts if HTTP traffic is seen. Don't turn this on if you don't have a default server configuration that encompasses all of the HTTP server ports that your users might access. In the future, we want to limit this to specific networks so it's more useful, but for right now, this inspects all network traffic.

3. `proxy_alert`

   This enables global alerting on HTTP server proxy usage. By configuring HTTP Inspect servers and enabling `allow_proxy_use`, you will only receive proxy use alerts for web users that aren't using the configured proxies or are using a rogue proxy server.

   Please note that if users aren't required to configure web proxy use, then you may get a lot of proxy alerts. So, please only use this feature with traditional proxy environments. Blind firewall proxies don't count.

Example Global Configuration

```
preprocessor http_inspect: \
    global iis_unicode_map unicode.map 1252
```

Server Configuration

There are two types of server configurations: default and by IP address.

Default This configuration supplies the default server configuration for any server that is not individually configured. Most of your web servers will most likely end up using the default configuration.

Example Default Configuration

```
preprocessor http_inspect_server: \
    server default profile all ports { 80 }
```

Configuration by IP Address This format is very similar to "default", the only difference being that specific IPs can be configured.

Example IP Configuration

```
preprocessor http_inspect_server: \
    server 10.1.1.1 profile all ports { 80 }
```

Configuration by Multiple IP Addresses This format is very similar to "Configuration by IP Address", the only difference being that multiple IPs can be specified via a space separated list. There is a limit of 40 IP addresses or CIDR notations per `http_inspect_server` line.

Example Multiple IP Configuration

```
preprocessor http_inspect_server: \
    server { 10.1.1.1 10.2.2.0/24 } profile all ports { 80 }
```

Server Configuration Options

Important: Some configuration options have an argument of 'yes' or 'no'. This argument specifies whether the user wants the configuration option to generate an HTTP Inspect alert or not. The 'yes/no' argument does not specify whether the configuration option itself is on or off, only the alerting functionality. In other words, whether set to 'yes' or 'no', HTTP normalization will still occur, and rules based on HTTP traffic will still trigger.

1. `profile <all|apache|iis|iis5_0|iis4_0>`

   Users can configure HTTP Inspect by using pre-defined HTTP server profiles. Profiles allow the user to easily configure the preprocessor for a certain type of server, but are not required for proper operation.

   There are five profiles available: all, apache, iis, iis5_0, and iis4_0.

   1-A. `all`

   The `all` profile is meant to normalize the URI using most of the common tricks available. We alert on the more serious forms of evasions. This is a great profile for detecting all types of attacks, regardless of the HTTP server. `profile all` sets the configuration options described in Table 2.3.

Table 2.3: Options for the “all” Profile

Option	Setting
server_flow_depth	300
client_flow_depth	300
post_depth	0
chunk encoding	alert on chunks larger than 500000 bytes
iis_unicode_map	codepoint map in the global configuration
ascii decoding	on, alert off
multiple slash	on, alert off
directory normalization	on, alert off
apache whitespace	on, alert off
double decoding	on, alert on
%u decoding	on, alert on
bare byte decoding	on, alert on
iis unicode codepoints	on, alert on
iis backslash	on, alert off
iis delimiter	on, alert off
webroot	on, alert on
non_strict URL parsing	on
tab_uri_delimiter	is set
max_header_length	0, header length not checked
max_headers	0, number of headers not checked

1-B. `apache`

The `apache` profile is used for Apache web servers. This differs from the `iis` profile by only accepting UTF-8 standard Unicode encoding and not accepting backslashes as legitimate slashes, like IIS does. Apache also accepts tabs as whitespace. `profile apache` sets the configuration options described in Table 2.4.

Table 2.4: Options for the `apache` Profile

Option	Setting
server_flow_depth	300
client_flow_depth	300
post_depth	0
chunk encoding	alert on chunks larger than 500000 bytes
ascii decoding	on, alert off
multiple slash	on, alert off
directory normalization	on, alert off
webroot	on, alert on
apache whitespace	on, alert on
utf_8 encoding	on, alert off
non_strict url parsing	on
tab_uri_delimiter	is set
max_header_length	0, header length not checked
max_headers	0, number of headers not checked

1-C. `iis`

The `iis` profile mimics IIS servers. So that means we use IIS Unicode codemaps for each server, %u encoding, bare-byte encoding, double decoding, backslashes, etc. `profile iis` sets the configuration options described in Table 2.5.

1-D. `iis4_0, iis5_0`

In IIS 4.0 and IIS 5.0, there was a double decoding vulnerability. These two profiles are identical to `iis`,

Table 2.5: Options for the `iis` Profile

Option	Setting
server_flow_depth	300
client_flow_depth	300
post_depth	0
chunk encoding	alert on chunks larger than 500000 bytes
iis_unicode_map	codepoint map in the global configuration
ascii decoding	on, alert off
multiple slash	on, alert off
directory normalization	on, alert off
webroot	on, alert on
double decoding	on, alert on
%u decoding	on, alert on
bare byte decoding	on, alert on
iis unicode codepoints	on, alert on
iis backslash	on, alert off
iis delimiter	on, alert on
apache whitespace	on, alert on
non_strict URL parsing	on
max_header_length	0, header length not checked
max_headers	0, number of headers not checked

except they will alert by default if a URL has a double encoding. Double decode is not supported in IIS 5.1 and beyond, so it's disabled by default.

1-E. `default, no profile`

The default options used by HTTP Inspect do not use a profile and are described in Table 2.6.

Table 2.6: Default HTTP Inspect Options

Option	Setting
port	80
server_flow_depth	300
client_flow_depth	300
post_depth	0
chunk encoding	alert on chunks larger than 500000 bytes
ascii decoding	on, alert off
utf_8 encoding	on, alert off
multiple slash	on, alert off
directory normalization	on, alert off
webroot	on, alert on
iis backslash	on, alert off
apache whitespace	on, alert off
iis delimiter	on, alert off
non_strict URL parsing	on
max_header_length	0, header length not checked
max_headers	0, number of headers not checked

Profiles must be specified as the first server option and cannot be combined with any other options except:

- `ports`
- `iis_unicode_map`
- `allow_proxy_use`
- `server_flow_depth`

- client_flow_depth
- post_depth
- no_alerts
- inspect_uri_only
- oversize_dir_length
- normalize_headers
- normalize_cookies
- max_header_length
- max_headers

These options must be specified after the profile option.

Example

```
preprocessor http_inspect_server: \
    server 1.1.1.1 profile all ports { 80 3128 }
```

2. ports {<port> [<port>< ... >]}

This is how the user configures which ports to decode on the HTTP server. However, HTTPS traffic is encrypted and cannot be decoded with HTTP Inspect. To ignore HTTPS traffic, use the SSL preprocessor.

3. iis_unicode_map <map_filename> codemap <integer>

The IIS Unicode map is generated by the program ms_unicode_generator.c. This program is located on the Snort.org web site at http://www.snort.org/dl/contrib/ directory. Executing this program generates a Unicode map for the system that it was run on. So, to get the specific Unicode mappings for an IIS web server, you run this program on that server and use that Unicode map in this configuration.

When using this option, the user needs to specify the file that contains the IIS Unicode map and also specify the Unicode map to use. For US servers, this is usually 1252. But the ms_unicode_generator program tells you which codemap to use for you server; it's the ANSI code page. You can select the correct code page by looking at the available code pages that the ms_unicode_generator outputs.

4. server_flow_depth <integer>

This specifies the amount of server response payload to inspect. This option significantly increases IDS performance because we are ignoring a large part of the network traffic (HTTP server response payloads). A small percentage of Snort rules are targeted at this traffic and a small flow_depth value may cause false negatives in some of these rules. Most of these rules target either the HTTP header, or the content that is likely to be in the first hundred or so bytes of non-header data. Headers are usually under 300 bytes long, but your mileage may vary.

This value can be set from -1 to 1460. A value of -1 causes Snort to ignore all server side traffic for ports defined in ports. Inversely, a value of 0 causes Snort to inspect all HTTP server payloads defined in ports (note that this will likely slow down IDS performance). Values above 0 tell Snort the number of bytes to inspect in the first packet of the server response.

server_flow_depth is the same as the old flow_depth option, which will be deprecated in a future release.

5. client_flow_depth <integer>

This specifies the amount of raw client request payload to inspect. It is similar to server_flow_depth (above), and has a default value of 300. It primarily eliminates Snort fro inspecting larger HTTP Cookies that appear at the end of many client request Headers.

6. post_depth <integer>

This specifies the amount of data to inspect in a client post message. The value can be set from 0 to 65495. The default value is 0. This increases the perfomance by inspecting only specified bytes in the post message.

7. `ascii <yes|no>`

   The `ascii` decode option tells us whether to decode encoded ASCII chars, a.k.a %2f = /, %2e = ., etc. It is normal to see ASCII encoding usage in URLs, so it is recommended that you disable HTTP Inspect alerting for this option.

8. `utf_8 <yes|no>`

   The `utf-8` decode option tells HTTP Inspect to decode standard UTF-8 Unicode sequences that are in the URI. This abides by the Unicode standard and only uses % encoding. Apache uses this standard, so for any Apache servers, make sure you have this option turned on. As for alerting, you may be interested in knowing when you have a UTF-8 encoded URI, but this will be prone to false positives as legitimate web clients use this type of encoding. When `utf_8` is enabled, ASCII decoding is also enabled to enforce correct functioning.

9. `u_encode <yes|no>`

   This option emulates the IIS %u encoding scheme. How the %u encoding scheme works is as follows: the encoding scheme is started by a %u followed by 4 characters, like %uxxxx. The xxxx is a hex-encoded value that correlates to an IIS Unicode codepoint. This value can most definitely be ASCII. An ASCII character is encoded like %u002f = /, %u002e = ., etc. If no iis_unicode_map is specified before or after this option, the default codemap is used.

   You should alert on %u encodings, because we are not aware of any legitimate clients that use this encoding. So it is most likely someone trying to be covert.

10. `bare_byte <yes|no>`

    Bare byte encoding is an IIS trick that uses non-ASCII characters as valid values when decoding UTF-8 values. This is not in the HTTP standard, as all non-ASCII values have to be encoded with a %. Bare byte encoding allows the user to emulate an IIS server and interpret non-standard encodings correctly.

    The alert on this decoding should be enabled, because there are no legitimate clients that encode UTF-8 this way since it is non-standard.

11. `base36 <yes|no>`

    This is an option to decode base36 encoded chars. This option is based on info from:

    `http://www.yk.rim.or.jp/~shikap/patch/spp\_http\_decode.patch`.

    If %u encoding is enabled, this option will not work. You have to use the `base36` option with the `utf_8` option. Don't use the %u option, because base36 won't work. When `base36` is enabled, ASCII encoding is also enabled to enforce correct behavior.

12. `iis_unicode <yes|no>`

    The `iis_unicode` option turns on the Unicode codepoint mapping. If there is no iis_unicode_map option specified with the server config, `iis_unicode` uses the default codemap. The `iis_unicode` option handles the mapping of non-ASCII codepoints that the IIS server accepts and decodes normal UTF-8 requests.

    You should alert on the `iis_unicode option`, because it is seen mainly in attacks and evasion attempts. When `iis_unicode` is enabled, ASCII and UTF-8 decoding are also enabled to enforce correct decoding. To alert on UTF-8 decoding, you must enable also enable `utf_8 yes`.

13. `double_decode <yes|no>`

    The `double_decode` option is once again IIS-specific and emulates IIS functionality. How this works is that IIS does two passes through the request URI, doing decodes in each one. In the first pass, it seems that all types of iis encoding is done: utf-8 unicode, ascii, bare byte, and %u. In the second pass, the following encodings are done: ascii, bare byte, and %u. We leave out utf-8 because I think how this works is that the % encoded utf-8 is decoded to the Unicode byte in the first pass, and then UTF-8 is decoded in the second stage. Anyway, this is really complex and adds tons of different encodings for one character. When `double_decode` is enabled, so ASCII is also enabled to enforce correct decoding.

14. `non_rfc_char {<byte> [<byte ...>]}`

    This option lets users receive an alert if certain non-RFC chars are used in a request URI. For instance, a user may not want to see null bytes in the request URI and we can alert on that. Please use this option with care, because you could configure it to say, alert on all '/' or something like that. It's flexible, so be careful.

15. `multi_slash <yes|no>`

This option normalizes multiple slashes in a row, so something like: “foo////////bar” get normalized to “foo/bar.”

If you want an alert when multiple slashes are seen, then configure with a `yes`; otherwise, use `no`.

16. `iis_backslash <yes|no>`

Normalizes backslashes to slashes. This is again an IIS emulation. So a request URI of “/foo\bar” gets normalized to “/foo/bar.”

17. `directory <yes|no>`

This option normalizes directory traversals and self-referential directories.

The directory:

```
/foo/fake\_dir/../bar
```

gets normalized to:

```
/foo/bar
```

The directory:

```
/foo/./bar
```

gets normalized to:

```
/foo/bar
```

If you want to configure an alert, specify `yes`, otherwise, specify `no`. This alert may give false positives, since some web sites refer to files using directory traversals.

18. `apache_whitespace <yes|no>`

This option deals with the non-RFC standard of using tab for a space delimiter. Apache uses this, so if the emulated web server is Apache, enable this option. Alerts on this option may be interesting, but may also be false positive prone.

19. `iis_delimiter <yes|no>`

This started out being IIS-specific, but Apache takes this non-standard delimiter was well. Since this is common, we always take this as standard since the most popular web servers accept it. But you can still get an alert on this option.

20. `chunk_length <non-zero positive integer>`

This option is an anomaly detector for abnormally large chunk sizes. This picks up the Apache chunk encoding exploits, and may also alert on HTTP tunneling that uses chunk encoding.

21. `no_pipeline_req`

This option turns HTTP pipeline decoding off, and is a performance enhancement if needed. By default, pipeline requests are inspected for attacks, but when this option is enabled, pipeline requests are not decoded and analyzed per HTTP protocol field. It is only inspected with the generic pattern matching.

22. `non_strict`

This option turns on non-strict URI parsing for the broken way in which Apache servers will decode a URI. Only use this option on servers that will accept URIs like this: ”get /index.html alsjdfk alsj lj aj la jsj s\n”. The non_strict option assumes the URI is between the first and second space even if there is no valid HTTP identifier after the second space.

23. allow_proxy_use

By specifying this keyword, the user is allowing proxy use on this server. This means that no alert will be generated if the proxy_alert global keyword has been used. If the proxy_alert keyword is not enabled, then this option does nothing. The allow_proxy_use keyword is just a way to suppress unauthorized proxy use for an authorized server.

24. no_alerts

This option turns off all alerts that are generated by the HTTP Inspect preprocessor module. This has no effect on HTTP rules in the rule set. No argument is specified.

25. oversize_dir_length <non-zero positive integer>

This option takes a non-zero positive integer as an argument. The argument specifies the max char directory length for URL directory. If a url directory is larger than this argument size, an alert is generated. A good argument value is 300 characters. This should limit the alerts to IDS evasion type attacks, like whisker -i 4.

26. inspect_uri_only

This is a performance optimization. When enabled, only the URI portion of HTTP requests will be inspected for attacks. As this field usually contains 90-95% of the web attacks, you'll catch most of the attacks. So if you need extra performance, enable this optimization. It's important to note that if this option is used without any uricontent rules, then no inspection will take place. This is obvious since the URI is only inspected with uricontent rules, and if there are none available, then there is nothing to inspect.

For example, if we have the following rule set:

```
alert tcp any any -> any 80 ( msg:"content"; content: "foo"; )
```

and the we inspect the following URI:

```
get /foo.htm http/1.0\r\n\r\n
```

No alert will be generated when inspect_uri_only is enabled. The inspect_uri_only configuration turns off all forms of detection except uricontent inspection.

27. max_header_length <positive integer up to 65535>

This option takes an integer as an argument. The integer is the maximum length allowed for an HTTP client request header field. Requests that exceed this length will cause a "Long Header" alert. This alert is off by default. To enable, specify an integer argument to max_header_length of 1 to 65535. Specifying a value of 0 is treated as disabling the alert.

28. webroot <yes|no>

This option generates an alert when a directory traversal traverses past the web server root directory. This generates much fewer false positives than the directory option, because it doesn't alert on directory traversals that stay within the web server directory structure. It only alerts when the directory traversals go past the web server root directory, which is associated with certain web attacks.

29. tab_uri_delimiter

This option turns on the use of the tab character (0x09) as a delimiter for a URI. Apache accepts tab as a delimiter; IIS does not. For IIS, a tab in the URI should be treated as any other character. Whether this option is on or not, a tab is treated as whitespace if a space character (0x20) precedes it. No argument is specified.

30. normalize_headers

This option turns on normalization for HTTP Header Fields, not including Cookies (using the same configuration parameters as the URI normalization (ie, multi-slash, directory, etc.). It is useful for normalizing Referrer URIs that may appear in the HTTP Header.

31. normalize_cookies

This option turns on normalization for HTTP Cookie Fields (using the same configuration parameters as the URI normalization (ie, multi-slash, directory, etc.). It is useful for normalizing data in HTTP Cookies that may be encoded.

32. max_headers <positive integer up to 1024>

This option takes an integer as an argument. The integer is the maximum number of HTTP client request header fields. Requests that contain more HTTP Headers than this value will cause a ”Max Header” alert. The alert is off by default. To enable, specify an integer argumnet to max_headers of 1 to 1024. Specifying a value of 0 is treated as disabling the alert.

Examples

```
preprocessor http_inspect_server: \
    server 10.1.1.1 \
    ports { 80 3128 8080 } \
    server_flow_depth 0 \
    ascii no \
    double_decode yes \
    non_rfc_char { 0x00 } \
    chunk_length 500000 \
    non_strict \
    no_alerts

preprocessor http_inspect_server: \
    server default \
    ports  { 80 3128 }  \
    non_strict \
    non_rfc_char  { 0x00 }  \
    server_flow_depth 300  \
    apache_whitespace yes \
    directory no \
    iis_backslash no \
    u_encode yes \
    ascii no \
    chunk_length 500000 \
    bare_byte yes \
    double_decode yes \
    iis_unicode yes \
    iis_delimiter yes \
    multi_slash no

preprocessor http_inspect_server: \
    server default \
    profile all \
    ports { 80 8080 }
```

2.2.7 SMTP Preprocessor

The SMTP preprocessor is an SMTP decoder for user applications. Given a data buffer, SMTP will decode the buffer and find SMTP commands and responses. It will also mark the command, data header data body sections, and TLS data.

SMTP handles stateless and stateful processing. It saves state between individual packets. However maintaining correct state is dependent on the reassembly of the client side of the stream (ie, a loss of coherent stream data results in a loss of state).

Configuration

SMTP has the usual configuration items, such as `port` and `inspection_type`. Also, SMTP command lines can be normalized to remove extraneous spaces. TLS-encrypted traffic can be ignored, which improves performance. In addition, regular mail data can be ignored for an additional performance boost. Since so few (none in the current snort rule set) exploits are against mail data, this is relatively safe to do and can improve the performance of data inspection.

The configuration options are described below:

1. `ports { <port> [<port>] ... }`

   This specifies on what ports to check for SMTP data. Typically, this will include 25 and possibly 465, for encrypted SMTP.

2. `inspection_type <stateful | stateless>`

   Indicate whether to operate in stateful or stateless mode.

3. `normalize <all | none | cmds>`

   This turns on normalization. Normalization checks for more than one space character after a command. Space characters are defined as space (ASCII 0x20) or tab (ASCII 0x09).

   `all` checks all commands

   `none` turns off normalization for all commands.

   `cmds` just checks commands listed with the `normalize_cmds` parameter.

4. `ignore_data`

   Ignore data section of mail (except for mail headers) when processing rules.

5. `ignore_tls_data`

   Ignore TLS-encrypted data when processing rules.

6. `max_command_line_len <int>`

   Alert if an SMTP command line is longer than this value. Absence of this option or a ”0” means never alert on command line length. RFC 2821 recommends 512 as a maximum command line length.

7. `max_header_line_len <int>`

   Alert if an SMTP DATA header line is longer than this value. Absence of this option or a ”0” means never alert on data header line length. RFC 2821 recommends 1024 as a maximum data header line length.

8. `max_response_line_len <int>`

   Alert if an SMTP response line is longer than this value. Absence of this option or a ”0” means never alert on response line length. RFC 2821 recommends 512 as a maximum response line length.

9. `alt_max_command_line_len <int> { <cmd> [<cmd>] }`

   Overrides `max_command_line_len` for specific commands.

10. `no_alerts`

    Turn off all alerts for this preprocessor.

11. `invalid_cmds { <Space-delimited list of commands> }`

    Alert if this command is sent from client side. Default is an empty list.

12. `valid_cmds { <Space-delimited list of commands> }`

    List of valid commands. We do not alert on commands in this list. Default is an empty list, but preprocessor has this list hard-coded:

    { ATRN AUTH BDAT DATA DEBUG EHLO EMAL ESAM ESND ESOM ETRN EVFY EXPN } { HELO HELP IDENT MAIL NOOP QUIT RCPT RSET SAML SOML SEND ONEX QUEU } { STARTTLS TICK TIME TURN TURNME VERB VRFY X-EXPS X-LINK2STATE } { XADR XAUTH XCIR XEXCH50 XGEN XLICENSE XQUE XSTA XTRN XUSR }

13. `alert_unknown_cmds`

    Alert if we don't recognize command. Default is off.

14. `normalize_cmds { <Space-delimited list of commands> }`

    Normalize this list of commands Default is { RCPT VRFY EXPN }.

15. `xlink2state { enable | disable [drop] }`

    Enable/disable xlink2state alert. Drop if alerted. Default is `enable`.

16. `print_cmds`

    List all commands understood by the preprocessor. This not normally printed out with the configuration because it can print so much data.

Example

```
preprocessor SMTP: \
    ports { 25 } \
    inspection_type stateful \
    normalize cmds \
    normalize_cmds { EXPN VRFY RCPT } \
    ignore_data \
    ignore_tls_data \
    max_command_line_len  512 \
    max_header_line_len   1024 \
    max_response_line_len 512 \
    no_alerts \
    alt_max_command_line_len 300 { RCPT } \
    invalid_cmds { } \
    valid_cmds { } \
    xlink2state { disable } \
    print_cmds
```

Default

```
preprocessor SMTP: \
    ports { 25 } \
    inspection_type stateful \
    normalize cmds \
    normalize_cmds { EXPN VRFY RCPT } \
    alt_max_command_line_len 260 { MAIL } \
    alt_max_command_line_len 300 { RCPT } \
    alt_max_command_line_len 500 { HELP HELO ETRN } \
    alt_max_command_line_len 255 { EXPN VRFY }
```

Note

`RCPT TO:` and `MAIL FROM:` are SMTP commands. For the preprocessor configuration, they are referred to as RCPT and MAIL, respectively. Within the code, the preprocessor actually maps RCPT and MAIL to the correct command name.

2.2.8 FTP/Telnet Preprocessor

FTP/Telnet is an improvement to the Telnet decoder and provides stateful inspection capability for both FTP and Telnet data streams. FTP/Telnet will decode the stream, identifying FTP commands and responses and Telnet escape sequences and normalize the fields. FTP/Telnet works on both client requests and server responses.

FTP/Telnet has the capability to handle stateless processing, meaning it only looks for information on a packet-by-packet basis.

The default is to run FTP/Telent in stateful inspection mode, meaning it looks for information and handles reassembled data correctly.

FTP/Telnet has a very "rich" user configuration, similar to that of HTTP Inspect (See 2.2.6). Users can configure individual FTP servers and clients with a variety of options, which should allow the user to emulate any type of FTP server or FTP Client. Within FTP/Telnet, there are four areas of configuration: Global, Telnet, FTP Client, and FTP Server.

⚠NOTE

Some configuration options have an argument of `yes` or `no`. This argument specifies whether the user wants the configuration option to generate a ftptelnet alert or not. The presence of the option indicates the option itself is on, while the `yes/no` argument applies to the alerting functionality associated with that option.

Global Configuration

The global configuration deals with configuration options that determine the global functioning of FTP/Telnet. The following example gives the generic global configuration format:

Format

```
preprocessor ftp_telnet: \
    global \
    inspection_type stateful \
    encrypted_traffic yes \
    check_encrypted
```

You can only have a single global configuration, you'll get an error if you try otherwise. The FTP/Telnet global configuration must appear before the other three areas of configuration.

Configuration

1. `inspection_type`

   This indicates whether to operate in stateful or stateless mode.

2. `encrypted_traffic <yes|no>`

   This option enables detection and alerting on encrypted Telnet and FTP command channels.

   ⚠NOTE

   When `inspection_type` is in stateless mode, checks for encrypted traffic will occur on every packet, whereas in stateful mode, a particular session will be noted as encrypted and not inspected any further.

3. `check_encrypted`

   Instructs the the preprocessor to continue to check an encrypted session for a subsequent command to cease encryption.

Example Global Configuration

```
preprocessor ftp_telnet: \
    global inspection_type stateful encrypted_traffic no
```

Telnet Configuration

The telnet configuration deals with configuration options that determine the functioning of the Telnet portion of the preprocessor. The following example gives the generic telnet configuration format:

Format

```
preprocessor ftp_telnet_protocol: \
    telnet \
    ports { 23 } \
    normalize \
    ayt_attack_thresh 6 \
    detect_anomalies
```

There should only be a single telnet configuration, and subsequent instances will override previously set values.

Configuration

1. `ports` {<port> [<port>< ... >]}

   This is how the user configures which ports to decode as telnet traffic. SSH tunnels cannot be decoded, so adding port 22 will only yield false positives. Typically port 23 will be included.

2. `normalize`

   This option tells the preprocessor to normalize the telnet traffic by eliminating the telnet escape sequences. It functions similarly to its predecessor, the telnet_decode preprocessor. Rules written with 'raw' content options will ignore the normailzed buffer that is created when this option is in use.

3. `ayt_attack_thresh` < number >

   This option causes the preprocessor to alert when the number of consecutive telnet Are You There (AYT) commands reaches the number specified. It is only applicable when the mode is stateful.

4. `detect_anomalies`

   In order to support certain options, Telnet supports subnegotiation. Per the Telnet RFC, subnegotiation begins with SB (subnegotiation begin) and must end with an SE (subnegotiation end). However, certain implementations of Telnet servers will ignore the SB without a cooresponding SE. This is anomalous behavior which could be an evasion case. Being that FTP uses the Telnet protocol on the control connection, it is also susceptible to this behavior. The `detect_anomalies` option enables alerting on Telnet SB without the corresponding SE.

Example Telnet Configuration

```
preprocessor ftp_telnet_protocol: \
    telnet ports { 23 } normalize ayt_attack_thresh 6
```

FTP Server Configuration

There are two types of FTP server configurations: default and by IP address.

Default This configuration supplies the default server configuration for any FTP server that is not individually configured. Most of your FTP servers will most likely end up using the default configuration.

Example Default FTP Server Configuration

```
preprocessor ftp_telnet_protocol: \
    ftp server default ports { 21 }
```

Refer to 60 for the list of options set in default ftp server configuration.

Configuration by IP Address This format is very similar to “default”, the only difference being that specific IPs can be configured.

Example IP specific FTP Server Configuration

```
preprocessor _telnet_protocol: \
    ftp server 10.1.1.1 ports { 21 } ftp_cmds { XPWD XCWD }
```

FTP Server Configuration Options

1. `ports` {<port> [<port>< ... >]}

   This is how the user configures which ports to decode as FTP command channel traffic. Typically port 21 will be included.

2. `print_cmds`

   During initialization, this option causes the preprocessor to print the configuration for each of the FTP commands for this server.

3. `ftp_cmds` {*cmd*[*cmd*]}

   The preprocessor is configured to alert when it sees an FTP command that is not allowed by the server.

   This option specifies a list of additional commands allowed by this server, outside of the default FTP command set as specified in RFC 959. This may be used to allow the use of the ’X’ commands identified in RFC 775, as well as any additional commands as needed.

   For example:

   ```
   ftp_cmds { XPWD XCWD XCUP XMKD XRMD }
   ```

4. `def_max_param_len` <number>

   This specifies the default maximum allowed parameter length for an FTP command. It can be used as a basic buffer overflow detection.

5. `alt_max_param_len` <number> {*cmd*[*cmd*]}

   This specifies the maximum allowed parameter length for the specified FTP command(s). It can be used as a more specific buffer overflow detection. For example the USER command – usernames may be no longer than 16 bytes, so the appropriate configuration would be:

   ```
   alt_max_param_len 16 { USER }
   ```

6. `chk_str_fmt` {*cmd*[*cmd*]}

   This option causes a check for string format attacks in the specified commands.

7. `cmd_validity cmd` < `fmt` >

   This option specifies the valid format for parameters of a given command.

   fmt must be enclosed in <>’s and may contain the following:

Value	Description
int	Parameter must be an integer
number	Parameter must be an integer between 1 and 255
char <chars>	Parameter must be a single character, one of <chars>
date <datefmt>	Parameter follows format specified, where: n Number C Character [] optional format enclosed | OR {} choice of options . + - literal
string	Parameter is a string (effectively unrestricted)
host_port	Parameter must be a host/port specified, per RFC 959
long_host_port	Parameter must be a long host port specified, per RFC 1639
extended_host_port	Parameter must be an extended host port specified, per RFC 2428
{}, |	One of choices enclosed within, separated by |
{}, []	One of the choices enclosed within {}, optional value enclosed within []

Examples of the cmd_validity option are shown below. These examples are the default checks, per RFC 959 and others performed by the preprocessor.

```
cmd_validity MODE <char SBC>
cmd_validity STRU <char FRP>
cmd_validity ALLO < int [ char R int ] >
cmd_validity TYPE < { char AE [ char NTC ] | char I | char L [ number ] } >
cmd_validity PORT < host_port >
```

A cmd_validity line can be used to override these defaults and/or add a check for other commands.

```
# This allows additional modes, including mode Z which allows for
# zip-style compression.
cmd_validity MODE < char ASBCZ >

# Allow for a date in the MDTM command.
cmd_validity MDTM < [ date nnnnnnnnnnnnnn[.n[n[n]]] ] string >
```

MDTM is an off case that is worth discussing. While not part of an established standard, certain FTP servers accept MDTM commands that set the modification time on a file. The most common among servers that do, accept a format using YYYYMMDDHHmmss[.uuu]. Some others accept a format using YYYYMMDDHHmmss[+—-]TZ format. The example above is for the first case (time format as specified in http://www.ietf.org/internet-drafts/draft-ietf-ftpext-mlst-16.txt)

To check validity for a server that uses the TZ format, use the following:

```
cmd_validity MDTM < [ date nnnnnnnnnnnnnn[{+|-}n[n]] ] string >
```

8. `telnet_cmds <yes|no>`

This option turns on detection and alerting when telnet escape sequences are seen on the FTP command channel. Injection of telnet escape sequences could be used as an evasion attempt on an FTP command channel.

9. `ignore_telnet_erase_cmds <yes|no>`

This option allows Snort to ignore telnet escape sequences for erase character (TNC EAC) and erase line (TNC EAL) when normalizing FTP command channel. Some FTP servers do not process those telnet escape sequences.

10. data_chan

This option causes the rest of snort (rules, other preprocessors) to ignore FTP data channel connections. Using this option means that **NO INSPECTION** other than TCP state will be performed on FTP data transfers. It can be used to improve performance, especially with large file transfers from a trusted source. If your rule set includes virus-type rules, it is recommended that this option not be used.

Use of the "data_chan" option is deprecated in favor of the "ignore_data_chan" option. "data_chan" will be removed in a future release.

11. ignore_data_chan <yes|no>

This option causes the rest of Snort (rules, other preprocessors) to ignore FTP data channel connections. Setting this option to "yes" means that **NO INSPECTION** other than TCP state will be performed on FTP data transfers. It can be used to improve performance, especially with large file transfers from a trusted source. If your rule set includes virus-type rules, it is recommended that this option not be used.

FTP Server Base Configuration Options

The base FTP server configuration is as follows. Options specified in the configuration file will modify this set of options. FTP commands are added to the set of allowed commands. The other options will override those in the base configuration.

```
def_max_param_len 100
ftp_cmds { USER PASS ACCT CWD CDUP SMNT
   QUIT REIN TYPE STRU MODE RETR
   STOR STOU APPE ALLO REST RNFR
   RNTO ABOR DELE RMD MKD PWD LIST
           NLST SITE SYST STAT HELP NOOP }
ftp_cmds { AUTH ADAT PROT PBSZ CONF ENC }
ftp_cmds { PORT PASV LPRT LPSV EPRT EPSV }
ftp_cmds { FEAT OPTS }
ftp_cmds { MDTM REST SIZE MLST MLSD }
alt_max_param_len 0 { CDUP QUIT REIN PASV STOU ABOR PWD SYST NOOP }
cmd_validity MODE < char SBC >
cmd_validity STRU < char FRPO [ string ] >
cmd_validity ALLO < int [ char R int ] >
cmd_validity TYPE < { char AE [ char NTC ] | char I | char L [ number ] } >
cmd_validity PORT < host_port >
cmd_validity LPRT < long_host_port >
cmd_validity EPRT < extd_host_port >
cmd_validity EPSV < [ { '1' | '2' | 'ALL' } ] >
```

FTP Client Configuration

Similar to the FTP Server configuration, the FTP client configurations has two types: default, and by IP address.

Default This configuration supplies the default client configuration for any FTP client that is not individually configured. Most of your FTP clients will most likely end up using the default configuration.

Example Default FTP Client Configuration

```
preprocessor ftp_telnet_protocol: \
    ftp client default bounce no max_resp_len 200
```

Configuration by IP Address This format is very similar to "default", the only difference being that specific IPs can be configured.

Example IP specific FTP Client Configuration

```
preprocessor ftp_telnet_protocol: \
    ftp client 10.1.1.1 bounce yes max_resp_len 500
```

FTP Client Configuration Options

1. `max_resp_len <number>`

   This specifies the maximum allowed response length to an FTP command accepted by the client. It can be used as a basic buffer overflow detection.

2. `bounce <yes|no>`

   This option turns on detection and alerting of FTP bounce attacks. An FTP bounce attack occurs when the FTP PORT command is issued and the specified host does not match the host of the client.

3. `bounce_to < CIDR,[port|portlow,porthi] >`

   When the bounce option is turned on, this allows the PORT command to use the IP address (in CIDR format) and port (or inclusive port range) without generating an alert. It can be used to deal with proxied FTP connections where the FTP data channel is different from the client.

   A few examples:

   - Allow bounces to 192.162.1.1 port 20020 – ie, the use of `PORT 192,168,1,1,78,52`.

     ```
     bounce_to { 192.168.1.1,20020 }
     ```

   - Allow bounces to 192.162.1.1 ports 20020 through 20040 – ie, the use of `PORT 192,168,1,1,78,xx`, where xx is 52 through 72 inclusive.

     ```
     bounce_to { 192.168.1.1,20020,20040 }
     ```

   - Allow bounces to 192.162.1.1 port 20020 and 192.168.1.2 port 20030.

     ```
     bounce_to { 192.168.1.1,20020 192.168.1.2,20030 }
     ```

4. `telnet_cmds <yes|no>`

   This option turns on detection and alerting when telnet escape sequences are seen on the FTP command channel. Injection of telnet escape sequences could be used as an evasion attempt on an FTP command channel.

5. `ignore_telnet_erase_cmds <yes|no>`

   This option allows Snort to ignore telnet escape sequences for erase character (TNC EAC) and erase line (TNC EAL) when normalizing FTP command channel. Some FTP clients do not process those telnet escape sequences.

Examples/Default Configuration from snort.conf

```
preprocessor ftp_telnet: \
    global \
    encrypted_traffic yes \
    inspection_type stateful

preprocessor ftp_telnet_protocol:\
    telnet \
    normalize \
    ayt_attack_thresh 200
```

```
# This is consistent with the FTP rules as of 18 Sept 2004.
# Set CWD to allow parameter length of 200
# MODE has an additional mode of Z (compressed)
# Check for string formats in USER & PASS commands
# Check MDTM commands that set modification time on the file.

preprocessor ftp_telnet_protocol: \
    ftp server default \
    def_max_param_len 100 \
    alt_max_param_len 200 { CWD } \
    cmd_validity MODE < char ASBCZ > \
    cmd_validity MDTM < [ date nnnnnnnnnnnnnn[.n[n[n]]] ] string > \
    chk_str_fmt { USER PASS RNFR RNTO SITE MKD } \
    telnet_cmds yes \
    ignore_data_chan yes

preprocessor ftp_telnet_protocol: \
    ftp client default \
    max_resp_len 256 \
    bounce yes \
    telnet_cmds yes
```

2.2.9 SSH

The SSH preprocessor detects the following exploits: Challenge-Response Buffer Overflow, CRC 32, Secure CRT, and the Protocol Mismatch exploit.

Both Challenge-Response Overflow and CRC 32 attacks occur after the key exchange, and are therefore encrypted. Both attacks involve sending a large payload (20kb+) to the server immediately after the authentication challenge. To detect the attacks, the SSH preprocessor counts the number of bytes transmitted to the server. If those bytes exceed a predefined limit within a predefined number of packets, an alert is generated. Since the Challenge-Response Overflow only effects SSHv2 and CRC 32 only effects SSHv1, the SSH version string exchange is used to distinguish the attacks.

The Secure CRT and protocol mismatch exploits are observable before the key exchange.

Configuration

By default, all alerts are disabled and the preprocessor checks traffic on port 22.

The available configuration options are described below.

1. `server_ports` {<port> [<port>< ... >]}

   This option specifies which ports the SSH preprocessor should inspect traffic to.

2. `max_encrypted_packets` < number >

   The number of encrypted packets that Snort will inspect before ignoring a given SSH session. The SSH vulnerabilities that Snort can detect all happen at the very beginning of an SSH session. Once max_encrypted_packets packets have been seen, Snort ignores the session to increase performance.

3. `max_client_bytes` < number >

   The number of unanswered bytes allowed to be transferred before alerting on Challenge-Response Overflow or CRC 32. This number must be hit before max_encrypted_packets packets are sent, or else Snort will ignore the traffic.

4. `max_server_version_len` < number >

The maximum number of bytes allowed in the SSH server version string before alerting on the Secure CRT server version string overflow.

5. `autodetect`

   Attempt to automatically detect SSH.

6. `enable_respoverflow`

   Enables checking for the Challenge-Response Overflow exploit.

7. `enable_ssh1crc32`

   Enables checking for the CRC 32 exploit.

8. `enable_srvoverflow`

   Enables checking for the Secure CRT exploit.

9. `enable_protomismatch`

   Enables checking for the Protocol Mismatch exploit.

10. `enable_badmsgdir`

    Enable alerts for traffic flowing the wrong direction. For instance, if the presumed server generates client traffic, or if a client generates server traffic.

11. `enable_paysize`

    Enables alerts for invalid payload sizes.

12. `enable_recognition`

    Enable alerts for non-SSH traffic on SSH ports.

The SSH preprocessor should work by default. After max_encrypted_packets is reached, the preprocessor will stop processing traffic for a given session. If Challenge-Respone Overflow or CRC 32 false positive, try increasing the number of required client bytes with max_client_bytes.

Example Configuration from snort.conf

Looks for attacks on SSH server port 22. Alerts at 19600 unacknowledged bytes within 20 encrypted packets for the Challenge-Response Overflow/CRC32 exploits.

```
preprocessor ssh: \
    server_ports { 22 } \
    max_client_bytes 19600 \
    max_encrypted_packets 20 \
    enable_respoverflow \
    enable_ssh1crc32
```

2.2.10 DCE/RPC

The dcerpc preprocessor detects and decodes SMB and DCE/RPC traffic. It is primarily interested in DCE/RPC requests, and only decodes SMB to get to the potential DCE/RPC requests carried by SMB.

Currently, the preprocessor only handles desegmentation (at SMB and TCP layers) and defragmentation of DCE/RPC. Snort rules can be evaded by using both types of fragmentation. With the preprocessor enabled, the rules are given reassembled DCE/RPC data to examine.

At the SMB layer, only segmentation using WriteAndX is currently reassembled. Other methods will be handled in future versions of the preprocessor.

Autodetection of SMB is done by looking for "\xFFSMB" at the start of the SMB data, as well as checking the NetBIOS header (which is always present for SMB) for the type "Session Message".

Autodetection of DCE/RPC is not as reliable. Currently, two bytes are checked in the packet. Assuming that the data is a DCE/RPC header, one byte is checked for DCE/RPC version 5 and another for a DCE/RPC PDU type of Request. If both match, the preprocessor proceeds with the assumption that it is looking at DCE/RPC data. If subsequent checks are nonsensical, it ends processing.

Configuration

The proprocessor has several optional configuration options. They are described below:

- `autodetect`

  In addition to configured ports, try to autodetect DCE/RPC sessions. Note that DCE/RPC can run on practically any port in addition to the more common ports. This option is not configured by default.

- `ports smb { <port> [<port> <...>] }`

  Ports that the preprocessor monitors for SMB traffic. Default are ports 139 and 445.

- `ports dcerpc { <port> [<port> <...>] }`

  Ports that the preprocessor monitors for DCE/RPC over TCP traffic. Default is port 135.

- `disable_smb_frag`

  Do not do SMB desegmentation. Unless you are experiencing severe performance issues, this option should not be configured as SMB segmentation provides for an easy evasion opportunity. This option is not configured by default.

- `disable_dcerpc_frag`

  Do not do DCE/RPC defragmentation. Unless you are experiencing severe performance issues, this option should not be configured as DCE/RPC fragmentation provides for an easy evasion opportunity. This option is not configured by default.

- `max_frag_size <number>`

  Maximum DCE/RPC fragment size to put in defragmentation buffer, in bytes. Default is 3000 bytes.

- `memcap <number>`

  Maximum amount of memory available to the DCE/RPC preprocessor for desegmentation and defragmentation, in kilobytes. Default is 100000 kilobytes.

- `alert_memcap`

  Alert if memcap is exceeded. This option is not configured by default.

- `reassemble_increment <number>`

  This option specifies how often the preprocessor should create a reassembled packet to send to the detection engine with the data that's been accrued in the segmentation and fragmentation reassembly buffers, before the final desegmentation or defragmentation of the DCE/RPC request takes place. This will potentially catch an attack earlier and is useful if in inline mode. Since the preprocessor looks at TCP reassembled packets (to avoid

TCP overlaps and segmentation evasions), the last packet of an attack using DCE/RPC segmented/fragmented evasion techniques may have already gone through before the preprocessor looks at it, so looking at the data early will likely catch the attack before all of the exploit data has gone through. Note, however, that in using this option, Snort will potentially take a performance hit. Not recommended if Snort is running in passive mode as it's not really needed. The argument to the option specifies how often the preprocessor should create a reassembled packet if there is data in the segmentation/fragmentation buffers. If not specified, this option is disabled. A value of 0 will in effect disable this option as well.

Configuration Examples

In addition to defaults, autodetect SMB and DCE/RPC sessions on non-configured ports. Don't do desegmentation on SMB writes. Truncate DCE/RPC fragment if greater than 4000 bytes.

```
preprocessor dcerpc: \
    autodetect \
    disable_smb_frag \
    max_frag_size 4000
```

In addition to defaults, don't do DCE/RPC defragmentation. Set memory cap for desegmentation/defragmentation to 50,000 kilobytes. (Since no DCE/RPC defragmentation will be done the memory cap will only apply to desegmentation.)

```
preprocessor dcerpc: \
    disable_dcerpc_frag \
    memcap 50000
```

In addition to the defaults, detect on DCE/RPC (or TCP) ports 135 and 2103 (overrides default). Set memory cap for desegmentation/defragmentation to 200,000 kilobytes. Create a reassembly packet every time through the preprocessor if there is data in the desegmentation/defragmentation buffers.

```
preprocessor dcerpc: \
    ports dcerpc { 135 2103 } \
    memcap 200000 \
    reassemble_increment 1
```

Default Configuration

If no options are given to the preprocessor, the default configuration will look like:

```
preprocessor dcerpc: \
    ports smb { 139 445 } \
    ports dcerpc { 135 } \
    max_frag_size 3000 \
    memcap 100000 \
    reassemble_increment 0
```

Preprocessor Events

There is currently only one alert, which is triggered when the preprocessor has reached the `memcap` limit for memory allocation. The alert is gid 130, sid 1.

Note

At the current time, there is not much to do with the dcerpc preprocessor other than turn it on and let it reassemble fragmented DCE/RPC packets.

2.2.11 DNS

The DNS preprocessor decodes DNS Responses and can detect the following exploits: DNS Client RData Overflow, Obsolete Record Types, and Experimental Record Types.

DNS looks at DNS Response traffic over UDP and TCP and it requires Stream preprocessor to be enabled for TCP decoding.

Configuration

By default, all alerts are disabled and the preprocessor checks traffic on port 53.

The available configuration options are described below.

1. `ports {<port> [<port>< ... >]}`
   This option specifies the source ports that the DNS preprocessor should inspect traffic.
2. `enable_obsolete_types`
   Alert on Obsolete (per RFC 1035) Record Types
3. `enable_experimental_types`
   Alert on Experimental (per RFC 1035) Record Types
4. `enable_rdata_overflow`
   Check for DNS Client RData TXT Overflow

The DNS preprocessor does nothing if none of the 3 vulnerabilities it checks for are enabled. It will not operate on TCP sessions picked up midstream, and it will cease operation on a session if it loses state because of missing data (dropped packets).

Examples/Default Configuration from snort.conf

Looks for traffic on DNS server port 53. Check for the DNS Client RData overflow vulnerability. Do not alert on obsolete or experimental RData record types.

```
preprocessor dns: \
    ports { 53 } \
    enable_rdata_overflow
```

2.2.12 SSL/TLS

Encrypted traffic should be ignored by Snort for both performance reasons and to reduce false positives. The SSL Dynamic Preprocessor (SSLPP) decodes SSL and TLS traffic and optionally determines if and when Snort should stop inspection of it.

Typically, SSL is used over port 443 as HTTPS. By enabling the SSLPP to inspect port 443 and enabling the noinspect_encrypted option, only the SSL handshake of each connection will be inspected. Once the traffic is determined to be encrypted, no further inspection of the data on the connection is made.

By default, SSLPP looks for a handshake followed by encrypted traffic traveling to both sides. If one side responds with an indication that something has failed, such as the handshake, the session is not marked as encrypted. Verifying that faultless encrypted traffic is sent from both endpoints ensures two things: the last client-side handshake packet was not crafted to evade Snort, and that the traffic is legitimately encrypted.

In some cases, especially when packets may be missed, the only observed response from one endpoint will be TCP ACKs. Therefore, if a user knows that server-side encrypted data can be trusted to mark the session as encrypted, the user should use the 'trustservers' option, documented below.

Configuration

1. `ports` {<port> [<port>< ... >]}

   This option specifies which ports SSLPP will inspect traffic on.

   By default, SSLPP watches the following ports:

   - `443` HTTPS
   - `465` SMTPS
   - `563` NNTPS
   - `636` LDAPS
   - `989` FTPS
   - `992` TelnetS
   - `993` IMAPS
   - `994` IRCS
   - `995` POPS

2. `noinspect_encrypted`

   Disable inspection on traffic that is encrypted. Default is off.

3. `trustservers`

   Disables the requirement that application (encrypted) data must be observed on both sides of the session before a session is marked encrypted. Use this option for slightly better performance if you trust that your servers are not compromised. This requires the `noinspect_encrypted` option to be useful. Default is off.

Examples/Default Configuration from snort.conf

Enables the SSL preprocessor and tells it to disable inspection on encrypted traffic.

```
preprocessor ssl: noinspect_encrypted
```

2.2.13 ARP Spoof Preprocessor

The ARP spoof preprocessor decodes ARP packets and detects ARP attacks, unicast ARP requests, and inconsistent Ethernet to IP mapping.

When no arguments are specified to arpspoof, the preprocessor inspects Ethernet addresses and the addresses in the ARP packets. When inconsistency occurs, an alert with GID 112 and SID 2 or 3 is generated.

When "`-unicast`" is specified as the argument of arpspoof, the preprocessor checks for unicast ARP requests. An alert with GID 112 and SID 1 will be generated if a unicast ARP request is detected.

Specify a pair of IP and hardware address as the argument to `arpspoof_detect_host`. The host with the IP address should be on the same layer 2 segment as Snort is. Specify one host IP MAC combo per line. The preprocessor will use this list when detecting ARP cache overwrite attacks. Alert SID 4 is used in this case.

Format

```
preprocessor arpspoof[: -unicast]
preprocessor arpspoof_detect_host: ip mac
```

Option	Description
ip	IP address.
mac	The Ethernet address corresponding to the preceding IP.

Example Configuration

The first example configuration does neither unicast detection nor ARP mapping monitoring. The preprosessor merely looks for Ethernet address inconsistencies.

```
preprocessor arpspoof
```

The next example configuration does not do unicast detection but monitors ARP mapping for hosts 192.168.40.1 and 192.168.40.2.

```
preprocessor arpspoof
preprocessor arpspoof_detect_host: 192.168.40.1 f0:0f:00:f0:0f:00
preprocessor arpspoof_detect_host: 192.168.40.2 f0:0f:00:f0:0f:01
```

The third example configuration has unicast detection enabled.

```
preprocessor arpspoof: -unicast
preprocessor arpspoof_detect_host: 192.168.40.1 f0:0f:00:f0:0f:00
preprocessor arpspoof_detect_host: 192.168.40.2 f0:0f:00:f0:0f:01
```

2.2.14 DCE/RPC 2 Preprocessor

The main purpose of the preprocessor is to perform SMB desegmentation and DCE/RPC defragmentation to avoid rule evasion using these techniques. SMB desegmentation is performed for the following commands that can be used to transport DCE/RPC requests and responses: `Write`, `Write Block Raw`, `Write and Close`, `Write AndX`, `Transaction`, `Transaction Secondary`, `Read`, `Read Block Raw` and `Read AndX`. The following transports are supported for DCE/RPC: SMB, TCP, UDP and RPC over HTTP v.1 proxy and server. New rule options have been implemented to improve performance, reduce false positives and reduce the count and complexity of DCE/RPC based rules.

Dependency Requirements

For proper functioning of the preprocessor:

- The `dcerpc` preprocessor (the initial iteration) must be disabled.
- Stream session tracking must be enabled, i.e. `stream5`. The preprocessor requires a session tracker to keep its data.
- Stream reassembly must be performed for TCP sessions. If it is decided that a session is SMB or DCE/RPC, either through configured ports, servers or autodetecting, the `dcerpc2` preprocessor will enable stream reassembly for that session if necessary.
- IP defragmentation should be enabled, i.e. the `frag3` preprocessor should be enabled and configured.

Target Based

There are enough important differences between Windows and Samba versions that a target based approach has been implemented. Some important differences:

Named pipe instance tracking

A combination of valid login handle or UID, share handle or TID and file/named pipe handle or FID must be used to write data to a named pipe. The binding between these is dependent on OS/software version.

Samba 3.0.22 and earlier

Any valid UID and TID, along with a valid FID can be used to make a request, however, if the TID used in creating the FID is deleted (via a tree disconnect), the FID that was created using this TID becomes invalid, i.e. no more requests can be written to that named pipe instance.

Samba greater than 3.0.22

Any valid TID, along with a valid FID can be used to make a request. However, only the UID used in opening the named pipe can be used to make a request using the FID handle to the named pipe instance. If the TID used to create the FID is deleted (via a tree disconnect), the FID that was created using this TID becomes invalid, i.e. no more requests can be written to that named pipe instance. If the UID used to create the named pipe instance is deleted (via a `Logoff AndX`), since it is necessary in making a request to the named pipe, the FID becomes invalid.

Windows 2003

Windows XP

Windows Vista

These Windows versions require strict binding between the UID, TID and FID used to make a request to a named pipe instance. Both the UID and TID used to open the named pipe instance must be used when writing data to the same named pipe instance. Therefore, deleting either the UID or TID invalidates the FID.

Windows 2000

Windows 2000 is interesting in that the first request to a named pipe must use the same binding as that of the other Windows versions. However, requests after that follow the same binding as Samba 3.0.22 and earlier, i.e. no binding. It also follows Samba greater than 3.0.22 in that deleting the UID or TID used to create the named pipe instance also invalidates it.

Accepted SMB commands

Samba in particular does not recognize certain commands under an `IPC$` tree.

Samba (all versions)

Under an `IPC$` tree, does not accept:

```
Open
Write And Close
Read
Read Block Raw
Write Block Raw
```

Windows (all versions)

Accepts all of the above commands under an `IPC$` tree.

AndX command chaining

Windows is very strict in what command combinations it allows to be chained. Samba, on the other hand, is very lax and allows some nonsensical combinations, e.g. multiple logins and tree connects (only one place to return handles for these), login/logoff and tree connect/tree disconnect. Ultimately, we don't want to keep track of data that the server won't accept. An evasion possibility would be accepting a fragment in a request that the server won't accept that gets sandwiched between an exploit.

Transaction tracking

The differences between a `Transaction` request and using one of the `Write*` commands to write data to a named pipe are that (1) a `Transaction` performs the operations of a write and a read from the named pipe, whereas in using the `Write*` commands, the client has to explicitly send one of the `Read*` requests to tell the server to send the response and (2) a `Transaction` request is not written to the named pipe until all of the data is received (via potential `Transaction Secondary` requests) whereas with the `Write*` commands, data is written to the named pipe as it is received by the server. Multiple Transaction requests can be made simultaneously to the same named pipe. These requests can also be segmented with `Transaction Secondary` commands. What distinguishes them (when the same named pipe is being written to, i.e. having the same FID) are fields in the SMB header representing a process id (PID) and multiplex id (MID). The PID represents the process this request is a part of. An MID represents different sub-processes within a process (or under a PID). Segments for each "thread" are stored separately and written to the named pipe when all segments are received. It is necessary to track this so as not to munge these requests together (which would be a potential evasion opportunity).

Windows (all versions)

Uses a combination of PID and MID to define a "thread".

Samba (all versions)

Uses just the MID to define a "thread".

Multliple Bind requests

A `Bind` request is the first request that must be made in a connection-oriented DCE/RPC session in order to specify the interface/interfaces that one wants to communicate with.

Windows (all versions)

For all of the Windows versions, only one `Bind` can ever be made on a session whether or not it succeeds or fails. Any binding after that must use the `Alter Context` request. If another `Bind` is made, all previous interface bindings are invalidated.

Samba 3.0.20 and earlier

Any amount of `Bind` requests can be made.

Samba later than 3.0.20

Another `Bind` request can be made if the first failed and no interfaces were successfully bound to. If a `Bind` after a successful `Bind` is made, all previous interface bindings are invalidated.

DCE/RPC Fragmented requests - Context ID

Each fragment in a fragmented request carries the context id of the bound interface it wants to make the request to.

Windows (all versions)

The context id that is ultimately used for the request is contained in the first fragment. The context id field in any other fragment can contain any value.

Samba (all versions)

The context id that is ultimately used for the request is contained in the last fragment. The context id field in any other fragment can contain any value.

DCE/RPC Fragmented requests - Operation number

Each fragment in a fragmented request carries an operation number (opnum) which is more or less a handle to a function offered by the interface.

Samba (all versions)

Windows 2000

Windows 2003

Windows XP

The opnum that is ultimately used for the request is contained in the last fragment. The opnum field in any other fragment can contain any value.

Windows Vista

The opnum that is ultimately used for the request is contained in the first fragment. The opnum field in any other fragment can contain any value.

DCE/RPC Stub data byte order

The byte order of the stub data is determined differently for Windows and Samba.

Windows (all versions)

The byte order of the stub data is that which was used in the `Bind` request.

Samba (all versions)

The byte order of the stub data is that which is used in the request carrying the stub data.

Configuration

The `dcerpc2` preprocessor has a global configuration and one or more server configurations. The global preprocessor configuration name is `dcerpc2` and the server preprocessor configuration name is `dcerpc2_server`.

Global Configuration

```
preprocessor dcerpc2
```

The global `dcerpc2` configuration is required. Only one global `dcerpc2` configuration can be specified.

Option syntax

Option	Argument	Required	Default
`memcap`	`<memcap>`	NO	`memcap 102400`
`disable_defrag`	NONE	NO	OFF
`max_frag_len`	`<max-frag-len>`	NO	OFF
`events`	`<events>`	NO	`events [smb, co, cl]`
`reassemble_threshold`	`<re-thresh>`	NO	OFF

```
memcap          = 1024-4194303 (kilobytes)
max-frag-len    = 1514-65535
events          = pseudo-event | event | '[' event-list ']'
pseudo-event    = "none" | "all"
event-list      = event | event ',' event-list
event           = "memcap" | "smb" | "co" | "cl"
re-thresh       = 0-65535
```

Option explanations

`memcap`

Specifies the maximum amount of run-time memory that can be allocated. Run-time memory includes any memory allocated after configuration. Default is 100 MB.

`disable_defrag`

Tells the preprocessor not to do DCE/RPC defragmentation. Default is to do defragmentation.

`max_frag_len`

Specifies the maximum fragment size that will be added to the defragmention module. If a fragment is greater than this size, it is truncated before being added to the defragmentation module. Default is not set.

`events`

Specifies the classes of events to enable. (See Events section for an enumeration and explanation of events.)

`memcap`

Only one event. If the memcap is reached or exceeded, alert.

`smb`

Alert on events related to SMB processing.

`co`

Stands for connection-oriented DCE/RPC. Alert on events related to connection-oriented DCE/RPC processing.

`cl`

Stands for connectionless DCE/RPC. Alert on events related to connectionless DCE/RPC processing. Defaults are `smb`, `co` and `cl`.

`reassemble_threshold`

Specifies a minimum number of bytes in the DCE/RPC desegmentation and defragmentation buffers before creating a reassembly packet to send to the detection engine. This option is useful in inline mode so as to potentially catch an exploit early before full defragmentation is done. A value of 0 supplied as an argument to this option will, in effect, disable this option. Default is disabled.

Option examples

```
memcap 30000
max_frag_len 16840
events none
events all
events smb
events co
events [co]
events [smb, co]
events [memcap, smb, co, cl]
reassemble_threshold 500
```

Configuration examples

```
preprocessor dcerpc2
preprocessor dcerpc2: memcap 500000
preprocessor dcerpc2: max_frag_len 16840, memcap 300000, events smb
preprocessor dcerpc2: memcap 50000, events [memcap, smb, co, cl], max_frag_len 14440
preprocessor dcerpc2: disable_defrag, events [memcap, smb]
preprocessor dcerpc2: reassemble_threshold 500
```

Default global configuration

```
preprocessor dcerpc2: memcap 102400, events [smb, co, cl]
```

Server Configuration

```
preprocessor dcerpc2_server
```

The dcerpc2_server configuration is optional. A dcerpc2_server configuration must start with default or net options. The default and net options are mutually exclusive. At most one default configuration can be specified. If no default configuration is specified, default values will be used for the default configuration. Zero or more net configurations can be specified. For any dcerpc2_server configuration, if non-required options are not specified, the defaults will be used. When processing DCE/RPC traffic, the default configuration is used if no net configurations match. If a net configuration matches, it will override the default configuration. A net configuration matches if the packet's server IP address matches an IP address or net specified in the net configuration. The net option supports IPv6 addresses. Note that port and ip variables defined in snort.conf CANNOT be used.

Option syntax

Option	Argument	Required	Default
default	NONE	YES	NONE
net	<net>	YES	NONE
policy	<policy>	NO	policy WinXP
detect	<detect>	NO	detect [smb [139,445], tcp 135, udp 135, rpc-over-http-server 593]
autodetect	<detect>	NO	autodetect [tcp 1025:, udp 1025:, rpc-over-http-server 1025:]
no_autodetect_http_proxy_ports	NONE	NO	DISABLED (The preprocessor autodetects on all proxy ports by default)
smb_invalid_shares	<shares>	NO	NONE
smb_max_chain	<max-chain>	NO	smb_max_chain 3

```
net          = ip | '[' ip-list ']'
ip-list      = ip | ip ',' ip-list
ip           = ip-addr | ip-addr '/' prefix | ip4-addr '/' netmask
ip-addr      = ip4-addr | ip6-addr
ip4-addr     = a valid IPv4 address
ip6-addr     = a valid IPv6 address (can be compressed)
prefix       = a valid CIDR
netmask      = a valid netmask
policy       = "Win2000" | "Win2003" | "WinXP" | "WinVista" |
               "Samba" | "Samba-3.0.22" | "Samba-3.0.20"
detect       = "none" | detect-opt | '[' detect-list ']'
detect-list  = detect-opt | detect-opt ',' detect-list
detect-opt   = transport | transport port-item |
               transport '[' port-list ']'
transport    = "smb" | "tcp" | "udp" | "rpc-over-http-proxy" |
               "rpc-over-http-server"
port-list    = port-item | port-item ',' port-list
port-item    = port | port-range
port-range   = ':' port | port ':' port
port         = 0-65535
shares       = share | '[' share-list ']'
share-list   = share | share ',' share-list
share        = word | '"' word '"' | '"' var-word '"'
word         = graphical ascii characters except ',' '"' ']' '[' '$'
var-word     = graphical ascii characters except ',' '"' ']' '['
max-chain    = 0-255
```

Because the Snort main parser treats '$' as the start of a variable and tries to expand it, shares with '$' must be enclosed quotes.

Option explanations

default

Specifies that this configuration is for the default server configuration.

`net`

Specifies that this configuration is an IP or net specific configuration. The configuration will only apply to the IP addresses and nets supplied as an argument.

`policy`

Specifies the target-based policy to use when processing. Default is ”WinXP”.

`detect`

Specifies the DCE/RPC transport and server ports that should be detected on for the transport. Defaults are ports 139 and 445 for SMB, 135 for TCP and UDP, 593 for RPC over HTTP server and 80 for RPC over HTTP proxy.

`autodetect`

Specifies the DCE/RPC transport and server ports that the preprocessor should attempt to autodetect on for the transport. The autodetect ports are only queried if no detect transport/ports match the packet. The order in which the preprocessor will attempt to autodetect will be - TCP/UDP, RPC over HTTP server, RPC over HTTP proxy and lastly SMB. Note that most dynamic DCE/RPC ports are above 1024 and ride directly over TCP or UDP. It would be very uncommon to see SMB on anything other than ports 139 and 445. Defaults are 1025-65535 for TCP, UDP and RPC over HTTP server.

`no_autodetect_http_proxy_ports`

By default, the preprocessor will always attempt to autodetect for ports specified in the detect configuration for rpc-over-http-proxy. This is because the proxy is likely a web server and the preprocessor should not look at all web traffic. This option is useful if the RPC over HTTP proxy configured with the detect option is only used to proxy DCE/RPC traffic. Default is to autodetect on RPC over HTTP proxy detect ports.

`smb_invalid_shares`

Specifies SMB shares that the preprocessor should alert on if an attempt is made to connect to them via a `Tree Connect` or `Tree Connect AndX`. Default is empty.

`smb_max_chain`

Specifies the maximum amount of AndX command chaining that is allowed before an alert is generated. Default maximum is 3 chained commands. A value of 0 disables this option.

Option examples

```
net 192.168.0.10
net 192.168.0.0/24
net [192.168.0.0/24]
net 192.168.0.0/255.255.255.0
net feab:45b3:ab92:8ac4:d322:007f:e5aa:7845
net feab:45b3:ab92:8ac4:d322:007f:e5aa:7845/128
net feab:45b3::/32
net [192.168.0.10, feab:45b3::/32]
net [192.168.0.0/24, feab:45b3:ab92:8ac4:d322:007f:e5aa:7845]
policy Win2000
policy Samba-3.0.22
detect none
detect smb
detect [smb]
detect smb 445
detect [smb 445]
detect smb [139,445]
detect [smb [139,445]]
detect [smb, tcp]
detect [smb 139, tcp [135,2103]]
detect [smb [139,445], tcp 135, udp 135, rpc-over-http-server [593,6002:6004]]
```

```
autodetect none
autodetect tcp
autodetect [tcp]
autodetect tcp 2025:
autodetect [tcp 2025:]
autodetect tcp [2025:3001,3003:]
autodetect [tcp [2025:3001,3003:]]
autodetect [tcp, udp]
autodetect [tcp 2025:, udp 2025:]
autodetect [tcp 2025:, udp, rpc-over-http-server [1025:6001,6005:]]
smb_invalid_shares private
smb_invalid_shares "private"
smb_invalid_shares "C$"
smb_invalid_shares [private, "C$"]
smb_invalid_shares ["private", "C$"]
smb_max_chain 1
```

Configuration examples

```
preprocessor dcerpc2_server: \
    default

preprocessor dcerpc2_server: \
    default, policy Win2000

preprocessor dcerpc2_server: \
    default, policy Win2000, detect [smb, tcp], autodetect tcp 1025:, \
    smb_invalid_shares ["C$", "D$", "ADMIN$"]

preprocessor dcerpc2_server: net 10.4.10.0/24, policy Win2000

preprocessor dcerpc2_server: \
    net [10.4.10.0/24,feab:45b3::/126], policy WinVista, smb_max_chain 1

preprocessor dcerpc2_server: \
    net [10.4.10.0/24,feab:45b3::/126], policy WinVista, \
    detect [smb, tcp, rpc-over-http-proxy 8081],
    autodetect [tcp, rpc-over-http-proxy [1025:6001,6005:]], \
    smb_invalid_shares ["C$", "ADMIN$"], no_autodetect_http_proxy_ports

preprocessor dcerpc2_server: \
    net [10.4.11.56,10.4.11.57], policy Samba, detect smb, autodetect none
```

Default server configuration

```
preprocessor dcerpc2_server: default, policy WinXP, \
    detect [smb [139,445], tcp 135, udp 135, rpc-over-http-server 593], \
    autodetect [tcp 1025:, udp 1025:, rpc-over-http-server 1025:], smb_max_chain 3
```

Complete `dcerpc2` default configuration

```
preprocessor dcerpc2: \
    memcap 102400, events [smb, co, cl]

preprocessor dcerpc2_server: \
    default, policy WinXP, \
    detect [smb [139,445], tcp 135, udp 135, rpc-over-http-server 593], \
    autodetect [tcp 1025:, udp 1025:, rpc-over-http-server 1025:], smb_max_chain 3
```

Events

The preprocessor uses GID 133 to register events.

Memcap events

SID	Description
1	If the memory cap is reached and the preprocessor is configured to alert.

SMB events

SID	Description
2	An invalid NetBIOS Session Service type was specified in the header. Valid types are: `Message`, `Request` (only from client), `Positive Response` (only from server), `Negative Response` (only from server), `Retarget Response` (only from server) and `Keep Alive`.
3	An SMB message type was specified in the header. Either a request was made by the server or a response was given by the client.
4	The SMB id does not equal \`xffSMB`. Note that since the preprocessor does not yet support SMB2, id of \`xfeSMB` is turned away before an eventable point is reached.
5	The word count of the command header is invalid. SMB commands have pretty specific word counts and if the preprocessor sees a command with a word count that doesn't jive with that command, the preprocessor will alert.
6	Some commands require a minimum number of bytes after the command header. If a command requires this and the byte count is less than the minimum required byte count for that command, the preprocessor will alert.
7	Some commands, especially the commands from the SMB Core implementation require a data format field that specifies the kind of data that will be coming next. Some commands require a specific format for the data. The preprocessor will alert if the format is not that which is expected for that command.
8	Many SMB commands have a field containing an offset from the beginning of the SMB header to where the data the command is carrying starts. If this offset puts us before data that has already been processed or after the end of payload, the preprocessor will alert.
9	Some SMB commands, such as `Transaction`, have a field containing the total amount of data to be transmitted. If this field is zero, the preprocessor will alert.
10	The preprocessor will alert if the NetBIOS Session Service length field contains a value less than the size of an SMB header.
11	The preprocessor will alert if the remaining NetBIOS packet length is less than the size of the SMB command header to be decoded.
12	The preprocessor will alert if the remaining NetBIOS packet length is less than the size of the SMB command byte count specified in the command header.
13	The preprocessor will alert if the remaining NetBIOS packet length is less than the size of the SMB command data size specified in the command header.
14	The preprocessor will alert if the total data count specified in the SMB command header is less than the data size specified in the SMB command header. (Total data count must always be greater than or equal to current data size.)
15	The preprocessor will alert if the total amount of data sent in a transaction is greater than the total data count specified in the SMB command header.
16	The preprocessor will alert if the byte count specified in the SMB command header is less than the data size specified in the SMB command. (The byte count must always be greater than or equal to the data size.)
17	Some of the Core Protocol commands (from the initial SMB implementation) require that the byte count be some value greater than the data size exactly. The preprocessor will alert if the byte count minus a predetermined amount based on the SMB command is not equal to the data size.

18	For the `Tree Connect` command (and not the `Tree Connect AndX` command), the preprocessor has to queue the requests up and wait for a server response to determine whether or not an IPC share was successfully connected to (which is what the preprocessor is interested in). Unlike the `Tree Connect AndX` response, there is no indication in the `Tree Connect` response as to whether the share is IPC or not. There should be under normal circumstances no more than a few pending tree connects at a time and the preprocessor will alert if this number is excessive.
19	After a client is done writing data using the `Write*` commands, it issues a `Read*` command to the server to tell it to send a response to the data it has written. In this case the preprocessor is concerned with the server response. The `Read*` request contains the file id associated with a named pipe instance that the preprocessor will ultimately send the data to. The server response, however, does not contain this file id, so it need to be queued with the request and dequeued with the response. If multiple `Read*` requests are sent to the server, they are responded to in the order they were sent. There should be under normal circumstances no more than a few pending `Read*` requests at a time and the preprocessor will alert if this number is excessive.
20	The preprocessor will alert if the number of chained commands in a single request is greater than or equal to the configured amount (default is 3).
21	With `AndX` command chaining it is possible to chain multiple `Session Setup AndX` commands within the same request. There is, however, only one place in the SMB header to return a login handle (or Uid). Windows does not allow this behavior, however Samba does. This is anomalous behavior and the preprocessor will alert if it happens.
22	With `AndX` command chaining it is possible to chain multiple `Tree Connect AndX` commands within the same request. There is, however, only one place in the SMB header to return a tree handle (or Tid). Windows does not allow this behavior, however Samba does. This is anomalous behavior and the preprocessor will alert if it happens.
23	When a `Session Setup AndX` request is sent to the server, the server responds (if the client successfully authenticates) which a user id or login handle. This is used by the client in subsequent requests to indicate that it has authenticated. A `Logoff AndX` request is sent by the client to indicate it wants to end the session and invalidate the login handle. With commands that are chained after a `Session Setup AndX` request, the login handle returned by the server is used for the subsequent chained commands. The combination of a `Session Setup AndX` command with a chained `Logoff AndX` command, essentially logins in and logs off in the same request and is anomalous behavior. The preprocessor will alert if it sees this.
24	A `Tree Connect AndX` command is used to connect to a share. The `Tree Disconnect` command is used to disconnect from that share. The combination of a `Tree Connect AndX` command with a chained `Tree Disconnect` command, essentially connects to a share and disconnects from the same share in the same request and is anomalous behavior. The preprocessor will alert if it sees this.
25	An `Open AndX` or `Nt Create AndX` command is used to open/create a file or named pipe. (The preprocessor is only interested in named pipes as this is where DCE/RPC requests are written to.) The `Close` command is used to close that file or named pipe. The combination of a `Open AndX` or `Nt Create AndX` command with a chained `Close` command, essentially opens and closes the named pipe in the same request and is anomalous behavior. The preprocessor will alert if it sees this.
26	The preprocessor will alert if it sees any of the invalid SMB shares configured. It looks for a `Tree Connect` or `Tree Connect AndX` to the share.

Connection-oriented DCE/RPC events

SID	Description
27	The preprocessor will alert if the connection-oriented DCE/RPC major version contained in the header is not equal to 5.
28	The preprocessor will alert if the connection-oriented DCE/RPC minor version contained in the header is not equal to 0.

29	The preprocessor will alert if the connection-oriented DCE/RPC PDU type contained in the header is not a valid PDU type.
30	The preprocessor will alert if the fragment length defined in the header is less than the size of the header.
31	The preprocessor will alert if the remaining fragment length is less than the remaining packet size.
32	The preprocessor will alert if in a `Bind` or `Alter Context` request, there are no context items specified.
33	The preprocessor will alert if in a `Bind` or `Alter Context` request, there are no transfer syntaxes to go with the requested interface.
34	The preprocessor will alert if a non-last fragment is less than the size of the negotiated maximum fragment length. Most evasion techniques try to fragment the data as much as possible and usually each fragment comes well below the negotiated transmit size.
35	The preprocessor will alert if a fragment is larger than the maximum negotiated fragment length.
36	The byte order of the request data is determined by the Bind in connection-oriented DCE/RPC for Windows. It is anomalous behavior to attempt to change the byte order mid-session.
37	The call id for a set of fragments in a fragmented request should stay the same (it is incremented for each complete request). The preprocessor will alert if it changes in a fragment mid-request.
38	The operation number specifies which function the request is calling on the bound interface. If a request is fragmented, this number should stay the same for all fragments. The preprocessor will alert if the opnum changes in a fragment mid-request.
39	The context id is a handle to a interface that was bound to. If a request if fragmented, this number should stay the same for all fragments. The preprocessor will alert if the context id changes in a fragment mid-request.

Connectionless DCE/RPC events

SID	Description
40	The preprocessor will alert if the connectionless DCE/RPC major version is not equal to 4.
41	The preprocessor will alert if the connectionless DCE/RPC pdu type is not a valid pdu type.
42	The preprocessor will alert if the packet data length is less than the size of the connectionless header.
43	The preprocessor will alert if the sequence number uses in a request is the same or less than a previously used sequence number on the session. In testing, wrapping the sequence number space produces strange behavior from the server, so this should be considered anomalous behavior.

Rule Options

New rule options are supported by enabling the `dcerpc2` preprocessor:

```
dce_iface
dce_opnum
dce_stub_data
```

New modifiers to existing `byte_test` and `byte_jump` rule options:

```
byte_test: dce
byte_jump: dce
```

dce_iface

For DCE/RPC based rules it has been necessary to set flow-bits based on a client bind to a service to avoid false positives. It is necessary for a client to bind to a service before being able to make a call to it. When a client sends a bind request to the server, it can, however, specify one or more service interfaces to bind to. Each interface is represented by a UUID. Each interface UUID is paired with a unique index (or context id) that future requests can use to reference the service that the client is making a call to. The server will respond with the interface UUIDs it accepts as valid and will allow the client to make requests to those services. When a client makes a request, it will specify the context id so the server knows what service the client is making a request to. Instead of using flow-bits, a rule can simply ask the preprocessor, using this rule option, whether or not the client has bound to a specific interface UUID and whether or not this client request is making a request to it. This can eliminate false positives where more than one service is bound to successfully since the preprocessor can correlate the bind UUID to the context id used in the request. A DCE/RPC request can specify whether numbers are represented as big endian or little endian. The representation of the interface UUID is different depending on the endianness specified in the DCE/RPC previously requiring two rules - one for big endian and one for little endian. The preprocessor eliminates the need for two rules by normalizing the UUID. An interface contains a version. Some versions of an interface may not be vulnerable to a certain exploit. Also, a DCE/RPC request can be broken up into 1 or more fragments. Flags (and a field in the connectionless header) are set in the DCE/RPC header to indicate whether the fragment is the first, a middle or the last fragment. Many checks for data in the DCE/RPC request are only relevant if the DCE/RPC request is a first fragment (or full request), since subsequent fragments will contain data deeper into the DCE/RPC request. A rule which is looking for data, say 5 bytes into the request (maybe it's a length field), will be looking at the wrong data on a fragment other than the first, since the beginning of subsequent fragments are already offset some length from the beginning of the request. This can be a source of false positives in fragmented DCE/RPC traffic. By default it is reasonable to only evaluate if the request is a first fragment (or full request). However, if the `any_frag` option is used to specify evaluating on all fragments.

Syntax

```
<uuid> [ ',' <operator> <version> ] [ ',' "any_frag" ]

uuid       = hexlong '-' hexshort '-' hexshort '-' 2hexbyte '-' 6hexbyte
hexlong    = 4hexbyte
hexshort   = 2hexbyte
hexbyte    = 2HEXDIGIT
operator   = '<' | '>' | '=' | '!'
version    = 0-65535
```

Examples

```
dce_iface: 4b324fc8-1670-01d3-1278-5a47bf6ee188;
dce_iface: 4b324fc8-1670-01d3-1278-5a47bf6ee188,<2;
dce_iface: 4b324fc8-1670-01d3-1278-5a47bf6ee188,any_frag;
dce_iface: 4b324fc8-1670-01d3-1278-5a47bf6ee188,=1,any_frag;
```

This option is used to specify an interface UUID. Optional arguments are an interface version and operator to specify that the version be less than ('<'), greater than ('>'), equal to ('=') or not equal to ('!') the version specified. Also, by default the rule will only be evaluated for a first fragment (or full request, i.e. not a fragment) since most rules are written to start at the beginning of a request. The `any_frag` argument says to evaluate for middle and last fragments as well. This option requires tracking client `Bind` and `Alter Context` requests as well as server `Bind Ack` and `Alter Context` responses for connection-oriented DCE/RPC in the preprocessor. For each `Bind` and `Alter Context` request, the client specifies a list of interface UUIDs along with a handle (or context id) for each interface UUID that will be used during the DCE/RPC session to reference the interface. The server response indicates which interfaces it will allow the client to make requests to - it either accepts or rejects the client's wish to bind to a certain interface. This tracking is required so that when a request is processed, the context id used in the request can be correlated with the interface UUID it is a handle for.

`hexlong` and `hexshort` will be specified and interpreted to be in big endian order (this is usually the default way an interface UUID will be seen and represented). As an example, the following Messenger interface UUID as taken off the wire from a little endian `Bind` request:

```
|f8 91 7b 5a 00 ff d0 11 a9 b2 00 c0 4f b6 e6 fc|
```

must be written as:

```
5a7b91f8-ff00-11d0-a9b2-00c04fb6e6fc
```

The same UUID taken off the wire from a big endian `Bind` request:

```
|5a 7b 91 f8 ff 00 11 d0 a9 b2 00 c0 4f b6 e6 fc|
```

must be written the same way:

```
5a7b91f8-ff00-11d0-a9b2-00c04fb6e6fc
```

This option matches if the specified interface UUID matches the interface UUID (as referred to by the context id) of the DCE/RPC request and if supplied, the version operation is true. This option will not match if the fragment is not a first fragment (or full request) unless the `any_frag` option is supplied in which case only the interface UUID and version need match. Note that a defragmented DCE/RPC request will be considered a full request.

`dce_opnum`

The opnum represents a specific function call to an interface. After is has been determined that a client has bound to a specific interface and is making a request to it (see above - `dce_iface`) usually we want to know what function call it is making to that service. It is likely that an exploit lies in the particular DCE/RPC function call.

Syntax

```
<opnum-list>

opnum-list   = opnum-item | opnum-item ',' opnum-list
opnum-item   = opnum | opnum-range
opnum-range  = opnum '-' opnum
opnum        = 0-65535
```

Examples

```
dce_opnum: 15;
dce_opnum: 15-18;
dce_opnum: 15,18-20;
dce_opnum: 15,17,20-22;
```

This option is used to specify an opnum (or operation number), opnum range or list containing either or both opnum and/or opnum-range. The opnum of a DCE/RPC request will be matched against the opnums specified with this option. This option matches if any one of the opnums specified match the opnum of the DCE/RPC request.

`dce_stub_data`

Since most netbios rules were doing protocol decoding only to get to the DCE/RPC stub data, i.e. the remote procedure call or function call data, this option will alleviate this need and place the cursor at the beginning of the DCE/RPC stub data. This reduces the number of rule option checks and the complexity of the rule.

This option takes no arguments.

Example

```
dce_stub_data;
```

This option is used to place the cursor (used to walk the packet payload in rules processing) at the beginning of the DCE/RPC stub data, regardless of preceding rule options. There are no arguments to this option. This option matches if there is DCE/RPC stub data.

`byte_test` and `byte_jump`

A DCE/RPC request can specify whether numbers are represented in big or little endian. These rule options will take as a new argument `dce` and will work basically the same as the normal `byte_test`/`byte_jump`, but since the DCE/RPC preprocessor will know the endianness of the request, it will be able to do the correct conversion.

`byte_test`

Syntax

```
<convert> ',' [ '!' ] <operator> ',' <value> [ ',' <offset> [ ',' "relative" ]] \
    ',' "dce"

convert    = 1 | 2 | 4
operator   = '<' | '=' | '>' | '&' | '^'
value      = 0-4294967295
offset     = -65535 to 65535
```

Examples

```
byte_test: 4,>,35000,0,relative,dce;
byte_test: 2,!=,2280,-10,relative,dce;
```

When using the `dce` argument to a `byte_test`, the following normal `byte_test` arguments will not be allowed: `big`, `little`, `string`, `hex`, `dec` and `oct`.

`byte_jump`

Syntax

```
<convert> ',' <offset> [ ',' "relative" ] [ ',' "multiplier" <mult-value> ] \
    [ ',' "align" ] [ ',' "post_offet" <adjustment-value> ] ',' "dce"

convert           = 1 | 2 | 4
offset            = -65535 to 65535
mult-value        = 0-65535
adjustment-value  = -65535 to 65535
```

Example

```
byte_jump:4,-4,relative,align,multiplier 2,post_offset -4,dce;
```

When using the `dce` argument to a `byte_jump`, the following normal `byte_jump` arguments will not be allowed: `big`, `little`, `string`, `hex`, `dec`, `oct` and `from_beginning`.

Example of rule complexity reduction

The following two rules using the new rule options replace 64 (set and isset flowbit) rules that are necessary if the new rule options are not used:

```
alert tcp $EXTERNAL_NET any -> $HOME_NET [135,139,445,593,1024:] \
    (msg:"dns R_Dnssrv funcs2 overflow attempt"; flow:established,to_server; \
    dce_iface:50abc2a4-574d-40b3-9d66-ee4fd5fba076; dce_opnum:0-11; dce_stub_data; \
    pcre:"/^.{12}(\x00\x00\x00\x00|.{12})/sR"; byte_jump:4,-4,relative,align,dce; \
    byte_test:4,>,256,4,relative,dce; reference:bugtraq,23470; reference:cve,2007-1748; \
    classtype:attempted-admin; sid:1000068;)

alert udp $EXTERNAL_NET any -> $HOME_NET [135,1024:] \
    (msg:"dns R_Dnssrv funcs2 overflow attempt"; flow:established,to_server; \
    dce_iface:50abc2a4-574d-40b3-9d66-ee4fd5fba076; dce_opnum:0-11; dce_stub_data; \
    pcre:"/^.{12}(\x00\x00\x00\x00|.{12})/sR"; byte_jump:4,-4,relative,align,dce; \
    byte_test:4,>,256,4,relative,dce; reference:bugtraq,23470; reference:cve,2007-1748; \
    classtype:attempted-admin; sid:1000069;)
```

2.3 Decoder and Preprocessor Rules

Decoder and preprocessor rules allow one to enable and disable decoder and preprocessor events on a rule by rule basis. They also allow one to specify the rule type or action of a decoder or preprocessor event on a rule by rule basis.

Decoder config options will still determine whether or not to generate decoder events. For example, if `config disable_decode_alerts` is in `snort.conf`, decoder events will not be generated regardless of whether or not there are corresponding rules for the event. Also note that if the decoder is configured to enable drops, e.g. `config enable_decode_drops`, these options will take precedence over the event type of the rule. A packet will be dropped if either a decoder config drop option is in `snort.conf` or the decoder or preprocessor rule type is `drop`. Of course, the drop cases only apply if Snort is running inline. See `doc/README.decode` for config options that control decoder events.

2.3.1 Configuring

The following options to configure will enable decoder and preprocessor rules:

```
$ ./configure --enable-decoder-preprocessor-rules
```

The decoder and preprocessor rules are located in the `preproc_rules/` directory in the top level source tree, and have the names `decoder.rules` and `preprocessor.rules` respectively. These files are updated as new decoder and preprocessor events are added to Snort.

To enable these rules in `snort.conf`, define the path to where the rules are located and uncomment the `include` lines in `snort.conf` that reference the rules files.

```
var PREPROC_RULE_PATH /path/to/preproc_rules
...
include $PREPROC_RULE_PATH/preprocessor.rules
include $PREPROC_RULE_PATH/decoder.rules
```

To disable any rule, just comment it with a # or remove the rule completely from the file (commenting is recommended).

To change the rule type or action of a decoder/preprocessor rule, just replace `alert` with the desired rule type. Any one of the following rule types can be used:

```
alert
log
pass
drop
sdrop
reject
```

For example one can change:

```
alert ( msg: "DECODE_NOT_IPV4_DGRAM"; sid: 1; gid: 116; rev: 1; \
    metadata: rule-type decode ; classtype:protocol-command-decode;)
```

to

```
drop ( msg: "DECODE_NOT_IPV4_DGRAM"; sid: 1; gid: 116; rev: 1; \
    metadata: rule-type decode ; classtype:protocol-command-decode;)
```

to drop (as well as alert on) packets where the Ethernet protocol is IPv4 but version field in IPv4 header has a value other than 4.

See `README.decode`, `README.gre` and the various preprocessor READMEs for descriptions of the rules in `decoder.rules` and `preprocessor.rules`.

2.3.2 Reverting to original behavior

If you have configured snort to use decoder and preprocessor rules, the following config option in `snort.conf` will make Snort revert to the old behavior:

```
config autogenerate_preprocessor_decoder_rules
```

Note that if you want to revert to the old behavior, you also have to remove the decoder and preprocessor rules and any reference to them from `snort.conf`, otherwise they will be loaded. This option applies to rules not specified and the default behavior is to alert.

2.4 Event Processing

Snort provides a variety of mechanisms to tune event processing to suit your needs:

- `Detection Filters`

  You can use detection filters to specifiy a threshold that must be exceeded before a rule generates an event. This is covered in section 3.7.10.

- `Rate Filters`

  You can use rate filters to change a rule action when the number or rate of events indicates a possible attack.

- `Event Filters`

  You can use event filters to reduce the number of logged events for noisy rules. This can be tuned to significantly reduce false alarms.

- `Event Suppression`

  You can completely suppress the logging of unintersting events.

2.4.1 Rate Filtering

`rate_filter` provides rate based attack prevention by allowing users to configure a new action to take for a specified time when a given rate is exceeded. Multiple rate filters can be defined on the same rule, in which case they are evaluated in the order they appear in the configuration file, and the first applicable action is taken.

Format

Rate filters are used as standalone configurations (outside of a rule) and have the following format:

```
rate_filter \
    gen_id <gid>, sig_id <sid>, \
    track <by_src|by_dst|by_rule>, \
    count <c>, seconds <s>, \
    new_action alert|drop|pass|log|sdrop|reject, \
    timeout <seconds> \
    [, apply_to <ip-list>]
```

The options are described in the table below - all are required except `apply_to`, which is optional.

Option	Description
track by_src | by_dst | by_rule	rate is tracked either by source IP address, destination IP address, or by rule. This means the match statistics are maintained for each unique source IP address, for each unique destination IP address, or they are aggregated at rule level. For rules related to Stream5 sessions, source and destination means client and server respectively. track by_rule and apply_to may not be used together.
count c	the maximum number of rule matches in s seconds before the rate filter limit to is exceeded. c must be nonzero value.
seconds s	the time period over which count is accrued. 0 seconds means count is a total count instead of a specific rate. For example, rate_filter may be used to detect if the number of connections to a specific server exceed a specific count. 0 seconds only applies to internal rules (gen_id 135) and other use will produce a fatal error by Snort.
new_action alert | drop | pass | log | sdrop | reject	new_action replaces rule action for t seconds. drop, reject, and sdrop can be used only when snort is used in inline mode. sdrop and reject are conditionally compiled with GIDS.
timeout t	revert to the original rule action after t seconds. If t is 0, then rule action is never reverted back. An event_filter may be used to manage number of alerts after the rule action is enabled by rate_filter.
apply_to <ip-list>	restrict the configuration to only to source or destination IP address (indicated by track parameter) determined by <ip-list>. track by_rule and apply_to may not be used together. Note that events are generated during the timeout period, even if the rate falls below the configured limit.

Examples

Example 1 - allow a maximum of 100 connection attempts per second from any one IP address, and block further connection attempts from that IP address for 10 seconds:

```
rate_filter \
    gen_id 135, sig_id 1, \
    track by_src, \
    count 100, seconds 1, \
    new_action drop, timeout 10
```

Example 2 - allow a maximum of 100 successful simultaneous connections from any one IP address, and block further connections from that IP address for 10 seconds:

```
rate_filter \
    gen_id 135, sig_id 2, \
    track by_src, \
    count 100, seconds 0, \
    new_action drop, timeout 10
```

2.4.2 Event Filtering

Event filtering can be used to reduce the number of logged alerts for noisy rules by limiting the number of times a particular event is logged during a specified time interval. This can be tuned to significantly reduce false alarms.

There are 3 types of event filters:

- limit

  Alerts on the 1st *m* events during the time interval, then ignores events for the rest of the time interval.

- `threshold`

  Alerts every *m* times we see this event during the time interval.

- `both`

  Alerts once per time interval after seeing *m* occurrences of the event, then ignores any additional events during the time interval.

Format

```
event_filter \
    gen_id <gid>, sig_id <sid>, \
    type <limit|threshold|both>, \
    track <by_src|by_dst>, \
    count <c>, seconds <s>

threshold \
    gen_id <gid>, sig_id <sid>, \
    type <limit|threshold|both>, \
    track <by_src|by_dst>, \
    count <c>, seconds <s>
```

`threshold` is an alias for `event_filter`. Both formats are equivalent and support the options described below - all are required. `threshold` is deprecated and will not be supported in future releases.

Option	Description
`gen_id <gid>`	Specify the generator ID of an associated rule. `gen_id 0, sig_id 0` can be used to specify a ”global” threshold that applies to all rules.
`sig_id <sid>`	Specify the signature ID of an associated rule. `sig_id 0` specifies a ”global” filter because it applies to all `sig_id`s for the given `gen_id`.
`type limit|threshold|both`	type `limit` alerts on the 1st m events during the time interval, then ignores events for the rest of the time interval. Type `threshold` alerts every m times we see this event during the time interval. Type `both` alerts once per time interval after seeing m occurrences of the event, then ignores any additional events during the time interval.
`track by_src|by_dst`	rate is tracked either by source IP address, or destination IP address. This means count is maintained for each unique source IP addresses, or for each unique destination IP addresses. Ports or anything else are not tracked.
`count c`	number of rule matching in s seconds that will cause `event_filter` limit to be exceeded. `c` must be nonzero value.
`seconds s`	time period over which `count` is accrued. `s` must be nonzero value.

Only one `event_filter` may be defined for a given `gen_id, sig_id`. If more than one `event_filter` is applied to a specific `gen_id, sig_id` pair, Snort will terminate with an error while reading the configuration information.

`event_filter`s with `sig_id` 0 are considered ”global” because they apply to all rules with the given `gen_id`. If `gen_id` is also 0, then the filter applies to all rules. (`gen_id 0, sig_id != 0` is not allowed). Standard filtering tests are applied first, if they do not block an event from being logged, the global filtering test is applied. Thresholds in a rule (deprecated) will override a global `event_filter`. Global `event_filter`s do not override what’s in a signature or a more specific stand-alone `event_filter`.

⚠NOTE

event_filters can be used to suppress excessive rate_filter alerts, however, the first new_action event of the timeout period is never suppressed. Such events indicate a change of state that are significant to the user monitoring the network.

Examples

Limit logging to 1 event per 60 seconds:

```
event_filter \
    gen_id 1, sig_id 1851, \
    type limit, track by_src,  \
    count 1, seconds 60
```

Limit logging to every 3rd event:

```
event_filter \
    gen_id 1, sig_id 1852,  \
    type threshold, track by_src, \
    count 3, seconds 60
```

Limit logging to just 1 event per 60 seconds, but only if we exceed 30 events in 60 seconds:

```
event_filter \
    gen_id 1, sig_id 1853, \
    type both, track by_src, \
    count 30, seconds 60
```

Limit to logging 1 event per 60 seconds per IP triggering each rule (rule gen_id is 1):

```
event_filter \
    gen_id 1, sig_id 0, \
    type limit, track by_src, \
    count 1, seconds 60
```

Limit to logging 1 event per 60 seconds per IP, triggering each rule for each event generator:

```
event_filter \
    gen_id 0, sig_id 0, \
    type limit, track by_src, \
    count 1, seconds 60
```

Events in Snort are generated in the usual way, event filters are handled as part of the output system. Read gen-msg.map for details on gen ids.

Users can also configure a memcap for threshold with a “config:” option:

```
config event_filter: memcap <bytes>

# this is deprecated:
config threshold: memcap <bytes>
```

2.4.3 Event Suppression

Event suppression stops specified events from firing without removing the rule from the rule base. Suppression uses an IP list to select specific networks and users for suppression. Suppression tests are performed prior to either standard or global thresholding tests.

Suppression are standalone configurations that reference generators, SIDs, and IP addresses via an IP list . This allows a rule to be completely suppressed, or suppressed when the causative traffic is going to or coming from a specific IP or group of IP addresses.

You may apply multiple suppressions to a non-zero SID. You may also combine one `event_filter` and several suppressions to the same non-zero SID.

Format

The suppress configuration has two forms:

```
suppress \
    gen_id <gid>, sig_id <sid>, \

suppress \
    gen_id <gid>, sig_id <sid>, \
    track <by_src|by_dst>, ip <ip-list>
```

Option	Description
`gen_id <gid>`	Specify the generator ID of an associated rule. `gen_id 0, sig_id 0` can be used to specify a ”global” threshold that applies to all rules.
`sig_id <sid>`	Specify the signature ID of an associated rule. `sig_id 0` specifies a ”global” filter because it applies to all `sig_id`s for the given `gen_id`.
`track by_src|by_dst`	Suppress by source IP address or destination IP address. This is optional, but if present, `ip` must be provided as well.
`ip <list>`	Restrict the suppression to only source or destination IP addresses (indicated by `track` parameter) determined by ¡list¿. If track is provided, ip must be provided as well.

Examples

Suppress this event completely:

```
suppress gen_id 1, sig_id 1852:
```

Suppress this event from this IP:

```
suppress gen_id 1, sig_id 1852, track by_src, ip 10.1.1.54
```

Suppress this event to this CIDR block:

```
suppress gen_id 1, sig_id 1852, track by_dst, ip 10.1.1.0/24
```

2.4.4 Event Logging

Snort supports logging multiple events per packet/stream that are prioritized with different insertion methods, such as max content length or event ordering using the event queue.

The general configuration of the event queue is as follows:

```
config event_queue: [max_queue [size]] [log [size]] [order_events [TYPE]]
```

Event Queue Configuration Options There are three configuration options to the configuration parameter 'event_queue'.

1. `max_queue`

   This determines the maximum size of the event queue. For example, if the event queue has a max size of 8, only 8 events will be stored for a single packet or stream.

   The default value is 8.

2. `log`

   This determines the number of events to log for a given packet or stream. You can't log more than the max_event number that was specified.

   The default value is 3.

3. `order_events`

   This argument determines the way that the incoming events are ordered. We currently have two different methods:

   - `priority` - The highest priority (1 being the highest) events are ordered first.
   - `content_length` - Rules are ordered before decode or preprocessor alerts, and rules that have a longer content are ordered before rules with shorter contents.

   The method in which events are ordered does not affect rule types such as pass, alert, log, etc.

   The default value is content_length.

Event Queue Configuration Examples The default configuration:

```
config event_queue: max_queue 8 log 3 order_events content_length
```

Example of a reconfigured event queue:

```
config event_queue: max_queue 10 log 3 order_events content_length
```

Use the default event queue values, but change event order:

```
config event_queue: order_events priority
```

Use the default event queue values but change the number of logged events:

```
config event_queue: log 2
```

2.5 Performance Profiling

Snort can provide statistics on rule and preprocessor performance. Each require only a simple `config` option to `snort.conf` and Snort will print statistics on the worst (or all) performers on exit. When a file name is provided in `profile_rules` or `profile_preprocs`, the statistics will be saved in these files. If the `append` option is not present, previous data in these files will be overwritten.

2.5.1 Rule Profiling

Format

```
config profile_rules: \
    print [all | <num>], \
    sort <sort_option> \
    [,filename <filename> [append]]
```

- `<num>` is the number of rules to print
- `<sort_option>` is one of:
  - `checks`
  - `matches`
  - `nomatches`
  - `avg_ticks`
  - `avg_ticks_per_match`
  - `avg_ticks_per_nomatch`
  - `total_ticks`
- `<filename>` is the output filename
- `[append]` dictates that the output will go to the same file each time (optional)

Examples

- Print all rules, sort by avg_ticks (default configuration if option is turned on)
  ```
  config profile_rules
  ```
- Print all rules, sort by avg_ticks, and append to file `rules_stats.txt`
  ```
  config profile_rules filename rules_stats.txt append
  ```
- Print the top 10 rules, based on highest average time
  ```
  config profile_rules:  print 10, sort avg_ticks
  ```
- Print all rules, sorted by number of checks
  ```
  config profile_rules:  print all, sort checks
  ```
- Print top 100 rules, based on total time
  ```
  config profile_rules:  print 100, sort total_ticks
  ```
- Print with default options, save results to performance.txt each time
  ```
  config profile_rules:  filename performance.txt append
  ```
- Print top 20 rules, save results to perf.txt with timestamp in filename
  ```
  config profile_rules:  print 20, filename perf.txt
  ```

```
Rule Profile Statistics (worst 4 rules)
==========================================================
   Num      SID GID Rev     Checks   Matches    Alerts               Ticks Avg/Check  Avg/Match Avg/Nonmatch
   ===      === === ===     ======   =======    ======               ===== =========  ========= ============
     1     2389   1  12          1         1         1              385698  385698.0   385698.0          0.0
     2     2178   1  17          2         0         0              107822   53911.0        0.0      53911.0
     3     2179   1   8          2         0         0               92458   46229.0        0.0      46229.0
     4     1734   1  37          2         0         0               90054   45027.0        0.0      45027.0
```

Figure 2.1: Rule Profiling Example Output

Output

Snort will print a table much like the following at exit.

Configuration line used to print the above table:

```
config profile_rules:  print 4, sort total_ticks
```

The columns represent:

- Number (rank)
- Sig ID
- Generator ID
- Checks (number of times rule was evaluated after fast pattern match within portgroup or any->any rules)
- Matches (number of times ALL rule options matched, will be high for rules that have no options)
- Alerts (number of alerts generated from this rule)
- CPU Ticks
- Avg Ticks per Check
- Avg Ticks per Match
- Avg Ticks per Nonmatch

Interpreting this info is the key. The Microsecs (or Ticks) column is important because that is the total time spent evaluating a given rule. But, if that rule is causing alerts, it makes sense to leave it alone.

A high Avg/Check is a poor performing rule, that most likely contains PCRE. High Checks and low Avg/Check is usually an any->any rule with few rule options and no content. Quick to check, the few options may or may not match. We are looking at moving some of these into code, especially those with low SIDs.

By default, this information will be printed to the console when Snort exits. You can use the "filename" option in snort.conf to specify a file where this will be written. If "append" is not specified, a new file will be created each time Snort is run. The filenames will have timestamps appended to them. These files will be found in the logging directory.

2.5.2 Preprocessor Profiling

Format

```
config profile_preprocs: \
    print [all | <num>], \
    sort <sort_option> \
    [, filename <filename> [append]]
```

- <num> is the number of preprocessors to print

- <sort_option> is one of:
  checks
  avg_ticks
  total_ticks
- <filename> is the output filename
- [append] dictates that the output will go to the same file each time (optional)

Examples

- Print all preprocessors, sort by avg_ticks (default configuration if option is turned on)
  ```
  config profile_preprocs
  ```
- Print all preprocessors, sort by avg_ticks, and append to file preprocs_stats.txt
  ```
  config profile_preprocs, filename preprocs_stats.txt append
  ```
- Print the top 10 preprocessors, based on highest average time
  ```
  config profile_preprocs:  print 10, sort avg_ticks
  ```
- Print all preprocessors, sorted by number of checks
  ```
  config profile_preprocs:  print all, sort checks
  ```

Output

Snort will print a table much like the following at exit.

Configuration line used to print the above table:

```
config profile_rules: \
    print 3, sort total_ticks
```

The columns represent:

- Number (rank) - The number is indented for each layer. Layer 1 preprocessors are listed under their respective caller (and sorted similarly).
- Preprocessor Name
- Layer - When printing a specific number of preprocessors all subtasks info for a particular preprocessor is printed for each layer 0 preprocessor stat.
- Checks (number of times preprocessor decided to look at a packet, ports matched, app layer header was correct, etc)
- Exits (number of corresponding exits – just to verify code is instrumented correctly, should ALWAYS match Checks, unless an exception was trapped)
- CPU Ticks
- Avg Ticks per Check
- Percent of caller - For non layer 0 preprocessors, i.e. subroutines within preprocessors, this identifies the percent of the caller's ticks that is spent for this subtask.

Because of task swapping, non-instrumented code, and other factors, the Pct of Caller field will not add up to 100% of the caller's time. It does give a reasonable indication of how much relative time is spent within each subtask.

By default, this information will be printed to the console when Snort exits. You can use the "filename" option in snort.conf to specify a file where this will be written. If "append" is not specified, a new file will be created each time Snort is run. The filenames will have timestamps appended to them. These files will be found in the logging directory.

```
Preprocessor Profile Statistics (all)
=========================================================
 Num            Preprocessor Layer     Checks      Exits          Microsecs  Avg/Check Pct of Caller Pct of Total
 ===            ============ =====     ======      =====          =========  ========= ============= ============
  1           ftptelnet_ftp     0       2697       2697             135720      50.32          0.20          0.20
  2                  detect     0     930237     930237           31645670      34.02         47.20         47.20
   1              rule eval     1    1347969    1347969           26758596      19.85         84.56         39.91
    1         rule tree eval     2    1669390    1669390           26605086      15.94         99.43         39.68
     1                 pcre     3     488652     488652           18994719      38.87         71.40         28.33
     2                 asn1     3          1          1                  8       8.56          0.00          0.00
     3           uricontent     3     647122     647122            2638614       4.08          9.92          3.94
     4              content     3    1043099    1043099            3154396       3.02         11.86          4.70
     5            ftpbounce     3         23         23                 19       0.87          0.00          0.00
     6            byte_jump     3       9007       9007               3321       0.37          0.01          0.00
     7            byte_test     3     239015     239015              64401       0.27          0.24          0.10
     8             icmp_seq     3          2          2                  0       0.16          0.00          0.00
     9             fragbits     3      65259      65259              10168       0.16          0.04          0.02
    10             isdataat     3       5085       5085                757       0.15          0.00          0.00
    11                flags     3       4147       4147                517       0.12          0.00          0.00
    12             flowbits     3    2002630    2002630             212231       0.11          0.80          0.32
    13                  ack     3       4042       4042                261       0.06          0.00          0.00
    14                 flow     3    1347822    1347822              79002       0.06          0.30          0.12
    15                icode     3      75538      75538               4280       0.06          0.02          0.01
    16                itype     3      27009      27009               1524       0.06          0.01          0.00
    17               icmp_id     3      41150      41150               1618       0.04          0.01          0.00
    18             ip_proto     3     142625     142625               5004       0.04          0.02          0.01
    19               ipopts     3      13690      13690                457       0.03          0.00          0.00
   2               rtn eval     2      55836      55836              22763       0.41          0.09          0.03
  2                    mpse     1     492836     492836            4135697       8.39         13.07          6.17
 3                   frag3     0      76925      76925            1683797      21.89          2.51          2.51
  1            frag3insert     1      70885      70885             434980       6.14         25.83          0.65
  2           frag3rebuild     1       5419       5419               6280       1.16          0.37          0.01
 4                  dcerpc     0     127332     127332            2426830      19.06          3.62          3.62
 5                      s5     0     809682     809682           14195602      17.53         21.17         21.17
  1                  s5tcp     1     765281     765281           14128577      18.46         99.53         21.07
   1            s5TcpState     2     742464     742464           13223585      17.81         93.59         19.72
    1           s5TcpFlush     3      51987      51987              92918       1.79          0.70          0.14
     1  s5TcpProcessRebuilt     4      47355      47355           14548497     307.22      15657.23         21.70
     2    s5TcpBuildPacket     4      47360      47360              41711       0.88         44.89          0.06
    2            s5TcpData     3     250035     250035             141490       0.57          1.07          0.21
     1       s5TcpPktInsert     4      88173      88173             110136       1.25         77.84          0.16
   2           s5TcpNewSess     2      60880      60880              81779       1.34          0.58          0.12
 6                  eventq     0    2089428    2089428           26690209      12.77         39.81         39.81
 7              httpinspect     0     296030     296030            1862359       6.29          2.78          2.78
 8                     smtp     0     137653     137653             227982       1.66          0.34          0.34
 9                   decode     0    1057635    1057635            1162456       1.10          1.73          1.73
10        ftptelnet_telnet     0        175        175                175       1.00          0.00          0.00
11              sfportscan     0     881153     881153             518655       0.59          0.77          0.77
12             backorifice     0      35369      35369               4875       0.14          0.01          0.01
13                     dns     0      16639      16639               1346       0.08          0.00          0.00
total                total     0    1018323    1018323           67046412      65.84          0.00          0.00
```

Figure 2.2: Preprocessor Profiling Example Output

2.5.3 Packet Performance Monitoring (PPM)

PPM provides thresholding mechanisms that can be used to provide a basic level of latency control for snort. It does not provide a hard and fast latency guarantee but should in effect provide a good average latency control. Both rules and packets can be checked for latency. The action taken upon detection of excessive latency is configurable. The following sections describe configuration, sample output, and some implementation details worth noting.

To use PPM, you must build with the –enable-ppm or the –enable-sourcefire option to configure.

PPM is configured as follows:

```
# Packet configuration:
config ppm: max-pkt-time <micro-secs>, \
    fastpath-expensive-packets, \
    pkt-log, \
    debug-pkts

# Rule configuration:
config ppm: max-rule-time <micro-secs>, \
    threshold count, \
    suspend-expensive-rules, \
    suspend-timeout <seconds>, \
    rule-log [log] [alert]
```

Packets and rules can be configured separately, as above, or together in just one config ppm statement. Packet and rule monitoring is independent, so one or both or neither may be enabled.

Configuration

Packet Configuration Options

`max-pkt-time <micro-secs>`

- enables packet latency thresholding using 'micros-secs' as the limit.
- default is 0 (packet latency thresholding disabled)
- reasonable starting defaults: 100/250/1000 for 1G/100M/5M nets

`fastpath-expensive-packets`

- enables stopping further inspection of a packet if the max time is exceeded
- default is off

`pkt-log`

- enables logging packet event if packet exceeds max-pkt-time
- logging is to syslog or console depending upon snort configuration
- default is no logging

`debug-pkts`

- enables per packet timing stats to be printed after each packet
- default is off

Rule Configuration Options

`max-rule-time <micro-secs>`

- enables rule latency thresholding using 'micros-secs' as the limit.
- default is 0 (rule latency thresholding disabled)
- reasonable starting defaults: 100/250/1000 for 1G/100M/5M nets

`threshold <count>`

- sets the number of consecutive rule time excesses before disabling a rule
- default is 5

`suspend-expensive-rules`

- enables suspending rule inspection if the max rule time is exceeded
- default is off

`suspend-timeout <seconds>`

- rule suspension time in seconds
- default is 60 seconds
- set to zero to permanently disable expensive rules

`rule-log [log] [alert]`

- enables event logging output for rules
- default is no logging
- one or both of the options 'log' and 'alert' must be used with 'rule-log'
- the log option enables output to syslog or console depending upon snort configuration

Examples

Example 1: The following enables packet tracking:

```
config ppm: max-pkt-time 100
```

The following enables rule tracking:

```
config ppm: max-rule-time 50, threshold 5
```

If fastpath-expensive-packets or suspend-expensive-rules is not used, then no action is taken other than to increment the count of the number of packets that should be fastpath'd or the rules that should be suspended. A summary of this information is printed out when snort exits.

Example 2:

The following suspends rules and aborts packet inspection. These rules were used to generate the sample output that follows.

```
config ppm: \
    max-pkt-time 50, fastpath-expensive-packets, \
    pkt-log, debug-pkt

config ppm: \
    max-rule-time 50, threshold 5, suspend-expensive-rules, \
    suspend-timeout 300, rule-log log alert
```

Sample Snort Output

Sample Snort Startup Output

```
Packet Performance Monitor Config:
  ticks per usec  : 1600 ticks
  max packet time : 50 usecs
  packet action   : fastpath-expensive-packets
  packet logging  : log
  debug-pkts      : disabled

Rule Performance Monitor Config:
  ticks per usec  : 1600 ticks
  max rule time   : 50 usecs
  rule action     : suspend-expensive-rules
  rule threshold  : 5
  suspend timeout : 300 secs
  rule logging    : alert log
```

Sample Snort Run-time Output

```
...
PPM: Process-BeginPkt[61] caplen=60
PPM: Pkt[61] Used= 8.15385 usecs
PPM: Process-EndPkt[61]

PPM: Process-BeginPkt[62] caplen=342
PPM: Pkt[62] Used= 65.3659 usecs
PPM: Process-EndPkt[62]

PPM: Pkt-Event Pkt[63] used=56.0438 usecs, 0 rules, 1 nc-rules tested, packet fastpathed.
PPM: Process-BeginPkt[63] caplen=60
PPM: Pkt[63] Used= 8.394 usecs
PPM: Process-EndPkt[63]

PPM: Process-BeginPkt[64] caplen=60
PPM: Pkt[64] Used= 8.21764 usecs
PPM: Process-EndPkt[64]
...
```

Sample Snort Exit Output

```
Packet Performance Summary:
   max packet time       : 50 usecs
   packet events         : 1
   avg pkt time          : 0.633125 usecs
Rule Performance Summary:
```

```
max rule time         : 50 usecs
rule events           : 0
avg nc-rule time      : 0.2675 usecs
```

Implementation Details

- Enforcement of packet and rule processing times is done after processing each rule. Latency control is not enforced after each preprocessor.
- This implementation is software based and does not use an interrupt driven timing mechanism and is therefore subject to the granularity of the software based timing tests. Due to the granularity of the timing measurements any individual packet may exceed the user specified packet or rule processing time limit. Therefore this implementation cannot implement a precise latency guarantee with strict timing guarantees. Hence the reason this is considered a best effort approach.
- Since this implementation depends on hardware based high performance frequency counters, latency thresholding is presently only available on Intel and PPC platforms.
- Time checks are made based on the total system time, not processor usage by Snort. This was a conscious design decision because when a system is loaded, the latency for a packet is based on the total system time, not just the processor time the Snort application receives. Therefore, it is recommended that you tune your thresholding to operate optimally when your system is under load.

2.6 Output Modules

Output modules are new as of version 1.6. They allow Snort to be much more flexible in the formatting and presentation of output to its users. The output modules are run when the alert or logging subsystems of Snort are called, after the preprocessors and detection engine. The format of the directives in the rules file is very similar to that of the preprocessors.

Multiple output plugins may be specified in the Snort configuration file. When multiple plugins of the same type (log, alert) are specified, they are stacked and called in sequence when an event occurs. As with the standard logging and alerting systems, output plugins send their data to /var/log/snort by default or to a user directed directory (using the -l command line switch).

Output modules are loaded at runtime by specifying the output keyword in the rules file:

```
output <name>: <options>

output alert_syslog: log_auth log_alert
```

2.6.1 alert_syslog

This module sends alerts to the syslog facility (much like the -s command line switch). This module also allows the user to specify the logging facility and priority within the Snort rules file, giving users greater flexibility in logging alerts.

Available Keywords

Facilities

- `log_auth`
- `log_authpriv`
- `log_daemon`

- log_local0
- log_local1
- log_local2
- log_local3
- log_local4
- log_local5
- log_local6
- log_local7
- log_user

Priorities

- log_emerg
- log_alert
- log_crit
- log_err
- log_warning
- log_notice
- log_info
- log_debug

Options

- log_cons
- log_ndelay
- log_perror
- log_pid

Format

```
alert_syslog: \
    <facility> <priority> <options>
```

As WIN32 does not run syslog servers locally by default, a hostname and port can be passed as options. The default host is 127.0.0.1. The default port is 514.

```
output alert_syslog: \
    [host=<hostname[:<port>],] \
    <facility> <priority> <options>
```

Example

```
output alert_syslog: 10.1.1.1:514, <facility> <priority> <options>
```

2.6.2 alert_fast

This will print Snort alerts in a quick one-line format to a specified output file. It is a faster alerting method than full alerts because it doesn't need to print all of the packet headers to the output file

Format

```
alert_fast: <output filename>
```

Example

```
output alert_fast: alert.fast
```

2.6.3 alert_full

This will print Snort alert messages with full packet headers. The alerts will be written in the default logging directory (/var/log/snort) or in the logging directory specified at the command line.

Inside the logging directory, a directory will be created per IP. These files will be decoded packet dumps of the packets that triggered the alerts. The creation of these files slows Snort down considerably. This output method is discouraged for all but the lightest traffic situations.

Format

```
alert_full: <output filename>
```

Example

```
output alert_full: alert.full
```

2.6.4 alert_unixsock

Sets up a UNIX domain socket and sends alert reports to it. External programs/processes can listen in on this socket and receive Snort alert and packet data in real time. This is currently an experimental interface.

Format

```
alert_unixsock
```

Example

```
output alert_unixsock
```

2.6.5 log_tcpdump

The log_tcpdump module logs packets to a tcpdump-formatted file. This is useful for performing post-process analysis on collected traffic with the vast number of tools that are available for examining tcpdump-formatted files. This module only takes a single argument: the name of the output file. Note that the file name will have the UNIX timestamp in seconds appended the file name. This is so that data from separate Snort runs can be kept distinct.

Format

```
log_tcpdump: <output filename>
```

Example

```
output log_tcpdump: snort.log
```

2.6.6 database

This module from Jed Pickel sends Snort data to a variety of SQL databases. More information on installing and configuring this module can be found on the [91]incident.org web page. The arguments to this plugin are the name of the database to be logged to and a parameter list. Parameters are specified with the format parameter = argument. see Figure 2.3 for example usage.

Format

```
database: <log | alert>, <database type>, <parameter list>
```

The following parameters are available:

`host` - Host to connect to. If a non-zero-length string is specified, TCP/IP communication is used. Without a host name, it will connect using a local UNIX domain socket.

`port` - Port number to connect to at the server host, or socket filename extension for UNIX-domain connections.

`dbname` - Database name

`user` - Database username for authentication

`password` - Password used if the database demands password authentication

`sensor_name` - Specify your own name for this Snort sensor. If you do not specify a name, one will be generated automatically

`encoding` - Because the packet payload and option data is binary, there is no one simple and portable way to store it in a database. Blobs are not used because they are not portable across databases. So i leave the encoding option to you. You can choose from the following options. Each has its own advantages and disadvantages:

`hex` (default) - Represent binary data as a hex string.

Storage requirements - 2x the size of the binary
Searchability - very good
Human readability - not readable unless you are a true geek, requires post processing

`base64` - Represent binary data as a base64 string.

Storage requirements - ~1.3x the size of the binary
Searchability - impossible without post processing
Human readability - not readable requires post processing

```
output database: \
    log, mysql, dbname=snort user=snort host=localhost password=xyz
```

Figure 2.3: Database Output Plugin Configuration

ascii - Represent binary data as an ASCII string. This is the only option where you will actually lose data. Non-ASCII Data is represented as a '.'. If you choose this option, then data for IP and TCP options will still be represented as hex because it does not make any sense for that data to be ASCII.

Storage requirements - slightly larger than the binary because some characters are escaped (&,<,>)
Searchability - very good for searching for a text string impossible if you want to search for binary
human readability - very good

detail - How much detailed data do you want to store? The options are:

full (default) - Log all details of a packet that caused an alert (including IP/TCP options and the payload)

fast - Log only a minimum amount of data. You severely limit the potential of some analysis applications if you choose this option, but this is still the best choice for some applications. The following fields are logged: `timestamp`, `signature`, `source ip`, `destination ip`, `source port`, `destination port`, `tcp flags`, and `protocol`)

Furthermore, there is a logging method and database type that must be defined. There are two logging types available, `log` and `alert`. Setting the type to log attaches the database logging functionality to the log facility within the program. If you set the type to log, the plugin will be called on the log output chain. Setting the type to alert attaches the plugin to the alert output chain within the program.

There are five database types available in the current version of the plugin. These are `mssql`, `mysql`, `postgresql`, `oracle`, and `odbc`. Set the type to match the database you are using.

⚠NOTE

The database output plugin does not have the ability to handle alerts that are generated by using the `tag` keyword. See section 3.7.5 for more details.

2.6.7 csv

The csv output plugin allows alert data to be written in a format easily importable to a database. The plugin requires 2 arguments: a full pathname to a file and the output formatting option.

The list of formatting options is below. If the formatting option is default, the output is in the order the formatting option is listed.

- `timestamp`
- `sig_generator`
- `sig_id`
- `sig_rev`
- `msg`
- `proto`
- `src`
- `srcport`

- dst
- dstport
- ethsrc
- ethdst
- ethlen
- tcpflags
- tcpseq
- tcpack
- tcplen
- tcpwindow
- ttl
- tos
- id
- dgmlen
- iplen
- icmptype
- icmpcode
- icmpid
- icmpseq

Format

```
output alert_csv: <filename> <format>
```

Example

```
output alert_csv: /var/log/alert.csv default

output alert_csv: /var/log/alert.csv timestamp, msg
```

2.6.8 unified

The unified output plugin is designed to be the fastest possible method of logging Snort events. The unified output plugin logs events in binary format, allowing another programs to handle complex logging mechanisms that would otherwise diminish the performance of Snort.

The name *unified* is a misnomer, as the unified output plugin creates two different files, an *alert* file, and a *log* file. The alert file contains the high-level details of an event (eg: IPs, protocol, port, message id). The log file contains the detailed packet information (a packet dump with the associated event ID). Both file types are written in a bimary format described in *spo_unified.h*.

Files have the file creation time (in Unix Epoch format) appended to each file when it is created.

Format

```
output alert_unified: <base file name> [, <limit <file size limit in MB>]
output log_unified: <base file name> [, <limit <file size limit in MB>]
```

Example

```
output alert_unified: snort.alert, limit 128
output log_unified: snort.log, limit 128
```

2.6.9 unified 2

The unified2 output plugin is a replacement for the unified output plugin. It has the same performance characteristics, but a slightly different logging format. See section 2.6.8 on unified logging for more information.

Unified2 can work in one of three modes, packet logging, alert logging, or true unified logging. Packet logging includes a capture of the entire packet and is specified with `log_unified2`. Likewise, alert logging will only log events and is specified with `alert_unified2`. To include both logging styles in a single, unified file, simply specify `unified2`.

When MPLS support is turned on, MPLS labels can be included in unified2 events. Use option `mpls_event_types` to enable this. If option `mpls_event_types` is not used, then MPLS labels will be not be included in unified2 events.

By default, unified 2 files have the file creation time (in Unix Epoch format) appended to each file when it is created.

Format

```
output alert_unified2: \
    filename <base filename> [, <limit <size in MB>] [, nostamp] [, mpls_event_types]

output log_unified2: \
    filename <base filename> [, <limit <size in MB>] [, nostamp]

output unified2: \
    filename <base file name> [, <limit <size in MB>] [, nostamp] [, mpls_event_types]
```

Example

```
output alert_unified2: filename snort.alert, limit 128, nostamp
output log_unified2: filename snort.log, limit 128, nostamp
output unified2: filename merged.log, limit 128, nostamp
output unified2: filename merged.log, limit 128, nostamp, mpls_event_types
```

2.6.10 alert_prelude

support to use alert_prelude is not built in by default. To use alert_prelude, snort must be built with the –enable-prelude argument passed to ./configure.

The alert_prelude output plugin is used to log to a Prelude database. For more information on Prelude, see http://www.prelude-ids.org/.

Format

```
output alert_prelude: \
    profile=<name of prelude profile> \
    [ info=<priority number for info priority alerts>] \
    [ low=<priority number for low priority alerts>] \
    [ medium=<priority number for medium priority alerts>]
```

Example

```
output alert_prelude: profile=snort info=4 low=3 medium=2
```

2.6.11 log null

Sometimes it is useful to be able to create rules that will alert to certain types of traffic but will not cause packet log entries. In Snort 1.8.2, the log_null plugin was introduced. This is equivalent to using the -n command line option but it is able to work within a ruletype.

Format

```
output log_null
```

Example

```
output log_null  # like using snort -n

ruletype info {
    type alert
    output alert_fast: info.alert
    output log_null
}
```

2.6.12 alert_aruba_action

Support to use alert_aruba_action is not built in by default. To use alert_aruba_action, snort must be built with the –enable-aruba argument passed to ./configure.

Communicates with an Aruba Networks wireless mobility controller to change the status of authenticated users. This allows Snort to take action against users on the Aruba controller to control their network privilege levels.

For more information on Aruba Networks access control, see http://www.arubanetworks.com/.

Format

```
output alert_aruba_action: \
    <controller address> <secrettype> <secret> <action>
```

The following parameters are required:

controller address - Aruba mobility controller address.

secrettype - Secret type, one of ”sha1”, ”md5” or ”cleartext”.

secret - Authentication secret configured on the Aruba mobility controller with the ”aaa xml-api client” configuration command, represented as a sha1 or md5 hash, or a cleartext password.

action - Action to apply to the source IP address of the traffic generating an alert.

blacklist - Blacklist the station by disabling all radio communication.

setrole:rolename - Change the userś role to the specified rolename.

Example

```
output alert_aruba_action: \
    10.3.9.6 cleartext foobar setrole:quarantine_role
```

2.7 Host Attribute Table

Starting with version 2.8.1, Snort has the capability to use information from an outside source to determine both the protocol for use with Snort rules, and IP-Frag policy (see section 2.2.1) and TCP Stream reassembly policies (see section 2.2.2). This information is stored in an attribute table, which is loaded at startup. The table is re-read during run time upon receipt of signal number 30.

Snort associates a given packet with its attribute data from the table, if applicable.

For rule evaluation, service information is used instead of the ports when the protocol metadata in the rule matches the service corresponding to the traffic. If the rule doesn’t have protocol metadata, or the traffic doesn’t have any matching service information, the rule relies on the port information.

⚠NOTE

To use a host attribute table, Snort must be configured with the –enable-targetbased flag.

2.7.1 Configuration Format

```
attribute_table filename <path to file>
```

2.7.2 Attribute Table File Format

The attribute table uses an XML format and consists of two sections, a mapping section, used to reduce the size of the file for common data elements, and the host attribute section. The mapping section is optional.

An example of the file format is shown below.

```
<SNORT_ATTRIBUTES>
    <ATTRIBUTE_MAP>
        <ENTRY>
            <ID>1</ID>
            <VALUE>Linux</VALUE>
        </ENTRY>
        <ENTRY>
            <ID>2</ID>
```

```
        <VALUE>ssh</VALUE>
    </ENTRY>
</ATTRIBUTE_MAP>
<ATTRIBUTE_TABLE>
    <HOST>
        <IP>192.168.1.234</IP>
        <OPERATING_SYSTEM>
            <NAME>
                <ATTRIBUTE_ID>1</ATTRIBUTE_ID>
                <CONFIDENCE>100</CONFIDENCE>
            </NAME>
            <VENDOR>
                <ATTRIBUTE_VALUE>Red Hat</ATTRIBUTE_VALUE>
                <CONFIDENCE>99</CONFIDENCE>
            </VENDOR>
            <VERSION>
                <ATTRIBUTE_VALUE>2.6</ATTRIBUTE_VALUE>
                <CONFIDENCE>98</CONFIDENCE>
            </VERSION>
            <FRAG_POLICY>linux</FRAG_POLICY>
            <STREAM_POLICY>linux</STREAM_POLICY>
        </OPERATING_SYSTEM>
        <SERVICES>
            <SERVICE>
                <PORT>
                    <ATTRIBUTE_VALUE>22</ATTRIBUTE_VALUE>
                    <CONFIDENCE>100</CONFIDENCE>
                </PORT>
                <IPPROTO>
                    <ATTRIBUTE_VALUE>tcp</ATTRIBUTE_VALUE>
                    <CONFIDENCE>100</CONFIDENCE>
                </IPPROTO>
                <PROTOCOL>
                    <ATTRIBUTE_ID>2</ATTRIBUTE_ID>
                    <CONFIDENCE>100</CONFIDENCE>
                </PROTOCOL>
                <APPLICATION>
                    <ATTRIBUTE_ID>OpenSSH</ATTRIBUTE_ID>
                    <CONFIDENCE>100</CONFIDENCE>
                    <VERSION>
                        <ATTRIBUTE_VALUE>3.9p1</ATTRIBUTE_VALUE>
                        <CONFIDENCE>93</CONFIDENCE>
                    </VERSION>
                </APPLICATION>
            </SERVICE>
            <SERVICE>
                <PORT>
                    <ATTRIBUTE_VALUE>23</ATTRIBUTE_VALUE>
                    <CONFIDENCE>100</CONFIDENCE>
                </PORT>
                <IPPROTO>
                    <ATTRIBUTE_VALUE>tcp</ATTRIBUTE_VALUE>
                    <CONFIDENCE>100</CONFIDENCE>
                </IPPROTO>
                <PROTOCOL>
                    <ATTRIBUTE_VALUE>telnet</ATTRIBUTE_VALUE>
                    <CONFIDENCE>100</CONFIDENCE>
```

```
                </PROTOCOL>
                <APPLICATION>
                    <ATTRIBUTE_VALUE>telnet</ATTRIBUTE_VALUE>
                    <CONFIDENCE>50</CONFIDENCE>
                </APPLICATION>
            </SERVICE>
        </SERVICES>
        <CLIENTS>
            <CLIENT>
                <IPPROTO>
                    <ATTRIBUTE_VALUE>tcp</ATTRIBUTE_VALUE>
                    <CONFIDENCE>100</CONFIDENCE>
                </IPPROTO>
                <PROTOCOL>
                    <ATTRIBUTE_ID>http</ATTRIBUTE_ID>
                    <CONFIDENCE>91</CONFIDENCE>
                </PROTOCOL>
                <APPLICATION>
                    <ATTRIBUTE_ID>IE Http Browser</ATTRIBUTE_ID>
                    <CONFIDENCE>90</CONFIDENCE>
                    <VERSION>
                        <ATTRIBUTE_VALUE>6.0</ATTRIBUTE_VALUE>
                        <CONFIDENCE>89</CONFIDENCE>
                    </VERSION>
                </APPLICATION>
            </CLIENT>
        </CLIENTS>
    </HOST>
</ATTRIBUTE_TABLE>
</SNORT_ATTRIBUTES>
```

With Snort 2.8.1, for a given host entry, the stream and IP frag information are both used. Of the service attributes, only the IP protocol (tcp, udp, etc), port, and protocol (http, ssh, etc) are used. The application and version for a given service attribute, and any client attributes are ignored. They will be used in a future release.

A DTD for verification of the Host Attribute Table XML file is provided with the snort packages.

2.8 Dynamic Modules

Dynamically loadable modules were introduced with Snort 2.6. They can be loaded via directives in `snort.conf` or via command-line options.

To disable use of dynamic modules, Snort must be configured with the `--disable-dynamicplugin` flag.

2.8.1 Format

```
<directive> <parameters>
```

2.8.2 Directives

Syntax	Description
dynamicpreprocessor [file <shared library path> | directory <directory of shared libraries>]	Tells snort to load the dynamic preprocessor shared library (if file is used) or all dynamic preprocessor shared libraries (if directory is used). Specify file, followed by the full or relative path to the shared library. Or, specify directory, followed by the full or relative path to a directory of preprocessor shared libraries. (Same effect as --dynamic-preprocessor-lib or --dynamic-preprocessor-lib-dir options). See chapter 5 for more information on dynamic preprocessor libraries.
dynamicengine [file <shared library path> | directory <directory of shared libraries>]	Tells snort to load the dynamic engine shared library (if file is used) or all dynamic engine shared libraries (if directory is used). Specify file, followed by the full or relative path to the shared library. Or, specify directory, followed by the full or relative path to a directory of preprocessor shared libraries. (Same effect as --dynamic-engine-lib or --dynamic-preprocessor-lib-dir options). See chapter 5 for more information on dynamic engine libraries.
dynamicdetection [file <shared library path> | directory <directory of shared libraries>]	Tells snort to load the dynamic detection rules shared library (if file is used) or all dynamic detection rules shared libraries (if directory is used). Specify file, followed by the full or relative path to the shared library. Or, specify directory, followed by the full or relative path to a directory of detection rules shared libraries. (Same effect as --dynamic-detection-lib or --dynamic-detection-lib-dir options). See chapter 5 for more information on dynamic detection rules libraries.

2.9 Reloading a Snort Configuration

Snort now supports reloading a configuration in lieu of restarting Snort in so as to provide seamless traffic inspection during a configuration change. A separate thread will parse and create a swappable configuration object while the main Snort packet processing thread continues inspecting traffic under the current configuration. When a swappable configuration object is ready for use, the main Snort packet processing thread will swap in the new configuration to use and will continue processing under the new configuration. Note that for some preprocessors, existing session data will continue to use the configuration under which they were created in order to continue with proper state for that session. All newly created sessions will, however, use the new configuration.

2.9.1 Enabling support

To enable support for reloading a configuration, add --enable-reload to configure when compiling.

There is also an ancillary option that determines how Snort should behave if any non-reloadable options are changed (see section 2.9.3 below). This option is enabled by default and the behavior is for Snort to restart if any non-reloadable options are added/modified/removed. To disable this behavior and have Snort exit instead of restart, add --disable-reload-error-restart in addition to --enable-reload to configure when compiling.

This functionality is not currently supported in Windows.

2.9.2 Reloading a configuration

First modify your snort.conf (the file passed to the -c option on the command line).

Then, to initiate a reload, send Snort a SIGHUP signal, e.g.

```
$ kill -SIGHUP <snort pid>
```

If reload support is not enabled, Snort will restart (as it always has) upon receipt of a SIGHUP.

An invalid configuration will still result in Snort fatal erroring, so you should test your new configuration before issuing a reload, e.g. `$ snort -c snort.conf -T`

2.9.3 Non-reloadable configuration options

There are a number of option changes that are currently non-reloadable because they require changes to output, startup memory allocations, etc. Modifying any of these options will cause Snort to restart (as a `SIGHUP` previously did) or exit (if `--disable-reload-error-restart` was used to configure Snort).

Reloadable configuration options of note:

- Adding/modifying/removing text rules and variables are reloadable.
- Adding/modifying/removing preprocessor configurations are reloadable (except as noted below).

Non-reloadable configuration options of note:

- Adding/modifying/removing shared objects via dynamicdetection, dynamicengine and dynamicpreprocessor are not reloadable, i.e. any new/modified/removed shared objects will require a restart.
- Any changes to output will require a restart.

Changes to the following options are not reloadable:

```
attribute_table
config alertfile
config asn1
config chroot
config daemon
config detection_filter
config flexresp2_attempts
config flexresp2_interface
config flexresp2_memcap
config flexresp2_rows
config flowbits_size
config interface
config logdir
config max_attribute_hosts
config nolog
config no_promisc
config pkt_count
config rate_filter
config read_bin_file
config set_gid
config set_uid
config snaplen
config threshold
```

```
dynamicdetection
dynamicengine
dynamicpreprocessor
output
```

In certain cases, only some of the parameters to a config option or preprocessor configuration are not reloadable. Those parameters are listed below the relevant config option or preprocessor.

```
config ppm: max-rule-time <int>
 rule-log
config profile_rules
 filename
 print
 sort
config profile_preprocs
 filename
 print
 sort
preprocessor dcerpc2
 memcap
preprocessor frag3_global
 max_frags
 memcap
 prealloc_frags
 prealloc_memcap
preprocessor perfmonitor
 file
 snortfile
preprocessor sfportscan
 memcap
 logfile
preprocessor stream5_global
 memcap
 max_tcp
 max_udp
 max_icmp
 track_tcp
 track_udp
 track_icmp
```

2.10 Multiple Configurations

Snort now supports multiple configurations based on VLAN Id or IP subnet within a single instance of Snort. This will allow administrators to specify multiple snort configuration files and bind each configuration to one or more VLANs or subnets rather than running one Snort for each configuration required. Each unique snort configuration file will create a new configuration instance within snort. VLANs/Subnets not bound to any specific configuration will use the default configuration. Each configuration can have different preprocessor settings and detection rules.

2.10.1 Creating Multiple Configurations

Default configuration for snort is specified using the existing -c option. A default configuration binds multiple vlans or networks to non-default configurations, using the following configuration line:

```
config binding: <path_to_snort.conf> vlan <vlanIdList>
config binding: <path_to_snort.conf> net <ipList>
```

path_to_snort.conf - Refers to the absolute or relative path to the snort.conf for specific configuration.

vlanIdList - Refers to the comma seperated list of vlandIds and vlanId ranges. The format for ranges is two vlanId separated by a ”-”. Spaces are allowed within ranges. Valid vlanId is any number in 0-4095 range. Negative vland Ids and alphanumeric are not supported.

ipList - Refers to ip subnets. Subnets can be CIDR blocks for IPV6 or IPv4.

Vlan and Subnets can not be used in the same line. Configurations can be applied based on either Vlans or Subnets not both.

Even though Vlan Ids 0 and 4095 are reserved, they are included as valid in terms of configuring Snort.

2.10.2 Configuration Specific Elements

Config Options

Generally config options defined within the default configuration are global by default i.e. their value applies to all other configurations. The following config options are specific to each configuration.

```
policy_id
policy_mode
policy_version
```

The following config options are specific to each configuration. If not defined in a configuration, the default values of the option (not the default configuration values) take effect.

```
config checksum_drop
config disable_decode_alerts
config disable_decode_drops
config disable_ipopt_alerts
config disable_ipopt_drops
config disable_tcpopt_alerts
config disable_tcpopt_drops
config disable_tcpopt_experimental_alerts
config disable_tcpopt_experimental_drops
config disable_tcpopt_obsolete_alerts
config disable_tcpopt_obsolete_drops
config disable_ttcp_alerts
config disable_tcpopt_ttcp_alerts
config disable_ttcp_drops
```

Rules

Rules are specific to configurations but only some parts of a rule can be customized for performance reasons. If a rule is not specified in a configuration then the rule will never raise an event for the configuration. A rule shares all parts of the rule options, including the general options, payload detection options, non-payload detection options, and post-detection options. Parts of the rule header can be specified differently across configurations, limited to:

```
Source IP address and port
Destination IP address and port
Action
```

A higher revision of a rule in one configuration will override other revisions of the same rule in other configurations.

Variables

Variables defined using ”var”, ”portvar” and ”ipvar” are specific to configurations. If the rules in a configuration use variables, those variables must be defined in that configuration.

Preprocessors

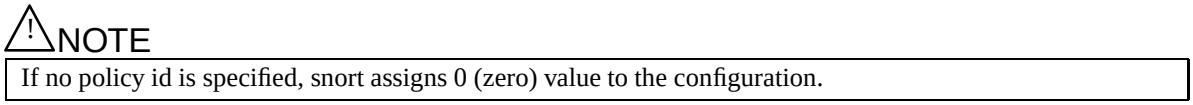
Preprocessors configurations can be defined within each vlan or subnet specific configuration. Options controlling specific preprocessor memory usage, through specific limit on memory usage or number of instances, are processed only in default policy. The options control total memory usage for a preprocessor across all policies. These options are ignored in non-default policies without raising an error. A preprocessor must be configured in default configuration before it can be configured in non-default configuration. This is required as some mandatory preprocessor configuration options are processed only in default configuration.

Events and Output

An unique policy id can be assigned by user, to each configuration using the following config line:

```
config policy_id: <id>
```

`id` - Refers to a 16-bit unsigned value. This policy id will be used to identify alerts from a specific configuration in the unified2 records.

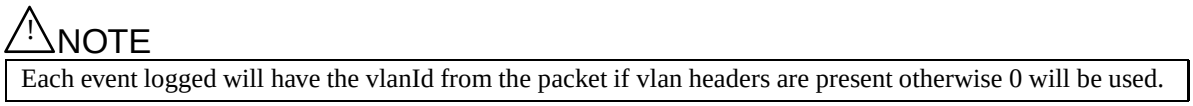


To enable vlanId logging in unified2 records the following option can be used.

```
output alert_unified2: vlan_event_types (alert logging only)
output unified2: filename <filename>, vlan_event_types (true unified logging)
```

`filename` - Refers to the absolute or relative filename.

`vlan_event_types` - When this option is set, snort will use unified2 event type 104 and 105 for IPv4 and IPv6 respectively.



2.10.3 How Configuration is applied?

Snort assigns every incoming packet to a unique configuration based on the following criteria. If VLANID is present, then the innermost VLANID is used to find bound configuration. If the bound configuration is the default configuration, then destination IP address is searched to the most specific subnet that is bound to a non-default configuration. The packet is assigned non-default configuration if found otherwise the check is repeated using source IP address. In the end, default configuration is used if no other matching configuration is found.

For addressed based configuration binding, this can lead to conflicts between configurations if source address is bound to one configuration and destination address is bound to another. In this case, snort will use the first configuration in the order of definition, that can be applied to the packet.

Chapter 3

Writing Snort Rules

3.1 The Basics

Snort uses a simple, lightweight rules description language that is flexible and quite powerful. There are a number of simple guidelines to remember when developing Snort rules that will help safeguard your sanity.

Most Snort rules are written in a single line. This was required in versions prior to 1.8. In current versions of Snort, rules may span multiple lines by adding a backslash \ to the end of the line.

Snort rules are divided into two logical sections, the rule header and the rule options. The rule header contains the rule's action, protocol, source and destination IP addresses and netmasks, and the source and destination ports information. The rule option section contains alert messages and information on which parts of the packet should be inspected to determine if the rule action should be taken.

Figure 3.1 illustrates a sample Snort rule.

The text up to the first parenthesis is the rule header and the section enclosed in parenthesis contains the rule options. The words before the colons in the rule options section are called option *keywords*.

Note that the rule options section is not specifically required by any rule, they are just used for the sake of making tighter definitions of packets to collect or alert on (or drop, for that matter).

All of the elements in that make up a rule must be true for the indicated rule action to be taken. When taken together, the elements can be considered to form a logical AND statement. At the same time, the various rules in a Snort rules library file can be considered to form a large logical OR statement.

3.2 Rules Headers

3.2.1 Rule Actions

The rule header contains the information that defines the who, where, and what of a packet, as well as what to do in the event that a packet with all the attributes indicated in the rule should show up. The first item in a rule is the rule

```
alert tcp any any -> 192.168.1.0/24 111 \
    (content:"|00 01 86 a5|"; msg:"mountd access";)
```

Figure 3.1: Sample Snort Rule

action. The rule action tells Snort what to do when it finds a packet that matches the rule criteria. There are 5 available default actions in Snort, alert, log, pass, activate, and dynamic. In addition, if you are running Snort in inline mode, you have additional options which include drop, reject, and sdrop.

1. alert - generate an alert using the selected alert method, and then log the packet
2. log - log the packet
3. pass - ignore the packet
4. activate - alert and then turn on another dynamic rule
5. dynamic - remain idle until activated by an activate rule , then act as a log rule
6. drop - make iptables drop the packet and log the packet
7. reject - make iptables drop the packet, log it, and then send a TCP reset if the protocol is TCP or an ICMP port unreachable message if the protocol is UDP.
8. sdrop - make iptables drop the packet but do not log it.

You can also define your own rule types and associate one or more output plugins with them. You can then use the rule types as actions in Snort rules.

This example will create a type that will log to just tcpdump:

```
ruletype suspicious
{
    type log
    output log_tcpdump: suspicious.log
}
```

This example will create a rule type that will log to syslog and a MySQL database:

```
ruletype redalert
{
      type alert
      output alert_syslog: LOG_AUTH LOG_ALERT
      output database: log, mysql, user=snort dbname=snort host=localhost
}
```

3.2.2 Protocols

The next field in a rule is the protocol. There are four protocols that Snort currently analyzes for suspicious behavior – TCP, UDP, ICMP, and IP. In the future there may be more, such as ARP, IGRP, GRE, OSPF, RIP, IPX, etc.

3.2.3 IP Addresses

The next portion of the rule header deals with the IP address and port information for a given rule. The keyword any may be used to define any address. Snort does not have a mechanism to provide host name lookup for the IP address fields in the rules file. The addresses are formed by a straight numeric IP address and a CIDR[3] block. The CIDR block indicates the netmask that should be applied to the rule's address and any incoming packets that are tested against the rule. A CIDR block mask of /24 indicates a Class C network, /16 a Class B network, and /32 indicates a specific machine address. For example, the address/CIDR combination 192.168.1.0/24 would signify the block of addresses from 192.168.1.1 to 192.168.1.255. Any rule that used this designation for, say, the destination address would match on any address in that range. The CIDR designations give us a nice short-hand way to designate large address spaces with just a few characters.

```
alert tcp !192.168.1.0/24 any -> 192.168.1.0/24 111 \
    (content: "|00 01 86 a5|"; msg: "external mountd access";)
```

Figure 3.2: Example IP Address Negation Rule

```
alert tcp ![192.168.1.0/24,10.1.1.0/24] any -> \
    [192.168.1.0/24,10.1.1.0/24] 111 (content: "|00 01 86 a5|"; \
    msg: "external mountd access";)
```

Figure 3.3: IP Address Lists

In Figure 3.1, the source IP address was set to match for any computer talking, and the destination address was set to match on the 192.168.1.0 Class C network.

There is an operator that can be applied to IP addresses, the negation operator. This operator tells Snort to match any IP address except the one indicated by the listed IP address. The negation operator is indicated with a !. For example, an easy modification to the initial example is to make it alert on any traffic that originates outside of the local net with the negation operator as shown in Figure 3.2.

This rule's IP addresses indicate any tcp packet with a source IP address not originating from the internal network and a destination address on the internal network.

You may also specify lists of IP addresses. An IP list is specified by enclosing a comma separated list of IP addresses and CIDR blocks within square brackets. For the time being, the IP list may not include spaces between the addresses. See Figure 3.3 for an example of an IP list in action.

3.2.4 Port Numbers

Port numbers may be specified in a number of ways, including any ports, static port definitions, ranges, and by negation. Any ports are a wildcard value, meaning literally any port. Static ports are indicated by a single port number, such as 111 for portmapper, 23 for telnet, or 80 for http, etc. Port ranges are indicated with the range operator :. The range operator may be applied in a number of ways to take on different meanings, such as in Figure 3.4.

Port negation is indicated by using the negation operator !. The negation operator may be applied against any of the other rule types (except any, which would translate to none, how Zen...). For example, if for some twisted reason you wanted to log everything except the X Windows ports, you could do something like the rule in Figure 3.5.

3.2.5 The Direction Operator

The direction operator -> indicates the orientation, or direction, of the traffic that the rule applies to. The IP address and port numbers on the left side of the direction operator is considered to be the traffic coming from the source

```
log udp any any -> 192.168.1.0/24 1:1024 log udp
```

traffic coming from any port and destination ports ranging from 1 to 1024

```
log tcp any any -> 192.168.1.0/24 :6000
```

log tcp traffic from any port going to ports less than or equal to 6000

```
log tcp any :1024 -> 192.168.1.0/24 500:
```

log tcp traffic from privileged ports less than or equal to 1024 going to ports greater than or equal to 500

Figure 3.4: Port Range Examples

```
log tcp any any -> 192.168.1.0/24 !6000:6010
```

Figure 3.5: Example of Port Negation

```
log tcp !192.168.1.0/24 any <> 192.168.1.0/24 23
```

Figure 3.6: Snort rules using the Bidirectional Operator

host, and the address and port information on the right side of the operator is the destination host. There is also a bidirectional operator, which is indicated with a <> symbol. This tells Snort to consider the address/port pairs in either the source or destination orientation. This is handy for recording/analyzing both sides of a conversation, such as telnet or POP3 sessions. An example of the bidirectional operator being used to record both sides of a telnet session is shown in Figure 3.6.

Also, note that there is no <- operator. In Snort versions before 1.8.7, the direction operator did not have proper error checking and many people used an invalid token. The reason the <- does not exist is so that rules always read consistently.

3.2.6 Activate/Dynamic Rules

Activate and Dynamic rules are being phased out in favor of a combination of tagging (3.7.5) and flowbits (3.6.10).

Activate/dynamic rule pairs give Snort a powerful capability. You can now have one rule activate another when it's action is performed for a set number of packets. This is very useful if you want to set Snort up to perform follow on recording when a specific rule goes off. Activate rules act just like alert rules, except they have a *required* option field: activates. Dynamic rules act just like log rules, but they have a different option field: activated_by. Dynamic rules have a second required field as well, count.

Activate rules are just like alerts but also tell Snort to add a rule when a specific network event occurs. Dynamic rules are just like log rules except are dynamically enabled when the activate rule id goes off.

Put 'em together and they look like Figure 3.7.

These rules tell Snort to alert when it detects an IMAP buffer overflow and collect the next 50 packets headed for port 143 coming from outside $HOME_NET headed to $HOME_NET. If the buffer overflow happened and was successful, there's a very good possibility that useful data will be contained within the next 50 (or whatever) packets going to that same service port on the network, so there's value in collecting those packets for later analysis.

3.3 Rule Options

Rule options form the heart of Snort's intrusion detection engine, combining ease of use with power and flexibility. All Snort rule options are separated from each other using the semicolon (;) character. Rule option keywords are separated from their arguments with a colon (:) character.

```
activate tcp !$HOME_NET any -> $HOME_NET 143 (flags: PA; \
    content: "|E8C0FFFFFF|/bin"; activates: 1;  \
    msg: "IMAP buffer overflow!";)
dynamic tcp !$HOME_NET any -> $HOME_NET 143 (activated_by: 1; count: 50;)
```

Figure 3.7: Activate/Dynamic Rule Example

There are four major categories of rule options.

general These options provide information about the rule but do not have any affect during detection

payload These options all look for data inside the packet payload and can be inter-related

non-payload These options look for non-payload data

post-detection These options are rule specific triggers that happen after a rule has "fired."

3.4 General Rule Options

3.4.1 msg

The msg rule option tells the logging and alerting engine the message to print along with a packet dump or to an alert. It is a simple text string that utilizes the \ as an escape character to indicate a discrete character that might otherwise confuse Snort's rules parser (such as the semi-colon ; character).

Format

```
msg: "<message text>";
```

3.4.2 reference

The reference keyword allows rules to include references to external attack identification systems. The plugin currently supports several specific systems as well as unique URLs. This plugin is to be used by output plugins to provide a link to additional information about the alert produced.

Make sure to also take a look at `http://www.snort.org/pub-bin/sigs-search.cgi/` for a system that is indexing descriptions of alerts based on of the sid (See Section 3.4.4).

Table 3.1: Supported Systems

System	URL Prefix
bugtraq	http://www.securityfocus.com/bid/
cve	http://cve.mitre.org/cgi-bin/cvename.cgi?name=
nessus	http://cgi.nessus.org/plugins/dump.php3?id=
arachnids	(currently down) http://www.whitehats.com/info/IDS
mcafee	http://vil.nai.com/vil/dispVirus.asp?virus_k=
url	http://

Format

```
reference: <id system>,<id>; [reference: <id system>,<id>;]
```

Examples

```
alert tcp any any -> any 7070 (msg:"IDS411/dos-realaudio"; \
    flags:AP; content:"|fff4 fffd 06|"; reference:arachnids,IDS411;)

alert tcp any any -> any 21 (msg:"IDS287/ftp-wuftp260-venglin-linux"; \
    flags:AP; content:"|31c031db 31c9b046 cd80 31c031db|"; \
```

```
reference:arachnids,IDS287; reference:bugtraq,1387; \
reference:cve,CAN-2000-1574;)
```

3.4.3 gid

The `gid` keyword (generator id) is used to identify what part of Snort generates the event when a particular rule fires. For example gid 1 is associated with the rules subsystem and various gids over 100 are designated for specific preprocessors and the decoder. See etc/generators in the source tree for the current generator ids in use. Note that the gid keyword is optional and if it is not specified in a rule, it will default to 1 and the rule will be part of the general rule subsystem. To avoid potential conflict with gids defined in Snort (that for some reason aren't noted it etc/generators), it is recommended that a value greater than 1,000,000 be used. For general rule writing, it is not recommended that the `gid` keyword be used. This option should be used with the `sid` keyword. (See section 3.4.4)

The file etc/gen-msg.map contains contains more information on preprocessor and decoder gids.

Format

```
gid: <generator id>;
```

Example

This example is a rule with a generator id of 1000001.

```
alert tcp any any -> any 80 (content:"BOB"; gid:1000001; sid:1; rev:1;)
```

3.4.4 sid

The `sid` keyword is used to uniquely identify Snort rules. This information allows output plugins to identify rules easily. This option should be used with the `rev` keyword. (See section 3.4.5)

- $<$100 Reserved for future use
- 100-1,000,000 Rules included with the Snort distribution
- $>$1,000,000 Used for local rules

The file sid-msg.map contains a mapping of alert messages to Snort rule IDs. This information is useful when post-processing alert to map an ID to an alert message.

Format

```
sid: <snort rules id>;
```

Example

This example is a rule with the Snort Rule ID of 1000983.

```
alert tcp any any -> any 80 (content:"BOB"; sid:1000983; rev:1;)
```

3.4.5 rev

The `rev` keyword is used to uniquely identify revisions of Snort rules. Revisions, along with Snort rule id's, allow signatures and descriptions to be refined and replaced with updated information. This option should be used with the `sid` keyword. (See section 3.4.4)

Format

```
rev: <revision integer>;
```

Example

This example is a rule with the Snort Rule Revision of 1.

```
alert tcp any any -> any 80 (content:"BOB"; sid:1000983; rev:1;)
```

3.4.6 classtype

The `classtype` keyword is used to categorize a rule as detecting an attack that is part of a more general type of attack class. Snort provides a default set of attack classes that are used by the default set of rules it provides. Defining classifications for rules provides a way to better organize the event data Snort produces.

Format

```
classtype: <class name>;
```

Example

```
alert tcp any any -> any 25 (msg:"SMTP expn root"; flags:A+; \
    content:"expn root"; nocase; classtype:attempted-recon;)
```

Attack classifications defined by Snort reside in the `classification.config` file. The file uses the following syntax:

```
config classification:  <class name>,<class description>,<default priority>
```

These attack classifications are listed in Table 3.2. They are currently ordered with 3 default priorities. A priority of 1 (high) is the most severe and 3 (low) is the least severe.

Table 3.2: Snort Default Classifications

Classtype	Description	Priority
attempted-admin	Attempted Administrator Privilege Gain	high
attempted-user	Attempted User Privilege Gain	high
kickass-porn	SCORE! Get the lotion!	high
policy-violation	Potential Corporate Privacy Violation	high
shellcode-detect	Executable code was detected	high
successful-admin	Successful Administrator Privilege Gain	high
successful-user	Successful User Privilege Gain	high
trojan-activity	A Network Trojan was detected	high
unsuccessful-user	Unsuccessful User Privilege Gain	high
web-application-attack	Web Application Attack	high

attempted-dos	Attempted Denial of Service	medium
attempted-recon	Attempted Information Leak	medium
bad-unknown	Potentially Bad Traffic	medium
default-login-attempt	Attempt to login by a default username and password	medium
denial-of-service	Detection of a Denial of Service Attack	medium
misc-attack	Misc Attack	medium
non-standard-protocol	Detection of a non-standard protocol or event	medium
rpc-portmap-decode	Decode of an RPC Query	medium
successful-dos	Denial of Service	medium
successful-recon-largescale	Large Scale Information Leak	medium
successful-recon-limited	Information Leak	medium
suspicious-filename-detect	A suspicious filename was detected	medium
suspicious-login	An attempted login using a suspicious username was detected	medium
system-call-detect	A system call was detected	medium
unusual-client-port-connection	A client was using an unusual port	medium
web-application-activity	Access to a potentially vulnerable web application	medium
icmp-event	Generic ICMP event	low
misc-activity	Misc activity	low
network-scan	Detection of a Network Scan	low
not-suspicious	Not Suspicious Traffic	low
protocol-command-decode	Generic Protocol Command Decode	low
string-detect	A suspicious string was detected	low
unknown	Unknown Traffic	low
tcp-connection	A TCP connection was detected	very low

Warnings

The `classtype` option can only use classifications that have been defined in `snort.conf` by using the `config classification` option. Snort provides a default set of classifications in `classification.config` that are used by the rules it provides.

3.4.7 priority

The `priority` tag assigns a severity level to rules. A `classtype` rule assigns a default priority (defined by the `config classification` option) that may be overridden with a priority rule. Examples of each case are given below.

Format

```
priority: <priority integer>;
```

Examples

```
alert TCP any any -> any 80 (msg: "WEB-MISC phf attempt"; flags:A+; \
    content: "/cgi-bin/phf"; priority:10;)

alert tcp any any -> any 80 (msg:"EXPLOIT ntpdx overflow"; \
    dsize: >128; classtype:attempted-admin; priority:10 );
```

3.4.8 metadata

The `metadata` tag allows a rule writer to embed additional information about the rule, typically in a key-value format. Certain metadata keys and values have meaning to Snort and are listed in Table 3.3. Keys other than those listed in the table are effectively ignored by Snort and can be free-form, with a key and a value. Multiple keys are separated by a comma, while keys and values are separated by a space.

Table 3.3: Snort Metadata Keys

Key	Description	Value Format
`engine`	Indicate a Shared Library Rule	”shared”
`soid`	Shared Library Rule Generator and SID	gid|sid
`service`	Target-Based Service Identifier	”http”

⚠NOTE

The `service` Metadata Key is only meaningful when a Host Atttribute Table is provided. When the value exactly matches the service ID as specified in the table, the rule is applied to that packet, otherwise, the rule is not applied (even if the ports specified in the rule match). See Section 2.7 for details on the Host Attribute Table.

.

Format

The examples below show an stub rule from a shared library rule. The first uses multiple metadata keywords, the second a single metadata keyword, with keys separated by commas.

```
metadata: key1 value1;
metadata: key1 value1, key2 value2;
```

Examples

```
alert tcp any any -> any 80 (msg: "Shared Library Rule Example"; \
    metadata:engine shared; metadata:soid 3|12345;)

alert tcp any any -> any 80 (msg: "Shared Library Rule Example"; \
    metadata:engine shared, soid 3|12345;)

alert tcp any any -> any 80 (msg: "HTTP Service Rule Example"; \
    metadata:service http;)
```

3.4.9 General Rule Quick Reference

Table 3.4: General rule option keywords

Keyword	Description
`msg`	The msg keyword tells the logging and alerting engine the message to print with the packet dump or alert.
`reference`	The reference keyword allows rules to include references to external attack identification systems.
`gid`	The gid keyword (generator id) is used to identify what part of Snort generates the event when a particular rule fires.

sid	The sid keyword is used to uniquely identify Snort rules.
rev	The rev keyword is used to uniquely identify revisions of Snort rules.
classtype	The classtype keyword is used to categorize a rule as detecting an attack that is part of a more general type of attack class.
priority	The priority keyword assigns a severity level to rules.
metadata	The metadata keyword allows a rule writer to embed additional information about the rule, typically in a key-value format.

3.5 Payload Detection Rule Options

3.5.1 content

The content keyword is one of the more important features of Snort. It allows the user to set rules that search for specific content in the packet payload and trigger response based on that data. Whenever a content option pattern match is performed, the Boyer-Moore pattern match function is called and the (rather computationally expensive) test is performed against the packet contents. If data exactly matching the argument data string is contained anywhere within the packet's payload, the test is successful and the remainder of the rule option tests are performed. Be aware that this test is case sensitive.

The option data for the content keyword is somewhat complex; it can contain mixed text and binary data. The binary data is generally enclosed within the pipe (|) character and represented as bytecode. Bytecode represents binary data as hexadecimal numbers and is a good shorthand method for describing complex binary data. The example below shows use of mixed text and binary data in a Snort rule.

Note that multiple content rules can be specified in one rule. This allows rules to be tailored for less false positives.

If the rule is preceded by a `!`, the alert will be triggered on packets that do not contain this content. This is useful when writing rules that want to alert on packets that do not match a certain pattern

Also note that the following characters must be escaped inside a content rule:
`: ; \ "`

Format

```
content: [!] "<content string>";
```

Examples

```
alert tcp any any -> any 139 (content:"|5c 00|P|00|I|00|P|00|E|00 5c|";)

alert tcp any any -> any 80 (content:!"GET";)
```

A `!` modifier negates the results of the entire content search, modifiers included. For example, if using `content:!"A"; within:50;` and there are only 5 bytes of payload and there is no "A" in those 5 bytes, the result will return a match. If there must be 50 bytes for a valid match, use `isdataat` as a pre-cursor to the content.

Changing content behavior

The `content` keyword has a number of modifier keywords. The modifier keywords change how the previously specified content works. These modifier keywords are:

Table 3.5: Content Modifiers

Modifier	Section
nocase	3.5.2
rawbytes	3.5.3
depth	3.5.4
offset	3.5.5
distance	3.5.6
within	3.5.7
http_client_body	3.5.8
http_cookie	3.5.9
http_header	3.5.10
http_method	3.5.11
http_uri	3.5.12
fast_pattern	3.5.13

3.5.2 nocase

The nocase keyword allows the rule writer to specify that the Snort should look for the specific pattern, ignoring case. nocase modifies the previous 'content' keyword in the rule.

Format

```
nocase;
```

Example

```
alert tcp any any -> any 21 (msg:"FTP ROOT"; content:"USER root"; nocase;)
```

3.5.3 rawbytes

The rawbytes keyword allows rules to look at the raw packet data, ignoring any decoding that was done by preprocessors. This acts as a modifier to the previous content 3.5.1 option.

format

```
rawbytes;
```

Example

This example tells the content pattern matcher to look at the raw traffic, instead of the decoded traffic provided by the Telnet decoder.

```
alert tcp any any -> any 21 (msg: "Telnet NOP"; content: "|FF F1|"; rawbytes;)
```

3.5.4 depth

The depth keyword allows the rule writer to specify how far into a packet Snort should search for the specified pattern. depth modifies the previous ‘content’ keyword in the rule.

A depth of 5 would tell Snort to only look for the specified pattern within the first 5 bytes of the payload.

As the depth keyword is a modifier to the previous ‘content’ keyword, there must be a content in the rule before ‘depth’ is specified.

Format

```
depth: <number>;
```

3.5.5 offset

The offset keyword allows the rule writer to specify where to start searching for a pattern within a packet. offset modifies the previous ’content’ keyword in the rule.

An offset of 5 would tell Snort to start looking for the specified pattern after the first 5 bytes of the payload.

As this keyword is a modifier to the previous ’content’ keyword, there must be a content in the rule before ’offset’ is specified.

Format

```
offset: <number>;
```

Example

The following example shows use of a combined content, offset, and depth search rule.

```
alert tcp any any -> any 80 (content: "cgi-bin/phf"; offset:4; depth:20;)
```

3.5.6 distance

The distance keyword allows the rule writer to specify how far into a packet Snort should ignore before starting to search for the specified pattern relative to the end of the previous pattern match.

This can be thought of as exactly the same thing as offset (See Section 3.5.5), except it is relative to the end of the last pattern match instead of the beginning of the packet.

Format

```
distance: <byte count>;
```

Example

The rule below maps to a regular expression of /ABC.{1}DEF/.

```
alert tcp any any -> any any (content:"ABC"; content: "DEF"; distance:1;)
```

3.5.7 within

The within keyword is a content modifier that makes sure that at most N bytes are between pattern matches using the content keyword (See Section 3.5.1). It's designed to be used in conjunction with the distance (Section 3.5.6) rule option.

Format

```
within: <byte count>;
```

Examples

This rule constrains the search of EFG to not go past 10 bytes past the ABC match.

```
alert tcp any any -> any any (content:"ABC"; content: "EFG"; within:10;)
```

3.5.8 http_client_body

The http_client_body keyword is a content modifier that restricts the search to the NORMALIZED body of an HTTP client request.

As this keyword is a modifier to the previous 'content' keyword, there must be a content in the rule before 'http_client_body' is specified.

Format

```
http_client_body;
```

Examples

This rule constrains the search for the pattern "EFG" to the NORMALIZED body of an HTTP client request.

```
alert tcp any any -> any 80 (content:"ABC"; content: "EFG"; http_client_body;)
```

The `http_client_body` modifier is not allowed to be used with the `rawbytes` modifier for the same content.

3.5.9 http_cookie

The http_cookie keyword is a content modifier that restricts the search to the extracted Cookie Header field of an HTTP client request.

As this keyword is a modifier to the previous 'content' keyword, there must be a content in the rule before 'http_cookie' is specified.

The extracted Cookie Header field may be NORMALIZED, per the configuration of HttpInspect (see 2.2.6).

Format

```
http_cookie;
```

Examples

This rule constrains the search for the pattern ”EFG” to the extracted Cookie Header field of an HTTP client request.

```
alert tcp any any -> any 80 (content:"ABC"; content: "EFG"; http_cookie;)
```

The `http_cookie` modifier is not allowed to be used with the `rawbytes` or `fast_pattern` modifiers for the same content.

3.5.10 http_header

The http_header keyword is a content modifier that restricts the search to the extracted Header fields of an HTTP client request.

As this keyword is a modifier to the previous ’content’ keyword, there must be a content in the rule before ’http_header’ is specified.

The extracted Header fields may be NORMALIZED, per the configuration of HttpInspect (see 2.2.6).

Format

```
http_header;
```

Examples

This rule constrains the search for the pattern ”EFG” to the extracted Header fields of an HTTP client request.

```
alert tcp any any -> any 80 (content:"ABC"; content: "EFG"; http_header;)
```

The `http_header` modifier is not allowed to be used with the `rawbytes` modifier for the same content.

3.5.11 http_method

The http_method keyword is a content modifier that restricts the search to the extracted Method from an HTTP client request.

As this keyword is a modifier to the previous ’content’ keyword, there must be a content in the rule before ’http_method’ is specified.

Format

```
http_method;
```

Examples

This rule constrains the search for the pattern ”GET” to the extracted Method from an HTTP client request.

```
alert tcp any any -> any 80 (content:"ABC"; content: "GET"; http_method;)
```

⚠NOTE

The `http_method` modifier is not allowed to be used with the `rawbytes` modifier for the same content.

3.5.12 http_uri

The http_uri keyword is a content modifier that restricts the search to the NORMALIZED request URI field . Using a content rule option followed by a http_uri modifier is the same as using a uricontent by itself (see: 3.5.14).

As this keyword is a modifier to the previous ’content’ keyword, there must be a content in the rule before ’http_uri’ is specified.

Format

```
http_uri;
```

Examples

This rule constrains the search for the pattern ”EFG” to the NORMALIZED URI.

```
alert tcp any any -> any 80 (content:"ABC"; content: "EFG"; http_uri;)
```

⚠NOTE

The `http_uri` modifier is not allowed to be used with the `rawbytes` modifier for the same content.

3.5.13 fast_pattern

The fast_pattern keyword is a content modifier that sets the content within a rule to be used with the Fast Pattern Matcher. It overrides the default of using the longest content within the rule.

fast_pattern may be specified at most once for each of the buffer modifiers (excluding the http_cookie modifier).

As this keyword is a modifier to the previous ’content’ keyword, there must be a content in the rule before ’fast_pattern’ is specified.

Format

```
fast_pattern;
```

Examples

This rule causes the pattern ”EFG” to be used with the Fast Pattern Matcher, even though it is shorter than the earlier pattern ”ABCD”.

```
alert tcp any any -> any 80 (content:"ABCD"; content: "EFG"; fast_pattern;)
```

⚠NOTE

The `fast_pattern` modifier is not allowed to be used with the `http_cookie` modifier for the same content, nor with a content that is negated with a `!`.

3.5.14 uricontent

The `uricontent` keyword in the Snort rule language searches the NORMALIZED request URI field. This means that if you are writing rules that include things that are normalized, such as %2f or directory traversals, these rules will not alert. The reason is that the things you are looking for are normalized out of the URI buffer.

For example, the URI:

```
/scripts/..%c0%af../winnt/system32/cmd.exe?/c+ver
```

will get normalized into:

```
/winnt/system32/cmd.exe?/c+ver
```

Another example, the URI:

```
/cgi-bin/aaaaaaaaaaaaaaaaaaaaaaaaa/..%252fp%68f?
```

will get normalized into:

```
/cgi-bin/phf?
```

When writing a `uricontent` rule, write the content that you want to find in the context that the URI will be normalized. For example, if Snort normalizes directory traversals, do not include directory traversals.

You can write rules that look for the non-normalized content by using the content option. (See Section 3.5.1)

For a description of the parameters to this function, see the content rule options in Section 3.5.1.

This option works in conjunction with the HTTP Inspect preprocessor specified in Section 2.2.6.

Format

```
uricontent:[!]<content string>;
```

⚠NOTE

`uricontent` cannot be modified by a `rawbytes` modifier.

3.5.15 urilen

The `urilen` keyword in the Snort rule language specifies the exact length, the minimum length, the maximum length, or range of URI lengths to match.

Format

```
urilen: int<>int;
urilen: [<,>] <int>;
```

The following example will match URIs that are 5 bytes long:

```
urilen: 5
```

The following example will match URIs that are shorter than 5 bytes:

```
urilen: < 5
```

The following example will match URIs that are greater than 5 bytes and less than 10 bytes:

```
urilen: 5<>10
```

This option works in conjunction with the HTTP Inspect preprocessor specified in Section 2.2.6.

3.5.16 isdataat

Verify that the payload has data at a specified location, optionally looking for data relative to the end of the previous content match.

Format

```
isdataat:<int>[,relative];
```

Example

```
alert tcp any any -> any 111 (content:"PASS"; isdataat:50,relative; \
    content:!"|0a|"; within:50;)
```

This rule looks for the string PASS exists in the packet, then verifies there is at least 50 bytes after the end of the string PASS, then verifies that there is not a newline character within 50 bytes of the end of the PASS string.

3.5.17 pcre

The pcre keyword allows rules to be written using perl compatible regular expressions. For more detail on what can be done via a pcre regular expression, check out the PCRE web site `http://www.pcre.org`

Format

```
pcre:[!]"(/<regex>/|m<delim><regex><delim>)[ismxAEGRUBPHMCO]";
```

The post-re modifiers set compile time flags for the regular expression. See tables 3.6, 3.7, and 3.8 for descriptions of each modifier.

⚠NOTE

The modifiers R and B should not be used together.

Table 3.6: Perl compatible modifiers for `pcre`

i	case insensitive
s	include newlines in the dot metacharacter
m	By default, the string is treated as one big line of characters. ^ and $ match at the beginning and ending of the string. When m is set, ^ and $ match immediately following or immediately before any newline in the buffer, as well as the very start and very end of the buffer.
x	whitespace data characters in the pattern are ignored except when escaped or inside a character class

Table 3.7: PCRE compatible modifiers for `pcre`

A	the pattern must match only at the start of the buffer (same as ^)
E	Set $ to match only at the end of the subject string. Without E, $ also matches immediately before the final character if it is a newline (but not before any other newlines).
G	Inverts the ”greediness” of the quantifiers so that they are not greedy by default, but become greedy if followed by ”?”.

Example

This example performs a case-insensitive search for the string BLAH in the payload.

```
alert ip any any -> any any (pcre:"/BLAH/i";)
```

Snort’s handling of multiple URIs with PCRE does not work as expected. PCRE when used without a `uricontent` only evaluates the first URI. In order to use pcre to inspect all URIs, you must use either a content or a uricontent.

3.5.18 byte_test

Test a byte field against a specific value (with operator). Capable of testing binary values or converting representative byte strings to their binary equivalent and testing them.

For a more detailed explanation, please read Section 3.9.5.

Format

```
byte_test: <bytes to convert>, [!]<operator>, <value>, <offset>  \
    [,relative] [,<endian>] [,<number type>, string];
```

Table 3.8: Snort specific modifiers for `pcre`

R	Match relative to the end of the last pattern match. (Similar to distance:0;)
U	Match the decoded URI buffers (Similar to `uricontent` and `http_uri`)
P	Match normalized HTTP request body (Similar to `http_client_body`)
H	Match normalized HTTP request header (Similar to `http_header`)
M	Match normalized HTTP request method (Similar to `http_method`)
C	Match normalized HTTP request cookie (Similar to `http_cookie`)
B	Do not use the decoded buffers (Similar to rawbytes)
O	Override the configured pcre match limit for this expression (See section 2.1.3)

Option	**Description**
`bytes_to_convert`	Number of bytes to pick up from the packet
`operator`	Operation to perform to test the value: • < - less than • > - greater than • = - equal • ! - not • & - bitwise AND • ^ - bitwise OR
`value`	Value to test the converted value against
`offset`	Number of bytes into the payload to start processing
`relative`	Use an offset relative to last pattern match
`endian`	Endian type of the number being read: • `big` - Process data as big endian (default) • `little` - Process data as little endian
`string`	Data is stored in string format in packet
`number type`	Type of number being read: • `hex` - Converted string data is represented in hexadecimal • `dec` - Converted string data is represented in decimal • `oct` - Converted string data is represented in octal
`dce`	Let the DCE/RPC 2 preprocessor determine the byte order of the value to be converted. See section 2.2.14 for a description and examples (2.2.14 for quick reference).

Any of the operators can also include *!* to check if the operator is not true. If *!* is specified without an operator, then the operator is set to =.

⚠NOTE

Snort uses the C operators for each of these operators. If the & operator is used, then it would be the same as using *if (data & value)* { *do_something();*}

Examples

```
alert udp $EXTERNAL_NET any -> $HOME_NET any \
    (msg:"AMD procedure 7 plog overflow "; \
    content: "|00 04 93 F3|"; \
    content: "|00 00 00 07|"; distance: 4; within: 4; \
    byte_test: 4,>, 1000, 20, relative;)

alert tcp $EXTERNAL_NET any -> $HOME_NET any \
    (msg:"AMD procedure 7 plog overflow "; \
    content: "|00 04 93 F3|"; \
    content: "|00 00 00 07|"; distance: 4; within: 4; \
    byte_test: 4, >,1000, 20, relative;)

alert udp any any -> any 1234 \
    (byte_test: 4, =, 1234, 0, string, dec; \
    msg: "got 1234!";)

alert udp any any -> any 1235 \
    (byte_test: 3, =, 123, 0, string, dec; \
    msg: "got 123!";)

alert udp any any -> any 1236 \
    (byte_test: 2, =, 12, 0, string, dec; \
    msg: "got 12!";)

alert udp any any -> any 1237 \
    (byte_test: 10, =, 1234567890, 0, string, dec; \
    msg: "got 1234567890!";)

alert udp any any -> any 1238 \
    (byte_test: 8, =, 0xdeadbeef, 0, string, hex; \
    msg: "got DEADBEEF!";)
```

3.5.19 byte_jump

The byte_jump keyword allows rules to be written for length encoded protocols trivially. By having an option that reads the length of a portion of data, then skips that far forward in the packet, rules can be written that skip over specific portions of length-encoded protocols and perform detection in very specific locations.

The byte_jump option does this by reading some number of bytes, convert them to their numeric representation, move that many bytes forward and set a pointer for later detection. This pointer is known as the detect offset end pointer, or doe_ptr.

For a more detailed explanation, please read Section 3.9.5.

Format

```
byte_jump: <bytes_to_convert>, <offset> \
    [,relative] [,multiplier <multiplier value>] [,big] [,little][,string]\
    [,hex] [,dec] [,oct] [,align] [,from_beginning] [,post_offset <adjustment value>];
```

Option	Description
bytes_to_convert	Number of bytes to pick up from the packet
offset	Number of bytes into the payload to start processing
relative	Use an offset relative to last pattern match
multiplier <value>	Multiply the number of calculated bytes by <value> and skip forward that number of bytes.
big	Process data as big endian (default)
little	Process data as little endian
string	Data is stored in string format in packet
hex	Converted string data is represented in hexadecimal
dec	Converted string data is represented in decimal
oct	Converted string data is represented in octal
align	Round the number of converted bytes up to the next 32-bit boundary
from_beginning	Skip forward from the beginning of the packet payload instead of from the current position in the packet.
post_offset <value>	Skip forward or backwards (positive of negative value) by <value> number of bytes after the other jump options have been applied.
dce	Let the DCE/RPC 2 preprocessor determine the byte order of the value to be converted. See section 2.2.14 for a description and examples (2.2.14 for quick reference).

Example

```
alert udp any any -> any 32770:34000 (content: "|00 01 86 B8|"; \
    content: "|00 00 00 01|"; distance: 4; within: 4; \
    byte_jump: 4, 12, relative, align; \
    byte_test: 4, >, 900, 20, relative; \
    msg: "statd format string buffer overflow";)
```

3.5.20 ftpbounce

The ftpbounce keyword detects FTP bounce attacks.

Format

```
ftpbounce;
```

Example

```
alert tcp $EXTERNAL_NET any -> $HOME_NET 21 (msg:"FTP PORT bounce attempt"; \
    flow:to_server,established; content:"PORT"; nocase; ftpbounce; pcre:"/^PORT/smi";\
    classtype:misc-attack; sid:3441; rev:1;)
```

3.5.21 asn1

The ASN.1 detection plugin decodes a packet or a portion of a packet, and looks for various malicious encodings.

Multiple options can be used in an 'asn1' option and the implied logic is boolean OR. So if any of the arguments evaluate as true, the whole option evaluates as true.

The ASN.1 options provide programmatic detection capabilities as well as some more dynamic type detection. If an option has an argument, the option and the argument are separated by a space or a comma. The preferred usage is to use a space between option and argument.

Format

```
asn1: option[ argument][, option[ argument]] . . .
```

Option	Description
bitstring_overflow	Detects invalid bitstring encodings that are known to be remotely exploitable.
double_overflow	Detects a double ASCII encoding that is larger than a standard buffer. This is known to be an exploitable function in Microsoft, but it is unknown at this time which services may be exploitable.
oversize_length <value>	Compares ASN.1 type lengths with the supplied argument. The syntax looks like, "oversize_length 500". This means that if an ASN.1 type is greater than 500, then this keyword is evaluated as true. This keyword must have one argument which specifies the length to compare against.
absolute_offset <value>	This is the absolute offset from the beginning of the packet. For example, if you wanted to decode snmp packets, you would say "absolute_offset 0". absolute_offset has one argument, the offset value. Offset may be positive or negative.
relative_offset <value>	This is the relative offset from the last content match or byte_test/jump. relative_offset has one argument, the offset number. So if you wanted to start decoding and ASN.1 sequence right after the content "foo", you would specify 'content:"foo"; asn1: bitstring_overflow, relative_offset 0'. Offset values may be positive or negative.

Examples

```
alert udp any any -> any 161 (msg:"Oversize SNMP Length"; \
    asn1: oversize_length 10000, absolute_offset 0;)

alert tcp any any -> any 80 (msg:"ASN1 Relative Foo"; content:"foo"; \
    asn1: bitstring_overflow, relative_offset 0;)
```

3.5.22 cvs

The CVS detection plugin aids in the detection of: Bugtraq-10384, CVE-2004-0396: "Malformed Entry Modified and Unchanged flag insertion". Default CVS server ports are 2401 and 514 and are included in the default ports for stream reassembly.

This plugin cannot do detection over encrypted sessions, e.g. SSH (usually port 22).

Format

```
cvs:<option>;
```

Option	Description
invalid-entry	Looks for an invalid Entry string, which is a way of causing a heap overflow (see CVE-2004-0396) and bad pointer derefenece in versions of CVS 1.11.15 and before.

Examples

```
alert tcp any any -> any 2401 (msg:"CVS Invalid-entry"; \
    flow:to_server,established; cvs:invalid-entry;)
```

3.5.23 dce_iface

See the DCE/RPC 2 Preprocessor section 2.2.14 for a description and examples of using this rule option.

3.5.24 dce_opnum

See the DCE/RPC 2 Preprocessor section 2.2.14 for a description and examples of using this rule option.

3.5.25 dce_stub_data

See the DCE/RPC 2 Preprocessor section 2.2.14 for a description and examples of using this rule option.

3.5.26 Payload Detection Quick Reference

Table 3.9: Payload detection rule option keywords

Keyword	Description
content	The content keyword allows the user to set rules that search for specific content in the packet payload and trigger response based on that data.
rawbytes	The rawbytes keyword allows rules to look at the raw packet data, ignoring any decoding that was done by preprocessors.
depth	The depth keyword allows the rule writer to specify how far into a packet Snort should search for the specified pattern.
offset	The offset keyword allows the rule writer to specify where to start searching for a pattern within a packet.
distance	The distance keyword allows the rule writer to specify how far into a packet Snort should ignore before starting to search for the specified pattern relative to the end of the previous pattern match.
within	The within keyword is a content modifier that makes sure that at most N bytes are between pattern matches using the content keyword.
uricontent	The uricontent keyword in the Snort rule language searches the normalized request URI field.
isdataat	The isdataat keyword verifies that the payload has data at a specified location.
pcre	The pcre keyword allows rules to be written using perl compatible regular expressions.
byte_test	The byte_test keyword tests a byte field against a specific value (with operator).
byte_jump	The byte_jump keyword allows rules to read the length of a portion of data, then skip that far forward in the packet.
ftpbounce	The ftpbounce keyword detects FTP bounce attacks.
asn1	The asn1 detection plugin decodes a packet or a portion of a packet, and looks for various malicious encodings.
cvs	The cvs keyword detects invalid entry strings.
dce_iface	See the DCE/RPC 2 Preprocessor section 2.2.14.
dce_opnum	See the DCE/RPC 2 Preprocessor section 2.2.14.
dce_stub_data	See the DCE/RPC 2 Preprocessor section 2.2.14.

3.6 Non-Payload Detection Rule Options

3.6.1 fragoffset

The fragoffset keyword allows one to compare the IP fragment offset field against a decimal value. To catch all the first fragments of an IP session, you could use the fragbits keyword and look for the More fragments option in conjunction with a fragoffset of 0.

Format

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

Example

```
alert ip any any -> any any \
    (msg: "First Fragment"; fragbits: M; fragoffset: 0;)
```

3.6.2 ttl

The ttl keyword is used to check the IP time-to-live value. This option keyword was intended for use in the detection of traceroute attempts.

Format

```
ttl:[[<number>-]><=]<number>;
```

Example

This example checks for a time-to-live value that is less than 3.

```
ttl:<3;
```

This example checks for a time-to-live value that between 3 and 5.

```
ttl:3-5;
```

3.6.3 tos

The tos keyword is used to check the IP TOS field for a specific value.

Format

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

Example

This example looks for a tos value that is not 4

```
tos:!4;
```

3.6.4 id

The id keyword is used to check the IP ID field for a specific value. Some tools (exploits, scanners and other odd programs) set this field specifically for various purposes, for example, the value 31337 is very popular with some hackers.

Format

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

Example

This example looks for the IP ID of 31337.

```
id:31337;
```

3.6.5 ipopts

The ipopts keyword is used to check if a specific IP option is present.

The following options may be checked:

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

The most frequently watched for IP options are strict and loose source routing which aren't used in any widespread internet applications.

Format

```
ipopts:<rr|eol|nop|ts|sec|esec|lsrr|ssrr|satid|any>;
```

Example

This example looks for the IP Option of Loose Source Routing.

```
ipopts:lsrr;
```

Warning

Only a single ipopts keyword may be specified per rule.

3.6.6 fragbits

The `fragbits` keyword is used to check if fragmentation and reserved bits are set in the IP header.

The following bits may be checked:

M - More Fragments

D - Don't Fragment

R - Reserved Bit

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

+ 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

This example checks if the More Fragments bit and the Do not Fragment bit are set.

```
fragbits:MD+;
```

3.6.7 dsize

The dsize keyword is used to test the packet payload size. This may be used to check for abnormally sized packets. In many cases, it is useful for detecting buffer overflows.

Format

```
dsize: [<>]<number>[<><number>];
```

Example

This example looks for a dsize that is between 300 and 400 bytes.

```
dsize:300<>400;
```

Warning

dsize will fail on stream rebuilt packets, regardless of the size of the payload.

3.6.8 flags

The flags keyword is used to check if specific TCP flag bits are present.

The following bits may be checked:

F - FIN (LSB in TCP Flags byte)

S - SYN

R - RST

P - PSH

A - ACK

U - URG

1 - Reserved bit 1 (MSB in TCP Flags byte)

2 - Reserved bit 2

0 - No TCP Flags Set

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

+ - 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

To handle writing rules for session initiation packets such as ECN where a SYN packet is sent with the previously reserved bits 1 and 2 set, an option mask may be specified. A rule could check for a flags value of S,12 if one wishes to find packets with just the syn bit, regardless of the values of the reserved bits.

Format

```
flags:[!|*|+]<FSRPAU120>[,<FSRPAU120>];
```

Example

This example checks if just the SYN and the FIN bits are set, ignoring reserved bit 1 and reserved bit 2.

```
alert tcp any any -> any any (flags:SF,12;)
```

3.6.9 flow

The flow keyword is used in conjunction with TCP stream reassembly (see Section 2.2.2). It allows rules to only apply to certain directions of the traffic flow.

This allows rules to only apply to clients or servers. This allows packets related to $HOME_NET clients viewing web pages to be distinguished from servers running in the $HOME_NET.

The established keyword will replace the `flags: A+` used in many places to show established TCP connections.

Options

Option	Description
to_client	Trigger on server responses from A to B
to_server	Trigger on client requests from A to B
from_client	Trigger on client requests from A to B
from_server	Trigger on server responses from A to B
established	Trigger only on established TCP connections
stateless	Trigger regardless of the state of the stream processor (useful for packets that are designed to cause machines to crash)
no_stream	Do not trigger on rebuilt stream packets (useful for dsize and stream5)
only_stream	Only trigger on rebuilt stream packets

Format

```
flow: [(established|stateless)]
    [,(to_client|to_server|from_client|from_server)]
    [,(no_stream|only_stream)];
```

Examples

```
alert tcp !$HOME_NET any -> $HOME_NET 21 (msg:"cd incoming detected"; \
    flow:from_client; content:"CWD incoming"; nocase;)

alert tcp !$HOME_NET 0 -> $HOME_NET 0 (msg: "Port 0 TCP traffic"; \
    flow:stateless;)
```

3.6.10 flowbits

The `flowbits` keyword is used in conjunction with conversation tracking from the Stream preprocessor (see Section2.2.2). It allows rules to track states across transport protocol sessions. The flowbits option is most useful for TCP sessions, as it allows rules to generically track the state of an application protocol.

There are seven keywords associated with flowbits. Most of the options need a user-defined name for the specific state that is being checked. This string should be limited to any alphanumeric string including periods, dashes, and underscores.

Option	Description
set	Sets the specified state for the current flow.
unset	Unsets the specified state for the current flow.
toggle	Sets the specified state if the state is unset, otherwise unsets the state if the state is set.
isset	Checks if the specified state is set.
isnotset	Checks if the specified state is not set.
noalert	Cause the rule to not generate an alert, regardless of the rest of the detection options.

Format

```
flowbits: [set|unset|toggle|isset|reset|noalert][,<STATE_NAME>];
```

Examples

```
alert tcp any 143 -> any any (msg:"IMAP login";
```

```
        content:"OK LOGIN"; flowbits:set,logged_in;
        flowbits:noalert;)

    alert tcp any any -> any 143 (msg:"IMAP LIST"; content:"LIST";
        flowbits:isset,logged_in;)
```

3.6.11 seq

The seq keyword is used to check for a specific TCP sequence number.

Format

```
seq:<number>;
```

Example

This example looks for a TCP sequence number of 0.

```
seq:0;
```

3.6.12 ack

The ack keyword is used to check for a specific TCP acknowledge number.

Format

```
ack: <number>;
```

Example

This example looks for a TCP acknowledge number of 0.

```
ack:0;
```

3.6.13 window

The window keyword is used to check for a specific TCP window size.

Format

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

Example

This example looks for a TCP window size of 55808.

```
window:55808;
```

3.6.14 itype

The itype keyword is used to check for a specific ICMP type value.

Format

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

Example

This example looks for an ICMP type greater than 30.

```
itype:>30;
```

3.6.15 icode

The icode keyword is used to check for a specific ICMP code value.

Format

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

Example

This example looks for an ICMP code greater than 30.

```
code:>30;
```

3.6.16 icmp_id

The icmp_id keyword is used to check for a specific ICMP ID value.

This is useful because some covert channel programs use static ICMP fields when they communicate. This particular plugin was developed to detect the stacheldraht DDoS agent.

Format

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

Example

This example looks for an ICMP ID of 0.

```
icmp_id:0;
```

3.6.17 icmp_seq

The icmp_seq keyword is used to check for a specific ICMP sequence value.

This is useful because some covert channel programs use static ICMP fields when they communicate. This particular plugin was developed to detect the stacheldraht DDoS agent.

Format

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

Example

This example looks for an ICMP Sequence of 0.

```
icmp_seq:0;
```

3.6.18 rpc

The rpc keyword is used to check for a RPC application, version, and procedure numbers in SUNRPC CALL requests. Wildcards are valid for both version and procedure numbers by using '*';

Format

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

Example

The following example looks for an RPC portmap GETPORT request.

```
alert tcp any any -> any 111 (rpc: 100000,*,3;);
```

Warning

Because of the fast pattern matching engine, the RPC keyword is slower than looking for the RPC values by using normal content matching.

3.6.19 ip_proto

The ip_proto keyword allows checks against the IP protocol header. For a list of protocols that may be specified by name, see /etc/protocols.

Format

```
ip_proto:[!|>|<] <name or number>;
```

Example

This example looks for IGMP traffic.

```
alert ip any any -> any any (ip_proto:igmp;)
```

3.6.20 sameip

The sameip keyword allows rules to check if the source ip is the same as the destination IP.

Format

```
sameip;
```

Example

This example looks for any traffic where the Source IP and the Destination IP is the same.

```
alert ip any any -> any any (sameip;)
```

3.6.21 stream_size

The stream_size keyword allows a rule to match traffic according to the number of bytes observed, as determined by the TCP sequence numbers.

The stream_size option is only available when the Stream5 preprocessor is enabled.

Format

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

Where the operator is one of the following:

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

Example

For example, to look for a session that is less that 6 bytes from the client side, use:

```
alert tcp any any -> any any (stream_size:client,<,6;)
```

3.6.22 Non-Payload Detection Quick Reference

Table 3.10: Non-payload detection rule option keywords

Keyword	Description
fragoffset	The fragoffset keyword allows one to compare the IP fragment offset field against a decimal value.
ttl	The ttl keyword is used to check the IP time-to-live value.
tos	The tos keyword is used to check the IP TOS field for a specific value.
id	The id keyword is used to check the IP ID field for a specific value.

ipopts	The ipopts keyword is used to check if a specific IP option is present.
fragbits	The fragbits keyword is used to check if fragmentation and reserved bits are set in the IP header.
dsize	The dsize keyword is used to test the packet payload size.
flags	The flags keyword is used to check if specific TCP flag bits are present.
flow	The flow keyword allows rules to only apply to certain directions of the traffic flow.
flowbits	The flowbits keyword allows rules to track states across transport protocol sessions.
seq	The seq keyword is used to check for a specific TCP sequence number.
ack	The ack keyword is used to check for a specific TCP acknowledge number.
window	The window keyword is used to check for a specific TCP window size.
itype	The itype keyword is used to check for a specific ICMP type value.
icode	The icode keyword is used to check for a specific ICMP code value.
icmp_id	The icmp_id keyword is used to check for a specific ICMP ID value.
icmp_seq	The icmp_seq keyword is used to check for a specific ICMP sequence value.
rpc	The rpc keyword is used to check for a RPC application, version, and procedure numbers in SUNRPC CALL requests.
ip_proto	The ip_proto keyword allows checks against the IP protocol header.
sameip	The sameip keyword allows rules to check if the source ip is the same as the destination IP.

3.7 Post-Detection Rule Options

3.7.1 logto

The logto keyword tells Snort to log all packets that trigger this rule to a special output log file. This is especially handy for combining data from things like NMAP activity, HTTP CGI scans, etc. It should be noted that this option does not work when Snort is in binary logging mode.

Format

```
logto:"filename";
```

3.7.2 session

The session keyword is built to extract user data from TCP Sessions. There are many cases where seeing what users are typing in telnet, rlogin, ftp, or even web sessions is very useful.

There are two available argument keywords for the session rule option, printable or all. The printable keyword only prints out data that the user would normally see or be able to type.

The all keyword substitutes non-printable characters with their hexadecimal equivalents.

Format

```
session: [printable|all];
```

Example

The following example logs all printable strings in a telnet packet.

```
log tcp any any <> any 23 (session:printable;)
```

Warnings

Using the session keyword can slow Snort down considerably, so it should not be used in heavy load situations. The session keyword is best suited for post-processing binary (pcap) log files.

3.7.3 resp

The resp keyword is used to attempt to close sessions when an alert is triggered. In Snort, this is called flexible response.

Flexible Response supports the following mechanisms for attempting to close sessions:

Option	Description
rst_snd	Send TCP-RST packets to the sending socket
rst_rcv	Send TCP-RST packets to the receiving socket
rst_all	Send TCP_RST packets in both directions
icmp_net	Send a ICMP_NET_UNREACH to the sender
icmp_host	Send a ICMP_HOST_UNREACH to the sender
icmp_port	Send a ICMP_PORT_UNREACH to the sender
icmp_all	Send all above ICMP packets to the sender

These options can be combined to send multiple responses to the target host.

Format

```
resp: <resp_mechanism>[,<resp_mechanism>[,<resp_mechanism>]];
```

Warnings

This functionality is not built in by default. Use the – –enable-flexresp flag to configure when building Snort to enable this functionality.

Be very careful when using Flexible Response. It is quite easy to get Snort into an infinite loop by defining a rule such as:

```
alert tcp any any -> any any (resp:rst_all;)
```

It is easy to be fooled into interfering with normal network traffic as well.

Example

The following example attempts to reset any TCP connection to port 1524.

```
alert tcp any any -> any 1524 (flags:S; resp:rst_all;)
```

3.7.4 react

This keyword implements an ability for users to react to traffic that matches a Snort rule. The basic reaction is blocking interesting sites users want to access: New York Times, slashdot, or something really important - napster and porn sites. The React code allows Snort to actively close offending connections and send a visible notice to the browser. The notice may include your own comment. The following arguments (basic modifiers) are valid for this option:

- block - close connection and send the visible notice

The basic argument may be combined with the following arguments (additional modifiers):

- msg - include the msg option text into the blocking visible notice
- proxy <port_nr> - use the proxy port to send the visible notice

Multiple additional arguments are separated by a comma. The react keyword should be placed as the last one in the option list.

Format

```
react: block[, <react_additional_modifier>];
```

Example

```
alert tcp any any <> 192.168.1.0/24 80 (content: "bad.htm"; \
    msg: "Not for children!"; react: block, msg, proxy 8000;)
```

Warnings

React functionality is not built in by default; you must configure with –enable-react to build it. (Note that react may now be enabled independently of flexresp and flexresp2.)

Be very careful when using react. Causing a network traffic generation loop is very easy to do with this functionality.

3.7.5 tag

The tag keyword allow rules to log more than just the single packet that triggered the rule. Once a rule is triggered, additional traffic involving the source and/or destination host is *tagged*. Tagged traffic is logged to allow analysis of response codes and post-attack traffic. *tagged* alerts will be sent to the same output plugins as the original alert, but it is the responsibility of the output plugin to properly handle these special alerts. Currently, the database output plugin, described in Section 2.6.6, does not properly handle *tagged* alerts.

Format

```
tag: <type>, <count>, <metric>, [direction];
```

`type`

- `session` - Log packets in the session that set off the rule
- `host` - Log packets from the host that caused the tag to activate (uses [direction] modifier)

`count`

- `<integer>` - Count is specified as a number of units. Units are specified in the <metric> field.

`metric`

- `packets` - Tag the host/session for <count> packets
- `seconds` - Tag the host/session for <count> seconds
- `bytes` - Tag the host/session for <count> bytes

`direction` - only relevant if host type is used.

- `src` - Tag packets containing the source IP address of the packet that generated the initial event.
- `dst` - Tag packets containing the destination IP address of the packet that generated the initial event.

Note, any packets that generate an alert will not be tagged. For example, it may seem that the following rule will tag the first 600 seconds of any packet involving 10.1.1.1.

```
alert tcp any any <> 10.1.1.1 any (tag:host,600,seconds,src;)
```

However, since the rule will fire on every packet involving 10.1.1.1, no packets will get tagged. The *flowbits* option would be useful here.

```
alert tcp any any <> 10.1.1.1 any (flowbits:isnotset,tagged;
    flowbits:set,tagged; tag:host,600,seconds,src;)
```

Also note that if you have a tag option in a rule that uses a metric other than `packets`, a `tagged_packet_limit` will be used to limit the number of tagged packets regardless of whether the `seconds` or `bytes` count has been reached. The default `tagged_packet_limit` value is 256 and can be modified by using a config option in your snort.conf file (see Section 2.1.3 on how to use the `tagged_packet_limit` config option). You can disable this packet limit for a particular rule by adding a `packets` metric to your tag option and setting its count to 0 (This can be done on a global scale by setting the `tagged_packet_limit` option in snort.conf to 0). Doing this will ensure that packets are tagged for the full amount of `seconds` or `bytes` and will not be cut off by the `tagged_packet_limit`. (Note that the `tagged_packet_limit` was introduced to avoid DoS situations on high bandwidth sensors for tag rules with a high `seconds` or `bytes` counts.)

```
alert tcp 10.1.1.4 any -> 10.1.1.1 any \
    (content:"TAGMYPACKETS"; tag:host,0,packets,600,seconds,src;)
```

Example

This example logs the first 10 seconds or the `tagged_packet_limit` (whichever comes first) of any telnet session.

```
alert tcp any any -> any 23 (flags:s,12; tag:session,10,seconds;)
```

3.7.6 activates

The `activates` keyword allows the rule writer to specify a rule to add when a specific network event occurs. See Section 3.2.6 for more information.

Format

```
activates: 1;
```

3.7.7 activated_by

The `activated_by` keyword allows the rule writer to dynamically enable a rule when a specific activate rule is triggered. See Section 3.2.6 for more information.

Format

```
activated_by: 1;
```

3.7.8 count

The `count` keyword must be used in combination with the `activated_by` keyword. It allows the rule writer to specify how many packets to leave the rule enabled for after it is activated. See Section 3.2.6 for more information.

Format

```
activated_by: 1; count: 50;
```

3.7.9 replace

The `replace` keyword is a feature available in inline mode which will cause Snort to replace the prior matching content with the given string. Both the new string and the content it is to replace must have the same length. You can have multiple replacements within a rule, one per content.

See section 1.5 for more on operating in inline mode.

```
replace: <string>;
```

3.7.10 detection_filter

detection_filter defines a rate which must be exceeded by a source or destination host before a rule can generate an event. detection_filter has the following format:

```
detection_filter: \
    track <by_src|by_dst>, \
    count <c>, seconds <s>;
```

Option	Description
`track by_src|by_dst`	Rate is tracked either by source IP address or destination IP address. This means count is maintained for each unique source IP address or each unique destination IP address.
`count c`	The maximum number of rule matches in s seconds allowed before the detection filter limit to be exceeded. C must be nonzero.
`seconds s`	Time period over which count is accrued. The value must be nonzero.

Snort evaluates a `detection_filter` as the last step of the detection phase, after evaluating all other rule options (regardless of the position of the filter within the rule source). At most one `detection_filter` is permitted per rule.

Example - this rule will fire on every failed login attempt from 10.1.2.100 during one sampling period of 60 seconds, after the first 30 failed login attempts:

```
drop tcp 10.1.2.100 any > 10.1.1.100 22 ( \
    msg:"SSH Brute Force Attempt";
    flow:established,to_server; \
    content:"SSH"; nocase; offset:0; depth:4; \
    detection_filter: track by_src, count 30, seconds 60; \
    sid:1000001; rev:1;)
```

Since potentially many events will be generated, a `detection_filter` would normally be used in conjunction with an `event_filter` to reduce the number of logged events.

3.7.11 Post-Detection Quick Reference

Table 3.11: Post-detection rule option keywords

Keyword	Description
`logto`	The logto keyword tells Snort to log all packets that trigger this rule to a special output log file.
`session`	The session keyword is built to extract user data from TCP Sessions.
`resp`	The resp keyword is used attempt to close sessions when an alert is triggered.
`react`	This keyword implements an ability for users to react to traffic that matches a Snort rule by closing connection and sending a notice.
`tag`	The tag keyword allow rules to log more than just the single packet that triggered the rule.
`activates`	This keyword allows the rule writer to specify a rule to add when a specific network event occurs.
`activated_by`	This keyword allows the rule writer to dynamically enable a rule when a specific activate rule is triggered.
`count`	This keyword must be used in combination with the `activated_by` keyword. It allows the rule writer to specify how many packets to leave the rule enabled for after it is activated.
`replace`	Replace the prior matching content with the given string of the same length. Available in inline mode only.
`detection_filter`	Track by source or destination IP address and if the rule otherwise matches more than the configured rate it will fire.

3.8 Rule Thresholds

Rule thresholds are deprecated and will not be supported in a future release. Use `detection_filters` (3.7.10) within rules, or `event_filters` (2.4.2) as standalone configurations instead.

`threshold` can be included as part of a rule, or you can use standalone thresholds that reference the generator and SID they are applied to. There is no functional difference between adding a threshold to a rule, or using a standalone threshold applied to the same rule. There is a logical difference. Some rules may only make sense with a threshold. These should incorporate the threshold into the rule. For instance, a rule for detecting a too many login password attempts may require more than 5 attempts. This can be done using the 'limit' type of threshold. It makes sense that the threshold feature is an integral part of this rule.

Format

```
threshold: \
    type <limit|threshold|both>, \
    track <by_src|by_dst>, \
    count <c>, seconds <s>;
```

Option	Description
type limit|threshold|both	type limit alerts on the 1st m events during the time interval, then ignores events for the rest of the time interval. Type threshold alerts every m times we see this event during the time interval. Type both alerts once per time interval after seeing m occurrences of the event, then ignores any additional events during the time interval.
track by_src|by_dst	rate is tracked either by source IP address, or destination IP address. This means count is maintained for each unique source IP addresses, or for each unique destination IP addresses. Ports or anything else are not tracked.
count c	number of rule matching in s seconds that will cause event_filter limit to be exceeded. c must be nonzero value.
seconds s	time period over which count is accrued. s must be nonzero value.

Examples

This rule logs the first event of this SID every 60 seconds.

```
alert tcp $external_net any -> $http_servers $http_ports \
    (msg:"web-misc robots.txt access"; flow:to_server, established; \
    uricontent:"/robots.txt"; nocase; reference:nessus,10302; \
    classtype:web-application-activity; threshold: type limit, track \
    by_src, count 1 , seconds 60 ; sid:1000852; rev:1;)
```

This rule logs every 10th event on this SID during a 60 second interval. So if less than 10 events occur in 60 seconds, nothing gets logged. Once an event is logged, a new time period starts for type=threshold.

```
alert tcp $external_net any -> $http_servers $http_ports \
    (msg:"web-misc robots.txt access"; flow:to_server, established; \
    uricontent:"/robots.txt"; nocase; reference:nessus,10302; \
    classtype:web-application-activity; threshold: type threshold, \
    track by_dst, count 10 , seconds 60 ; sid:1000852; rev:1;)
```

This rule logs at most one event every 60 seconds if at least 10 events on this SID are fired.

```
alert tcp $external_net any -> $http_servers $http_ports \
    (msg:"web-misc robots.txt access"; flow:to_server, established; \
    uricontent:"/robots.txt"; nocase; reference:nessus,10302; \
    classtype:web-application-activity; threshold: type both , track \
    by_dst, count 10 , seconds 60 ; sid:1000852; rev:1;)
```

3.9 Writing Good Rules

There are some general concepts to keep in mind when developing Snort rules to maximize efficiency and speed.

3.9.1 Content Matching

The 2.0 detection engine changes the way Snort works slightly by having the first phase be a setwise pattern match. The longer a content option is, the more *exact* the match. Rules without *content* (or *uricontent*) slow the entire system down.

While some detection options, such as *pcre* and *byte_test*, perform detection in the payload section of the packet, they do not use the setwise pattern matching engine. If at all possible, try and have at least one *content* option if at all possible.

3.9.2 Catch the Vulnerability, Not the Exploit

Try to write rules that target the vulnerability, instead of a specific exploit.

For example, look for a the vulnerable command with an argument that is too large, instead of shellcode that binds a shell.

By writing rules for the vulnerability, the rule is less vulnerable to evasion when an attacker changes the exploit slightly.

3.9.3 Catch the Oddities of the Protocol in the Rule

Many services typically send the commands in upper case letters. FTP is a good example. In FTP, to send the username, the client sends:

```
user username_here
```

A simple rule to look for FTP root login attempts could be:

```
alert tcp any any -> any any 21 (content:"user root";)
```

While it may *seem* trivial to write a rule that looks for the username root, a good rule will handle all of the odd things that the protocol might handle when accepting the user command.

For example, each of the following are accepted by most FTP servers:

```
user root
user root
user root
user root
user<tab>root
```

To handle all of the cases that the FTP server might handle, the rule needs more smarts than a simple string match.

A good rule that looks for root login on ftp would be:

```
alert tcp any any -> any 21 (flow:to_server,established; \
    content:"root"; pcre:"/user\s+root/i";)
```

There are a few important things to note in this rule:

- The rule has a *flow* option, verifying this is traffic going to the server on an enstablished session.
- The rule has a *content* option, looking for *root*, which is the longest, most unique string in the attack. This option is added to allow Snort's setwise pattern match detection engine to give Snort a boost in speed.
- The rule has a *pcre* option, looking for user, followed at least one space character (which includes tab), followed by root, ignoring case.

3.9.4 Optimizing Rules

The content matching portion of the detection engine has recursion to handle a few evasion cases. Rules that are not properly written can cause Snort to waste time duplicating checks.

The way the recursion works now is if a pattern matches, and if any of the detection options after that pattern fail, then look for the pattern again after where it was found the previous time. Repeat until the pattern is not found again or the opt functions all succeed.

On first read, that may not sound like a smart idea, but it is needed. For example, take the following rule:

```
alert ip any any -> any any (content:"a"; content:"b"; within:1;)
```

This rule would look for “a”, immediately followed by “b”. Without recursion, the payload “aab” would fail, even though it is obvious that the payload “aab” has “a” immediately followed by “b”, because the first ”a” is not immediately followed by “b”.

While recursion is important for detection, the recursion implementation is not very smart.

For example, the following rule options are not optimized:

```
content:"|13|"; dsize:1;
```

By looking at this rule snippit, it is obvious the rule looks for a packet with a single byte of 0x13. However, because of recursion, a packet with 1024 bytes of 0x13 could cause 1023 too many pattern match attempts and 1023 too many dsize checks. Why? The content 0x13 would be found in the first byte, then the dsize option would fail, and because of recursion, the content 0x13 would be found again starting after where the previous 0x13 was found, once it is found, then check the dsize again, repeating until 0x13 is not found in the payload again.

Reordering the rule options so that discrete checks (such as dsize) are moved to the begining of the rule speed up Snort.

The optimized rule snipping would be:

```
dsize:1; content:"|13|";
```

A packet of 1024 bytes of 0x13 would fail immediately, as the dsize check is the first option checked and dsize is a discrete check without recursion.

The following rule options are discrete and should generally be placed at the begining of any rule:

- `dsize`
- `flags`
- `flow`
- `fragbits`
- `icmp_id`
- `icmp_seq`
- `icode`
- `id`
- `ipopts`
- `ip_proto`
- `itype`

- seq
- session
- tos
- ttl
- ack
- window
- resp
- sameip

3.9.5 Testing Numerical Values

The rule options *byte_test* and *byte_jump* were written to support writing rules for protocols that have length encoded data. RPC was the protocol that spawned the requirement for these two rule options, as RPC uses simple length based encoding for passing data.

In order to understand *why* byte_test and byte_jump are useful, let's go through an exploit attempt against the sadmind service.

This is the payload of the exploit:

```
89 09 9c e2 00 00 00 00 00 00 00 02 00 01 87 88  ................
00 00 00 0a 00 00 00 01 00 00 00 01 00 00 00 20  ................
40 28 3a 10 00 00 00 0a 4d 45 54 41 53 50 4c 4f  @(:.....metasplo
49 54 00 00 00 00 00 00 00 00 00 00 00 00 00 00  it..............
00 00 00 00 00 00 00 00 40 28 3a 14 00 07 45 df  ........@(:...e.
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
00 00 00 00 00 00 00 06 00 00 00 00 00 00 00 00  ................
00 00 00 00 00 00 00 04 00 00 00 00 00 00 00 04  ................
7f 00 00 01 00 01 87 88 00 00 00 0a 00 00 00 04  ................
7f 00 00 01 00 01 87 88 00 00 00 0a 00 00 00 11  ................
00 00 00 1e 00 00 00 00 00 00 00 00 00 00 00 00  ................
00 00 00 00 00 00 00 3b 4d 45 54 41 53 50 4c 4f  .......;metasplo
49 54 00 00 00 00 00 00 00 00 00 00 00 00 00 00  it..............
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
00 00 00 00 00 00 00 06 73 79 73 74 65 6d 00 00  ........system..
00 00 00 15 2e 2e 2f 2e 2e 2f 2e 2e 2f 2e 2e 2f  ....../../../../
2e 2e 2f 62 69 6e 2f 73 68 00 00 00 00 00 04 1e  ../bin/sh.......
<snip>
```

Let's break this up, describe each of the fields, and figure out how to write a rule to catch this exploit.

There are a few things to note with RPC:

- Numbers are written as uint32s, taking four bytes. The number 26 would show up as 0x0000001a.
- Strings are written as a uint32 specifying the length of the string, the string, and then null bytes to pad the length of the string to end on a 4 byte boundary. The string "bob" would show up as 0x00000003626f6200.

```
89 09 9c e2     - the request id, a random uint32, unique to each request
00 00 00 00     - rpc type (call = 0, response = 1)
00 00 00 02     - rpc version (2)
00 01 87 88     - rpc program (0x00018788 = 100232 = sadmind)
```

```
00 00 00 0a     - rpc program version (0x0000000a = 10)
00 00 00 01     - rpc procedure (0x00000001 = 1)
00 00 00 01     - credential flavor (1 = auth\_unix)
00 00 00 20     - length of auth\_unix data (0x20 = 32

## the next 32 bytes are the auth\_unix data
40 28 3a 10 - unix timestamp (0x40283a10 = 1076378128 = feb 10 01:55:28 2004 gmt)
00 00 00 0a - length of the client machine name (0x0a = 10)
4d 45 54 41 53 50 4c 4f 49 54 00 00  - metasploit

00 00 00 00 - uid of requesting user (0)
00 00 00 00 - gid of requesting user (0)
00 00 00 00 - extra group ids (0)

00 00 00 00     - verifier flavor (0 = auth\_null, aka none)
00 00 00 00     - length of verifier (0, aka none)
```

The rest of the packet is the request that gets passed to procedure 1 of sadmind.

However, we know the vulnerability is that sadmind trusts the uid coming from the client. sadmind runs any request where the client's uid is 0 as root. As such, we have decoded enough of the request to write our rule.

First, we need to make sure that our packet is an RPC call.

```
    content:"|00 00 00 00|"; offset:4; depth:4;
```

Then, we need to make sure that our packet is a call to sadmind.

```
    content:"|00 01 87 88|"; offset:12; depth:4;
```

Then, we need to make sure that our packet is a call to the procedure 1, the vulnerable procedure.

```
    content:"|00 00 00 01|"; offset:16; depth:4;
```

Then, we need to make sure that our packet has auth_unix credentials.

```
    content:"|00 00 00 01|"; offset:20; depth:4;
```

We don't care about the hostname, but we want to skip over it and check a number value after the hostname. This is where byte_test is useful. Starting at the length of the hostname, the data we have is:

```
00 00 00 0a 4d 45 54 41 53 50 4c 4f 49 54 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00
```

We want to read 4 bytes, turn it into a number, and jump that many bytes forward, making sure to account for the padding that RPC requires on strings. If we do that, we are now at:

```
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00
```

which happens to be the exact location of the uid, the value we want to check.

In english, we want to read 4 bytes, 36 bytes from the beginning of the packet, and turn those 4 bytes into an integer and jump that many bytes forward, aligning on the 4 byte boundary. To do that in a Snort rule, we use:

```
byte_jump:4,36,align;
```

then we want to look for the uid of 0.

```
content:"|00 00 00 00|"; within:4;
```

Now that we have all the detection capabilities for our rule, let's put them all together.

```
content:"|00 00 00 00|"; offset:4; depth:4;
content:"|00 01 87 88|"; offset:12; depth:4;
content:"|00 00 00 01|"; offset:16; depth:4;
content:"|00 00 00 01|"; offset:20; depth:4;
byte_jump:4,36,align;
content:"|00 00 00 00|"; within:4;
```

The 3rd and fourth string match are right next to each other, so we should combine those patterns. We end up with:

```
content:"|00 00 00 00|"; offset:4; depth:4;
content:"|00 01 87 88|"; offset:12; depth:4;
content:"|00 00 00 01 00 00 00 01|"; offset:16; depth:8;
byte_jump:4,36,align;
content:"|00 00 00 00|"; within:4;
```

If the sadmind service was vulnerable to a buffer overflow when reading the client's hostname, instead of reading the length of the hostname and jumping that many bytes forward, we would check the length of the hostname to make sure it is not too large.

To do that, we would read 4 bytes, starting 36 bytes into the packet, turn it into a number, and then make sure it is not too large (let's say bigger than 200 bytes). In Snort, we do:

```
byte_test:4,>,200,36;
```

Our full rule would be:

```
content:"|00 00 00 00|"; offset:4; depth:4;
content:"|00 01 87 88|"; offset:12; depth:4;
content:"|00 00 00 01 00 00 00 01|"; offset:16; depth:8;
byte_test:4,>,200,36;
```

Chapter 4

Making Snort Faster

4.1 MMAPed pcap

On Linux, a modified version of libpcap is available that implements a shared memory ring buffer. Phil Woods (cpw@lanl.gov) is the current maintainer of the libpcap implementation of the shared memory ring buffer. The shared memory ring buffer libpcap can be downloaded from his website at `http://public.lanl.gov/cpw/`.

Instead of the normal mechanism of copying the packets from kernel memory into userland memory, by using a shared memory ring buffer, libpcap is able to queue packets into a shared buffer that Snort is able to read directly. This change speeds up Snort by limiting the number of times the packet is copied before Snort gets to perform its detection upon it.

Once Snort linked against the shared memory libpcap, enabling the ring buffer is done via setting the enviornment variable *PCAP_FRAMES*. *PCAP_FRAMES* is the size of the ring buffer. According to Phil, the maximum size is 32768, as this appears to be the maximum number of iovecs the kernel can handle. By using *PCAP_FRAMES=max*, libpcap will automatically use the most frames possible. On Ethernet, this ends up being 1530 bytes per frame, for a total of around 52 Mbytes of memory for the ring buffer alone.

Chapter 5

Dynamic Modules

Preprocessors, detection capabilities, and rules can now be developed as dynamically loadable module to snort. When enabled via the *–enable-dynamicplugin* configure option, the dynamic API presents a means for loading dynamic libraries and allowing the module to utilize certain functions within the main snort code.

The remainder of this chapter will highlight the data structures and API functions used in developing preprocessors, detection engines, and rules as a dynamic plugin to snort.

Beware: the definitions herein may be out of date; check the appropriate header files for the current definitions.

5.1 Data Structures

A number of data structures are central to the API. The definition of each is defined in the following sections.

5.1.1 DynamicPluginMeta

The *DynamicPluginMeta* structure defines the type of dynamic module (preprocessor, rules, or detection engine), the version information, and path to the shared library. A shared library can implement all three types, but typically is limited to a single functionality such as a preprocessor. It is defined in `sf_dynamic_meta.h` as:

```
#define MAX_NAME_LEN 1024

#define TYPE_ENGINE 0x01
#define TYPE_DETECTION 0x02
#define TYPE_PREPROCESSOR 0x04

typedef struct _DynamicPluginMeta
{
    int type;
    int major;
    int minor;
    int build;
    char uniqueName[MAX_NAME_LEN];
    char *libraryPath;
} DynamicPluginMeta;
```

5.1.2 DynamicPreprocessorData

The *DynamicPreprocessorData* structure defines the interface the preprocessor uses to interact with snort itself. This inclues functions to register the preprocessor's configuration parsing, restart, exit, and processing functions. It includes

function to log messages, errors, fatal errors, and debugging info. It also includes information for setting alerts, handling Inline drops, access to the StreamAPI, and it provides access to the normalized http and alternate data buffers. This data structure should be initialized when the preprocessor shared library is loaded. It is defined in `sf_dynamic_preprocessor.h`. Check the header file for the current definition.

5.1.3 DynamicEngineData

The *DynamicEngineData* structure defines the interface a detection engine uses to interact with snort itself. This includes functions for logging messages, errors, fatal errors, and debugging info as well as a means to register and check flowbits. It also includes a location to store rule-stubs for dynamic rules that are loaded, and it provides access to the normalized http and alternate data buffers. It is defined in `sf_dynamic_engine.h` as:

```
typedef struct _DynamicEngineData
{
    int version;
    u_int8_t *altBuffer;
    UriInfo *uriBuffers[MAX_URIINFOS];
    RegisterRule ruleRegister;
    RegisterBit flowbitRegister;
    CheckFlowbit flowbitCheck;
    DetectAsn1 asn1Detect;
    LogMsgFunc logMsg;
    LogMsgFunc errMsg;
    LogMsgFunc fatalMsg;
    char *dataDumpDirectory;

    GetPreprocRuleOptFuncs getPreprocOptFuncs;

    SetRuleData setRuleData;
    GetRuleData getRuleData;

    DebugMsgFunc debugMsg;
#ifdef HAVE_WCHAR_H
    DebugWideMsgFunc debugWideMsg;
#endif

    char **debugMsgFile;
    int *debugMsgLine;

    PCRECompileFunc pcreCompile;
    PCREStudyFunc pcreStudy;
    PCREExecFunc pcreExec;

} DynamicEngineData;
```

5.1.4 SFSnortPacket

The *SFSnortPacket* structure mirrors the snort Packet structure and provides access to all of the data contained in a given packet.

It and the data structures it incorporates are defined in `sf_snort_packet.h`. Additional data structures may be defined to reference other protocol fields. Check the header file for the current definitions.

5.1.5 Dynamic Rules

A dynamic rule should use any of the following data structures. The following structures are defined in `sf_snort_plugin_api.h`.

Rule

The *Rule* structure defines the basic outline of a rule and contains the same set of information that is seen in a text rule. That includes protocol, address and port information and rule information (classification, generator and signature IDs, revision, priority, classification, and a list of references). It also includes a list of rule options and an optional evaluation function.

```
#define RULE_MATCH 1
#define RULE_NOMATCH 0

typedef struct _Rule
{
    IPInfo ip;
    RuleInformation info;

    RuleOption **options; /* NULL terminated array of RuleOption union */

    ruleEvalFunc evalFunc;

    char initialized;     /* Rule Initialized, used internally */
    u_int32_t numOptions; /* Rule option count, used internally */
    char noAlert;         /* Flag with no alert, used internally */
    void *ruleData;    /* Hash table for dynamic data pointers */
} Rule;
```

The rule evaluation function is defined as

```
typedef int (*ruleEvalFunc)(void *);
```

where the parameter is a pointer to the SFSnortPacket structure.

RuleInformation

The *RuleInformation* structure defines the meta data for a rule and includes generator ID, signature ID, revision, classification, priority, message text, and a list of references.

```
typedef struct _RuleInformation
{
    u_int32_t genID;
    u_int32_t sigID;
    u_int32_t revision;
    char     *classification; /* String format of classification name */
    u_int32_t priority;
    char     *message;
    RuleReference **references; /* NULL terminated array of references */
    RuleMetaData **meta; /* NULL terminated array of references */
} RuleInformation;
```

RuleReference

The *RuleReference* structure defines a single rule reference, including the system name and rereference identifier.

```
typedef struct _RuleReference
{
    char *systemName;
    char *refIdentifier;
} RuleReference;
```

IPInfo

The *IPInfo* structure defines the initial matching criteria for a rule and includes the protocol, src address and port, destination address and port, and direction. Some of the standard strings and variables are predefined - any, HOME_NET, HTTP_SERVERS, HTTP_PORTS, etc.

```
typedef struct _IPInfo
{
    u_int8_t protocol;
    char *   src_addr;
    char *   src_port; /* 0 for non TCP/UDP */
    char     direction;     /* non-zero is bi-directional */
    char *   dst_addr;
    char *   dst_port; /* 0 for non TCP/UDP */
} IPInfo;

#define ANY_NET         "any"
#define HOME_NET        "$HOME_NET"
#define EXTERNAL_NET    "$EXTERNAL_NET"
#define ANY_PORT        "any"
#define HTTP_SERVERS    "$HTTP_SERVERS"
#define HTTP_PORTS      "$HTTP_PORTS"
#define SMTP_SERVERS    "$SMTP_SERVERS"
```

RuleOption

The *RuleOption* structure defines a single rule option as an option type and a reference to the data specific to that option. Each option has a flags field that contains specific flags for that option as well as a ”Not” flag. The ”Not” flag is used to negate the results of evaluating that option.

```
typedef enum DynamicOptionType {
     OPTION_TYPE_PREPROCESSOR,
     OPTION_TYPE_CONTENT,
     OPTION_TYPE_PCRE,
     OPTION_TYPE_FLOWBIT,
     OPTION_TYPE_FLOWFLAGS,
     OPTION_TYPE_ASN1,
     OPTION_TYPE_CURSOR,
     OPTION_TYPE_HDR_CHECK,
     OPTION_TYPE_BYTE_TEST,
     OPTION_TYPE_BYTE_JUMP,
     OPTION_TYPE_BYTE_EXTRACT,
     OPTION_TYPE_SET_CURSOR,
     OPTION_TYPE_LOOP,
     OPTION_TYPE_MAX
```

```
};

typedef struct _RuleOption
{
    int optionType;
    union
    {
        void *ptr;
        ContentInfo *content;
        CursorInfo *cursor;
        PCREInfo *pcre;
        FlowBitsInfo *flowBit;
        ByteData *byte;
        ByteExtract *byteExtract;
        FlowFlags *flowFlags;
        Asn1Context *asn1;
        HdrOptCheck *hdrData;
        LoopInfo    *loop;
        PreprocessorOption *preprocOpt;
    } option_u;
} RuleOption;

#define NOT_FLAG                0x10000000
```

Some options also contain information that is initialized at run time, such as the compiled PCRE information, Boyer-Moore content information, the integer ID for a flowbit, etc.

The option types and related structures are listed below.

- OptionType: Content & Structure: *ContentInfo*

  The *ContentInfo* structure defines an option for a content search. It includes the pattern, depth and offset, and flags (one of which must specify the buffer – raw, URI or normalized – to search). Additional flags include nocase, relative, unicode, and a designation that this content is to be used for snorts fast pattern evaluation. The most unique content, that which distinguishes this rule as a possible match to a packet, should be marked for fast pattern evaluation. In the dynamic detection engine provided with Snort, if no *ContentInfo* structure in a given rules uses that flag, the one with the longest content length will be used.

  ```
  typedef struct _ContentInfo
  {
      u_int8_t *pattern;
      u_int32_t depth;
      int32_t   offset;
      u_int32_t flags;        /* must include a CONTENT_BUF_X */
      void     *boyer_ptr;
      u_int8_t *patternByteForm;
      u_int32_t patternByteFormLength;
      u_int32_t incrementLength;
  } ContentInfo;

  #define CONTENT_NOCASE          0x01
  #define CONTENT_RELATIVE        0x02
  #define CONTENT_UNICODE2BYTE    0x04
  #define CONTENT_UNICODE4BYTE    0x08
  #define CONTENT_FAST_PATTERN    0x10
  #define CONTENT_END_BUFFER      0x20

  #define CONTENT_BUF_NORMALIZED  0x100
  ```

```
#define CONTENT_BUF_RAW         0x200
#define CONTENT_BUF_URI         0x400
```

- OptionType: PCRE & Structure: *PCREInfo*

  The *PCREInfo* structure defines an option for a PCRE search. It includes the PCRE expression, pcre_flags such as caseless, as defined in PCRE.h, and flags to specify the buffer.

```
/*
pcre.h provides flags:

PCRE_CASELESS
PCRE_MULTILINE
PCRE_DOTALL
PCRE_EXTENDED
PCRE_ANCHORED
PCRE_DOLLAR_ENDONLY
PCRE_UNGREEDY
*/

typedef struct _PCREInfo
{
    char     *expr;
    void     *compiled_expr;
    void     *compiled_extra;
    u_int32_t compile_flags;
    u_int32_t flags; /* must include a CONTENT_BUF_X */
} PCREInfo;
```

- OptionType: Flowbit & Structure: *FlowBitsInfo*

  The *FlowBitsInfo* structure defines a flowbits option. It includes the name of the flowbit and the operation (set, unset, toggle, isset, isnotset).

```
#define FLOWBIT_SET       0x01
#define FLOWBIT_UNSET     0x02
#define FLOWBIT_TOGGLE    0x04
#define FLOWBIT_ISSET     0x08
#define FLOWBIT_ISNOTSET  0x10
#define FLOWBIT_RESET     0x20
#define FLOWBIT_NOALERT   0x40

typedef struct _FlowBitsInfo
{
    char      *flowBitsName;
    u_int8_t   operation;
    u_int32_t  id;
    u_int32_t  flags;
} FlowBitsInfo;
```

- OptionType: Flow Flags & Structure: *FlowFlags*

  The *FlowFlags* structure defines a flow option. It includes the flags, which specify the direction (from_server, to_server), established session, etc.

```
#define FLOW_ESTABLISHED 0x10
#define FLOW_IGNORE_REASSEMBLED 0x1000
#define FLOW_ONLY_REASSMBLED    0x2000
```

```
#define FLOW_FR_SERVER   0x40
#define FLOW_TO_CLIENT   0x40 /* Just for redundancy */
#define FLOW_TO_SERVER   0x80
#define FLOW_FR_CLIENT   0x80 /* Just for redundancy */

typedef struct _FlowFlags
{
    u_int32_t   flags;
} FlowFlags;
```

- OptionType: ASN.1 & Structure: *Asn1Context*

  The *Asn1Context* structure defines the information for an ASN1 option. It mirrors the ASN1 rule option and also includes a flags field.

```
#define ASN1_ABS_OFFSET 1
#define ASN1_REL_OFFSET 2

typedef struct _Asn1Context
{
    int bs_overflow;
    int double_overflow;
    int print;
    int length;
    unsigned int max_length;
    int offset;
    int offset_type;
    u_int32_t  flags;
} Asn1Context;
```

- OptionType: Cursor Check & Structure: *CursorInfo*

  The *CursorInfo* structure defines an option for a cursor evaluation. The cursor is the current position within the evaluation buffer, as related to content and PCRE searches, as well as byte tests and byte jumps. It includes an offset and flags that specify the buffer. This can be used to verify there is sufficient data to continue evaluation, similar to the isdataat rule option.

```
typedef struct _CursorInfo
{
    int32_t   offset;
    u_int32_t flags;        /* specify one of CONTENT_BUF_X */
} CursorInfo;
```

- OptionType: Protocol Header & Structure: *HdrOptCheck*

  The *HdrOptCheck* structure defines an option to check a protocol header for a specific value. It incldues the header field, the operation (¡,¿,=,etc), a value, a mask to ignore that part of the header field, and flags.

```
#define IP_HDR_ID           0x0001  /* IP Header ID */
#define IP_HDR_PROTO        0x0002  /* IP Protocol */
#define IP_HDR_FRAGBITS     0x0003  /* Frag Flags set in IP Header */
#define IP_HDR_FRAGOFFSET   0x0004  /* Frag Offset set in IP Header */
#define IP_HDR_OPTIONS      0x0005  /* IP Options -- is option xx included */
#define IP_HDR_TTL          0x0006  /* IP Time to live */
#define IP_HDR_TOS          0x0007  /* IP Type of Service */
#define IP_HDR_OPTCHECK_MASK 0x000f

#define TCP_HDR_ACK         0x0010  /* TCP Ack Value */
```

```
#define TCP_HDR_SEQ         0x0020  /* TCP Seq Value */
#define TCP_HDR_FLAGS       0x0030  /* Flags set in TCP Header */
#define TCP_HDR_OPTIONS     0x0040  /* TCP Options -- is option xx included */
#define TCP_HDR_WIN         0x0050  /* TCP Window */
#define TCP_HDR_OPTCHECK_MASK 0x00f0

#define ICMP_HDR_CODE       0x1000  /* ICMP Header Code */
#define ICMP_HDR_TYPE       0x2000  /* ICMP Header Type */
#define ICMP_HDR_ID         0x3000  /* ICMP ID for ICMP_ECHO/ICMP_ECHO_REPLY */
#define ICMP_HDR_SEQ        0x4000  /* ICMP ID for ICMP_ECHO/ICMP_ECHO_REPLY */
#define ICMP_HDR_OPTCHECK_MASK 0xf000

typedef struct _HdrOptCheck
{
    u_int16_t hdrField;   /* Field to check */
    u_int32_t op;         /* Type of comparison */
    u_int32_t value;      /* Value to compare value against */
    u_int32_t mask_value; /* bits of value to ignore */
    u_int32_t flags;
} HdrOptCheck;
```

- OptionType: Byte Test & Structure: *ByteData*

  The *ByteData* structure defines the information for both ByteTest and ByteJump operations. It includes the number of bytes, an operation (for ByteTest, ¡,¿,=,etc), a value, an offset, multiplier, and flags. The flags must specify the buffer.

```
#define CHECK_EQ            0
#define CHECK_NEQ           1
#define CHECK_LT            2
#define CHECK_GT            3
#define CHECK_LTE           4
#define CHECK_GTE           5
#define CHECK_AND           6
#define CHECK_XOR           7
#define CHECK_ALL           8
#define CHECK_ATLEASTONE    9
#define CHECK_NONE          10

typedef struct _ByteData
{
    u_int32_t bytes;      /* Number of bytes to extract */
    u_int32_t op;         /* Type of byte comparison, for checkValue */
    u_int32_t value;      /* Value to compare value against, for checkValue, or extracted value */
    int32_t   offset;     /* Offset from cursor */
    u_int32_t multiplier; /* Used for byte jump -- 32bits is MORE than enough */
    u_int32_t flags;      /* must include a CONTENT_BUF_X */
} ByteData;
```

- OptionType: Byte Jump & Structure: *ByteData*

  See *Byte Test* above.

- OptionType: Set Cursor & Structure: *CursorInfo*

  See *Cursor Check* above.

- OptionType: Loop & Structures: *LoopInfo,ByteExtract,DynamicElement*

  The *LoopInfo* structure defines the information for a set of options that are to be evaluated repeatedly. The loop option acts like a FOR loop and includes start, end, and increment values as well as the comparison operation for

termination. It includes a cursor adjust that happens through each iteration of the loop, a reference to a RuleInfo structure that defines the RuleOptions are to be evaluated through each iteration. One of those options may be a ByteExtract.

```
typedef struct _LoopInfo
{
    DynamicElement *start;      /* Starting value of FOR loop (i=start) */
    DynamicElement *end;        /* Ending value of FOR loop (i OP end) */
    DynamicElement *increment;  /* Increment value of FOR loop (i+= increment) */
    u_int32_t op;               /* Type of comparison for loop termination */
    CursorInfo *cursorAdjust;   /* How to move cursor each iteration of loop */
    struct _Rule *subRule;      /* Pointer to SubRule & options to evaluate within
                                 * the loop */
    u_int8_t initialized;       /* Loop initialized properly (safeguard) */
    u_int32_t flags;            /* can be used to negate loop results, specifies
} LoopInfo;
```

The *ByteExtract* structure defines the information to use when extracting bytes for a DynamicElement used a in Loop evaltion. It includes the number of bytes, an offset, multiplier, flags specifying the buffer, and a reference to the DynamicElement.

```
typedef struct _ByteExtract
{
    u_int32_t bytes;      /* Number of bytes to extract */
    int32_t   offset;     /* Offset from cursor */
    u_int32_t multiplier; /* Multiply value by this (similar to byte jump) */
    u_int32_t flags;      /* must include a CONTENT_BUF_X */
    char *refId;          /* To match up with a DynamicElement refId */
    void *memoryLocation; /* Location to store the data extracted */
} ByteExtract;
```

The *DynamicElement* structure is used to define the values for a looping evaluation. It includes whether the element is static (an integer) or dynamic (extracted from a buffer in the packet) and the value. For a dynamic element, the value is filled by a related ByteExtract option that is part of the loop.

```
#define DYNAMIC_TYPE_INT_STATIC 1
#define DYNAMIC_TYPE_INT_REF    2

typedef struct _DynamicElement
{
    char dynamicType;           /* type of this field - static or reference */
    char *refId;                /* reference ID (NULL if static) */
    union
    {
        void *voidPtr;          /* Holder */
        int32_t staticInt;        /* Value of static */
        int32_t *dynamicInt;  /* Pointer to value of dynamic */
    } data;
} DynamicElement;
```

5.2 Required Functions

Each dynamic module must define a set of functions and data objects to work within this framework.

5.2.1 Preprocessors

Each dynamic preprocessor library must define the following functions. These are defined in the file `sf_dynamic_preproc_lib.c`. The metadata and setup function for the preprocessor should be defined `sf_preproc_info.h`.

- *int LibVersion(DynamicPluginMeta *)*

  This function returns the metadata for the shared library.

- *int InitializePreprocessor(DynamicPreprocessorData *)*

  This function initializes the data structure for use by the preprocessor into a library global variable, `_dpd` and invokes the setup function.

5.2.2 Detection Engine

Each dynamic detection engine library must define the following functions.

- *int LibVersion(DynamicPluginMeta *)*

  This function returns the metadata for the shared library.

- *int InitializeEngineLib(DynamicEngineData *)*

  This function initializes the data structure for use by the engine.

The sample code provided with Snort predefines those functions and defines the following APIs to be used by a dynamic rules library.

- *int RegisterRules(Rule **)*

  This is the function to iterate through each rule in the list, initialize it to setup content searches, PCRE evalution data, and register flowbits.

- *int DumpRules(char *,Rule **)*

  This is the function to iterate through each rule in the list and write a rule-stop to be used by snort to control the action of the rule (alert, log, drop, etc).

- *int ruleMatch(void *p, Rule *rule)*

  This is the function to evaluate a rule if the rule does not have its own Rule Evaluation Function. This uses the individual functions outlined below for each of the rule options and handles repetitive content issues.

  Each of the functions below returns RULE_MATCH if the option matches based on the current criteria (cursor position, etc).

  - *int contentMatch(void *p, ContentInfo* content, u_int8_t **cursor)*

    This function evaluates a single content for a given packet, checking for the existence of that content as delimited by ContentInfo and cursor. Cursor position is updated and returned in *cursor.

    With a text rule, the with option corresponds to depth, and the distance option corresponds to offset.

  - *int checkFlow(void *p, FlowFlags *flowflags)*

    This function evaluates the flow for a given packet.

  - *int extractValue(void *p, ByteExtract *byteExtract, u_int8_t *cursor)*

    This function extracts the bytes from a given packet, as specified by ByteExtract and delimited by cursor. Value extracted is stored in ByteExtract memoryLocation paraneter.

  - *int processFlowbits(void *p, FlowBitsInfo *flowbits)*

    This function evaluates the flowbits for a given packet, as specified by FlowBitsInfo. It will interact with flowbits used by text-based rules.

– *int setCursor(void *p, CursorInfo *cursorInfo, u_int8_t **cursor)*

  This function adjusts the cursor as delimited by CursorInfo. New cursor position is returned in *cursor. It handles bounds checking for the specified buffer and returns RULE_NOMATCH if the cursor is moved out of bounds.

  It is also used by contentMatch, byteJump, and pcreMatch to adjust the cursor position after a successful match.

– *int checkCursor(void *p, CursorInfo *cursorInfo, u_int8_t *cursor)*

  This function validates that the cursor is within bounds of the specified buffer.

– *int checkValue(void *p, ByteData *byteData, u_int32_t value, u_int8_t *cursor)*

  This function compares the *value* to the value stored in ByteData.

– *int byteTest(void *p, ByteData *byteData, u_int8_t *cursor)*

  This is a wrapper for extractValue() followed by checkValue().

– *int byteJump(void *p, ByteData *byteData, u_int8_t **cursor)*

  This is a wrapper for extractValue() followed by setCursor().

– *int pcreMatch(void *p, PCREInfo *pcre, u_int8_t **cursor)*

  This function evaluates a single pcre for a given packet, checking for the existence of the expression as delimited by PCREInfo and cursor. Cursor position is updated and returned in *cursor.

– *int detectAsn1(void *p, Asn1Context *asn1, u_int8_t *cursor)*

  This function evaluates an ASN.1 check for a given packet, as delimited by Asn1Context and cursor.

– *int checkHdrOpt(void *p, HdrOptCheck *optData)*

  This function evaluates the given packet's protocol headers, as specified by HdrOptCheck.

– *int loopEval(void *p, LoopInfo *loop, u_int8_t **cursor)*

  This function iterates through the SubRule of LoopInfo, as delimited by LoopInfo and cursor. Cursor position is updated and returned in *cursor.

– *int preprocOptionEval(void *p, PreprocessorOption *preprocOpt, u_int8_t **cursor)*

  This function evaluates the preprocessor defined option, as spepcifed by PreprocessorOption. Cursor position is updated and returned in *cursor.

– *void setTempCursor(u_int8_t **temp_cursor, u_int8_t **cursor)*

  This function is used to handled repetitive contents to save off a cursor position temporarily to be reset at later point.

– *void revertTempCursor(u_int8_t **temp_cursor, u_int8_t **cursor)*

  This function is used to revert to a previously saved temporary cursor position.

If you decide to write you own rule evaluation function, patterns that occur more than once may result in false negatives. Take extra care to handle this situation and search for the matched pattern again if subsequent rule options fail to match. This should be done for both content and PCRE options.

5.2.3 Rules

Each dynamic rules library must define the following functions. Examples are defined in the file `sfnort_dynamic_detection_lib.c`
The metadata and setup function for the preprocessor should be defined in `sfsnort_dynamic_detection_lib.h`.

- *int LibVersion(DynamicPluginMeta *)*

  This function returns the metadata for the shared library.

- *int EngineVersion(DynamicPluginMeta *)*

  This function defines the version requirements for the corresponding detection engine library.

- *int DumpSkeletonRules()*

  This functions writes out the rule-stubs for rules that are loaded.

- *int InitializeDetection()*

  This function registers each rule in the rules library. It should set up fast pattern-matcher content, register flowbits, etc.

The sample code provided with Snort predefines those functions and uses the following data within the dynamic rules library.

- *Rule *rules[]*

  A NULL terminated list of Rule structures that this library defines.

5.3 Examples

This section provides a simple example of a dynamic preprocessor and a dynamic rule.

5.3.1 Preprocessor Example

The following is an example of a simple preprocessor. This preprocessor always alerts on a Packet if the TCP port matches the one configured.

This assumes the the files *sf_dynamic_preproc_lib.c* and *sf_dynamic_preproc_lib.h* are used.

This is the metadata for this preprocessor, defined in *sf_preproc_info.h*.

```
#define MAJOR_VERSION 1
#define MINOR_VERSION 0
#define BUILD_VERSION 0
#define PREPROC_NAME    "SF_Dynamic_Example_Preprocessor"

#define DYNAMIC_PREPROC_SETUP   ExampleSetup
extern void ExampleSetup();
```

The remainder of the code is defined in *spp_example.c* and is compiled together with *sf_dynamic_preproc_lib.c* into lib_sfdynamic_preprocessor_example.so.

Define the Setup function to register the initialization function.

```
#define GENERATOR_EXAMPLE 256
extern DynamicPreprocessorData _dpd;

void ExampleInit(unsigned char *);
void ExampleProcess(void *, void *);

void ExampleSetup()
{
    _dpd.registerPreproc("dynamic_example", ExampleInit);

    DEBUG_WRAP(_dpd.debugMsg(DEBUG_PLUGIN, "Preprocessor: Example is setup\n"););
}
```

The initialization function to parse the keywords from `snort.conf`.

```
u_int16_t portToCheck;

void ExampleInit(unsigned char *args)
{
    char *arg;
    char *argEnd;
    unsigned long port;

    _dpd.logMsg("Example dynamic preprocessor configuration\n");

    arg = strtok(args, " \t\n\r");

    if(!strcasecmp("port", arg))
    {
        arg = strtok(NULL, "\t\n\r");
        if (!arg)
        {
            _dpd.fatalMsg("ExamplePreproc: Missing port\n");
        }

        port = strtoul(arg, &argEnd, 10);
        if (port < 0 || port > 65535)
        {
            _dpd.fatalMsg("ExamplePreproc: Invalid port %d\n", port);
        }
        portToCheck = port;

        _dpd.logMsg("    Port: %d\n", portToCheck);
    }
    else
    {
        _dpd.fatalMsg("ExamplePreproc: Invalid option %s\n", arg);
    }

    /* Register the preprocessor function, Transport layer, ID 10000 */
    _dpd.addPreproc(ExampleProcess, PRIORITY_TRANSPORT, 10000);

    DEBUG_WRAP(_dpd.debugMsg(DEBUG_PLUGIN, "Preprocessor: Example is initialized\n"););
}
```

The function to process the packet and log an alert if the either port matches.

```
#define SRC_PORT_MATCH  1
#define SRC_PORT_MATCH_STR "example_preprocessor: src port match"
#define DST_PORT_MATCH  2
#define DST_PORT_MATCH_STR "example_preprocessor: dest port match"
void ExampleProcess(void *pkt, void *context)
{
    SFSnortPacket *p = (SFSnortPacket *)pkt;
    if (!p->ip4_header || p->ip4_header->proto != IPPROTO_TCP || !p->tcp_header)
    {
        /* Not for me, return */
        return;
    }

    if (p->src_port == portToCheck)
    {
```

```
        /* Source port matched, log alert */
        _dpd.alertAdd(GENERATOR_EXAMPLE, SRC_PORT_MATCH,
                      1, 0, 3, SRC_PORT_MATCH_STR, 0);
        return;
    }

    if (p->dst_port == portToCheck)
    {
        /* Destination port matched, log alert */
        _dpd.alertAdd(GENERATOR_EXAMPLE, DST_PORT_MATCH,
                      1, 0, 3, DST_PORT_MATCH_STR, 0);
        return;
    }
}
```

5.3.2 Rules

The following is an example of a simple rule, take from the current rule set, SID 109. It is implemented to work with the detection engine provided with snort.

The snort rule in normal format:

```
alert tcp $HOME_NET 12345:12346 -> $EXTERNAL_NET any \
(msg:"BACKDOOR netbus active"; flow:from_server,established; \
content:"NetBus"; reference:arachnids,401; classtype:misc-activity; \
sid:109; rev:5;)
```

This is the metadata for this rule library, defined in *detection_lib_meta.h*.

```
/* Version for this rule library */
#define DETECTION_LIB_MAJOR_VERSION 1
#define DETECTION_LIB_MINOR_VERSION 0
#define DETECTION_LIB_BUILD_VERSION 1
#define DETECTION_LIB_NAME "Snort_Dynamic_Rule_Example"

/* Required version and name of the engine */
#define REQ_ENGINE_LIB_MAJOR_VERSION 1
#define REQ_ENGINE_LIB_MINOR_VERSION 0
#define REQ_ENGINE_LIB_NAME "SF_SNORT_DETECTION_ENGINE"
```

The definition of each data structure for this rule is in *sid109.c*.

Declaration of the data structures.

- Flow option

  Define the *FlowFlags* structure and its corresponding *RuleOption*. Per the text version, flow is from_server,established.

  ```
  static FlowFlags sid109flow =
  {
      FLOW_ESTABLISHED|FLOW_TO_CLIENT
  };

  static RuleOption sid109option1 =
  {
  ```

```
    OPTION_TYPE_FLOWFLAGS,
    {
        &sid109flow
    }
};
```

- Content Option

  Define the *ContentInfo* structure and its corresponding *RuleOption*. Per the text version, content is ”NetBus”, no depth or offset, case sensitive, and non-relative. Search on the normalized buffer by default. **NOTE**: This content will be used for the fast pattern matcher since it is the longest content option for this rule and no contents have a flag of *CONTENT_FAST_PATTERN*.

```
static ContentInfo sid109content =
{
    "NetBus",               /* pattern to search for */
    0,                      /* depth */
    0,                      /* offset */
    CONTENT_BUF_NORMALIZED, /* flags */
    NULL,                   /* holder for boyer/moore info */
    NULL,                   /* holder for byte representation of "NetBus" */
    0,                      /* holder for length of byte representation */
    0                       /* holder for increment length */
};

static RuleOption sid109option2 =
{
    OPTION_TYPE_CONTENT,
    {
        &sid109content
    }
};
```

- Rule and Meta Data

  Define the references.

```
static RuleReference sid109ref_arachnids =
{
    "arachnids",    /* Type */
    "401"           /* value */
};

static RuleReference *sid109refs[] =
{
    &sid109ref_arachnids,
    NULL
};
```

  The list of rule options. Rule options are evaluated in the order specified.

```
RuleOption *sid109options[] =
{
    &sid109option1,
    &sid109option2,
    NULL
};
```

The rule itself, with the protocl header, meta data (sid, classification, message, etc).

```
Rule sid109 =
{
    /* protocol header, akin to => tcp any any -> any any               */
    {
        IPPROTO_TCP,        /* proto */
        HOME_NET,           /* source IP     */
        "12345:12346",      /* source port(s) */
        0,                  /* Direction */
        EXTERNAL_NET,       /* destination IP     */
        ANY_PORT,           /* destination port   */
    },
    /* metadata */
    {
        3,                  /* genid -- use 3 to distinguish a C rule */
        109,                /* sigid */
        5,                  /* revision */
        "misc-activity",    /* classification */
        0,                  /* priority */
        "BACKDOOR netbus active",     /* message */
        sid109refs          /* ptr to references */
    },
    sid109options,          /* ptr to rule options */
    NULL,                   /* Use internal eval func */
    0,                      /* Holder, not yet initialized, used internally */
    0,                      /* Holder, option count, used internally */
    0,                      /* Holder, no alert, used internally for flowbits */
    NULL                    /* Holder, rule data, used internally */
```

- The List of rules defined by this rules library

  The NULL terminated list of rules. The InitializeDetection iterates through each Rule in the list and initializes the content, flowbits, pcre, etc.

```
extern Rule sid109;
extern Rule sid637;

Rule *rules[] =
{
    &sid109,
    &sid637,
    NULL
};
```

Chapter 6

Snort Development

Currently, this chapter is here as a place holder. It will someday contain references on how to create new detection plugins and preprocessors. End users don't really need to be reading this section. This is intended to help developers get a basic understanding of whats going on quickly.

If you are going to be helping out with Snort development, please use the HEAD branch of cvs. We've had problems in the past of people submitting patches only to the stable branch (since they are likely writing this stuff for their own IDS purposes). Bugfixes are what goes into STABLE. Features go into HEAD.

6.1 Submitting Patches

Patches to Snort should be sent to the `snort-devel@lists.sourceforge.net` mailing list. Patches should done with the command `diff -nu snort-orig snort-new`.

6.2 Snort Data Flow

First, traffic is acquired from the network link via libpcap. Packets are passed through a series of decoder routines that first fill out the packet structure for link level protocols then are further decoded for things like TCP and UDP ports.

Packets are then sent through the registered set of preprocessors. Each preprocessor checks to see if this packet is something it should look at.

Packets are then sent through the detection engine. The detection engine checks each packet against the various options listed in the Snort rules files. Each of the keyword options is a plugin. This allows this to be easily extensible.

6.2.1 Preprocessors

For example, a TCP analysis preprocessor could simply return if the packet does not have a TCP header. It can do this by checking:

```
if (p->tcph==null)
   return;
```

Similarly, there are a lot of packet_flags available that can be used to mark a packet as "reassembled" or logged. Check out src/decode.h for the list of pkt_* constants.

6.2.2 Detection Plugins

Basically, look at an existing output plugin and copy it to a new item and change a few things. Later, we'll document what these few things are.

6.2.3 Output Plugins

Generally, new output plugins should go into the barnyard project rather than the Snort project. We are currently cleaning house on the available output options.

6.3 The Snort Team

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