Custom Intrusion Rules

The following topics describe how to use the intrusion rules editor:

Custom Intrusion Rules Overview

An *intrusion rule* is a set of keywords and arguments that the system uses to detect attempts to exploit vulnerabilities on your network. As the system analyzes network traffic, it compares packets against the conditions specified in each rule. If the packet data matches all the conditions specified in a rule, the rule triggers. If a rule is an *alert rule*, it generates an intrusion event. If it is a *pass rule*, it ignores the traffic. For a *drop* rule in an inline deployment, the system drops the packet and generates an event. You can view and evaluate intrusion events from the Secure Firewall Management Center web interface.

The system provides two types of intrusion rules: shared object rules and standard text rules. The Talos Intelligence Group can use shared object rules to detect attacks against vulnerabilities in ways that traditional standard text rules cannot. You cannot create shared object rules. When you write your own intrusion rule, you create a standard text rule.

You can write custom standard text rules to tune the types of events you are likely to see. Note that while this documentation sometimes discusses rules targeted to detect specific exploits, the most successful rules target traffic that may attempt to exploit known vulnerabilities rather than specific known exploits. By writing rules and specifying the rule's event message, you can more easily identify traffic that indicates attacks and policy evasions.

When you enable a custom standard text rule in a custom intrusion policy, keep in mind that some rule keywords and arguments require that traffic first be decoded or preprocessed in a certain way. This chapter explains the options you must configure in your network analysis policy, which governs preprocessing. Note that if you disable a required preprocessor, the system automatically uses it with its current settings, although the preprocessor remains disabled in the network analysis policy web interface.

Caution Make sure you use a controlled network environment to test any intrusion rules that you write before you use the rules in a production environment. Poorly written intrusion rules may seriously affect the performance of the system.

Note You can create custom intrusion rules using Snort. However, support for tuning and troubleshooting these rules is not available currently.

License Requirements for the Intrusion Rule Editor

Threat Defense License

IPS

Requirements and Prerequisites for the Intrusion Rule Editor

Model support

Any.

Supported domains

Any

User roles

- Admin
- Intrusion Admin

Rule Anatomy

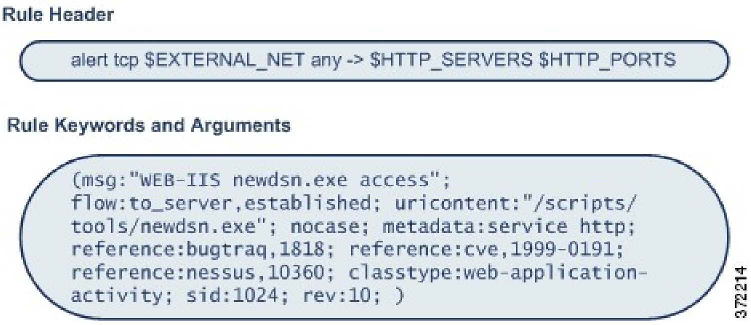
All standard text rules contain two logical sections: the rule header and the rule options. The rule header contains:

- the rule's action or type
- the protocol
- the source and destination IP addresses and netmasks
- direction indicators showing the flow of traffic from source to destination
- the source and destination ports

The rule options section contains:

- event messages
- keywords and their parameters and arguments
- patterns that a packet's payload must match to trigger the rule
- specifications of which parts of the packet the rules engine should inspect

The following diagram illustrates the parts of a rule:



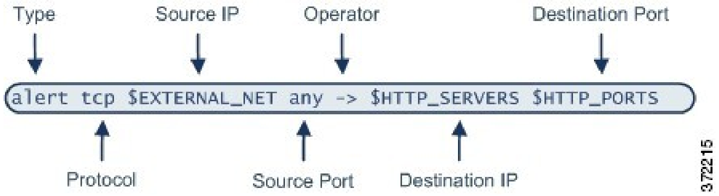
```
alert tcp $EXTERNAL_NET any -> $HTTP_SERVERS $HTTP_PORTS
```

```
(msg:"WEB-IIS newdsn.exe access";
flow:to_server,established; uricontent:"/scripts/
tools/newdsn.exe"; nocase; metadata:service http;
reference:bugtraq,1818; reference:cve,1999-0191;
reference:nessus,10360; classtype:web-application-
activity; sid:1024; rev:10; )
```

Note that the options section of a rule is the section enclosed in parentheses. The intrusion rules editor provides an easy-to-use interface to help you build standard text rules.

The Intrusion Rule Header

Every standard text rule and shared object rule has a rule header containing parameters and arguments. The following illustrates parts of a rule header:



```
alert tcp $EXTERNAL_NET any -> $HTTP_SERVERS $HTTP_PORTS
```

The following table describes each part of the rule header shown above.

Table 1: Rule Header Values

Rule Header Component	Example Value	This Value...
Action	`alert`	Generates an intrusion event when triggered.
Protocol	`tcp`	Tests TCP traffic only.
Source IP Address	`$EXTERNAL_NET`	Tests traffic coming from any host that is not on your internal network.
Source Ports	`any`	Tests traffic coming from any port on the originating host.

Rule Header Component	Example Value	This Value...
Operator	`->`	Tests external traffic (destined for the web servers on your network).
Destination IP Address	`$HTTP_SERVERS`	Tests traffic to be delivered to any host specified as a web server on your internal network.
Destination Ports	`$HTTP_PORTS`	Tests traffic delivered to an HTTP port on your internal network.

Note The previous example uses default variables, as do most intrusion rules.

Intrusion Rule Header Action

Each rule header includes a parameter that specifies the action the system takes when a packet triggers a rule. Rules with the action set to *alert* generate an intrusion event against the packet that triggered the rule and log the details of that packet. Rules with the action set to *pass* do not generate an event against, or log the details of, the packet that triggered the rule.

Note In an inline deployment, rules with the rule state set to *Drop and Generate Events* generate an intrusion event against the packet that triggered the rule. Also, if you apply a drop rule in a passive deployment, the rule acts as an alert rule.

By default, pass rules override alert rules. You can create pass rules to prevent packets that meet criteria defined in the pass rule from triggering the alert rule in specific situations, rather than disabling the alert rule. For example, you might want a rule that looks for attempts to log into an FTP server as the user “anonymous” to remain active. However, if your network has one or more legitimate anonymous FTP servers, you could write and activate a pass rule that specifies that, for those specific servers, anonymous users do not trigger the original rule.

Within the intrusion rules editor, you select the rule type from the **Action** list.

Intrusion Rule Header Protocol

In each rule header, you must specify the protocol of the traffic the rule inspects. You can specify the following network protocols for analysis:

- ICMP (Internet Control Message Protocol)
- IP (Internet Protocol)

  Note The system ignores port definitions in an intrusion rule header when the protocol is set to `ip`.

- TCP (Transmission Control Protocol)

- UDP (User Datagram Protocol)

Use **IP** as the protocol type to examine all protocols assigned by IANA, including TCP, UDP, ICMP, IGMP, and many more.

Note You cannot currently write rules that match patterns in the next header (for example, the TCP header) in an IP payload. Instead, content matches begin with the last decoded protocol. As a workaround, you can match patterns in TCP headers by using rule options.

Within the Intrusion Rules editor, you select the protocol type from the **Protocol** list.

Intrusion Rule Header Direction

Within the rule header, you can specify the direction that the packet must travel for the rule to inspect it. The following table describes these options.

Table 2: Directional Options in Rule Headers

Use...	To Test...
Directional	only traffic from the specified source IP address to the specified destination IP address
Bidirectional	all traffic traveling between the specified source and destination IP addresses

Intrusion Rule Header Source and Destination IP Addresses

Restricting packet inspection to the packets originating from specific IP addresses or destined to a specific IP address reduces the amount of packet inspection the system must perform. This also reduces false positives by making the rule more specific and removing the possibility of the rule triggering against packets whose source and destination IP addresses do not indicate suspicious behavior.

Tip The system recognizes only IP addresses and does not accept host names for source or destination IP addresses.

Within the intrusion rules editor, you specify source and destination IP addresses in the **Source IPs** and **Destination IPs** fields.

When writing standard text rules, you can specify IPv4 and IPv6 addresses in a variety of ways, depending on your needs. You can specify a single IP address, `any`, IP address lists, CIDR notation, prefix lengths, or a network variable. Additionally, you can indicate that you want to exclude a specific IP address or set of IP addresses. When specifying IPv6 addresses, you can use any addressing convention defined in RFC 4291.

IP Address Syntax in Intrusion Rules

The following table summarizes the various ways you can specify source and destination IP addresses.

Table 3: Source/Destination IP Address Syntax

To Specify...	Use...	Example
any IP address	`any`	`any`

To Specify...	Use...	Example

a specific IP address	the IP address
	Note that you would not mix IPv4 and IPv6 source and destination addresses in the same rule.
		`192.168.1.1`
		`2001:db8::abcd`

a list of IP addresses	brackets (`[]`) to enclose the IP addresses and commas to separate them	`[192.168.1.1,192.168.1.15]`
		`[2001:db8::b3ff, 2001:db8::0202]`

a block of IP addresses	IPv4 CIDR block or IPv6 address prefix notation	`192.168.1.0/24`
		`2001:db8::/32`

anything except a specific IP address or set of addresses	the `!` character before the IP address or addresses you want to negate	`!192.168.1.15` `!2001:db8::0202:b3ff:fe1e`

anything in a block of IP addresses except one or more specific IP addresses	a block of addresses followed by a list of negated addresses or blocks	`[10.0.0/8, !10.2.3.4, !10.1.0.0/16]`
		`[2001:db8::/32, !2001:db8::8329, !2001:db8::0202]`

IP addresses defined by a network variable	the variable name, in uppercase letters, preceded by `$` Note that preprocessor rules can trigger events regardless of the hosts defined by network variables used in intrusion rules.	`$HOME_NET`
all IP addresses except addresses defined by an IP address variable	the variable name, in uppercase letters, preceded by `!$`	`!$HOME_NET`

The following descritptions provide additional information on some of the IP address entry methods.

Any IP Address

You can specify the word `any` as a rule source or destination IP address to indicate any IPv4 or IPv6 address.

For example, the following rule uses the argument **any** in the **Source IPs** and **Destination IPs** fields and evaluates packets with any IPv4 or IPv6 source or destination address:

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

You can also specify `::` to indicate any IPv6 address.

Multiple IP Addresses

You can list individual IP addresses by separating the IP addresses with commas and, optionally, by surrounding non-negated lists with brackets, as shown in the following example:

```
[192.168.1.100,192.168.1.103,192.168.1.105]
```

You can list IPv4 and IPv6 addresses alone or in any combination, as shown in the following example:

```
[192.168.1.100,2001:db8::1234,192.168.1.105]
```

Note that surrounding an IP address list with brackets, which was required in earlier software releases, is not required. Note also that, optionally, you can enter lists with a space before or after each comma.

Note You must surround negated lists with brackets.

You can also use IPv4 Classless Inter-Domain Routing (CIDR) notation or IPv6 prefix lengths to specify address blocks. For example:

- 192.168.1.0/24 specifies the IPv4 addresses in the 192.168.1.0 network with a subnet mask of 255.255.255.0, that is, 192.168.1.0 through 192.168.1.255.
- 2001:db8::/32 specifies the IPv6 addresses in the 2001:db8:: network with a prefix length of 32 bits, that is, 2001:db8:: through 2001:db8:ffff:ffff:ffff:ffff:ffff:ffff.

Tip If you need to specify a block of IP addresses but cannot express it using CIDR or prefix length notation alone, you can use CIDR blocks and prefix lengths in an IP address list.

IP Addresses Negation

You can use an exclamation point (`!`) to negate a specified IP address. That is, you can match any IP address with the exception of the specified IP address or addresses. For example, `!192.168.1.1` specifies any IP address other than 192.168.1.1, and `!2001:db8:ca2e::fa4c` specifies any IP address other than 2001:db8:ca2e::fa4c.

To negate a list of IP addresses, place `!` before a bracketed list of IP addresses. For example, `![192.168.1.1,192.168.1.5]` would define any IP address other than 192.168.1.1 or 192.168.1.5.

Note You must use brackets to negate a list of IP addresses.

Be careful when using the negation character with IP address lists. For example, if you use `[!192.168.1.1,!192.168.1.5]` to match any address that is not 192.168.1.1 or 192.168.1.5, the system interprets this syntax as “anything that is not 192.168.1.1, **or** anything that is not 192.168.1.5.”

Because 192.168.1.5 is not 192.168.1.1, and 192.168.1.1 is not 192.168.1.5, both IP addresses match the IP address value of `[!192.168.1.1,!192.168.1.5]`, and it is essentially the same as using “`any`.”

Instead, use `![192.168.1.1,192.168.1.5]`. The system interprets this as “**not** 192.168.1.1 **and not** 192.168.1.5,” which matches any IP address other than those listed between brackets.

Note that you cannot logically use negation with `any` which, if negated, would indicate no address.

Intrusion Rule Header Source and Destination Ports

Within the intrusion rules editor, you specify source and destination ports in the **Source Port** and **Destination Port** fields.

Port Syntax in Intrusion Rules

The system uses a specific type of syntax to define the port numbers used in rule headers.

Note The system ignores port definitions in an intrusion rule header when the protocol is set to `ip`.

You can list ports by separating the ports with commas, as shown in the following example:

```
80, 8080, 8138, 8600-9000, !8650-8675
```

Optionally, the following example shows how you can surround a port list with brackets, which was required in previous software versions but is no longer required:

```
[80, 8080, 8138, 8600-9000, !8650-8675]
```

Note that you **must** surround negated port lists in brackets, as shown in the following example:

```
![20, 22, 23]
```

The following table summarizes the syntax you can use:

Table 4: Source/Destination Port Syntax

To Specify...	Use	Example
any port	`any`	`any`
a specific port	the port number	`80`
a range of ports	a dash between the first and last port number in the range	`80-443`
all ports less than or equal to a specific port	a dash before the port number	`-21`
all ports greater than or equal to a specific port	a dash after the port number	`80-`
all ports except a specific port or range of ports	the `!` character before the port, port list, or range of ports you want to negate Note that you can logically use negation with all port designations except any, which if negated would indicate *no port*.	`!20`
all ports defined by a port variable	the variable name, in uppercase letter, preceded by `$`	`$HTTP_PORTS`
all ports except ports defined by a port variable	the variable name, in uppercase letter, preceded by `!$`	`!$HTTP_PORTS`

Intrusion Event Details

As you construct a standard text rule, you can include contextual information that describes the vulnerability that the rule detects in exploit attempts. You can also include external references to vulnerability databases and define the priority that the event holds in your organization. When analysts see the event, they then have information about the priority, exploit, and known mitigation readily available.

Message

You can specify meaningful text that appears as a message when the rule triggers. The message gives immediate insight into the nature of the vulnerability that the rule detects attempts to exploit. You can use any printable standard ASCII characters except curly braces (`{}`). The system strips quotes that completely surround the message.

Tip You must specify a rule message. Also, the message cannot consist of white space only, one or more quotation marks only, one or more apostrophes only, or any combination of just white space, quotation marks, or apostrophes.

To define the event message in the intrusion rules editor, you enter the event message in the **Message** field.

Classification

For each rule, you can specify an attack classification that appears in the packet display of the event. The following table lists the name and number for each classification.

Table 5: Rule Classifications

Number	Classification Name	Description
1	not-suspicious	Not Suspicious Traffic
2	unknown	Unknown Traffic
3	bad-unknown	Potentially Bad Traffic
4	attempted-recon	Attempted Information Leak
5	successful-recon-limited	Information Leak
6	successful-recon-largescale	Large Scale Information Leak
7	attempted-dos	Attempted Denial of Service
8	successful-dos	Denial of Service
9	attempted-user	Attempted User Privilege Gain
10	unsuccessful-user	Unsuccessful User Privilege Gain
11	successful-user	Successful User Privilege Gain
12	attempted-admin	Attempted Administrator Privilege Gain
13	successful-admin	Successful Administrator Privilege Gain
14	rpc-portmap-decode	Decode of an RPC Query
15	shellcode-detect	Executable Code was Detected

Number	Classification Name	Description
16	string-detect	A Suspicious String was Detected
17	suspicious-filename-detect	A Suspicious Filename was Detected
18	suspicious-login	An Attempted Login Using a Suspicious Username was Detected
19	system-call-detect	A System Call was Detected
20	tcp-connection	A TCP Connection was Detected
21	trojan-activity	A Network Trojan was Detected
22	unusual-client-port-connection	A Client was Using an Unusual Port
23	network-scan	Detection of a Network Scan
24	denial-of-service	Detection of a Denial of Service Attack
25	non-standard-protocol	Detection of a Non-Standard Protocol or Event
26	protocol-command-decode	Generic Protocol Command Decode
27	web-application-activity	Access to a Potentially Vulnerable Web Application
28	web-application-attack	Web Application Attack
29	misc-activity	Misc Activity
30	misc-attack	Misc Attack
31	icmp-event	Generic ICMP Event
32	inappropriate-content	Inappropriate Content was Detected
33	policy-violation	Potential Corporate Privacy Violation
34	default-login-attempt	Attempt to Login By a Default Username and Password
35	sdf	Sensitive Data
36	malware-cnc	Known malware command and control traffic
37	client-side-exploit	Known client side exploit attempt
38	file-format	Known malicious file or file based exploit

Custom Classification

If you want more customized content for the packet display description of the events generated by a rule you define, you can create a custom classification.

Argument	Description
Classification Name	The name of the classification. The page is difficult to read if you use more than 40 characters. The following characters are not supported: `<>()\'"&$;` and the space character.
Classification Description	A description of the classification. You can use alphanumeric characters and spaces. The following characters are not supported: `<>()\'"&$;`
Priority	High, medium, or low.

Custom Priority

By default, the priority of a rule derives from the event classification for the rule. However, you can override the classification priority for a rule by adding the `priority` keyword to the rule and selecting a high, medium, or low priority. For example, to assign a high priority for a rule that detects web application attacks, add the `priority` keyword to the rule and select **high** as the priority.

Custom Reference

You can use the `reference` keyword to add references to external web sites and additional information about the event. Adding a reference provides analysts with an immediately available resource to help them identify why the packet triggered a rule. The following table lists some of the external systems that can provide data on known exploits and attacks.

Table 6: External Attack Identification Systems

System ID	Description	Example ID
`bugtraq`	Bugtraq page	`8550`
`cve`	Common Vulnerabilities and Exposure ID	`2020-9607`
`mcafee`	McAfee page	`98574`
`url`	Website reference	`www.example.com?exploit=14`
`msb`	Microsoft security bulletin	`MS11-082`
`nessus`	Nessus page	`10039`
`secure-url`	Secure Website Reference (https://...)	`intranet/exploits/exploit=14` Note that you can use `secure-url` with any secure website.

You specify a reference by entering a reference value, as follows:

```
id_system,id
```

where id_system is the system being used as a prefix, and id is the CVE ID number, Arachnids ID, or URL (without `http://`).

For example, to specify the Adobe Acrobat and Reader issue documented in CVE-2020-9607, enter the value:

```
cve,2020-9607
```

Note the following when adding references to a rule:

- Do not use a space after the comma.
- Do not use uppercase letters in the system ID.

Adding a Custom Classification

Procedure

Step 1 While creating or editing a rule, choose **Edit Classifications** from the **Classification** drop-down list (**Objects** > **Intrusion Rules** > **Create Rules** > **Edit Classifications**).

If **View Classifications** displays instead, the configuration belongs to an ancestor domain, or you do not have permission to modify the configuration.

Step 2 Enter a **Classification Name** and **Classification Description** as described in Intrusion Event Details, on page 8.

Step 3 Choose a priority for the classification from the **Priority** drop-down list.

Step 4 Click **Add**.

Step 5 Click **Done**.

What to do next

- Continue with creating or editing the rule. See Writing New Rules, on page 14 or Modifying Existing Rules, on page 15 for more information.

Defining an Event Priority

Procedure

Step 1 While creating or editing a rule, choose `priority` from the **Detection Options** drop-down list.

Step 2 Click **Add Option**.

Step 3 Choose a value from the **priority** drop-down list.

Step 4 Click **Save**.

What to do next

- Continue with creating or editing the rule. See Writing New Rules, on page 14 or Modifying Existing Rules, on page 15 for more information.

Defining an Event Reference

Procedure

Step 1 While creating or editing a rule, choose `reference` from the **Detection Options** drop-down list.

Step 2 Click **Add Option**.

Step 3 Enter a value in the **reference** field as described in Intrusion Event Details, on page 8.

Step 4 Click **Save**.

What to do next

- Continue with creating or editing the rule. See Writing New Rules, on page 14 or Modifying Existing Rules, on page 15 for more information.

Custom Rule Creation

You can create a custom intrusion rule by:

- creating your own standard text rules
- saving existing standard text rules as new
- saving system-provided shared object rules as new
- importing a local rule file

The system saves the custom rule in the local rule category, regardless of the method you used to create it.

When you create a custom intrusion rule, the system assigns it a unique rule number, which has the format `GID:SID:Rev`. The elements of this number are:

GID

Generator ID. For all standard text rules, this value is 1 (Global domain or legacy GID) or 1000 - 2000 (descendant domains). For all shared object rules you save as new, this value is 1.

SID

Snort ID. Indicates whether the rule is a local rule of a system rule. When you create a new rule, the system assigns the next available SID for a local rule.

SID numbers for local rules start at 1000000, and the SID for each new local rule is incremented by one.

Rev

The revision number. For a new rule, the revision number is one. Each time you modify a custom rule the revision number increments by one.

In a custom standard text rule, you set the rule header settings and the rule keywords and arguments. You can use the rule header settings to focus the rule to only match traffic using a specific protocol and traveling to or from specific IP addresses or ports.

In a custom system-provided standard text rule or shared object rule, you are limited to modifying rule header information such as the source and destination ports and IP addresses. You cannot modify the rule keywords or arguments.

Modifying header information for a shared object rule and saving your changes creates a new instance of the rule with a generator ID (GID) of 1 (Global domain) or 1000 - 2000 (descendant domains) and the next available SID for a custom rule. The system links the new instance of the shared object rule to the reserved `soid` keyword, which maps the rule you create to the rule created by the Talos Intelligence Group. You can delete instances of a shared object rule that you create, but you cannot delete shared object rules created by Talos.

Writing New Rules

Procedure

Step 1 Choose **Objects** > **Intrusion Rules**.

Step 2 Click **Create Rule**.

Step 3 Enter a value in the **Message** field.

Step 4 Choose a value from each of the following drop-down lists:

- **Classification**
- **Action**
- **Protocol**
- **Direction**

Step 5 Enter values in the following fields:

- **Source IPs**
- **Destination IPs**
- **Source Port**
- **Destination Port**

The system uses the value `any` if you do not specify a value for these fields.

Step 6 Choose a value from the **Detection Options** drop-down list.

Step 7 Click **Add Option**.

Step 8 Enter any arguments for the keyword you added.

Step 9 Optionally, repeat steps 6 to 8.

Step 10 If you added multiple keywords, you can:

- Reorder keywords — Click the up or down arrow next to the keyword you want to move.

- Delete a keyword — Click the **X** next to that keyword.

Step 11 Click **Save As New**.

What to do next

- Enable your new or changed rules within the appropriate intrusion policy.
- Deploy configuration changes.

Modifying Existing Rules

You can save system-provided rules and rules belonging to ancestor domains as new custom rules in the local rule category, which you can then modify.

Procedure

Step 1 Access the intrusion rules using either of the following methods:

- Choose **Policies** > **Access Control heading** > **Intrusion**.

  Click **Snort 2 Version** next to the policy you want to edit and click **Rules**.
- Choose **Objects** > **Intrusion Rules**.

Step 2 Locate the rule you want to modify. You have the following choices:

- Navigate through the folders to the rule.
- Search for the rule; see Searching for Rules, on page 18.
- Filter for the group to which the rule belongs; see Filtering Rules, on page 22.

Step 3 Click **Edit** (✎) next to the rule or, in the case of search results, click the rule message.

If **View** (👁) appears instead, the configuration belongs to an ancestor domain, or you do not have permission to modify the configuration.

Step 4 Modify the rule as appropriate for the rule type.

Note
Do not modify the protocol for a shared object rule; doing so would render the rule ineffective.

Step 5 You have the following choices:

- Click **Save** if you are editing a custom rule and want to overwrite the current version of that rule.
- Click **Save As New** if you are editing a system-provided rule or any rule belonging to an ancestor domain, or if you are editing a custom rule and want to save the changes as a new rule.

What to do next

- If you want to use the local modification of the rule instead of the system-provided rule, deactivate the system-provided rule by using the procedures at Intrusion Rule States and activate the local rule.
- Deploy configuration changes.

Viewing Rule Documentation

From the Rule Edit page, you can view rule documentation supplied by the Talos Intelligence Group. While viewing, you can click **Rule Documentation** and other external references to view additional information provided by Talos. You can also click **Context Explorer** to view contextual information for events generated by the rule.

Procedure

Step 1 Access an intrusion rule using either of the following methods:

- Choose **Policies** > **Access Control heading** > **Intrusion**.

  Click **Snort 2 Version** next to the policy you want to edit and click **Rules**.
- Choose **Objects** > **Intrusion Rules**.

Step 2 Locate the rule you want to view. You have the following choices:

- Navigate through the folders to the rule.
- Search for the rule; see Searching for Rules, on page 18.
- Filter for the group to which the rule belongs; see Filtering Rules, on page 22.

Step 3 Click **Edit** (✎) next to the rule or, in the case of search results, click the rule message.

If **View** (👁) appears instead, the configuration belongs to an ancestor domain, or you do not have permission to modify the configuration.

Step 4 Click **View Documentation**.

Step 5 Optionally, click any of the following links:

- **Rule Documentation** —to view detailed rule specifics.
- Other external references—see Keyword Filtering, on page 20 and *Custom Reference* in Intrusion Event Details, on page 8 for information on available external references.
- **Context Explorer**—see for information on viewing contextual data for the rule in the context explorer.

Tip
Selecting an external link closes the documentation pop-up window; to exit the rule edit page without modifying the rule, select any menu path.

Adding Comments to Intrusion Rules

You can add comments to any intrusion rule. Such comments can be helpful to provide context and additional information about the rule and the exploit or policy violation it identifies.

Procedure

Step 1 Access the intrusion rules using either of the following methods:

- Choose **Policies** > **Access Control heading** > **Intrusion**.

  Click **Snort 2 Version** next to the policy you want to edit and click **Rules**.
- Choose **Objects** > **Intrusion Rules**.

Step 2 Locate the rule you want to annotate. You have the following choices:

- Navigate through the folders to the rule.
- Search for the rule; see Searching for Rules, on page 18.
- Filter for the group where the rule belongs; see Filtering Rules, on page 22.

Step 3 Click **Edit** (✎) next to the rule or, in the case of search results, click the rule message.

If **View** (👁) appears next to a rule instead, the rule belongs to an ancestor policy, or you do not have permission to modify the rule.

Step 4 Click **Rule Comment**.

Step 5 Enter your comment in the text box.

Step 6 Click **Add Comment**.

Tip
You can also add and view rule comments in an intrusion event's packet view.

What to do next

- Continue with creating or editing the rule. See Writing New Rules, on page 14 or Modifying Existing Rules, on page 15 for more information.

Deleting Custom Rules

You can delete custom rules if the rules are not currently enabled in an intrusion policy. You cannot delete either standard text rules or shared object rules provided by the system.

The system stores deleted rules in the deleted category, and you can use a deleted rule as the basis for a new rule. The Rules page in an intrusion policy does not display the deleted category, so you cannot enable deleted custom rules.

Tip Custom rules include shared object rules that you save with modified header information. The system also saves these in the local rule category and lists them with a GID of 1 (Global domain or legacy GID) or 1000 - 2000 (descendant domains). You can delete your modified version of a shared object rule, but you cannot delete the original shared object rule.

Procedure

Step 1 Access the intrusion rules using either of the following methods:

- Choose **Policies** > **Access Control heading** > **Intrusion**.

  Click **Snort 2 Version** next to the policy you want to edit and click **Rules**.

- Choose **Objects** > **Intrusion Rules**.

Step 2 You have two choices:

- Delete all local rules — Click **Delete Local Rules**, then click **OK**.
- Delete a single rule — Choose `Local Rules` from the **Group Rules By** drop-down, click **Delete** (🗑) next to a rule you want to delete, and click **OK** to confirm the deletion.

Searching for Rules

The system provides thousands of standard text rules, and the Talos Intelligence Group continues to add rules as new vulnerabilities and exploits are discovered. You can easily search for specific rules so that you can activate, deactivate, or edit them.

Procedure

Step 1 Access the intrusion rules using either of the following methods:

- Choose **Policies** > **Access Control heading** > **Intrusion**.

  Click **Snort 2 Version** next to the policy you want to edit and click **Rules**.

- Choose **Objects** > **Intrusion Rules**.

Step 2 Click **Search** on the toolbar.

Step 3 Add search criteria.

Step 4 Click **Search**.

What to do next

- If you want to view or edit a located rule (or a copy of the rule, if it is a system rule), click the hyperlinked rule message. See Writing New Rules, on page 14 or Modifying Existing Rules, on page 15 for more information.

Search Criteria for Intrusion Rules

The following table describes the available search options:

Table 7: Rule Search Criteria

Option	Description
Signature ID	To search for a single rule based on Snort ID (SID), enter an SID number. To search for multiple rules, enter a comma-separated list of SID numbers. This field has an 80-character limit.
Generator ID	To search for standard text rules, select **1**. To search for shared object rules, select **3**.
Message	To search for a rule with a specific message, enter a single word from the rule message in the **Message** field. For example, to search for DNS exploits, you would enter `DNS`, or to search for buffer overflow exploits, enter `overflow`.
Protocol	To search rules that evaluate traffic of a specific protocol, select the protocol. If you do not select a protocol, search results contain rules for all protocols.
Source Port	To search for rules that inspect packets originating from a specified port, enter a source port number or a port-related variable.
Destination Port	To search for rules that inspect packets destined for a specific port, enter a destination port number or a port-related variable.
Source IP	To search for rules that inspect packets originating from a specified IP address, enter a source IP address or an IP address-related variable.
Destination IP	To search for rules that inspect packets destined for a specified IP address, enter a destination IP address or an IP address-related variable.
Keyword	To search for specific keywords, you can use the keyword search options. You select a keyword and enter a keyword value for which to search. You can also precede the keyword value with an exclamation point (`!`) to match any value other than the specified value.
Category	To search for rules in a specific category, select the category from the **Category** list.
Classification	To search for rules that have a specific classification, select the classification name from the **Classification** list.
Rule State	To search for rules within a specific policy and a specific rule state, select the policy from the first **Rule State** list, and choose a state from the second list to search for rules set to **Generate Events**, **Drop and Generate Events**, or **Disabled**.

Rule Filtering on the Intrusion Rules Editor Page

You can filter the rules on the intrusion rules editor page to display a subset of rules. This can be useful, for example, when you want to modify a rule or change its state but have difficulty finding it among the thousands of rules available.

When you enter a filter, the page displays any folder that includes at least one matching rule, or a message when no rule matches.

Filtering Guidelines

Your filter can include special keywords and their arguments, character strings, and literal character strings in quotes, with spaces separating multiple filter conditions. A filter cannot include regular expressions, wild card characters, or any special operator such as a negation character (!), a greater than symbol (>), less than symbol (<), and so on.

All keywords, keyword arguments, and character strings are case-insensitive. Except for the `gid` and `sid` keywords, all arguments and strings are treated as partial strings. Arguments for `gid` and `sid` return only exact matches.

You can expand a folder on the original, unfiltered page and the folder remains expanded when the subsequent filter returns matches in that folder. This can be useful when the rule you want to find is in a folder that contains a large number of rules.

You cannot constrain a filter with a subsequent filter. Any filter you enter searches the entire rules database and returns all matching rules. When you enter a filter while the page still displays the result of a previous filter, the page clears and returns the result of the new filter instead.

You can use the same features with rules in a filtered or unfiltered list. For example, you can edit rules in a filtered or unfiltered list on the intrusion rules editor page. You can also use any of the options in the context menu for the page.

Tip Filtering may take significantly longer when the combined total of rules in all sub-groups is large because rules appear in multiple categories, even when the total number of unique rules is much smaller.

Keyword Filtering

Each rule filter can include one or more keywords in the format:

```
keyword:argument
```

where keyword is one of the keywords in the following table and argument is a single, case-insensitive, alphanumeric string to search for in the specific field or fields relevant to the keyword.

Arguments for all keywords except `gid` and `sid` are treated as partial strings. For example, the argument `123` returns `"12345"`, `"41235"`, `"45123"`, and so on. The arguments for `gid` and `sid` return only exact matches; for example, `sid:3080` returns only SID 3080.

Tip You can search for a partial SID by filtering with one or more character strings.

The following table describes the specific filtering keywords and arguments you can use to filter rules.

Table 8: Rule Filter Keywords

Keyword	Description	Example
`arachnids`	Returns one or more rules based on all or part of the Arachnids ID in a rule reference.	`arachnids:181`
`bugtraq`	Returns one or more rules based on all or part of the Bugtraq ID in a rule reference.	`bugtraq:2120`
`cve`	Returns one or more rules based on all or part of the CVE number in a rule reference.	`cve:2003-0109`
`gid`	The argument `1` returns standard text rules. The argument `3` returns shared object rules.	`gid:3`
`mcafee`	Returns one or more rules based on all or part of the McAfee ID in a rule reference.	`mcafee:10566`
`msg`	Returns one or more rules based on all or part of the rule Message field, also known as the event message.	`msg:chat`
`nessus`	Returns one or more rules based on all or part of the Nessus ID in a rule reference.	`nessus:10737`
`ref`	Returns one or more rules based on all or part of a single alphanumeric string in a rule reference or in the rule Message field.	`ref:MS03-039`
`sid`	Returns the rule with the exact Snort ID.	`sid:235`
`url`	Returns one or more rules based on all or part of the URL in a rule reference.	`url:faqs.org`

Character String Filtering

Each rule filter can include one or more alphanumeric character strings. Character strings search the rule **Message** field, Snort ID (SID), and Generator ID (GID). For example, the string `123` returns the strings `"Lotus123"`, `"123mania"`, and so on in the rule message, and also returns SID 6123, SID 12375, and so on.

All character strings are case-insensitive and are treated as partial strings. For example, any of the strings `ADMIN`, `admin`, or `Admin` return `"admin"`, `"CFADMIN"`, `"Administrator"` and so on.

You can enclose character strings in quotes to return exact matches. For example, the literal string `"overflow attempt"` in quotes returns only that exact string, whereas a filter comprised of the two strings `overflow` and `attempt` without quotes returns `"overflow attempt"`, `"overflow multipacket attempt"`, `"overflow with evasion attempt"`, and so on.

Combination Keyword and Character String Filtering

You can narrow filter results by entering any combination of keywords, character strings, or both, separated by spaces. The result includes any rule that matches all the filter conditions.

You can enter multiple filter conditions in any order. For example, each of the following filters returns the same rules:

- `url:at login attempt cve:200`
- `login attempt cve:200 url:at`
- `login cve:200 attempt url:at`

Filtering Rules

On the Intrusion Rules page, you can filter rules into subsets so you can more easily find specific rules. You can then use any of the page features, including choosing any of the features available in the context menu.

Rule filtering can be particularly useful to locate a specific rule to edit.

Procedure

Step 1 Access the intrusion rules using either of the following methods:

- Choose **Policies** > **Access Control heading** > **Intrusion**.

  Click **Snort 2 Version** next to the policy you want to edit and click **Rules**.

- Choose **Objects** > **Intrusion Rules**.

Step 2 Prior to filtering, you have the following choices:

- Expand any rule group you want to expand. Some rule groups also have sub-groups that you can expand.

  Expanding a group on the original, unfiltered page can be useful when you expect that a rule might be in that group. The group remains expanded when the subsequent filter results in a match in that folder, and when you return to the original, unfiltered page by clicking filter **Clear** (✕).

- Choose a different grouping method from the **Group Rules By** drop-down list.

Step 3 Enter filter constraints in the text box next to **Filter** (🔍) under the **Group Rules By** list.

Step 4 Press Enter.

Note
Clear the current filtered list by clicking filter **Clear** (✕).

Keywords and Arguments in Intrusion Rules

Using the rules language, you can specify the behavior of a rule by combining keywords. Keywords and their associated values (called *arguments*) dictate how the system evaluates packets and packet-related values that the rules engine tests. The system currently supports keywords that allow you to perform inspection functions, such as content matching, protocol-specific pattern matching, and state-specific matching. You can define up to 100 arguments per keyword, and combine any number of compatible keywords to create highly specific rules. This helps decrease the chance of false positives and false negatives and focus the intrusion information you receive.

Note that you can also use adaptive profile updates in passive deployments to dynamically adapt active rule processing for specific packets based on rule metadata and host information.

Keywords described in this section are listed under Detection Options in the rules editor.

The content and protected_content Keywords

Use the `content` keyword or the `protected_content` keyword to specify content that you want to detect in a packet.

You should almost always follow a `content` or `protected_content` keyword by modifiers that indicate where the content should be searched for, whether the search is case sensitive, and other options.

Note that all content matches must be true for the rule to trigger an event, that is, each content match has an AND relationship with the others.

Note also that, in an inline deployment, you can set up rules that match malicious content and then replace it with your own text string of equal length.

content

When you use the `content` keyword, the rules engine searches the packet payload or stream for that string. For example, if you enter `/bin/sh` as the value for one of the `content` keywords, the rules engine searches the packet payload for the string `/bin/sh`.

Match content using either an ASCII string, hexadecimal content (binary byte code), or a combination of both. Surround hexadecimal content with pipe characters (|) in the keyword value. For example, you can mix hexadecimal content and ASCII content using something that looks like `|90C8 C0FF FFFF|/bin/sh`.

You can specify multiple content matches in a single rule. To do this, use additional instances of the `content` keyword. For each content match, you can indicate that content matches must be found in the packet payload or stream for the rule to trigger.

⚠ **Caution** You may invalidate your intrusion policy if you create a rule that includes only one `content` keyword and that keyword has the **Not** option selected.

protected_content

The `protected_content` keyword allows you to encode your search content string before configuring the rule argument. The original rule author uses a hash function (SHA-512, SHA-256, or MD5) to encode the string before configuring the keyword.

When you use the protected_content keyword instead of the content keyword, there is no change to how the rules engine searches the packet payload or stream for that string and most of the keyword options function as expected. The following table summarizes the exceptions, where the protected_content keyword options differ from the content keyword options.

Table 9: protected_content Option Exceptions

Option	Description
Hash Type	New option for the protected_content rule keyword.
Case Insensitive	Not supported
Within	Not supported
Depth	Not supported
Length	New option for the protected_content rule keyword.
Use Fast Pattern Matcher	Not supported
Fast Pattern Matcher Only	Not supported
Fast Pattern Matcher Offset and Length	Not supported

Cisco recommends that you include at least one content keyword in rules that include a protected_content keyword to ensure that the rules engine uses the fast pattern matcher, which increases processing speed and improves performance. Position the content keyword before the protected_content keyword in the rule. Note that the rules engine uses the fast pattern matcher when a rule includes at least one content keyword, regardless of whether you enable the content keyword Use Fast Pattern Matcher argument.

Caution You may invalidate your intrusion policy if you create a rule that includes only one protected_content keyword and that keyword has the **Not** option selected.

Basic content and protected_content Keyword Arguments

You can constrain the location and case-sensitivity of content searches with parameters that modify the content or protected_content keyword. Configure options that modify the content or protected_content keyword to specify the content for which you want to search.

Case Insensitive

Note This option is **not** supported when configuring the protected_content keyword.

You can instruct the rules engine to ignore case when searching for content matches in ASCII strings. To make your search case-insensitive, check **Case Insensitive** when specifying a content search.

Hash Type

Note This option is **only** configurable with the `protected_content` keyword.

Use the **Hash Type** drop-down to identify the hash function you used to encode your search string. The system supports SHA-512, SHA-256, and MD5 hashing for `protected_content` search strings. If the length of your hashed content does not match the selected hash type, the system does **not** save the rule.

The system automatically selects the Cisco-set default value. When **Default** is selected, no specific hash function is written into the rule and the system assumes SHA-512 for the hash function.

Raw Data

The **Raw Data** option instructs the rules engine to analyze the original packet payload before analyzing the normalized payload data (decoded by a network analysis policy) and does not use an argument value. You can use this keyword when analyzing telnet traffic to check the telnet negotiation options in the payload before normalization.

You cannot use the **Raw Data** option together in the same `content` or `protected_content` keyword with any HTTP content option.

Tip You can configure the HTTP Inspect preprocessor **Client Flow Depth** and **Server Flow Depth** options to determine whether raw data is inspected in HTTP traffic, and how much raw data is inspected.

Not

Select the **Not** option to search for content that does not match the specified content. If you create a rule that includes a `content` or `protected_content` keyword with the **Not** option selected, you must also include in the rule at least one other `content` or `protected_content` keyword without the **Not** option selected.

Caution Do not create a rule that includes only one `content` or `protected_content` keyword if that keyword has the **Not** option selected. You may invalidate your intrusion policy.

For example, SMTP rule 1:2541:9 includes three `content` keywords, one of which has the **Not** option selected. A custom rule based on this rule would be invalid if you removed all of the `content` keywords except the one with the **Not** option selected. Adding such a rule to your intrusion policy could invalidate the policy.

Tip You cannot select the **Not** check box and the **Use Fast Pattern Matcher** check box with the same `content` keyword.

content and protected_content Keyword Search Locations

You can use search location options to specify where to begin searching for the specified content and how far to continue searching.

Permitted Combinations: content Search Location Arguments

You can use either of two `content` location pairs to specify where to begin searching for the specified content and how far to continue searching, as follows:

- Use **Offset** and **Depth** together to search relative to the beginning of the packet payload.
- Use **Distance** and **Within** together to search relative to the current search location.

When you specify only one of a pair, the default for the other option in the pair is assumed.

You cannot mix the **Offset** and **Depth** options with the **Distance** and **Within** options. For example, you cannot pair **Offset** and **Within**. You can use any number of location options in a rule.

When no location is specified, the defaults for **Offset** and **Depth** are assumed; that is, the content search starts at the beginning of the packet payload and continues to the end of the packet.

You can also use an existing `byte_extract` variable to specify the value for a location option.

Tip You can use any number of location options in a rule.

Permitted Combinations: protected_content Search Location Arguments

Use the required **Length** `protected_content` location option in combination with either the **Offset** or **Distance** location option to specify where to begin searching for the specified content and how far to continue searching, as follows:

- Use **Length** and **Offset** together to search for the protected string relative to the beginning of the packet payload.
- Use **Length** and **Distance** together to search for the protected string relative to the current search location.

Tip You cannot mix the **Offset** and **Distance** options within a single keyword configuration, but you can use any number of location options in a rule.

When no location is specified, the defaults are assumed; that is, the content search starts at the beginning of the packet payload and continues to the end of the packet.

You can also use an existing `byte_extract` variable to specify the value for a location option.

content and protected_content Search Location Arguments

Depth

Note This option is **only** supported when configuring the `content` keyword.

Specifies the maximum content search depth, in bytes, from the beginning of the offset value, or if no offset is configured, from the beginning of the packet payload.

For example, in a rule with a content value of `cgi-bin/phf`, and `offset` value of `3`, and a `depth` value of `22`, the rule starts searching for a match to the `cgi-bin/phf` string at byte 3, and stops after processing 22 bytes (byte 25) in packets that meet the parameters specified by the rule header.

You must specify a value that is greater than or equal to the length of the specified content, up to a maximum of 65535 bytes. You cannot specify a value of 0.

The default depth is to search to the end of the packet.

Distance

Instructs the rules engine to identify subsequent content matches that occur a specified number of bytes after the previous successful content match.

Because the distance counter starts at byte 0, specify one less than the number of bytes you want to move forward from the last successful content match. For example, if you specify 4, the search begins at the fifth byte.

You can specify a value of -65535 to 65535 bytes. If you specify a negative `Distance` value, the byte you start searching on may fall outside the beginning of a packet. Any calculations will take into account the bytes outside the packet, even though the search actually starts on the first byte in the packet. For example, if the current location in the packet is the fifth byte, and the next content rule option specifies a `Distance` value of -10 and a `Within` value of 20, the search starts at the beginning of the payload and the `Within` option is adjusted to 15.

The default distance is 0, meaning the current location in the packet subsequent to the last content match.

Length

Note This option is **only** supported when configuring the `protected_content` keyword.

The **Length** `protected_content` keyword option indicates the length, in bytes, of the unlashed search string.

For example, if you used the content `Sample1` to generate a secure hash, use `7` for the **Length** value. You **must** enter a value in this field.

Offset

Specifies in bytes where in the packet payload to start searching for content relative to the beginning of the packet payload. You can specify a value of 65535 to 65535 bytes.

Because the offset counter starts at byte 0, specify one less than the number of bytes you want to move forward from the beginning of the packet payload. For example, if you specify 7, the search begins at the eighth byte.

The default offset is 0, meaning the beginning of the packet.

Within

Note This option is **only** supported when configuring the `content` keyword.

The **Within** option indicates that, to trigger the rule, the next content match must occur within the specified number of bytes after the end of the last successful content match. For example, if you specify a **Within** value of 8, the next content match must occur within the next eight bytes of the packet payload or it does not meet the criteria that triggers the rule.

You can specify a value that is greater than or equal to the length of the specified content, up to a maximum of 65535 bytes.

The default for **Within** is to search to the end of the packet.

Overview: HTTP content and protected_content Keyword Arguments

HTTP `content` or `protected_content` keyword options let you specify where to search for content matches within an HTTP message decoded by the HTTP Inspect preprocessor.

Two options search status fields in HTTP responses:

- **HTTP Status Code**
- **HTTP Status Message**

Note that although the rules engine searches the raw, unnormalized status fields, these options are listed here separately to simplify explanation below of the restrictions to consider when combining other raw HTTP fields and normalized HTTP fields.

Five options search normalized fields in HTTP requests, responses, or both, as appropriate :

- **HTTP URI**
- **HTTP Method**
- **HTTP Header**
- **HTTP Cookie**
- **HTTP Client Body**

Three options search raw (unnormalized) non-status fields in HTTP requests, responses, or both, as appropriate:

- **HTTP Raw URI**
- **HTTP Raw Header**
- **HTTP Raw Cookie**

Use the following guidelines when selecting HTTP `content` options:

- HTTP `content` options apply only to TCP traffic.
- To avoid a negative impact on performance, select only those parts of the message where the specified content might appear.

  For example, when traffic is likely to include large cookies such as those in shopping cart messages, you might search for the specified content in the HTTP header but not in HTTP cookies.

- To take advantage of HTTP Inspect preprocessor normalization, and to improve performance, any HTTP-related rule you create should at a minimum include at least one `content` or `protected_content` keyword with an **HTTP URI**, **HTTP Method**, **HTTP Header**, or **HTTP Client Body** option selected.

- You cannot use the `replace` keyword in conjunction with HTTP `content` or `protected_content` keyword options.

You can specify a single normalized HTTP option or status field, or use normalized HTTP options and status fields in any combination to target a content area to match. However, note the following restrictions when using HTTP field options:

- You cannot use the **Raw Data** option together in the same `content` or `protected_content` keyword with any HTTP option.
- You cannot use a raw HTTP field option (**HTTP Raw URI**, **HTTP Raw Header**, or **HTTP Raw Cookie**) together in the same `content` or `protected_content` keyword with its normalized counterpart (**HTTP URI**, **HTTP Header**, or **HTTP Cookie**, respectively).
- You cannot select **Use Fast Pattern Matcher** in combination with one or more of the following HTTP field options:

  HTTP Raw URI, **HTTP Raw Header**, **HTTP Raw Cookie**, **HTTP Cookie**, **HTTP Method**, **HTTP Status Message**, or **HTTP Status Code**

  However, you can include the options above in a `content` or `protected_content` keyword that also uses the fast pattern matcher to search one of the following normalized fields:

  HTTP URI, **HTTP Header**, or **HTTP Client Body**

  For example, if you select **HTTP Cookie**, **HTTP Header**, and **Use Fast Pattern Matcher**, the rules engine searches for content in both the HTTP cookie and the HTTP header, but the fast pattern matcher is applied only to the HTTP header, not to the HTTP cookie.
- When you combine restricted and unrestricted options, the fast pattern matcher searches only the unrestricted fields you specify to test whether to pass the rule to the intrusion rules editor for complete evaluation, including evaluation of the restricted fields.

HTTP content and protected_content Keyword Arguments

HTTP URI

Select this option to search for content matches in the normalized request URI field.

Note that you cannot use this option in combination with the `pcre` keyword HTTP URI (U) option to search the same content.

Note A pipelined HTTP request packet contains multiple URIs. When **HTTP URI** is selected and the rules engine detects a pipelined HTTP request packet, the rules engine searches all URIs in the packet for a content match.

HTTP Raw URI

Select this option to search for content matches in the normalized request URI field.

Note that you cannot use this option in combination with the `pcre` keyword HTTP URI (U) option to search the same content.

Note A pipelined HTTP request packet contains multiple URIs. When **HTTP URI** is selected and the rules engine detects a pipelined HTTP request packet, the rules engine searches all URIs in the packet for a content match.

HTTP Method

Select this option to search for content matches in the request method field, which identifies the action such as GET and POST to take on the resource identified in the URI.

HTTP Header

Select this option to search for content matches in the normalized header field, except for cookies, in HTTP requests; also in responses when the HTTP Inspect preprocessor **Inspect HTTP Responses** option is enabled.

Note that you cannot use this option in combination with the `pcre` keyword HTTP header (H) option to search the same content.

HTTP Raw Header

Select this option to search for content matches in the raw header field, except for cookies, in HTTP requests; also in responses when the HTTP Inspect preprocessor I**nspect HTTP Responses** option is enabled.

Note that you cannot use this option in combination with the `pcre` keyword HTTP raw header (D) option to search the same content.

HTTP Cookie

Select this option to search for content matches in any cookie identified in a normalized HTTP client request header; also in response set-cookie data when the HTTP Inspect preprocessor **Inspect HTTP Responses** option is enabled. Note that the system treats cookies included in the message body as body content.

You must enable the HTTP Inspect preprocessor **Inspect HTTP Cookies** option to search only the cookie for a match; otherwise, the rules engine searches the entire header, including the cookie.

Note the following:

- You cannot use this option in combination with the `pcre` keyword HTTP cookie (C) option to search the same content.
- The `Cookie:` and `Set-Cookie:` header names, leading spaces on the header line, and the `CRLF` that terminates the header line are inspected as part of the header and not as part of the cookie.

HTTP Raw Cookie

Select this option to search for content matches in any cookie identified in a raw HTTP client request header; also in response set-cookie data when the HTTP Inspect preprocessor **Inspect HTTP Responses** option is enabled; note that the system treats cookies included in the message body as body content.

You must enable the HTTP Inspect preprocessor **Inspect HTTP Cookies** option to search only the cookie for a match; otherwise, the rules engine searches the entire header, including the cookie.

Note the following:

- You cannot use this option in combination with the `pcre` keyword HTTP raw cookie (K) option to search the same content.
- The `Cookie:` and `Set-Cookie:` header names, leading spaces on the header line, and the `CRLF` that terminates the header line are inspected as part of the header and not as part of the cookie.

HTTP Client Body

Select this option to search for content matches in the message body in an HTTP client request.

Note that for this option to function, you must specify a value of 0 to 65535 for the HTTP Inspect preprocessor **HTTP Client Body Extraction Depth** option.

HTTP Status Code

Select this option to search for content matches in the 3-digit status code in an HTTP response.

You must enable the HTTP Inspect preprocessor **Inspect HTTP Responses** option for this option to return a match.

HTTP Status Message

Select this option to search for content matches in the textual description that accompanies the status code in an HTTP response.

You must enable the HTTP Inspect preprocessor **Inspect HTTP Responses** option for this option to return a match.

Overview: content Keyword Fast Pattern Matcher

Note These options are **not** supported when configuring the `protected_content` keyword.

The fast pattern matcher quickly determines which rules to evaluate before passing a packet to the rules engine. This initial determination improves performance by significantly reducing the number of rules used in packet evaluation.

By default, the fast pattern matcher searches packets for the longest content specified in a rule; this is to eliminate as much as possible needless evaluation of a rule. Consider the following example rule fragment:

```
alert tcp any any -> any 80 (msg:"Exploit"; content:"GET";

http_method; nocase; content:"/exploit.cgi"; http_uri;

nocase;)
```

Almost all HTTP client requests contain the content `GET`, but few will contain the content `/exploit.cgi`. Using `GET` as the fast pattern content would cause the rules engine to evaluate this rule in most cases and would rarely result in a match. However, most client `GET` requests would not be evaluated using `/exploit.cgi`, thus increasing performance.

The rules engine evaluates the packet against the rule only when the fast pattern matcher detects the specified content. For example, if one `content` keyword in a rule specifies the content `short`, another specifies `longer`, and a third specifies `longest`, the fast pattern matcher will use the content `longest` and the rule will be evaluated only if the rules engine finds `longest` in the payload.

content Keyword Fast Pattern Matcher Arguments

Use Fast Pattern Matcher

Use this option to specify a shorter search pattern for the fast pattern matcher to use. Ideally, the pattern you specify is less likely to be found in the packet than the longest pattern and, therefore, more specifically identifies the targeted exploit.

Note the following restrictions when selecting **Use Fast Pattern Matcher** and other options in the same `content` keyword:

- You can specify **Use Fast Pattern Matcher** only one time per rule.
- You cannot use **Distance**, **Within**, **Offset**, or **Depth** when you select **Use Fast Pattern Matcher** in combination with **Not**.
- You cannot select Use Fast Pattern Matcher in combination with any of the following HTTP field options:

  HTTP Raw URI, **HTTP Raw Header**, **HTTP Raw Cookie**, **HTTP Cookie**, **HTTP Method**, **HTTP Status Message**, or **HTTP Status Code**

  However, you can include the options above in a `content` keyword that also uses the fast pattern matcher to search one of the following normalized fields:

  HTTP URI, **HTTP Header**, or **HTTP Client Body**

  For example, if you select **HTTP Cookie**, **HTTP Header**, and **Use Fast Pattern Matcher**, the rules engine searches for content in both the HTTP cookie and the HTTP header, but the fast pattern matcher is applied only to the HTTP header, not to the HTTP cookie.

  Note that you cannot use a raw HTTP field option (**HTTP Raw URI**, **HTTP Raw Header**, or **HTTP Raw Cookie**) together in the same `content` keyword with its normalized counterpart (**HTTP URI**, **HTTP Header**, or **HTTP Cookie**, respectively).

  When you combine restricted and unrestricted options, the fast pattern matcher searches only the unrestricted fields you specify to test whether to pass the packet to the rules engine for complete evaluation, including evaluation of the restricted fields.

- Optionally, when you select **Use Fast Pattern Matcher** you can also select **Fast Pattern Matcher Only** or **Fast Pattern Matcher Offset and Length**, but not both.
- You cannot use the fast pattern matcher when inspecting Base64 data.

Fast Pattern Matcher Only

This option allows you to use the `content` keyword only as a fast pattern matcher option and not as a rule option. You can use this option to conserve resources when rules engine evaluation of the specified content is not necessary. For example, consider a case where a rule requires only that the content `12345` be anywhere in the payload. When the fast pattern matcher detects the pattern, the packet can be evaluated against additional keywords in the rule. There is no need for the rules engine to reevaluate the packet to determine if it includes the pattern `12345`.

You would not use this option when the rule contains other conditions relative to the specified content. For example, you would not use this option to search for the content `1234` if another rule condition sought to determine if `abcd` occurs before `1234`. In this case, the rules engine could not determine the relative location because specifying **Fast Pattern Matcher Only** instructs the rules engine not to search for the specified content.

Note the following conditions when using this option:

- The specified content is location-independent; that is, it may occur anywhere in the payload; thus, you cannot use positional options (**Distance**, **Within**, **Offset**, **Depth**, or **Fast Pattern Matcher Offset and Length**).
- You cannot use this option in combination with **Not**.

- You cannot use this option in combination with **Fast Pattern Matcher Offset and Length**.
- The specified content will be treated as case-insensitive, because all patterns are inserted into the fast pattern matcher in a case-insensitive manner; this is handled automatically, so it is not necessary to select **Case Insensitive** when you select this option.
- You should not immediately follow a `content` keyword that uses the **Fast Pattern Matcher Only** option with the following keywords, which set the search location relative to the current search location:
    - `isdataat`
    - `pcre`
    - `content` when **Distance** or **Within** is selected
    - `content` when **HTTP URI** is selected
    - `asn1`
    - `byte_jump`
    - `byte_test`
    - `byte_math`
    - `byte_extract`
    - `base64_decode`

Fast Pattern Matcher Offset and Length

The **Fast Pattern Matcher Offset and Length** option allows you to specify a portion of the content to search. This can reduce memory consumption in cases where the pattern is very long and only a portion of the pattern is sufficient to identify the rule as a likely match. When a rule is selected by the fast pattern matcher, the entire pattern is evaluated against the rule.

You determine the portion for the fast pattern matcher to use by specifying in bytes where to begin the search (offset) and how far into the content (length) to search, using the syntax:

```
offset,length
```

For example, for the content:

```
1234567
```

if you specify the number of offset and length bytes as:

```
1,5
```

the fast pattern matcher searches only for the content `23456`.

Note that you cannot use this option together with **Fast Pattern Matcher Only**.

The replace Keyword

You can use the `replace` keyword in an inline deployment to replace specified content or to replace content in SSL traffic detected by the Cisco SSL Appliance.

To use the replace keyword, construct a custom standard text rule that uses the content keyword to look for a specific string. Then use the replace keyword to specify a string to replace the content. The replace value and content value must be the same length.

Note You **cannot** use the replace keyword to replace hashed content in a protected_content keyword.

Optionally, you can enclose the replacement string in quotation marks for backward compatibility with previous software versions. If you do not include quotation marks, they are added to the rule automatically so the rule is syntactically correct. To include a leading or trailing quotation mark as part of the replacement text, you must use a backslash to escape it, as shown in the following example:

```
"replacement text plus \"quotation\" marks""
```

A rule can contain multiple replace keywords, but only one per content keyword. Only the first instance of the content found by the rule is replaced.

The following are example uses of the replace keyword:

- If the system detects an incoming packet that contains an exploit, you can replace the malicious string with a harmless one. Sometimes this technique is more successful than simply dropping the offending packet. In some attack scenarios, the attacker simply resends the dropped packet until it bypasses your network defenses or floods your network. By substituting one string for another rather than dropping the packet, you may trick the attacker into believing that the attack was launched against a target that was not vulnerable.
- If you are concerned about reconnaissance attacks that try to learn whether you are running a vulnerable version of, for example, a web server, then you can detect the outgoing packet and replace the banner with your own text.

Note Make sure that you set the rule state to Generate Events in the inline intrusion policy where you want to use the replace rule; setting the rule to Drop and Generate events would cause the packet to drop, which would prevent replacing the content.

As part of the string replacement process, the system automatically updates the packet checksums so that the destination host can receive the packet without error.

Note that you cannot use the replace keyword in combination with HTTP request message content keyword options.

The byte_jump Keyword

The byte_jump keyword calculates the number of bytes defined in a specified byte segment, and then skips that number of bytes within the packet, either forward from the end of the specified byte segment, or from the beginning or end of the packet payload, or from a point relative to the last content match, depending on the options you specify. This is useful in packets where a specific segment of bytes describe the number of bytes included in variable data within the packet.

The following table describes the arguments required by the byte_jump keyword.

Table 10: Required byte_jump Arguments

Argument	Description
Bytes	The number of bytes to pick up from the packet. If used without DCE/RPC, the allowed values are 0 to 10, with the following restrictions: • If used with the `From End` argument, bytes can be 0. If Bytes is 0, the extracted value is 0. • If you specify a number of bytes other than 1, 2, or 4, you must specify a Number Type (hexadecimal, octal, or decimal.) If used with DCE/RPC, allowed values are 1, 2, and 4.
Offset	The number of bytes into the payload to start processing. The `offset` counter starts at byte 0, so calculate the `offset` value by subtracting 1 from the number of bytes you want to jump forward from the beginning of the packet payload or the last successful content match. You can specify -65535 to 65535 bytes. You can also use an existing `byte_extract` variable or `byte_math` result to specify the value for this argument.

The following table describes options you can use to define how the system interprets the values you specified for the required arguments.

Table 11: Additional Optional byte_jump Arguments

Argument	Description
Relative	Makes the offset relative to the last pattern found in the last successful content match.
Align	Rounds the number of converted bytes up to the next 32-bit boundary.
Multiplier	Indicates the value by which the rules engine should multiply the `byte_jump` value obtained from the packet to get the final `byte_jump` value. That is, instead of skipping the number of bytes defined in a specified byte segment, the rules engine skips that number of bytes multiplied by an integer you specify with the Multiplier argument.
Post Jump Offset	The number of bytes -65535 through 65535 to skip forward or backward after applying other `byte_jump` arguments. A positive value skips forward and a negative value skips backward. Leave the field blank or enter `0` to disable. Note that some `byte_jump` arguments do not apply when you select the **DCE/RPC** argument.
From Beginning	Indicates that the rules engine should skip the specified number of bytes in the payload starting from the beginning of the packet payload, instead of from the current position in the packet.
From End	The jump will originate from the byte that follows the last byte of the buffer.

Argument	Description
Bitmask	Applies the specified hexadecimal bitmask using the AND operator to the bytes extracted from the Bytes argument. A bitmask can be 1 to 4 bytes. The result will be right-shifted by the number of bits equal to the number of trailing zeros in the mask.

You can specify only one of **DCE/RPC**, **Endian**, or **Number Type**.

If you want to define how the `byte_jump` keyword calculates the bytes, you can choose from the arguments described in the following table. If you do not select a byte-ordering argument, the rules engine uses big endian byte order.

Table 12: Byte-Ordering byte_jump Arguments

Argument	Description
Big Endian	Processes data in big endian byte order, which is the default network byte order.
Little Endian	Processes data in little endian byte order.
DCE/RPC	Specifies a `byte_jump` keyword for traffic processed by the DCE/RPC preprocessor. The DCE/RPC preprocessor determines big endian or little endian byte order, and the **Number Type** and **Endian** arguments do not apply. When you enable this argument, you can also use `byte_jump` in conjunction with other specific DCE/RPC keywords.

Define how the system views string data in a packet by using one of the arguments in the following table.

Table 13: Number Type Arguments

Argument	Description
Hexadecimal String	Represents converted string data in hexadecimal format.
Decimal String	Represents converted string data in decimal format.
Octal String	Represents converted string data in octal format.

For example, if the values you set for `byte_jump` are as follows:

- Bytes = 4
- Offset = 12
- Relative enabled
- Align enabled

the rules engine calculates the number described in the four bytes that appear 13 bytes after the last successful content match, and skips ahead that number of bytes in the packet. For instance, if the four calculated bytes in a specific packet were `00 00 00 1F`, the rules engine would convert this to 31. Because `align` is specified (which instructs the engine to move to the next 32-bit boundary), the rules engine skips ahead 32 bytes in the packet.

Alternately, if the values you set for `byte_jump` are as follows:

- Bytes = 4
- Offset = 12
- From Beginning enabled
- Multiplier = 2

the rules engine calculates the number described in the four bytes that appear 13 bytes after the beginning of the packet. Then, the engine multiplies that number by two to obtain the total number of bytes to skip. For instance, if the four calculated bytes in a specific packet were `00 00 00 1F`, the rules engine would convert this to 31, then multiply it by two to get 62. Because From Beginning is enabled, the rules engine skips the first 63 bytes in the packet.

The byte_test Keyword

The `byte_test` keyword tests the specified byte segment against the Value argument and its operator.

The following table describes the required arguments for the `byte_test` keyword.

Table 14: Required byte_test Arguments

Argument	Description
Bytes	The number of bytes to calculate from the packet. If used without DCE/RPC, the allowed values are 1 to 10. However, if you specify a number of bytes other than 1, 2, or 4, you must specify a Number Type (hexadecimal, octal, or decimal.). If used with DCE/RPC, allowed values are 1, 2, and 4.
Value	Value to test, including its operator. Supported operators: <, >, =, !, &, ^, !>, !<, !=, !&, or !^. For example, if you specify `!1024`, `byte_test` would convert the specified number, and if it did not equal 1024, it would generate an event (if all other keyword parameters matched). Note that ! and != are equivalent. You can also use an existing `byte_extract` variable or `byte_math` result to specify the value for this argument.
Offset	The number of bytes into the payload to start processing. The `offset` counter starts at byte 0, so calculate the `offset` value by subtracting 1 from the number of bytes you want to count forward from the beginning of the packet payload or the last successful content match. You can use an existing `byte_extract` variable or `byte_math` result to specify the value for this argument.

You can further define how the system uses `byte_test` arguments with the arguments described in the following table.

Table 15: Additional Optional byte_test Arguments

Argument	Description
Bitmask	Applies the specified hexadecimal bitmask using the AND operator to the bytes extracted from the Bytes argument. A bitmask can be 1 to 4 bytes. The result will be right-shifted by the number of bits equal to the number of trailing zeros in the mask.
Relative	Makes the offset relative to the last successful pattern match.

You can specify only one of **DCE/RPC**, **Endian**, or **Number Type**.

To define how the `byte_test` keyword calculates the bytes it tests, choose from the arguments in the following table. If you do not select a byte-ordering argument, the rules engine uses big endian byte order.

Table 16: Byte-Ordering byte_test Arguments

Argument	Description
Big Endian	Processes data in big endian byte order, which is the default network byte order.
Little Endian	Processes data in little endian byte order.
DCE/RPC	Specifies a `byte_test` keyword for traffic processed by the DCE/RPC preprocessor. The DCE/RPC preprocessor determines big endian or little endian byte order, and the **Number Type** and **Endian** arguments do not apply. When you enable this argument, you can also use `byte_test` in conjunction with other specific DCE/RPC keywords.

You can define how the system views string data in a packet by using one of the arguments in the following table.

Table 17: Number Type byte-test Arguments

Argument	Description
Hexadecimal String	Represents converted string data in hexadecimal format.
Decimal String	Represents converted string data in decimal format.
Octal String	Represents converted string data in octal format.

For example, if the value for `byte_test` is specified as the following:

- Bytes = 4
- Operator and Value > 128
- Offset = 8

- Relative enabled

The rules engine calculates the number described in the four bytes that appear 9 bytes away from (relative to) the last successful content match, and, if the calculated number is larger than 128 bytes, the rule is triggered.

The byte_extract Keyword

You can use the `byte_extract` keyword to read a specified number of bytes from a packet into a variable. You can then use the variable later in the same rule as the value for specific arguments in certain other detection keywords.

This is useful, for example, for extracting data size from packets where a specific segment of bytes describes the number of bytes included in data within the packet. For example, a specific segment of bytes might say that subsequent data is comprised of four bytes; you can extract the data size of four bytes to use as your variable value.

You can use `byte_extract` to create up to two separate variables in a rule concurrently. You can redefine a `byte_extract` variable any number of times; entering a new `byte_extract` keyword with the same variable name and a different variable definition overwrites the previous definition of that variable.

The following table describes the arguments required by the `byte_extract` keyword.

Table 18: Required byte_extract Arguments

Argument	Description
Bytes to Extract	The number of bytes to pick up from the packet. If you specify a number of bytes other than 1, 2, or 4, you must specify a Number Type (hexadecimal, octal, or decimal.)
Offset	The number of bytes into the payload to begin extracting data. You can specify -65535 to 65535 bytes. The offset counter starts at byte 0, so calculate the offset value by subtracting 1 from the number of bytes you want to count forward. For example, specify `7` to count forward 8 bytes. The rules engine counts forward from the beginning of the packet payload or, if you also specify **Relative**, after the last successful content match. Note that you can specify negative numbers only when you also specify **Relative**. You can use an existing `byte_math` result to specify the value for this argument.
Variable Name	The variable name to use in arguments for other detection keywords. You can specify an alphanumeric string that must begin with a letter.

To further define how the system locates the data to extract, you can use the arguments described in the following table.

Table 19: Additional Optional byte_extract Arguments

Argument	Description
Multiplier	A multiplier for the value extracted from the packet. You can specify 0 to 65535. If you do not specify a multiplier, the default value is 1.
Align	Rounds the extracted value to the nearest 2-byte or 4-byte boundary. When you also select **Multiplier**, the system applies the multiplier before the alignment.

Argument	Description
Relative	Makes **Offset** relative to the end of the last successful content match instead of the beginning of the payload.
Bitmask	Applies the specified hexadecimal bitmask using the AND operator to the bytes extracted from the Bytes to Extract argument. A bitmask can be 1 to 4 bytes. The result will be right-shifted by the number of bits equal to the number of trailing zeros in the mask.

You can specify only one of **DCE/RPC**, **Endian**, or **Number Type**.

To define how the `byte_extract` keyword calculates the bytes it tests, you can choose from the arguments in the following table. If you do not select a byte-ordering argument, the rules engine uses big endian byte order.

Table 20: Byte-Ordering byte_extract Arguments

Argument	Description
Big Endian	Processes data in big endian byte order, which is the default network byte order.
Little Endian	Processes data in little endian byte order.
DCE/RPC	Specifies a `byte_extract` keyword for traffic processed by the DCE/RPC preprocessor. The DCE/RPC preprocessor determines big endian or little endian byte order, and the **Number Type** and **Endian** arguments do not apply. When you enable this argument, you can also use `byte_extract` in conjunction with other specific DCE/RPC keywords.

You can specify a number type to read data as an ASCII string. To define how the system views string data in a packet, you can select one of the arguments in the following table.

Table 21: Number Type byte_extract arguments

Argument	Description
Hexadecimal String	Reads extracted string data in hexadecimal format.
Decimal String	Reads extracted string data in decimal format.
Octal String	Reads extracted string data in octal format.

For example, if the value for `byte_extract` is specified as the following:

- Bytes to Extract = 4
- Variable Name = var
- Offset = 8
- Relative = enabled

the rules engine reads the number described in the four bytes that appear 9 bytes away from (relative to) the last successful content match into a variable named `var`, which you can specify later in the rule as the value for certain keyword arguments.

The following table lists the keyword arguments where you can specify a variable defined in the `byte_extract` keyword.

Table 22: Arguments Accepting a byte_extract Variable

Keyword	Argument
content	Depth, Offset, Distance, Within
byte_jump	Offset
byte_test	Offset, Value
byte_math	RValue, Offset
isdataat	Offset

The byte_math Keyword

The `byte_math` keyword performs a mathematical operation on an extracted value and a specified value or existing variable, and stores the outcome in a new resulting variable. You can then use the resulting variable as an argument in other keywords.

You can use multiple `byte_math` keywords in a rule to perform multiple byte_math operations.

The following table describes the arguments required by the `byte_math` keyword.

Table 23: Required byte_math Arguments

Argument	Description
Bytes	The number of bytes to calculate from the packet. If used without DCE/RPC, the allowed values are 1 to 10: • Bytes can be 1 to 10 when the operator is +, -. *, or /. • Bytes can be 1 to 4 when the operator is << or >>. • If you specify a number of bytes other than 1, 2, or 4, you must specify a Number Type (hexadecimal, octal, or decimal.) If used with DCE/RPC, allowed values are 1, 2, and 4.
Offset	The number of bytes into the payload to start processing. The `offset` counter starts at byte 0, so calculate the `offset` value by subtracting 1 from the number of bytes you want to jump forward from the beginning of the packet payload or (if you specified Relative) from the last successful content match. You can specify -65535 to 65535 bytes. You can also specify the `byte_extract` variable here.

Argument	Description
Operator	+, -, *, /, <<, or >>
RValue	The value following the operator. This can be an unsigned integer or a variable passed from `byte_extract`.
Result Variable	The name of the variable into which the result of the `byte_math` calculation will be stored. You can use this variable as an argument in other keywords. This value is stored as an unsigned integer. This variable name: • Must use alphanumeric characters • Must not begin with a number • May include special characters supported by the Microsoft filename/variable name convention • Cannot consist entirely of special characters

The following table describes options you can use to define how the system interprets the values you specified for the required arguments.

Table 24: Additional Optional byte_math Arguments

Argument	Description
Relative	Makes the offset relative to the last pattern found in the last successful content match instead of the beginning of the payload.
Bitmask	Applies the specified hexadecimal bitmask using the AND operator to the bytes extracted from the Bytes argument. A bitmask can be 1 to 4 bytes. The result will be right-shifted by the number of bits equal to the number of trailing zeros in the mask.

You can specify only one of **DCE/RPC**, **Endian**, or **Number Type**.

If you want to define how the `byte_math` keyword calculates the bytes, you can choose from the arguments described in the following table. If you do not select a byte-ordering argument, the rules engine uses big endian byte order.

Table 25: Byte-Ordering byte_math Arguments

Argument	Description
Big Endian	Processes data in big endian byte order, which is the default network byte order.
Little Endian	Processes data in little endian byte order.

Argument	Description
DCE/RPC	Specifies a `byte_math` keyword for traffic processed by the DCE/RPC preprocessor. The DCE/RPC preprocessor determines big endian or little endian byte order, and the **Number Type** and **Endian** arguments do not apply. When you enable this argument, you can also use `byte_math` in conjunction with other specific DCE/RPC keywords.

Define how the system views string data in a packet by using one of the arguments in the following table.

Table 26: Number Type Arguments

Argument	Description
Hexadecimal String	Represents string data in hexadecimal format.
Decimal String	Represents string data in decimal format.
Octal String	Represents string data in octal format.

For example, if the values you set for `byte_math` are as follows:

- Bytes = 2
- Offset = 0
- Operator = *
- RValue = height
- Result Variable = area

the rules engine extracts the number described in the first two bytes in the packet and multiplies it by the RValue (which uses the existing variable, `height`) to create the new variable, `area`.

Table 27: Arguments Accepting a byte_math Variable

Keyword	Argument
byte_jump	Offset
byte_test	Offset, Value
byte_extract	Offset
isdataat	Offset

Overview: The pcre Keyword

The `pcre` keyword allows you to use Perl-compatible regular expressions (PCRE) to inspect packet payloads for specified content. You can use PCRE to avoid writing multiple rules to match slight variations of the same content.

Regular expressions are useful when searching for content that could be displayed in a variety of ways. The content may have different attributes that you want to account for in your attempt to locate it within a packet's payload.

Note that the regular expression syntax used in intrusion rules is a subset of the full regular expression library and varies in some ways from the syntax used in commands in the full library. When adding a `pcre` keyword using the intrusion rules editor, enter the full value in the following format:

```
!/pcre/ ismxAEGRBUIPHDMCKSY
```

where:

- ! is an optional negation (use this if you want to match patterns that **do not** match the regular expression).
- `/`pcre`/` is a Perl-compatible regular expression.
- `ismxAEGRBUIPHDMCKSY` is any combination of modifier options.

Also note that you must escape the characters listed in the following table for the rules engine to interpret them correctly when you use them in a PCRE to search for specific content in a packet payload.

Table 28: Escaped PCRE Characters

You must escape...	with a backslash...	or Hex code...
# (hash mark)	\#	\x23
; (semicolon)	\;	\x3B
| (vertical bar)	\\|	\x7C
: (colon)	\:	\x3A

You can also use `m?regex?`, where `?` is a delimiter other than /. You may want to use this in situations where you need to match a forward slash within a regular expression and do not want to escape it with a backslash. For example, you might use `m?`regex`? ismxAEGRBUIPHDMCKSY` where regex is your Perl-compatible regular expression and `ismxAEGRBUIPHDMCKSY` is any combination of modifier options.

Tip Optionally, you can surround your Perl-compatible regular expression with quote characters, for example, pcre_expression or “pcre_expression”. The option of using quotes accommodates experienced users accustomed to previous versions when quotes were required instead of optional. The intrusion rules editor does not display quotation marks when you display a rule after saving it.

pcre Syntax

The `pcre` keyword accepts standard Perl-compatible regular expression (PCRE) syntax. The following sections describe that syntax.

Tip While this section describes the basic syntax you may use for PCRE, you may want to consult an online reference or book dedicated to Perl and PCRE for more advanced information.

Metacharacters

Metacharacters are literal characters that have special meaning within regular expressions. When you use them within a regular expression, you must ��escape” them by preceding them with a backslash.

The following table describes the metacharacters you can use with PCRE and gives examples of each.

Table 29: PCRE Metacharacters

Metacharacter	Description	Example
`.`	Matches any character except newlines. If `s` is used as a modifying option, it also includes newline characters.	`abc.` matches `abcd`, `abc1`, `abc#`, and so on.
`*`	Matches zero or more occurrences of a character or expression.	`abc*` matches `abc`, `abcc`, `abccc`, `abccccc`, and so on.
`?`	Matches zero or one occurrence of a character or expression.	`abc?` matches `abc`.
`+`	Matches one or more occurrences of a character or expression.	`abc+` matches `abc`, `abcc`, `abccc`, `abccccc`, and so on.
`()`	Groups expressions.	`(abc)+` matches `abc`, `abcabc`, `abcabcabc` and so on.
`{}`	Specifies a limit for the number of matches for a character or expression. If you want to set a lower and upper limit, separate the lower limit and upper limit with a comma.	`a{4,6}` matches `aaaa`, `aaaaa`, or `aaaaaa`. `(ab){2}` matches `abab`.
`[]`	Allows you to define character classes, and matches any character or combination of characters described in the set.	`[abc123]` matches `a` or `b` or `c`, and so on.
`^`	Matches content at the beginning of a string. Also used for negation, if used within a character class.	`^in` matches the “in” in `info`, but not in `bin`. `[^a]` matches anything that does not contain `a`.
`$`	Matches content at the end of a string.	`ce$` matches the “`ce`” in `announce`, but not `cent`.
`|`	Indicates an OR expression.	`(MAILTO|HELP)` matches `MAILTO` or `HELP`.
`\`	Allows you to use metacharacters as actual characters and is also used to specify a predefined character class.	`\.` matches a period, `\*` matches an asterisk, `\\` matches a backslash and so on. `\d` matches the numeric characters, `\w` matches alphanumeric characters, and so on.

Character Classes

Character classes include alphabetic characters, numeric characters, alphanumeric characters, and white space characters. While you can create your own character classes within brackets, you can use the predefined classes as shortcuts for different types of character types. When used without additional qualifiers, a character class matches a single digit or character.

The following table describes and provides examples of the predefined character classes accepted by PCRE.

Table 30: PCRE Character Classes

Character Class	Description	Character Class Definition
\d	Matches a numeric character (“digit”).	[0-9]
\D	Matches anything that is not an numeric character.	[^0-9]
\w	Matches an alphanumeric character (“word”).	[a-zA-Z0-9_]
\W	Matches anything that is not an alphanumeric character.	[^a-zA-Z0-9_]
\s	Matches white space characters, including spaces, carriage returns, tabs, newlines, and form feeds.	[\r\t\n\f]
\S	Matches anything that is not a white space character.	[^ \r\t\n\f]

pcre Modifier Options

You can use modifying options after you specify regular expression syntax in the `pcre` keyword’s value. These modifiers perform Perl, PCRE, and Snort-specific processing functions. Modifiers always appear at the end of the PCRE value, and appear in the following format:

```
/pcre/ismxAEGRBUIPHDMCKSY
```

where `ismxAEGRBUPHMC` can include any of the modifying options that appear in the following tables.

Tip Optionally, you can surround the regular expression and any modifying options with quotes, for example, `“/pcre/ismxAEGRBUIPHDMCKSY”`. The option of using quotes accommodates experienced users accustomed to previous versions when quotes were required instead of optional. The intrusion rules editor does not display quotation marks when you display a rule after saving it.

The following table describes options you can use to perform Perl processing functions.

Table 31: Perl-Related Post Regular Expression Options

Option	Description
i	Makes the regular expression case-insensitive.
s	The dot character (.) describes all characters except the newline or `\n` character. You can use `"s"` as an option to override this and have the dot character match all characters, including the newline character.
m	By default, a string is treated as a single line of characters, and `^` and `$` match the beginning and ending of a specific string. When you use `"m"` as an option, `^` and `$` match content immediately before or after any newline character in the buffer, as well as at the beginning or end of the buffer.
x	Ignores white space data characters that may appear within the pattern, except when escaped (preceded by a backslash) or included inside a character class.

The following table describes the PCRE modifiers you can use after the regular expression.

Table 32: PCRE-Related Post Regular Expression Options

Option	Description
A	The pattern must match at the beginning of the string (same as using `^` in a regular expression).
E	Sets `$` to match only at the end of the subject string. (Without `E`, `$` also matches immediately before the final character if it is a newline, but not before any other newline characters).
G	By default, `*` `+` and `?` are "greedy," which means that if two or more matches are found, they will choose the longest match. Use the G character to change this so that these characters always choose the first match unless followed by a question mark character (`?`). For example, `*?` `+?` and `??` would be greedy in a construct using the G modifier, and any incidences of `*`, `+`, or `?` without the additional question mark will not be greedy.

The following table describes the Snort-specific modifiers that you can use after the regular expression.

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Table 33: Snort-Specific Post Regular Expression Modifiers

Option	Description
R	Searches for matching content relative to the end of the last match found by the rules engine.
B	Searches for the content within data before it is decoded by a preprocessor (this option is similar to using the `Raw Data` argument with the `content` or `protected_content` keyword).
U	Searches for the content within the URI of a normalized HTTP request message decoded by the HTTP Inspect preprocessor. Note that you cannot use this option in combination with the `content` or `protected_content` keyword **HTTP URI** option to search the same content. Note that a pipelined HTTP request packet contains multiple URIs. A PCRE expression that includes the U option causes the rules engine to search for a content match only in the first URI in a pipelined HTTP request packet. To search all URIs in the packet, use the `content` or `protected_content` keyword with **HTTP URI** selected, either with or without an accompanying PCRE expression that uses the U option.
I	Searches for the content within the URI of a raw HTTP request message decoded by the HTTP Inspect preprocessor. Note that you cannot use this option in combination with the `content` or `protected_content` keyword **HTTP Raw URI** option to search the same content
P	Searches for the content within the body of a normalized HTTP request message decoded by the HTTP Inspect preprocessor.

Option	Description
H	Searches for the content within the header, excluding cookies, of an HTTP request or response message decoded by the HTTP Inspect preprocessor. Note that you cannot use this option in combination with the `content` or `protected_content` keyword **HTTP Header** option to search the same content.
D	Searches for the content within the header, excluding cookies, of a raw HTTP request or response message decoded by the HTTP Inspect preprocessor. Note that you cannot use this option in combination with the `content` or `protected_content` keyword **HTTP Raw Header** option to search the same content.
M	Searches for the content within the method field of a normalized HTTP request message decoded by the HTTP Inspect preprocessor; the method field identifies the action such as GET, PUT, CONNECT, and so on to take on the resource identified in the URI.
C	When the HTTP Inspect preprocessor **Inspect HTTP Cookies** option is enabled, searches for the normalized content within any cookie in an HTTP request header, and also within any set-cookie in an HTTP response header when the preprocessor **Inspect HTTP Responses** option is enabled. When **Inspect HTTP Cookies** is not enabled, searches the entire header, including the cookie or set-cookie data. Note the following: • Cookies included in the message body are treated as body content. • You cannot use this option in combination with the `content` or `protected_content` keyword **HTTP Cookie** option to search the same content. • The `Cookie:` and `Set-Cookie:` header names, leading spaces on the header line, and the `CRLF` that terminates the header line are inspected as part of the header and not as part of the cookie.
K	When the HTTP Inspect preprocessor **Inspect HTTP Cookies** option is enabled, searches for the raw content within any cookie in an HTTP request header, and also within any set-cookie in an HTTP response header when the preprocessor **Inspect HTTP Responses** option is enabled. When **Inspect HTTP Cookies** is not enabled, searches the entire header, including the cookie or set-cookie data. Note the following: • Cookies included in the message body are treated as body content. • You cannot use this option in combination with the `content` or `protected_content` keyword **HTTP Raw Cookie** option to search the same content. • The `Cookie:` and `Set-Cookie:` header names, leading spaces on the header line, and the `CRLF` that terminates the header line are inspected as part of the header and not as part of the cookie.
S	Searches the 3-digit status code in an HTTP response.
Y	Searches the textual description that accompanies the status code in an HTTP response.

Note Do not use the U option in combination with the R option. This could cause performance problems. Also, do not use the U option in combination with any other HTTP content option (I, P, H, D, M, C, K, S, or Y).

pcre Example Keyword Values

The following examples show values that you could enter for `pcre`, with descriptions of what each example would match.

- **`/feedback[(\d{0,1})]?\.cgi/U`**

This example searches packet payload for `feedback`, followed by zero or one numeric character, followed by `.cgi`, and located only in URI data.

This example would match:

- `feedback.cgi`
- `feedback1.cgi`
- `feedback2.cgi`
- `feedback3.cgi`

This example would **not** match:

- `feedbacka.cgi`
- `feedback11.cgi`
- `feedback21.cgi`
- `feedbackzb.cgi`

- **`/^ez(\w{3,5})\.cgi/iU`**

This example searches packet payload for `ez` at the beginning of a string, followed by a word of 3 to 5 letters, followed by `.cgi`. The search is case-insensitive and only searches URI data.

This example would match:

- `EZBoard.cgi`
- `ezman.cgi`
- `ezadmin.cgi`
- `EZAdmin.cgi`

This example would **not** match:

- `ezez.cgi`
- `fez.cgi`
- `abcezboard.cgi`
- `ezboardman.cgi`

- **`/mail(file|seek)\.cgi/U`**

This example searches packet payload for `mail`, followed by either `file` or `seek`, in URI data.

This example would match:

- `mailfile.cgi`
- `mailseek.cgi`

This example would **not** match:

- `MailFile.cgi`
- `mailfilefile.cgi`

- **`m?http\\x3a\x2f\x2f.*(\n|\t)+?U`**

This example searches packet payload for URI content for a tab or newline character in an HTTP request, after any number of characters. This example uses `m?`regex`?` to avoid using `http\:\/\/` in the expression. Note that the colon is preceded by a backslash.

This example would match:

- `http://www.example.com?scriptvar=x&othervar=\n\..\..`
- `http://www.example.com?scriptvar=\t`

This example would **not** match:

- `ftp://ftp.example.com?scriptvar=&othervar=\n\..\..`
- `http://www.example.com?scriptvar=|/bin/sh -i|`

- **`m?http\\x3a\x2f\x2f.*=\|.*\|+?sU`**

This example searches packet payload for a URL with any number of characters, including newlines, followed by an equal sign, and pipe characters that contain any number of characters or white space. This example uses `m?`regex`?` to avoid using `http\:\/\/` in the expression.

This example would match:

- `http://www.example.com?value=|/bin/sh/ -i|`
- `http://www.example.com?input=|cat /etc/passwd|`

This example would **not** match:

- `ftp://ftp.example.com?value=|/bin/sh/ -i|`
- `http://www.example.com?value=x&input?|cat /etc/passwd|`

- **`/[0-9a-f]{2}\:[0-9a-f]{2}\:[0-9a-f]{2}\:[0-9a-f]{2}\:[0-9a-f]{2}\:[0-9a-f]{2}/i`**

This example searches packet payload for any MAC address. Note that it escapes the colon characters with backslashes.

The metadata Keyword

You can use the `metadata` keyword to add your own descriptive information to a rule. You can also use the `metadata` keyword with `service` arguments to identify applications and ports in network traffic. You can use the information you add to organize or identify rules in ways that suit your needs, and you can search rules for information you add and for `service` arguments.

The system validates metadata based on the argument format:

key value

where *key* and *value* provide a combined description separated by a space. This is the format used by the Talos Intelligence Group for adding metadata to rules provided by Cisco.

Alternatively, you can also use the format:

key = *value*

For example, you could use the *key value* format to identify rules by author and date, using a category and sub-category as follows:

```
author SnortGuru_20050406
```

You can use multiple `metadata` keywords in a rule. You can also use commas to separate multiple *key value* arguments in a single `metadata` keyword, as seen in the following example:

```
author SnortGuru_20050406, revised_by SnortUser1_20050707,

revised_by SnortUser2_20061003,

revised_by SnortUser1_20070123
```

You are not limited to using a *key value* or *key*=*value* format; however, you should be aware of limitations resulting from validation based on these formats.

Restricted Characters to Avoid

Note the following character restrictions:

- Do not use a semicolon (;) or colon (:).
- The system interprets a comma as a separator for multiple *key value* or *key*=*value* arguments. For example:

  key value,*key value*,*key value*
- The system interprets the equal to (=) character or space character as separators between *key* and *value*. For example:

  key value

  key=*value*

All other characters are permitted.

Reserved Metadata to Avoid

Avoid using the following words in a `metadata` keyword, either as a single argument or as the *key* in a *key value* argument; these are reserved for use by Talos:

```
application
```

```
engine
impact_flag
os
policy
rule-type
rule-flushing
soid
```

Note Contact Support for assistance in adding restricted metadata to local rules that might not otherwise function as expected.

Impact Level 1

You can use the following reserved *key value* argument in a `metadata` keyword:

```
impact_flag red
```

This *key value* argument sets the impact flag to red (level 1) for a local rule you import or a custom rule you create using the intrusion rules editor.

Note that when Talos includes the `impact_flag red` argument in a rule provided by Cisco, Talos has determined that a packet triggering the rule indicates that the source or destination host is potentially compromised by a virus, trojan, or other piece of malicious software.

Service Metadata

The system detects applications running on the hosts in your network and inserts application protocol information into your network traffic; it does this regardless of the configuration of your discovery policy. You can use `metadata` keyword `service` arguments in a TCP or UDP rule to match application protocols and ports in your network traffic. You can combine one or more `service` application arguments in a rule with a single port argument.

Service Applications

You can use the `metadata` keyword with `service` as the *key* and an application as the *value* to match packets with the identified application protocol. For example, the following *key value* argument in a `metadata` keyword associates the rule with HTTP traffic:

```
service http
```

You can identify multiple applications separated by commas. For example:

```
service http, service smtp, service ftp
```

Caution Adaptive profiling **must** be enabled (its default state) for intrusion rules to use service metadata.

The following table describes the most common application values used with the `service` keyword.

Note Contact Support for assistance if you have difficulty identifying applications not in the table.

Table 34: service Values

Value	Description
`cvs`	Concurrent Versions System
`dcerpc`	Distributed Computing Environment/Remote Procedure Calls System
`dns`	Domain Name System
`finger`	Finger user information protocol
`ftp`	File Transfer Protocol
`ftp-data`	File Transfer Protocol (Data Channel)
`http`	Hypertext Transfer Protocol
`imap`	Internet Message Access Protocol
`isakmp`	Internet Security Association and Key Management Protocol
`mysql`	My Structured Query Language
`netbios-dgm`	NETBIOS Datagram Service
`netbios-ns`	NETBIOS Name Service
`netbios-ssn`	NETBIOS Session Service
`nntp`	Network News Transfer Protocol
`oracle`	Oracle Net Services
`shell`	OS Shell
`pop2`	Post Office Protocol, version 2
`pop3`	Post Office Protocol, version 3
`smtp`	Simple Mail Transfer Protocol
`snmp`	Simple Network Management Protocol
`ssh`	Secure Shell network protocol
`sunrpc`	Sun Remote Procedure Call Protocol
`telnet`	Telnet network protocol
`tftp`	Trivial File Transfer Protocol
`x11`	X Window System

Service Ports

You can use the `metadata` keyword with `service` as the *key* and a specified port argument as the *value* to define how the rule matches ports in combination with applications.

You can specify any of the port values in the table below, one value per rule.

Table 35: service Port Values

Value	Description
`else-ports` or `unknown`	The system applies the rule if either of the following conditions is met: • The packet application is known and matches the rule application. • The packet application is unknown and packet ports match the rule ports. The `else-ports` and `unknown` values produce the default behavior that the system uses when `service` specifies an application protocol with no port modifier.
`and-ports`	The system applies the rule if the packet application is known and matches the rule application, and the packet port matches the ports in the rule header. You cannot use `and-ports` in a rule that does not specify an application.
`or-ports`	The system applies the rule if any of the following conditions are met: • The packet application is known and matches the rule application. • The packet application is unknown and packet port matches the rule ports. • The packet application does not match the rule application and packet ports match the rule ports. • The rule does not specify an application and packet ports match the rule ports.

Note the following:

- You must include a `service` application argument with the `service and-ports` argument.
- If a rule specifies more than one of the values in the table above, the system applies the last one that appears in the rule.
- Port and application arguments can be in any order.

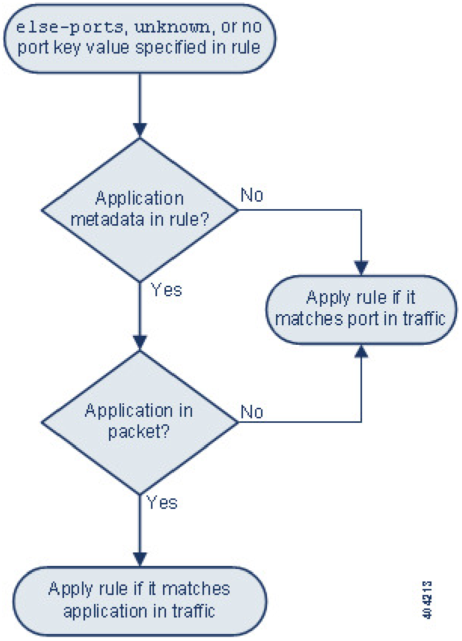
Except for the `and-ports` value, you can include a `service` port argument with or without one or more `service` application arguments. For example:

```
service or-ports, service http, service smtp
```

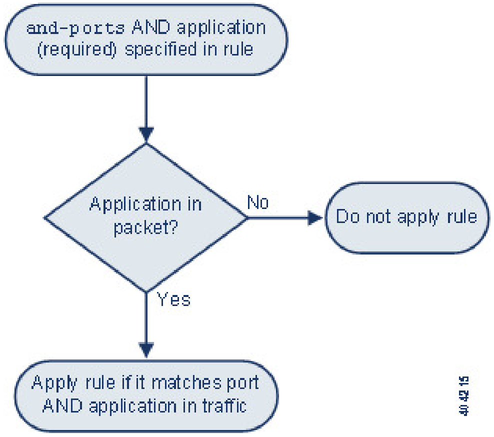
Applications and Ports in Traffic

The diagrams below illustrate the application and port combinations that intrusion rules support, and the results of applying these rule constraints to packet data.

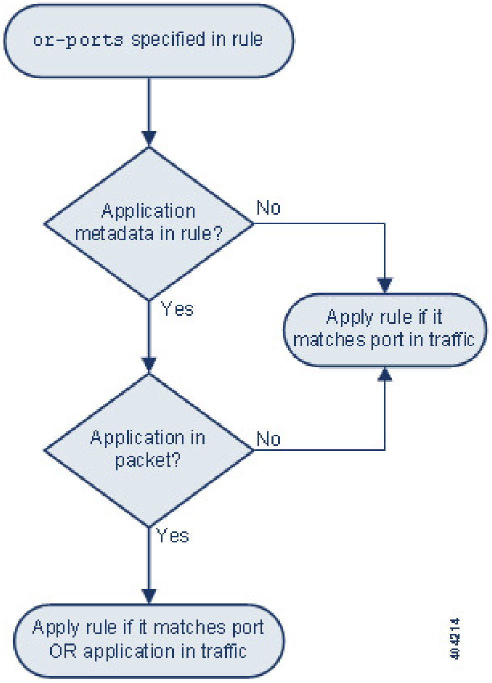
Host application protocol else source/destination ports:


else-ports, unknown, or no port key value specified in rule
Application metadata in rule?
No
Yes
Apply rule if it matches port in traffic
Application in packet?
No
Yes
Apply rule if it matches application in traffic
404213

Host application protocol and source/destination ports:


and-ports AND application (required) specified in rule
Application in packet?
No
Do not apply rule
Yes
Apply rule if it matches port AND application in traffic
404215

Host application protocol or source/destination ports:


or-ports specified in rule
Application metadata in rule?
No
Yes
Apply rule if it matches port in traffic
Application in packet?
No
Yes
Apply rule if it matches port OR application in traffic
404214

Example Matches

The following sample rules using the `metadata` keyword with `service` arguments are shown with examples of data they match and do not match:

- `alert tcp any any -> any [80,8080] (metadata:service and-ports, service http, service smtp;)`

Example Matches	Example Non-Matches
• HTTP traffic over TCP port 80 • HTTP traffic over TCP port 8080 • SMTP traffic over TCP port 80 • SMTP traffic over TCP port 8080	• POP3 traffic on ports 80 or 8080 • Traffic of unknown application on ports 80 or 8080 • HTTP traffic on port 9999

- `alert tcp any any -> any [80,8080] (metadata:service or-ports, service http;)`

Example Matches	Example Non-Matches
• HTTP traffic on any port • SMTP traffic on port 80 • SMTP traffic on port 8080 • Traffic of unknown application on port 80 and 8080	• Non-HTTP and non-SMTP traffic on ports other than 80 or 8080

- Any of the following rules:
  - `alert tcp any any -> any [80,8080] metadata:service else-ports, service http;)`
  - `alert tcp any any -> any [80,8080] metadata:service unknown, service http;)`
  - `alert tcp any any -> any [80,8080] metadata:service http;)`

Example Matches	Example Non-Matches
• HTTP traffic on any port • port 80 if packet application is unknown • port 8080 if packet application is unknown	• SMTP traffic on ports 80 or 8080 • POP3 traffic on ports 80 or 8080

Metadata Search Guidelines

To search for rules that use the `metadata` keyword, select the `metadata` keyword on the rules Search page and, optionally, type any portion of the metadata. For example, you can type:

- `search` to display all rules where you have used `search` for *key*.
- `search http` to display all rules where you have used `search` for *key* and `http` for *value*.
- `author snortguru` to display all rules where you have used `author` for *key* and `SnortGuru` for *value*.
- `author s` to display all rules where you have used `author` for *key* and any terms such as `SnortGuru` or `SnortUser1` or `SnortUser2` for *value*.

Tip When you search for both *key* and *value* , use the same connecting operator (equal to [=] or a space character) in searches that is used in the *key value* argument in the rule; searches return different results depending on whether you follow *key* with equal to (=) or a space character.

Note that regardless of the format you use to add metadata, the system interprets your metadata search term as all or part of a *key value* or *key*=*value* argument. For example, the following would be valid metadata that does not follow a *key value* or *key*=*value* format:

```
ab cd ef gh
```

However, the system would interpret each space in the example as a separator between a *key* and *value* . Thus, you could successfully locate a rule containing the example metadata using any of the following searches for juxtaposed and single terms:

```
cd ef
ef gh
ef
```

but you would not locate the rule using the following search, which the system would interpret as a single *key value* argument:

```
ab ef
```

IP Header Values

You can use keywords to identify possible attacks or security policy violations in the IP headers of packets.

fragbits

The `fragbits` keyword inspects the fragment and reserved bits in the IP header. You can check each packet for the Reserved Bit, the More Fragments bit, and the Don't Fragment bit in any combination.

Table 36: Fragbits Argument Values

Argument	Description
R	Reserved bit
M	More Fragments bit
D	Don’t Fragment bit

To further refine a rule using the `fragbits` keyword, you can specify any operator described in the following table after the argument value in the rule.

Table 37: Fragbit Operators

Operator	Description
plus sign (+)	The packet must match against all specified bits.
asterisk (*)	The packet can match against any of the specified bits.
exclamation point (!)	The packet meets the criteria if none of the specified bits are set.

For example, to generate an event against packets that have the Reserved Bit set (and possibly any other bits), use `R+` as the `fragbits` value.

id

The `id` keyword tests the IP header fragment identification field against the value you specify in the keyword’s argument. Some denial-of-service tools and scanners set this field to a specific number that is easy to detect. For example, in SID 630, which detects a Synscan portscan, the `id` value is set to `39426`, the static value used as the ID number in packets transmitted by the scanner.

Note `id` argument values must be numeric.

ipopts

The `IPopts` keyword allows you to search packets for specified IP header options. The following table lists the available argument values.

Table 38: IPoption Arguments

Argument	Description
rr	record route
eol	end of list
nop	no operation
ts	time stamp
sec	IP security option
lsrr	loose source routing
ssrr	strict source routing
satid	stream identifier

Analysts most frequently watch for strict and loose source routing because these options may be an indication of a spoofed source IP address.

ip_proto

The `ip_proto` keyword allows you to identify packets with the IP protocol specified as the keyword's value. You can specify the IP protocols as a number, 0 through 255. You can combine these numbers with the following operators: `<`, `>`, or `!`. For example, to inspect traffic with any protocol that is not ICMP, use `!1` as a value to the `ip_proto` keyword. You can also use the `ip_proto` keyword multiple times in a single rule; note, however, that the rules engine interprets multiple instances of the keyword as having a Boolean AND relationship. For example, if you create a rule containing `ip_proto:!3; ip_proto:!6`, the rule ignores traffic using the GGP protocol AND the TCP protocol.

tos

Some networks use the type of service (ToS) value to set precedence for packets traveling on that network. The `tos` keyword allows you to test the packet's IP header ToS value against the value you specify as the keyword's argument. Rules using the `tos` keyword will trigger on packets whose ToS is set to the specified value and that meet the rest of the criteria set forth in the rule.

Note Argument values for `tos` must be numeric.

The ToS field has been deprecated in the IP header protocol and replaced with the Differentiated Services Code Point (DSCP) field.

ttl

A packet's time-to-live (ttl) value indicates how many hops it can make before it is dropped. You can use the `ttl` keyword to test the packet's IP header ttl value against the value, or range of values, you specify as the keyword's argument. It may be helpful to set the `ttl` keyword parameter to a low value such as 0 or 1, as low time-to-live values are sometimes indicative of a traceroute or intrusion evasion attempt. (Note, though, that the appropriate value for this keyword depends on your managed device placement and network topology.) Use syntax as follows:

- Use an integer from 0 to 255 to set a specific value for the TTL value. You can also precede the value with an equal (=) sign (for example, you can specify `5` or `=5`).
- Use a hyphen (-) to specify a range of TTL values (for example, `0-2` specifies all values 0 through 2, `-5` specifies all values 0 through 5, and `5-` specifies all values 5 through 255).
- Use the greater than (>) sign to specify TTL values greater than a specific value (for example, `>3` specifies all values greater than 3).
- Use the greater than and equal to signs (>=) to specify TTL values greater than or equal to a specific value (for example, `>=3` specifies all values greater than or equal to 3).
- Use the less than (<) sign to specify TTL values less than a specific value (for example, `<3` specifies all values less than 3).
- Use the less than and equal to signs (<=) to specify TTL values less than or equal to a specific value (for example, `<=3` specifies all values less than or equal to 3).

ICMP Header Values

The system supports keywords that you can use to identify attacks and security policy violations in the headers of ICMP packets. Note, however, that predefined rules exist that detect most ICMP types and codes. Consider enabling an existing rule or creating a local rule based on an existing rule; you may be able to find a rule that meets your needs more quickly than if you build an ICMP rule from scratch.

icmp_id and icmp_seq

The ICMP identification and sequence numbers help associate ICMP replies with ICMP requests. In normal traffic, these values are dynamically assigned to packets. Some covert channel and Distributed Denial of Server (DDoS) programs use static ICMP ID and sequence values. The following keywords allow you to identify ICMP packets with static values.

Keyword	Definition
icmp_id	Inspects an ICMP echo request or reply packet's ICMP ID number. Use a numeric value that corresponds with the ICMP ID number as the argument for the `icmp_id` keyword.
icmp_seq	The `icmp_seq` keyword inspects an ICMP echo request or reply packet's ICMP sequence. Use a numeric value that corresponds with the ICMP sequence number as the argument for the `icmp_seq` keyword.

itype

Use the `itype` keyword to look for packets with specific ICMP message type values. You can specify either a valid ICMP type value or an invalid ICMP type value to test for different types of traffic. For example, attackers may set ICMP type values out of range to cause denial of service and flooding attacks.

You can specify a range for the `itype` argument value using less than (<) and greater than (>).

For example:

- <35

- >36

- 3<>55

icode

ICMP messages sometimes include a code value that provides details when a destination is unreachable.

You can use the `icode` keyword to identify packets with specific ICMP code values. You can choose to specify either a valid ICMP code value or an invalid ICMP code value to test for different types of traffic.

You can specify a range for the `icode` argument value using less than (<) and greater than (>).

For example:

- to find values less than 35, specify `<35`.

- to find values greater than 36, specify `>36`.

- to find values between 3 and 55, specify `3<>55`.

Tip You can use the `icode` and `itype` keywords together to identify traffic that matches both. For example, to identify ICMP traffic that contains an ICMP Destination Unreachable code type with an ICMP Port Unreachable code type, specify an `itype` keyword with a value of 3 (for Destination Unreachable) and an `icode` keyword with a value of 3 (for Port Unreachable).

TCP Header Values and Stream Size

The system supports keywords that are designed to identify attacks attempted using TCP headers of packets and TCP stream size.

ack

You can use the `ack` keyword to compare a value against a packet's TCP acknowledgment number. The rule triggers if a packet's TCP acknowledgment number matches the value specified for the `ack` keyword.

Argument values for `ack` must be numeric.

flags

You can use the `flags` keyword to specify any combination of TCP flags that, when set in an inspected packet, cause the rule to trigger.

Note In situations where you would traditionally use `A+` as the value for `flags`, you should instead use the `flow` keyword with a value of `established`. Generally, you should use the `flow` keyword with a value of `stateless` when using flags to ensure that all combinations of flags are detected.

You can either check for or ignore the values described in the following table for the `flag` keyword.

Table 39: flag Arguments

Argument	TCP Flag
Ack	Acknowledges data.
Psh	Data should be sent in this packet.
Syn	A new connection.
Urg	Packet contains urgent data.
Fin	A closed connection.
Rst	An aborted connection.
CWR	An ECN congestion window has been reduced. This was formerly the R1 argument, which is still supported for backward compatibility.
ECE	ECN echo. This was formerly the R2 argument, which is still supported for backward compatibility.

When using the `flags` keyword, you can use an operator to indicate how the system performs matches against multiple flags. The following table describes these operators.

Table 40: Operators Used with flags

Operator	Description	Example
all	The packet must contain all specified flags.	Select `Urg` and `all` to specify that a packet must contain the Urgent flag and may contain any other flags.
any	The packet can contain any of the specified flags.	Select `Ack`, `Psh`, and `any` to specify that either or both the `Ack` and `Psh` flags must be set to trigger the rule, and that other flags may also be set on a packet.
not	The packet must **not** contain the specified flag set.	Select `Urg` and `not` to specify that the Urgent flag is **not** set on packets that trigger this rule.

flow

You can use the `flow` keyword to select packets for inspection by a rule based on session characteristics. The `flow` keyword allows you to specify the direction of the traffic flow to which a rule applies, applying rules to either the client flow or server flow. To specify how the `flow` keyword inspects your packets, you can set the direction of traffic you want analyzed, the state of packets inspected, and whether the packets are part of a rebuilt stream.

Stateful inspection of packets occurs when rules are processed. If you want a TCP rule to ignore stateless traffic (traffic without an established session context), you must add the `flow` keyword to the rule and select the **Established** argument for the keyword. If you want a UDP rule to ignore stateless traffic, you must add the `flow` keyword to the rule and select either the **Established** argument or a directional argument, or both. This causes the TCP or UDP rule to perform stateful inspection of a packet.

When you add a directional argument, the rules engine inspects only those packets that have an established state with a flow that matches the direction specified. For example, if you add the `flow` keyword with the `established` argument and the `From Client` argument to a rule that triggers when a TCP or UDP connection is detected, the rules engine only inspects packets that are sent from the client.

Tip For maximum performance, always include a `flow` keyword in a TCP rule or a UDP session rule.

The following table describes the stream-related arguments you can specify for the `flow` keyword:

Table 41: State-Related flow Arguments

Argument	Description
Established	Triggers on established connections.
Stateless	Triggers regardless of the state of the stream processor.

The following table describes the directional options you can specify for the `flow` keyword:

Table 42: flow Directional Arguments

Argument	Description
To Client	Triggers on server responses.
To Server	Triggers on client responses.
From Client	Triggers on client responses.
From Server	Triggers on server responses.

Notice that `From Server` and `To Client` perform the same function, as do `To Server` and `From Client`. These options exist to add context and readability to the rule. For example, if you create a rule designed to detect an attack from a server to a client, use `From Server`. But, if you create a rule designed to detect an attack from the client to the server, use `From Client`.

The following table describes the stream-related arguments you can specify for the `flow` keyword:

Table 43: Stream-Related flow Arguments

Argument	Description
Ignore Stream Traffic	Does not trigger on rebuilt stream packets.
Only Stream Traffic	Triggers only on rebuilt stream packets.

For example, you can use `To Server, Established, Only Stream Traffic` as the value for the `flow` keyword to detect traffic, traveling from a client to the server in an established session, that has been reassembled by the stream preprocessor.

seq

The `seq` keyword allows you to specify a static sequence number value. Packets whose sequence number matches the specified argument trigger the rule containing the keyword. While this keyword is used rarely, it is helpful in identifying attacks and network scans that use generated packets with static sequence numbers.

window

You can use the `window` keyword to specify the TCP window size you are interested in. A rule containing this keyword triggers whenever it encounters a packet with the specified TCP window size. While this keyword is used rarely, it is helpful in identifying attacks and network scans that use generated packets with static TCP window sizes.

stream_size

You can use the `stream_size` keyword in conjunction with the stream preprocessor to determine the size in bytes of a TCP stream, using the format:

```
direction,operator,bytes
```

where bytes is number of bytes. You must separate each option in the argument with a comma (,).

The following table describes the case-insensitive directional options you can specify for the `stream_size` keyword:

Table 44: stream_size Keyword Directional Arguments

Argument	Description
client	triggers on a stream from the client matching the specified stream size.
server	triggers on a stream from the server matching the specified stream size.
both	triggers on traffic from the client and traffic from the server both matching the specified stream size. For example, the argument `both, >, 200` would trigger when traffic from the client is greater than 200 bytes AND traffic from the server is greater than 200 bytes.
either	triggers on traffic from either the client or the server matching the specified stream size, whichever occurs first. For example, the argument `either, >, 200` would trigger when traffic from the client is greater than 200 bytes OR traffic from the server is greater than 200 bytes.

The following table describes the operators you can use with the `stream_size` keyword:

Table 45: stream_size Keyword Argument Operators

Operator	Description
=	equal to
!=	not equal to
>	greater than

Operator	Description
<	less than
>=	greater than or equal to
<=	less than or equal to

For example, you could use `client, >=, 5001216` as the argument for the `stream_size` keyword to detect a TCP stream traveling from a client to a server and greater than or equal to 5001216 bytes.

The stream_reassembly Keyword

You can use the `stream_reassemble` keyword to enable or disable TCP stream reassembly for a single connection when inspected traffic on the connection matches the conditions of the rule. Optionally, you can use this keyword multiple times in a rule.

Use the following syntax to enable or disable stream reassembly:

```
enable|disable, server|client|both, option, option
```

The following table describes the optional arguments you can use with the `stream_reassemble` keyword.

Table 46: stream_reassemble Optional Arguments

Argument	Description
noalert	Generate no events regardless of any other detection options specified in the rule.
fastpath	Ignore the rest of the connection traffic when there is a match.

For example, the following rule disables TCP client-side stream reassembly without generating an event on the connection where a 200 OK status code is detected in an HTTP response:

```
alert tcp any 80 -> any any (flow:to_client, established; content: “200 OK”;
stream_reassemble:disable, client, noalert
```

SSL Keywords

You can use SSL rule keywords to invoke the Secure Sockets Layer (SSL) preprocessor and extract information about SSL version and session state from packets in an encrypted session.

When a client and server communicate to establish an encrypted session using SSL or Transport Layer Security (TLS), they exchange handshake messages. Although the data transmitted in the session is encrypted, the handshake messages are not.

The SSL preprocessor extracts state and version information from specific handshake fields. Two fields within the handshake indicate the version of SSL or TLS used to encrypt the session and the stage of the handshake.

ssl_state

The `ssl_state` keyword can be used to match against state information for an encrypted session. To check for two or more SSL versions used simultaneously, use multiple `ssl_version` keywords in a rule.

When a rule uses the ssl_state keyword, the rules engine invokes the SSL preprocessor to check traffic for SSL state information.

For example, to detect an attacker's attempt to cause a buffer overflow on a server by sending a ClientHello message with an overly long challenge length and too much data, you could use the ssl_state keyword with client_hello as an argument then check for abnormally large packets.

Use a comma-separated list to specify multiple arguments for the SSL state. When you list multiple arguments, the system evaluates them using the OR operator. For example, if you specify client_hello and server_hello as arguments, the system evaluates the rule against traffic that has a client_hello OR a server_hello.

You can also negate any argument; for example:

```
!client_hello, !unknown
```

To ensure the connection has reached each of a set of states, multiple rules using the ssl_state rule option should be used. The ssl_state keyword takes the following identifiers as arguments:

Table 47: ssl_state Arguments

Argument	Purpose
client_hello	Matches against a handshake message with ClientHello as the message type, where the client requests an encrypted session.
server_hello	Matches against a handshake message with ServerHello as the message type, where the server responds to the client's request for an encrypted session.
client_keyx	Matches against a handshake message with ClientKeyExchange as the message type, where the client transmits a key to the server to confirm receipt of a key from the server.
server_keyx	Matches against a handshake message with ServerKeyExchange as the message type, where the client transmits a key to the server to confirm receipt of a key from the server.
unknown	Matches against any handshake message type.

ssl_version

The ssl_version keyword can be used to match against version information for an encrypted session. When a rule uses the ssl_version keyword, the rules engine invokes the SSL preprocessor to check traffic for SSL version information.

For example, if you know there is a buffer overflow vulnerability in SSL version 2, you could use the ssl_version keyword with the sslv2 argument to identify traffic using that version of SSL.

Use a comma-separated list to specify multiple arguments for the SSL version. When you list multiple arguments, the system evaluates them using the OR operator. For example, if you wanted to identify any encrypted traffic that was not using SSLv2, you could add ssl_version:ssl_v3,tls1.0,tls1.1,tls1.2 to a rule. The rule would evaluate any traffic using SSL Version 3, TLS Version 1.0, TLS Version 1.1, or TLS Version 1.2.

The ssl_version keyword takes the following SSL/TLS version identifiers as arguments:

Table 48: `ssl_version` Arguments

Argument	Purpose
`sslv2`	Matches against traffic encoded using Secure Sockets Layer (SSL) Version 2.
`sslv3`	Matches against traffic encoded using Secure Sockets Layer (SSL) Version 3.
`tls1.0`	Matches against traffic encoded using Transport Layer Security (TLS) Version 1.0.
`tls1.1`	Matches against traffic encoded using Transport Layer Security (TLS) Version 1.1.
`tls1.2`	Matches against traffic encoded using Transport Layer Security (TLS) Version 1.2.

The appid Keyword

You can use the `appid` keyword to identify the application protocol, client application, or web application in a packet. For example, you could target a specific application that you know is susceptible to a specific vulnerability.

Within the `appid` keyword of an intrusion rule, click **Configure AppID** to select one or more applications that you want to detect.

Browsing the Available Applications

When you first start to build the condition, the **Available Applications** list is unconstrained and displays every application the system detects, 100 per page:

- To page through the applications, click the arrows underneath the list.
- To display a pop-up window with summary information about the application's characteristics, as well as Internet search links that you can follow, click **Information** (ⓘ) next to an application.

Using Application Filters

To help you find the applications you want to match, you can constrain the **Available Applications** list in the following ways:

- To search for applications, click the **Search by name** prompt above the list, then type a name. The list updates as you type to display matching applications.
- To constrain the applications by applying a filter, use the **Application Filters** list. The **Available Applications** list updates as you apply filters. For your convenience, the system uses an **Unlock icon** to mark applications that the system can identify only in decrypted traffic—not encrypted or unencrypted.

Note If you select one or more filters in the Application Filters list and also search the **Available Applications** list, your selections and the search-filtered **Available Applications** list are combined using an AND operation.

Selecting Applications

To select a single application, select it and click **Add to Rule**. To select all applications in the current constrained view, right-click and select **Select All**.

Application Layer Protocol Values

Although preprocessors perform most of the normalization and inspection of application layer protocol values, you can continue to inspect application layer values using various preprocessor options.

The RPC Keyword

The `rpc` keyword identifies Open Network Computing Remote Procedure Call (ONC RPC) services in TCP or UDP packets. This allows you to detect attempts to identify the RPC programs on a host. Intruders can use an RPC portmapper to determine if any of the RPC services running on your network can be exploited. They can also attempt to access other ports running RPC without using portmapper. The following table lists the arguments that the `rpc` keyword accepts.

Table 49: rpc Keyword Arguments

Argument	Description
application	The RPC application number
procedure	The RPC procedure invoked
version	The RPC version

To specify the arguments for the `rpc` keyword, use the following syntax:

```
application,procedure,version
```

where application is the RPC application number, procedure is the RPC procedure number, and version is the RPC version number. You must specify all arguments for the `rpc` keyword — if you are not able to specify one of the arguments, replace it with an asterisk (`*`).

For example, to search for RPC portmapper (which is the RPC application indicated by the number 100000), with any procedure or version, use `100000,*,*` as the arguments.

The ASN.1 Keyword

The `asn1` keyword allows you to decode a packet or a portion of a packet, looking for various malicious encodings.

The following table describes the arguments for the `asn1` keyword.

Table 50: asn.1 Keyword Arguments

Argument	Description
Bitstring Overflow	Detects invalid, remotely exploitable bitstring encodings.
Double Overflow	Detects a double ASCII encoding that is larger than a standard buffer. This is known to be an exploitable function in Microsoft Windows, but it is unknown at this time which services may be exploitable.

Argument	Description
Oversize Length	Detects ASN.1 type lengths greater than the supplied argument. For example, if you set the Oversize Length to 500, any ASN.1 type greater than 500 triggers the rule.
Absolute Offset	Sets an absolute offset from the beginning of the packet payload. (Remember that the offset counter starts at byte 0.) For example, if you want to decode SNMP packets, set Absolute Offset to 0 and do not set a Relative Offset. Absolute Offset may be positive or negative.
Relative Offset	This is the relative offset from the last successful content match, `pcre`, or `byte_jump`. To decode an ASN.1 sequence right after the content "foo", set Relative Offset to 0, and do not set an Absolute Offset. Relative Offset may be positive or negative. (Remember that the offset counter starts at 0.)

For example, there is a known vulnerability in the Microsoft ASN.1 Library that creates a buffer overflow, allowing an attacker to exploit the condition with a specially crafted authentication packet. When the system decodes the asn.1 data, exploit code in the packet could execute on the host with system-level privileges or could cause a DoS condition. The following rule uses the `asn1` keyword to detect attempts to exploit this vulnerability:

```
alert tcp $EXTERNAL_NET any -> $HOME_NET 445

(flow:to_server, established; content:”|FF|SMB|73|”;

nocase; offset:4; depth:5;

asn1:bitstring_overflow,double_overflow,oversize_length 100,

relative_offset 54;)
```

The above rule generates an event against TCP traffic traveling from any IP address defined in the $EXTERNAL_NET variable, from any port, to any IP address defined in the $HOME_NET variable using port 445. In addition, it only executes the rule on established TCP connections to servers. The rule then tests for specific content in specific locations. Finally, the rule uses the `asn1` keyword to detect bitstring encodings and double ASCII encodings and to identify asn.1 type lengths over 100 bytes in length starting 55 bytes from the end of the last successful content match. (Remember that the `offset` counter starts at byte 0.)

The urilen Keyword

You can use the `urilen` keyword in conjunction with the HTTP Inspect preprocessor to inspect HTTP traffic for URIs of a specific length, less than a maximum length, greater than a minimum length, or within a specified range.

After the HTTP Inspect preprocessor normalizes and inspects the packet, the rules engine evaluates the packet against the rule and determines whether the URI matches the length condition specified by the `urilen` keyword. You can use this keyword to detect exploits that attempt to take advantage of URI length vulnerabilities, for example, by creating a buffer overflow that allows the attacker to cause a DoS condition or execute code on the host with system-level privileges.

Note the following when using the `urilen` keyword in a rule:

- In practice, you always use the `urilen` keyword in combination with the `flow:established` keyword and one or more other keywords.
- The rule protocol is always TCP.
- Target ports are always HTTP ports.

You specify the URI length using a decimal number of bytes, less than (<) and greater than (>).

For example:

- specify `5` to detect a URI 5 bytes long.
- specify `< 5` (separated by one space character) to detect a URI less than 5 bytes long.
- specify `> 5` (separated by one space character) to detect a URI greater than 5 bytes long.
- specify `3 <> 5` (with one space character before and after <>) to detect a URI between 3 and 5 bytes long inclusive.

For example, there is a known vulnerability in Novell's server monitoring and diagnostics utility iMonitor version 2.4, which comes with eDirectory version 8.8. A packet containing an excessively long URI creates a buffer overflow, allowing an attacker to exploit the condition with a specially crafted packet that could execute on the host with system-level privileges or could cause a DoS condition. The following rule uses the `urilen` keyword to detect attempts to exploit this vulnerability:

```
alert tcp $EXTERNAL_NET any -> $HOME_NET $HTTP_PORTS
(msg:"EXPLOIT eDirectory 8.8 Long URI iMonitor buffer
overflow attempt"; flow:to_server,established;
urilen:> 8192; uricontent:"/nds/"; nocase;
classtype:attempted-admin; sid:x; rev:1;)
```

The above rule generates an event against TCP traffic traveling from any IP address defined in the $EXTERNAL_NET variable, from any port, to any IP address defined in the $HOME_NET variable using the ports defined in the $HTTP_PORTS variable. In addition, packets are evaluated against the rule only on established TCP connections to servers. The rule uses the `urilen` keyword to detect any URI over 8192 bytes in length. Finally, the rule searches the URI for the specific case-insensitive content `/nds/`.

DCE/RPC Keywords

The three DCE/RPC keywords described in the following table allow you to monitor DCE/RPC session traffic for exploits. When the system processes rules with these keywords, it invokes the DCE/RPC preprocessor.

Table 51: DCE/RPC Keywords

Use...	In this way...	To detect...
`dce_iface`	alone	packets identifying a specific DCE/RPC service
`dce_opnum`	preceded by `dce_iface`	packets identifying specific DCE/RPC service operations
`dce_stub_data`	preceded by `dce_iface` + `dce_opnum`	stub data defining a specific operation request or response

Note in the table that you should always precede `dce_opnum` with `dce_iface`, and you should always precede `dce_stub_data` with `dce_iface` + `dce_opnum`.

You can also use these DCE/RPC keywords in combination with other rule keywords. Note that for DCE/RPC rules, you use the `byte_jump`, `byte_test`, `and byte_extract` keywords with their **DCE/RPC** arguments selected.

Cisco recommends that you include at least one `content` keyword in rules that include DCE/RPC keywords to ensure that the rules engine uses the fast pattern matcher, which increases processing speed and improves performance. Note that the rules engine uses the fast pattern matcher when a rule includes at least one `content` keyword, regardless of whether you enable the `content` keyword **Use Fast Pattern Matcher** argument.

You can use the DCE/RPC version and adjoining header information as the matching content in the following cases:

- the rule does not include another `content` keyword
- the rule contains another `content` keyword, but the DCE/RPC version and adjoining information represent a more unique pattern than the other content

  For example, the DCE/RPC version and adjoining information are more likely to be unique than a single byte of content.

You should end qualifying rules with one of the following version and adjoining information content matches:

- For connection-oriented DCE/RPC rules, use the content `|05 00 00|` (for major version 05, minor version 00, and the request PDU (protocol data unit) type 00).
- For connectionless DCE/RPC rules, use the content `|04 00|` (for version 04, and the request PDU type 00).

In either case, position the `content` keyword for version and adjoining information as the last keyword in the rule to invoke the fast pattern matcher without repeating processing already completed by the DCE/RPC preprocessor. Note that placing the `content` keyword at the end of the rule applies to version content used as a device to invoke the fast pattern matcher, and not necessarily to other content matches in the rule.

dce_iface

You can use the `dce_iface` keyword to identify a specific DCE/RPC service.

Optionally, you can also use `dce_iface` in combination with the `dce_opnum` and `dce_stub_data` keywords to further limit the DCE/RPC traffic to inspect.

A fixed, sixteen-byte Universally Unique Identifier (UUID) identifies the application interface assigned to each DCE/RPC service. For example, the UUID 4b324fc8-670-01d3-1278-5a47bf6ee188 identifies the DCE/RPC lanmanserver service, also known as the srvsvc service, which provides numerous management functions for sharing peer-to-peer printers, files, and SMB named pipes. The DCE/RPC preprocessor uses the UUID and associated header values to track DCE/RPC sessions.

The interface UUID is comprised of five hexadecimal strings separated by hyphens:

```
<4hexbytes>-<2hexbytes>-<2hexbytes>-<2hexbytes>-<6hexbytes>
```

You specify the interface by entering the entire UUID including hyphens, as seen in the following UUID for the netlogon interface:

```
12345678-1234-abcd-ef00-01234567cffb
```

Note that you must specify the first three strings in the UUID in big endian byte order. Although published interface listings and protocol analyzers typically display UUIDs in the correct byte order, you might encounter a need to rearrange the UUID byte order before entering it. Consider the following messenger service UUID shown as it might sometimes be displayed in raw ASCII text with the first three strings in little endian byte order:

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

You would specify the same UUID for the `dce_iface` keyword by inserting hyphens and putting the first three strings in big endian byte order as follows:

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

Although a DCE/RPC session can include requests to multiple interfaces, you should include only one `dce_iface` keyword in a rule. Create additional rules to detect additional interfaces.

DCE/RPC application interfaces also have interface version numbers. You can optionally specify an interface version with an operator indicating that the version equals, does not equal, is less than, or greater than the specified value.

Both connection-oriented and connectionless DCE/RPC can be fragmented in addition to any TCP segmentation or IP fragmentation. Typically, it is not useful to associate any DCE/RPC fragment other than the first with the specified interface, and doing so may result in a large number of false positives. However, for flexibility you can optionally evaluate all fragments against the specified interface.

The following table summarizes the `dce_iface` keyword arguments.

Table 52: `dce_iface` Arguments

Argument	Description
Interface UUID	The UUID, including hyphens, that identifies the application interface of the specific service that you want to detect in DCE/RPC traffic. Any request associated with the specified interface would match the interface UUID.
Version	Optionally, the application interface version number 0 to 65535 and an operator indicating whether to detect a version greater than (>), less than (<), equal to (=), or not equal to (!) the specified value.
All Fragments	Optionally, enable to match against the interface in all associated DCE/RPC fragments and, if specified, on the interface version. This argument is disabled by default, indicating that the keyword matches only if the first fragment or the entire unfragmented packet is associated with the specified interface. Note that enabling this argument may result in false positives.

The dce_opnum Keyword

You can use the `dce_opnum` keyword in conjunction with the DCE/RPC preprocessor to detect packets that identify one or more specific operations that a DCE/RPC service provides.

Client function calls request specific service functions, which are referred to in DCE/RPC specifications as *operations*. An operation number (opnum) identifies a specific operation in the DCE/RPC header. It is likely that an exploit would target a specific operation.

For example, the UUID 12345678-1234-abcd-ef00-01234567cffb identifies the interface for the netlogon service, which provides several dozen different operations. One of these is operation 6, the NetrServerPasswordSet operation.

You should precede a `dce_opnum` keyword with a `dce_iface` keyword to identify the service for the operation.

You can specify a single decimal value 0 to 65535 for a specific operation, a range of operations separated by a hyphen, or a comma-separated list of operations and ranges in any order.

Any of the following examples would specify valid netlogon operation numbers:

```
15
15-18
15, 18-20
15, 20-22, 17
15, 18-20, 22, 24-26
```

The dce_stub_data Keyword

You can use the `dce_stub_data` keyword in conjunction with the DCE/RPC preprocessor to specify that the rules engine should start inspection at the beginning of the stub data, regardless of any other rule options. Packet payload rule options that follow the `dce_stub_data` keyword are applied relative to the stub data buffer.

DCE/RPC stub data provides the interface between a client procedure call and the DCE/RPC run-time system, the mechanism that provides the routines and services central to DCE/RPC. DCE/RPC exploits are identified in the stub data portion of the DCE/RPC packet. Because stub data is associated with a specific operation or function call, you should always precede `dce_stub_data` with `dce_iface` and `dce_opnum` to identify the related service and operation.

The `dce_stub_data` keyword has no arguments.

SIP Keywords

Four SIP keywords allow you to monitor SIP session traffic for exploits.

Note that the SIP protocol is vulnerable to denial of service (DoS) attacks. Rules addressing these attacks can benefit from rate-based attack prevention.

The sip_header Keyword

You can use the `sip_header` keyword to start inspection at the beginning of the extracted SIP request or response header and restrict inspection to header fields.

The `sip_header` keyword has no arguments.

The following example rule fragment points to the SIP header and matches the CSeq header field:

```
alert udp any any -> any 5060 ( sip_header; content:"CSeq"; )
```

The sip_body Keyword

You can use the `sip_body` keyword to start inspection at the beginning of the extracted SIP request or response message body and restrict inspection to the message body.

The `sip_body` keyword has no arguments.

The following example rule fragment points to the SIP message body and matches a specific IP address in the c (connection information) field in extracted SDP data:

```
alert udp any any -> any 5060 ( sip_body; content:"c=IN 192.168.12.14"; )
```

Note that rules are not limited to searching for SDP content. The SIP preprocessor extracts the entire message body and makes it available to the rules engine.

The sip_method Keyword

A *method* field in each SIP request identifies the purpose of the request. You can use the `sip_method` keyword to test SIP requests for specific methods. Separate multiple methods with commas.

You can specify any of the following currently defined SIP methods:

```
ack, benotify, bye, cancel, do, info, invite, join, message, notify, options, prack,
publish, quath, refer, register, service, sprack, subscribe, unsubscribe, update
```

Methods are case-insensitive. You can separate multiple methods with commas.

Because new SIP methods might be defined in the future, you can also specify a custom method, that is, a method that is not a currently defined SIP method. Accepted field values are defined in RFC 2616, which allows all characters except control characters and separators such as `=`, `(`, and `}`. See RFC 2616 for the complete list of excluded separators. When the system encounters a specified custom method in traffic, it will inspect the packet header but not the message.

The system supports up to 32 methods, including the 21 currently defined methods and an additional 11 methods. The system ignores any undefined methods that you might configure. Note that the 32 total methods includes methods specified using the **Methods to Check** SIP preprocessor option.

You can specify only one method when you use negation. For example:

```
!invite
```

Note, however, that multiple `sip_method` keywords in a rule are linked with an **AND** operation. For example, to test for all extracted methods except `invite` and `cancel`, you would use two negated `sip_method` keywords:

```
sip_method: !invite
sip_method: !cancel
```

Cisco recommends that you include at least one `content` keyword in rules that include the `sip_method` keyword to ensure that the rules engine uses the fast pattern matcher, which increases processing speed and improves performance. Note that the rules engine uses the fast pattern matcher when a rule includes at least one `content` keyword, regardless of whether you enable the `content` keyword **Use Fast Pattern Matcher** argument.

The sip_stat_code Keyword

A three-digit status code in each SIP response indicates the outcome of the requested action. You can use the `sip_stat_code` keyword to test SIP responses for specific status codes.

You can specify a one-digit response-type number 1-9, a specific three-digit number 100-999, or a comma-separated list of any combination of either. A list matches if any single number in the list matches the code in the SIP response.

The following table describes the SIP status code values you can specify.

Table 53: `sip_stat_code` Values

To detect...	Specify...	For example...	Detects...
a specific status code	the three-digit status code	189	189
any three-digit code that begins with a specified single digit	the single digit	1	1xx; that is, 100, 101, 102, and so on

To detect...	Specify...	For example...	Detects...
a list of values	any comma-separated combination of specific codes and single digits	222, 3	222 plus 300, 301, 302, and so on

Note also that the rules engine does not use the fast pattern matcher to search for the value specify using the `sip_stat_code` keyword, regardless of whether your rule includes a `content` keyword.

GTP Keywords

Three GSRP Tunneling Protocol (GTP) keywords allow you to inspect the GTP command channel for GTP version, message type, and information elements. You cannot use GTP keywords in combination with other intrusion rule keywords such as `content` or `byte_jump`. You **must** use the `gtp_version` keyword in each rule that uses the `gtp_info` or `gtp_type` keyword.

The gtp_version Keyword

You can use the `gtp_version` keyword to inspect GTP control messages for GTP version 0, 1, or 2.

Because different GTP versions define different message types and information elements, you must use `gtp_version` when you use the `gtp_type` or `gtp_info` keyword. You can specify the value 0, 1, or 2.

The gtp_type Keyword

Each GTP message is identified by a message type, which is comprised of both a numeric value and a string. You can use the `gtp_type` keyword to inspect traffic for specific GTP message types. Because different GTP versions define different message types and information elements, you must also use `gtp_version` when you use the `gtp_type` or `gtp_info` keyword.

You can specify a defined decimal value for a message type, a defined string, or a comma-separated list of either or both in any combination, as seen in the following example:

```
10, 11, echo_request
```

The system uses an OR operation to match each value or string that you list. The order in which you list values and strings does not matter. Any single value or string in the list matches the keyword. You receive an error if you attempt to save a rule that includes an unrecognized string or an out-of-range value.

Note in the table that different GTP versions sometimes use different values for the same message type. For example, the `sgsn_context_request` message type has a value of 50 in GTPv0 and GTPv1, but a value of 130 in GTPv2.

The `gtp_type` keyword matches different values depending on the version number in the packet. In the example above, the keyword matches the message type value 50 in a GTPv0 or GTPv1 packet and the value 130 in a GTPv2 packet. The keyword does not match a packet when the message type value in the packet is not a known value for the version specified in the packet.

If you specify an integer for the message type, the keyword matches if the message type in the keyword matches the value in the GTP packet, regardless of the version specified in the packet.

The following table lists the defined values and strings recognized by the system for each GTP message type.

Table 54: GTP Message Types

Value	Version 0	Version 1	Version 2
1	echo_request	echo_request	echo_request
2	echo_response	echo_response	echo_response
3	version_not_supported	version_not_supported	version_not_supported
4	node_alive_request	node_alive_request	N/A
5	node_alive_response	node_alive_response	N/A
6	redirection_request	redirection_request	N/A
7	redirection_response	redirection_response	N/A
16	create_pdp_context_request	create_pdp_context_request	N/A
17	create_pdp_context_response	create_pdp_context_response	N/A
18	update_pdp_context_request	update_pdp_context_request	N/A
19	update_pdp_context_response	update_pdp_context_response	N/A
20	delete_pdp_context_request	delete_pdp_context_request	N/A
21	delete_pdp_context_response	delete_pdp_context_response	N/A
22	create_aa_pdp_context_request	init_pdp_context_activation_request	N/A
23	create_aa_pdp_context_response	init_pdp_context_activation_response	N/A
24	delete_aa_pdp_context_request	N/A	N/A
25	delete_aa_pdp_context_response	N/A	N/A
26	error_indication	error_indication	N/A
27	pdu_notification_request	pdu_notification_request	N/A
28	pdu_notification_response	pdu_notification_response	N/A
29	pdu_notification_reject_request	pdu_notification_reject_request	N/A
30	pdu_notification_reject_response	pdu_notification_reject_response	N/A
31	N/A	supported_ext_header_notification	N/A
32	send_routing_info_request	send_routing_info_request	create_session_request
33	send_routing_info_response	send_routing_info_response	create_session_response
34	failure_report_request	failure_report_request	modify_bearer_request
35	failure_report_response	failure_report_response	modify_bearer_response

Value	Version 0	Version 1	Version 2
36	note_ms_present_request	note_ms_present_request	delete_session_request
37	note_ms_present_response	note_ms_present_response	delete_session_response
38	N/A	N/A	change_notification_request
39	N/A	N/A	change_notification_response
48	identification_request	identification_request	N/A
49	identification_response	identification_response	N/A
50	sgsn_context_request	sgsn_context_request	N/A
51	sgsn_context_response	sgsn_context_response	N/A
52	sgsn_context_ack	sgsn_context_ack	N/A
53	N/A	forward_relocation_request	N/A
54	N/A	forward_relocation_response	N/A
55	N/A	forward_relocation_complete	N/A
56	N/A	relocation_cancel_request	N/A
57	N/A	relocation_cancel_response	N/A
58	N/A	forward_srns_contex	N/A
59	N/A	forward_relocation_complete_ack	N/A
60	N/A	forward_srns_contex_ack	N/A
64	N/A	N/A	modify_bearer_command
65	N/A	N/A	modify_bearer_failure_indication
66	N/A	N/A	delete_bearer_command
67	N/A	N/A	delete_bearer_failure_indication
68	N/A	N/A	bearer_resource_command
69	N/A	N/A	bearer_resource_failure_indication
70	N/A	ran_info_relay	downlink_failure_indication
71	N/A	N/A	trace_session_activation
72	N/A	N/A	trace_session_deactivation
73	N/A	N/A	stop_paging_indication
95	N/A	N/A	create_bearer_request

Value	Version 0	Version 1	Version 2
96	N/A	mbms_notification_request	create_bearer_response
97	N/A	mbms_notification_response	update_bearer_request
98	N/A	mbms_notification_reject_request	update_bearer_response
99	N/A	mbms_notification_reject_response	delete_bearer_request
100	N/A	create_mbms_context_request	delete_bearer_response
101	N/A	create_mbms_context_response	delete_pdn_request
102	N/A	update_mbms_context_request	delete_pdn_response
103	N/A	update_mbms_context_response	N/A
104	N/A	delete_mbms_context_request	N/A
105	N/A	delete_mbms_context_response	N/A
112	N/A	mbms_register_request	N/A
113	N/A	mbms_register_response	N/A
114	N/A	mbms_deregister_request	N/A
115	N/A	mbms_deregister_response	N/A
116	N/A	mbms_session_start_request	N/A
117	N/A	mbms_session_start_response	N/A
118	N/A	mbms_session_stop_request	N/A
119	N/A	mbms_session_stop_response	N/A
120	N/A	mbms_session_update_request	N/A
121	N/A	mbms_session_update_response	N/A
128	N/A	ms_info_change_request	identification_request
129	N/A	ms_info_change_response	identification_response
130	N/A	N/A	sgsn_context_request
131	N/A	N/A	sgsn_context_response
132	N/A	N/A	sgsn_context_ack
133	N/A	N/A	forward_relocation_request
134	N/A	N/A	forward_relocation_response
135	N/A	N/A	forward_relocation_complete

Value	Version 0	Version 1	Version 2
136	N/A	N/A	forward_relocation_complete_ack
137	N/A	N/A	forward_access
138	N/A	N/A	forward_access_ack
139	N/A	N/A	relocation_cancel_request
140	N/A	N/A	relocation_cancel_response
141	N/A	N/A	configuration_transfer_tunnel
149	N/A	N/A	detach
150	N/A	N/A	detach_ack
151	N/A	N/A	cs_paging
152	N/A	N/A	ran_info_relay
153	N/A	N/A	alert_mme
154	N/A	N/A	alert_mme_ack
155	N/A	N/A	ue_activity
156	N/A	N/A	ue_activity_ack
160	N/A	N/A	create_forward_tunnel_request
161	N/A	N/A	create_forward_tunnel_response
162	N/A	N/A	suspend
163	N/A	N/A	suspend_ack
164	N/A	N/A	resume
165	N/A	N/A	resume_ack
166	N/A	N/A	create_indirect_forward_tunnel_request
167	N/A	N/A	create_indirect_forward_tunnel_response
168	N/A	N/A	delete_indirect_forward_tunnel_request
169	N/A	N/A	delete_indirect_forward_tunnel_response
170	N/A	N/A	release_access_bearer_request
171	N/A	N/A	release_access_bearer_response
176	N/A	N/A	downlink_data
177	N/A	N/A	downlink_data_ack

Value	Version 0	Version 1	Version 2
179	N/A	N/A	pgw_restart
180	N/A	N/A	pgw_restart_ack
200	N/A	N/A	update_pdn_request
201	N/A	N/A	update_pdn_response
211	N/A	N/A	modify_access_bearer_request
212	N/A	N/A	modify_access_bearer_response
231	N/A	N/A	mbms_session_start_request
232	N/A	N/A	mbms_session_start_response
233	N/A	N/A	mbms_session_update_request
234	N/A	N/A	mbms_session_update_response
235	N/A	N/A	mbms_session_stop_request
236	N/A	N/A	mbms_session_stop_response
240	data_record_transfer_request	data_record_transfer_request	N/A
241	data_record_transfer_response	data_record_transfer_response	N/A
254	N/A	end_marker	N/A
255	pdu	pdu	N/A

The gtp_info Keyword

A GTP message can include multiple information elements, each of which is identified by both a defined numeric value and a defined string. You can use the `gtp_info` keyword to start inspection at the beginning of a specified information element, and restrict inspection to the specified information element. Because different GTP versions define different message types and information elements, you must also use `gtp_version` when you use this keyword.

You can specify either the defined decimal value or the defined string for an information element. You can specify a single value or string, and you can use multiple `gtp_info` keywords in a rule to inspect multiple information elements.

When a message includes multiple information elements of the same type, all are inspected for a match. When information elements occur in an invalid order, only the last instance is inspected.

Note that different GTP versions sometimes use different values for the same information element. For example, the `cause` information element has a value of 1 in GTPv0 and GTPv1, but a value of 2 in GTPv2.

The `gtp_info` keyword matches different values depending on the version number in the packet. In the example above, the keyword matches the information element value 1 in a GTPv0 or GTPv1 packet and the value 2 in a GTPv2 packet. The keyword does not match a packet when the information element value in the packet is not a known value for the version specified in the packet.

If you specify an integer for the information element, the keyword matches if the message type in the keyword matches the value in the GTP packet, regardless of the version specified in the packet.

The following table lists the values and strings recognized by the system for each GTP information element.

Table 55: GTP Information Elements

Value	Version 0	Version 1	Version 2
1	cause	cause	imsi
2	imsi	imsi	cause
3	rai	rai	recovery
4	tlli	tlli	N/A
5	p_tmsi	p_tmsi	N/A
6	qos	N/A	N/A
8	recording_required	recording_required	N/A
9	authentication	authentication	N/A
11	map_cause	map_cause	N/A
12	p_tmsi_sig	p_tmsi_sig	N/A
13	ms_validated	ms_validated	N/A
14	recovery	recovery	N/A
15	selection_mode	selection_mode	N/A
16	flow_label_data_1	teid_1	N/A
17	flow_label_signalling	teid_control	N/A
18	flow_label_data_2	teid_2	N/A
19	ms_unreachable	teardown_ind	N/A
20	N/A	nsapi	N/A
21	N/A	ranap	N/A
22	N/A	rab_context	N/A
23	N/A	radio_priority_sms	N/A
24	N/A	radio_priority	N/A
25	N/A	packet_flow_id	N/A
26	N/A	charging_char	N/A

Value	Version 0	Version 1	Version 2
27	N/A	trace_ref	N/A
28	N/A	trace_type	N/A
29	N/A	ms_unreachable	N/A
71	N/A	N/A	apn
72	N/A	N/A	ambr
73	N/A	N/A	ebi
74	N/A	N/A	ip_addr
75	N/A	N/A	mei
76	N/A	N/A	msisdn
77	N/A	N/A	indication
78	N/A	N/A	pco
79	N/A	N/A	paa
80	N/A	N/A	bearer_qos
80	N/A	N/A	flow_qos
82	N/A	N/A	rat_type
83	N/A	N/A	serving_network
84	N/A	N/A	bearer_tft
85	N/A	N/A	tad
86	N/A	N/A	uli
87	N/A	N/A	f_teid
88	N/A	N/A	tmsi
89	N/A	N/A	cn_id
90	N/A	N/A	s103pdf
91	N/A	N/A	s1udf
92	N/A	N/A	delay_value
93	N/A	N/A	bearer_context
94	N/A	N/A	charging_id
95	N/A	N/A	charging_char

Value	Version 0	Version 1	Version 2
96	N/A	N/A	trace_info
97	N/A	N/A	bearer_flag
99	N/A	N/A	pdn_type
100	N/A	N/A	pti
101	N/A	N/A	drx_parameter
103	N/A	N/A	gsm_key_tri
104	N/A	N/A	umts_key_cipher_quin
105	N/A	N/A	gsm_key_cipher_quin
106	N/A	N/A	umts_key_quin
107	N/A	N/A	eps_quad
108	N/A	N/A	umts_key_quad_quin
109	N/A	N/A	pdn_connection
110	N/A	N/A	pdn_number
111	N/A	N/A	p_tmsi
112	N/A	N/A	p_tmsi_sig
113	N/A	N/A	hop_counter
114	N/A	N/A	ue_time_zone
115	N/A	N/A	trace_ref
116	N/A	N/A	complete_request_msg
117	N/A	N/A	guti
118	N/A	N/A	f_container
119	N/A	N/A	f_cause
120	N/A	N/A	plmn_id
121	N/A	N/A	target_id
123	N/A	N/A	packet_flow_id
124	N/A	N/A	rab_contex
125	N/A	N/A	src_rnc_pdcp
126	N/A	N/A	udp_src_port

Value	Version 0	Version 1	Version 2
127	charge_id	charge_id	apn_restriction
128	end_user_address	end_user_address	selection_mode
129	mm_context	mm_context	src_id
130	pdp_context	pdp_context	N/A
131	apn	apn	change_report_action
132	protocol_config	protocol_config	fq_csid
133	gsn	gsn	channel
134	msisdn	msisdn	emlpp_pri
135	N/A	qos	node_type
136	N/A	authentication_qu	fqdn
137	N/A	tft	ti
138	N/A	target_id	mbms_session_duration
139	N/A	utran_trans	mbms_service_area
140	N/A	rab_setup	mbms_session_id
141	N/A	ext_header	mbms_flow_id
142	N/A	trigger_id	mbms_ip_multicast
143	N/A	omc_id	mbms_distribution_ack
144	N/A	ran_trans	rfsp_index
145	N/A	pdp_context_pri	uci
146	N/A	addi_rab_setup	csg_info
147	N/A	sgsn_number	csg_id
148	N/A	common_flag	cmi
149	N/A	apn_restriction	service_indicator
150	N/A	radio_priority_lcs	detach_type
151	N/A	rat_type	ldn
152	N/A	user_loc_info	node_feature
153	N/A	ms_time_zone	mbms_time_to_transfer
154	N/A	imei_sv	throttling

Value	Version 0	Version 1	Version 2
155	N/A	camel	arp
156	N/A	mbms_ue_context	epc_timer
157	N/A	tmp_mobile_group_id	signalling_priority_indication
158	N/A	rim_routing_addr	tmgi
159	N/A	mbms_config	mm_srvcc
160	N/A	mbms_service_area	flags_srvcc
161	N/A	src_rnc_pdcp	nmbr
162	N/A	addi_trace_info	N/A
163	N/A	hop_counter	N/A
164	N/A	plmn_id	N/A
165	N/A	mbms_session_id	N/A
166	N/A	mbms_2g3g_indicator	N/A
167	N/A	enhanced_nsapi	N/A
168	N/A	mbms_session_duration	N/A
169	N/A	addi_mbms_trace_info	N/A
170	N/A	mbms_session_repetition_num	N/A
171	N/A	mbms_time_to_data	N/A
173	N/A	bss	N/A
174	N/A	cell_id	N/A
175	N/A	pdu_num	N/A
177	N/A	mbms_bearer_capab	N/A
178	N/A	rim_routing_disc	N/A
179	N/A	list_pfc	N/A
180	N/A	ps_xid	N/A
181	N/A	ms_info_change_report	N/A
182	N/A	direct_tunnel_flags	N/A
183	N/A	correlation_id	N/A
184	N/A	bearer_control_mode	N/A

Value	Version 0	Version 1	Version 2
185	N/A	mbms_flow_id	N/A
186	N/A	mbms_ip_multicast	N/A
187	N/A	mbms_distribution_ack	N/A
188	N/A	reliable_inter_rat_handover	N/A
189	N/A	rfsp_index	N/A
190	N/A	fqdn	N/A
191	N/A	evolved_allocation1	N/A
192	N/A	evolved_allocation2	N/A
193	N/A	extended_flags	N/A
194	N/A	uci	N/A
195	N/A	csg_info	N/A
196	N/A	csg_id	N/A
197	N/A	cmi	N/A
198	N/A	apn_ambr	N/A
199	N/A	ue_network	N/A
200	N/A	ue_ambr	N/A
201	N/A	apn_ambr_nsapi	N/A
202	N/A	ggsn_backoff_timer	N/A
203	N/A	signalling_priority_indication	N/A
204	N/A	signalling_priority_indication_nsapi	N/A
205	N/A	high_bitrate	N/A
206	N/A	max_mbr	N/A
251	charging_gateway_addr	charging_gateway_addr	N/A
255	private_extension	private_extension	private_extension

SCADA Keywords

The rules engine uses Modbus, DNP3, CIP, and S7Commplus rules to access certain protocol fields.

Modbus Keywords

You can use Modbus keywords alone or in combination with other keywords such as `content` and `byte_jump`.

modbus_data

You can use the `modbus_data` keyword to point to the beginning of the Data field in a Modbus request or response.

modbus_func

You can use the `modbus_func` keyword to match against the Function Code field in a Modbus application layer request or response header. You can specify either a single defined decimal value or a single defined string for a Modbus function code.

The following table lists the defined values and strings recognized by the system for Modbus function codes.

Table 56: Modbus Function Codes

Value	String
1	read_coils
2	read_discrete_inputs
3	read_holding_registers
4	read_input_registers
5	write_single_coil
6	write_single_register
7	read_exception_status
8	diagnostics
11	get_comm_event_counter
12	get_comm_event_log
15	write_multiple_coils
16	write_multiple_registers
17	report_slave_id
20	read_file_record
21	write_file_record
22	mask_write_register
23	read_write_multiple_registers
24	read_fifo_queue

Value	String
43	encapsulated_interface_transport

modbus_unit

You can use the `modbus_unit` keyword to match a single decimal value against the Unit ID field in a Modbus request or response header.

DNP3 Keywords

You can use DNP3 keywords alone or in combination with other keywords such as `content` and `byte_jump`.

dnp3_data

You can use the `dnp3_data` keyword to point to the beginning of reassembled DNP3 application layer fragments.

The DNP3 preprocessor reassembles link layer frames into application layer fragments. The `dnp3_data` keyword points to the beginning of each application layer fragment; other rule options can match against the reassembled data within fragments without separating the data and adding checksums every 16 bytes.

dnp3_func

You can use the `dnp3_func` keyword to match against the Function Code field in a DNP3 application layer request or response header. You can specify either a single defined decimal value or a single defined string for a DNP3 function code.

The following table lists the defined values and strings recognized by the system for DNP3 function codes.

Table 57: DNP3 Function Codes

Value	String
0	confirm
1	read
2	write
3	select
4	operate
5	direct_operate
6	direct_operate_nr
7	immed_freeze
8	immed_freeze_nr
9	freeze_clear
10	freeze_clear_nr

Value	String
11	freeze_at_time
12	freeze_at_time_nr
13	cold_restart
14	warm_restart
15	initialize_data
16	initialize_appl
17	start_appl
18	stop_appl
19	save_config
20	enable_unsolicited
21	disable_unsolicited
22	assign_class
23	delay_measure
24	record_current_time
25	open_file
26	close_file
27	delete_file
28	get_file_info
29	authenticate_file
30	abort_file
31	activate_config
32	authenticate_req
33	authenticate_err
129	response
130	unsolicited_response
131	authenticate_resp

dnp3_ind

You can use the `dnp3_ind` keyword to match against flags in the Internal Indications field in a DNP3 application layer response header.

You can specify the string for a single known flag or a comma-separated list of flags, as seen in the following example:

```
class_1_events, class_2_events
```

When you specify multiple flags, the keyword matches against any flag in the list. To detect a combination of flags, use the `dnp3_ind` keyword multiple times in a rule.

The following list provides the string syntax recognized by the system for defined DNP3 internal indications flags.

```
class_1_events
class_2_events
class_3_events
need_time
local_control
device_trouble
device_restart
no_func_code_support
object_unknown
parameter_error
event_buffer_overflow
already_executing
config_corrupt
reserved_2
reserved_1
```

dnp3_obj

You can use the `dnp3_obj` keyword to match against DNP3 object headers in a request or response.

DNP3 data is comprised of a series of DNP3 objects of different types such as analog input, binary input, and so on. Each type is identified with a *group* such as analog input group, binary input group, and so on, each of which can be identified by a decimal value. The objects in each group are further identified by an *object variation* such as 16-bit integers, 32-bit integers, short floating point, and so on, each of which specifies the data format of the object. Each type of object variation can also be identified by a decimal value.

You identify object headers by specifying the decimal number for the type of object header group and the decimal number for the type of object variation. The combination of the two defines a specific type of DNP3 object.

CIP and ENIP Keywords

You can use the following keywords alone or in combination to create custom intrusion rules that identify attacks against CIP and ENIP traffic detected by the CIP preprocessor. For configurable keywords, specify a single integer within the allowed range. See The CIP Preprocessor for more information.

Table 58:

This keyword...	Matches against...	Range
`cip_attribute`	the Object Class/Instance Attribute field in a CIP message. Specify a single defined integer value.	0 - 65535

This keyword...	Matches against...	Range
`cip_class`	the Object Class field in a CIP message. Specify a single defined integer value.	0 - 65535
`cip_conn_path_class`	the Object Class in Connection Path. Specify a single integer value.	0 - 65535
`cip_instance`	the Instance ID field in a CIP message. Specify a single integer value.	0 - 4284927295
`cip_req`	the service request message.	N/A
`cip_rsp`	the service response message.	N/A
`cip_service`	the Service field in a CIP service request message. Specify a single integer value.	0 - 127
`cip_status`	the Status field in a CIP service response message. Specify a single integer value.	0 - 255
`enip_command`	the Command Code in EthNet/IP header. Specify a single integer value.	0 - 65535
`enip_req`	the EthNet/IP request message.	N/A
`enip_rsp`	the EthNet/IP response message.	N/A

S7Commplus Keywords

You can use the S7Commplus keywords alone or in combination to create custom intrusion rules that identify attacks against traffic detected by the S7Commplus preprocessor. For configurable keywords, specify a single known value or a single integer within the allowed range. See The S7Commplus Preprocessor for more information.

Note the following:

- Multiple S7commplus keywords in the same rule are AND-ed.
- Using multiple `s7commplus_func` or `s7commplus_opcode` keywords in the same rule negates the rule and it will never match traffic. To search for multiple values with these keywords, create multiple rules.

s7commplus_content

Before using a `content` or `protected_content` keyword in an S7Commplus intrusion rule, use the `s7commplus_content` keyword to position the cursor to the beginning of the packet payload. See The content and protected_content Keywords, on page 23 for more information.

s7commplus_func

Use the `s7commplus_func` keyword to match against one of the following values in an S7Commplus header:

- explore
- createobject

- deleteobject
- setvariable
- getlink
- setmultivar
- getmultivar
- beginsequence
- endsequence
- invoke
- getvarsubstr
- 0x0 through 0xFFF

  Note that numeric expressions allow for additional values.

s7commplus_opcode

Use the s7commplus_opcode keyword to match against one of the following values in an S7Commplus header:

- request
- response
- notification
- response2
- 0x0 through 0xFF

  Note that numeric expressions allow for additional values.

Packet Characteristics

You can write rules that only generate events against packets with specific packet characteristics.

dsize

The dsize keyword tests the packet payload size. With it, you can use the greater than and less than operators (< and >) to specify a range of values. You can use the following syntax to specify ranges:

```
>number_of_bytes
<number_of_bytes
number_of_bytes<>number_of_bytes
```

For example, to indicate a packet size greater than 400 bytes, use >400 as the dtype value. To indicate a packet size of less than 500 bytes, use <500. To specify that the rule trigger against any packet between 400 and 500 bytes inclusive, use 400<>500.

Caution The dsize keyword tests packets before they are decoded by any preprocessors.

isdataat

The isdataat keyword instructs the rules engine to verify that data resides at a specific location in the payload.

The following table lists the arguments you can use with the isdataat keyword.

Table 59: isdataat Arguments

Argument	Type	Description
Offset	Required	The specific location in the payload. For example, to test that data appears at byte 50 in the packet payload, you would specify 50 as the offset value. A ! modifier negates the results of the isdataat test; it alerts if a certain amount of data is not present within the payload. You can also use an existing byte_extract variable or byte_math result to specify the value for this argument.
Relative	Optional	Makes the location relative to the last successful content match. If you specify a relative location, note that the counter starts at byte 0, so calculate the location by subtracting 1 from the number of bytes you want to move forward from the last successful content match. For example, to specify that the data must appear at the ninth byte after the last successful content match, you would specify a relative offset of 8.
Raw Data	Optional	Specifies that the data is located in the original packet payload before decoding or application layer normalization by any Firepower System preprocessor. You can use this argument with **Relative** if the previous content match was in the raw packet data.

For example, in a rule searching for the content foo, if the value for isdataat is specified as the following:

- Offset = !10
- Relative = enabled

The system alerts if the rules engine does not detect 10 bytes after foo before the payload ends.

sameip

The sameip keyword tests that a packet's source and destination IP addresses are the same. It does not take an argument.

fragoffset

The fragoffset keyword tests the offset of a fragmented packet. This is useful because some exploits (such as WinNuke denial-of-service attacks) use hand-generated packet fragments that have specific offsets.

For example, to test whether the offset of a fragmented packet is 31337 bytes, specify 31337 as the fragoffset value.

You can use the following operators when specifying arguments for the fragoffset keyword.

Table 60: fragoffset Keyword Argument Operators

Operator	Description
!	not
>	greater than
<	less than

Note that you cannot use the not (`!`) operator in combination with < or >.

cvs

The `cvs` keyword tests Concurrent Versions System (CVS) traffic for malformed CVS entries. An attacker can use a malformed entry to force a heap overflow and execute malicious code on the CVS server. This keyword can be used to identify attacks against two known CVS vulnerabilities: CVE-2004-0396 (CVS 1.11.x up to 1.11.15, and 1.12.x up to 1.12.7) and CVS-2004-0414 (CVS 1.12.x through 1.12.8, and 1.11.x through 1.11.16). The `cvs` keyword checks for a well-formed entry, and generates alerts when a malformed entry is detected.

Your rule should include the ports where CVS runs. In addition, any ports where traffic may occur should be added to the list of ports for stream reassembly in your TCP policies so state can be maintained for CVS sessions. The TCP ports 2401 (`pserver`) and 514 (`rsh`) are included in the list of client ports where stream reassembly occurs. However, note that if your server runs as an `xinetd` server (i.e., pserver), it can run on any TCP port. Add any non-standard ports to the stream reassembly **Client Ports** list.

Active Response Keywords

The **resp** and **react** keywords provide two approaches to initiating active responses. An intrusion rule that contains either keyword initiates a single active response when a packet triggers the rule. Active response keywords initiate active responses to close TCP connections in response to triggered TCP rules or UDP sessions in response to triggered UDP rules. Active responses are not intended to take the place of a firewall for a number of reasons, including that an attacker may have chosen to ignore or circumvent active responses.

Active responses are supported in inline, including routed or transparent, deployments. For example, in response to the `react` keyword in an inline deployment, the system can insert a TCP reset (RST) packet directly into the traffic for each end of the connection, which normally should close the connection. Active responses are not supported or suited for passive deployments.

Because active responses can be routed back, the system does not allow TCP resets to initiate TCP resets; this prevents an unending sequence of active responses. The system also does not allow ICMP unreachable packets to initiate ICMP unreachable packets in keeping with standard practice.

You can configure the TCP stream preprocessor to detect additional traffic on a TCP connection after an intrusion rule has triggered an active response. When the preprocessor detects additional traffic, it sends additional active responses up to a specified maximum to both ends of the connection or session.

The resp Keyword

You can use the `resp` keyword to actively respond to TCP connections or UDP sessions, depending on whether you specify the TCP or UDP protocol in the rule header.

Keyword arguments allow you to specify the packet direction and whether to use TCP reset (RST) packets or ICMP unreachable packets as active responses.

You can use any of the TCP reset or ICMP unreachable arguments to close TCP connections. You should use only ICMP unreachable arguments to close UDP sessions.

Different TCP reset arguments also allow you to target active responses to the packet source, destination, or both. All ICMP unreachable arguments target the packet source and allow you to specify whether to use an ICMP network, host, or port unreachable packet, or all three.

The following table lists the arguments you can use with the `resp` keyword to specify exactly what you want the system to do when the rule triggers.

Table 61: resp Arguments

Argument	Description
reset_source	Directs a TCP reset packet to the endpoint that sent the packet that triggered the rule. Alternatively, you can specify `rst_snd`, which is supported for backward compatibility.
reset_dest	Directs a TCP reset packet to the intended destination endpoint of the packet that triggered the rule. Alternatively, you can specify `rst_rcv`, which is supported for backward compatibility.
reset_both	Directs a TCP reset packet to both the sending and receiving endpoints. Alternatively, you can specify `rst_all`, which is supported for backward compatibility.
icmp_net	Directs an ICMP network unreachable message to the sender.
icmp_host	Directs an ICMP host unreachable message to the sender.
icmp_port	Directs an ICMP port unreachable message to the sender. This argument is used to terminate UDP traffic.
icmp_all	Directs the following ICMP messages to the sender: • network unreachable • host unreachable • port unreachable

For example, to configure a rule to reset both sides of a connection when a rule is triggered, use `reset_both` as the value for the `resp` keyword.

You can use a comma-separated list to specify multiple arguments as follows:

```
argument,argument,argument
```

The react Keyword

You can use the `react` keyword to send a default HTML page to the TCP connection client when a packet triggers the rule; after sending the HTML page, the system uses TCP reset packets to initiate active responses to both ends of the connection. The `react` keyword does not trigger active responses for UDP traffic.

Optionally, you can specify the following argument:

```
msg
```

When a packet triggers a react rule that uses the msg argument, the HTML page includes the rule event message.

If you do not specify the msg argument, the HTML page includes the following message:

```
You are attempting to access a forbidden site.
Consult your system administrator for details.
```

Note Because active responses can be routed back, ensure that the HTML response page does not trigger a react rule; this could result in an unending sequence of active responses. Cisco recommends that you test react rules extensively before activating them in a production environment.

The detection_filter Keyword

You can use the detection_filter keyword to prevent a rule from generating events unless a specified number of packets trigger the rule within a specified time. This can stop the rule from prematurely generating events. For example, two or three failed login attempts within a few seconds could be expected behavior, but a large number of attempts within the same time could indicate a brute force attack.

The detection_filter keyword requires arguments that define whether the system tracks the source or destination IP address, the number of times the detection criteria must be met before triggering an event, and how long to continue the count.

Use the following syntax to delay the triggering of events:

```
track by_src/by_dst, count count, seconds number_of_seconds
```

The track argument specifies whether to use the packet's source or destination IP address when counting the number of packets that meet the rule's detection criteria. Select from the argument values described in the following table to specify how the system tracks event instances.

Table 62: detection_filter Track Arguments

Argument	Description
by_src	Detection criteria count by source IP address.
by_dst	Detection criteria count by destination IP address.

The count argument specifies the number of packets that must trigger the rule for the specified IP address within the specified time before the rule generates an event.

The seconds argument specifies the number of seconds within which the specified number of packets must trigger the rule before the rule generates an event.

Consider the case of a rule that searches packets for the content foo and uses the detection_filter keyword with the following arguments:

```
track by_src, count 10, seconds 20
```

In the example, the rule will not generate an event until it has detected foo in 10 packets within 20 seconds from a given source IP address. If the system detects only 7 packets containing foo within the first 20 seconds, no event is generated. However, if foo occurs 40 times in the first 20 seconds, the rule generates 30 events and the count begins again when 20 seconds have elapsed.

Comparing the threshold and detection_filter Keywords

The detection_filter keyword replaces the deprecated threshold keyword. The threshold keyword is still supported for backward compatibility and operates the same as thresholds that you set within an intrusion policy.

The detection_filter keyword is a detection feature that is applied before a packet triggers a rule. The rule does not generate an event for triggering packets detected before the specified packet count and, in an inline deployment, does not drop those packets if the rule is set to drop packets. Conversely, the rule does generate events for packets that trigger the rule and occur after the specified packet count and, in an inline deployment, drops those packets if the rule is set to drop packets.

Thresholding is an event notification feature that does not result in a detection action. It is applied after a packet triggers an event. In an inline deployment, a rule that is set to drop packets drops all packets that trigger the rule, independent of the rule threshold.

Note that you can use the detection_filter keyword in any combination with the intrusion event thresholding, intrusion event suppression, and rate-based attack prevention features in an intrusion policy. Note also that policy validation fails if you enable an imported local rule that uses the deprecated threshold keyword in combination with the intrusion event thresholding feature in an intrusion policy.

The tag Keyword

Use the tag keyword to tell the system to log additional traffic for the host or session. Use the following syntax when specifying the type and amount of traffic you want to capture using the tag keyword:

```
tagging_type, count, metric, optional_direction
```

The next three tables describe the other available arguments.

You can choose from two types of tagging. The following table describes the two types of tagging. Note that the session tag argument type causes the system to log packets from the same session as if they came from different sessions if you configure only rule header options in the intrusion rule. To group packets from the same session together, configure one or more rule options (such as a flag keyword or content keyword) within the same intrusion rule.

Table 63: Tag Arguments

Argument	Description
session	Logs packets in the session that triggered the rule.
host	Logs packets from the host that sent the packet that triggered the rule. You can add a directional modifier to log only the traffic coming from the host (src) or going to the host (dst).

To indicate how much traffic you want to log, use the following argument:

Table 64: Count Argument

Argument	Description
count	The number of packets or seconds you want to log after the rule triggers. This unit of measure is specified with the metric argument, which follows the count argument.

Select the metric you want to use to log by time or volume of traffic from those described in the following table.

Caution High-bandwidth networks can see thousands of packets per second, and tagging a large number of packets may seriously affect performance, so make sure you tune this setting for your network environment.

Table 65: Logging Metrics Arguments

Argument	Description
packets	Logs the number of packets specified by the count after the rule triggers.
seconds	Logs traffic for the number of seconds specified by the count after the rule triggers.

For example, when a rule with the following `tag` keyword value triggers:

```
host, 30, seconds, dst
```

all packets that are transmitted from the client to the host for the next 30 seconds are logged.

The flowbits Keyword

Use the `flowbits` keyword to assign state names to sessions. By analyzing subsequent packets in a session according to the previously named state, the system can detect and alert on exploits that span multiple packets in a single session.

The `flowbits` state name is a user-defined label assigned to packets in a specific part of a session. You can label packets with state names based on packet content to help distinguish malicious packets from those you do not want to alert on. You can define up to 1024 state names per managed device. For example, if you want to alert on malicious packets that you know only occur after a successful login, you can use the `flowbits` keyword to filter out the packets that constitute an initial login attempt so you can focus only on the malicious packets. You can do this by first creating a rule that labels all packets in the session that have an established login with a `logged_in` state, then creating a second rule where `flowbits` checks for packets with the state you set in the first rule and acts only on those packets.

An optional *group name* allows you to include a state name in a group of states. A state name can belong to several groups. States not associated with a group are not mutually exclusive, so a rule that triggers and sets a state that is not associated with a group does not affect other currently set states.

flowbits Keyword Options

The following table describes the various combinations of operators, states, and groups available to the `flowbits` keyword. Note that state names can contain alphanumeric characters, periods (.), underscores (_), and dashes (-).

Table 66: flowbits Options

Operator	State Option	Group	Description
`set`	`state_name`	optional	Sets the specified state for a packet. Sets the state in the specified group if a group is defined.
`set`	`state_name&state_name`	optional	Sets the specified states for a packet. Sets the states in the specified group if a group is defined.
`setx`	`state_name`	mandatory	Sets the specified state in the specified group for a packet, and unsets all other states in the group.
`setx`	`state_name&state_name`	mandatory	Sets the specified states in the specified group for a packet, and unsets all other states in the group.
`unset`	`state_name`	no group	Unsets the specified state for a packet.
`unset`	`state_name&state_name`	no group	Unsets the specified states for a packet.
`unset`	`all`	mandatory	Unsets all the states in the specified group.
`toggle`	`state_name`	no group	Unsets the specified state if it is set, and sets the specified state if it is unset.
`toggle`	`state_name&state_name`	no group	Unsets the specified states if they are set, and sets the specified states if they are unset.
`toggle`	`all`	mandatory	Unsets all states set in the specified group, and sets all states unset in the specified group.
`isset`	`state_name`	no group	Determines if the specified state is set in the packet.
`isset`	`state_name&state_name`	no group	Determines if the specified states are set in the packet.
`isset`	`state_name|state_name`	no group	Determines if any of the specified states are set in the packet.
`isset`	`any`	mandatory	Determines if any state is set in the specified group.
`isset`	`all`	mandatory	Determines if all states are set in the specified group.
`isnotset`	`state_name`	no group	Determines if the specified state is not set in the packet.

Operator	State Option	Group	Description
`isnotset`	`state_name&state_name`	no group	Determines if the specified states are not set in the packet.
`isnotset`	`state_name|state_name`	no group	Determines if any of the specified states is not set in the packet.
`isnotset`	`any`	mandatory	Determines if any state is not set in the packet.
`isnotset`	`all`	mandatory	Determines if all states are not set in the packet.
`reset`	(no state)	optional	Unsets all states for all packets. Unsets all states in a group if a group is specified.
`noalert`	(no state)	no group	Use this in conjunction with any other operator to suppress event generation.

Guidelines for Using the flowbits Keyword

Note the following when using the `flowbits` keyword:

- When using the `setx` operator, the specified state can only belong to the specified group, and not to any other group.
- You can define the `setx` operator multiple times, specifying different states and the same group with each instance.
- When you use the `setx` operator and specify a group, you cannot use the `set`, `toggle`, or `unset` operators on that specified group.
- The `isset` and `isnotset` operators evaluate for the specified state regardless of whether the state is in a group.
- During intrusion policy saves, intrusion policy reapplies, and access control policy applies (regardless of whether the access control policy references one intrusion policy or multiple intrusion policies), if you enable a rule that contains the `isset` or `isnotset` operator **without** a specified group, and you do not enable at least one rule that affects `flowbits` assignment (`set`, `setx`, `unset`, `toggle`) for the corresponding state name and protocol, all rules that affect `flowbits` assignment for the corresponding state name are enabled.
- During intrusion policy saves, intrusion policy reapplies, and access control policy applies (regardless of whether the access control policy references one intrusion policy or multiple intrusion policies), if you enable a rule that contains the `isset` or `isnotset` operator **with** a specified group, all rules that affect `flowbits` assignment (`set`, `setx`, `unset`, `toggle`) and define a corresponding group name are also enabled.

flowbits Keyword Examples

This section provides three examples that use the `flowbits` keyword.

flowbits Keyword Example: A Configuration Using state_name

This is an example of a flowbits configuration using `state_name`.

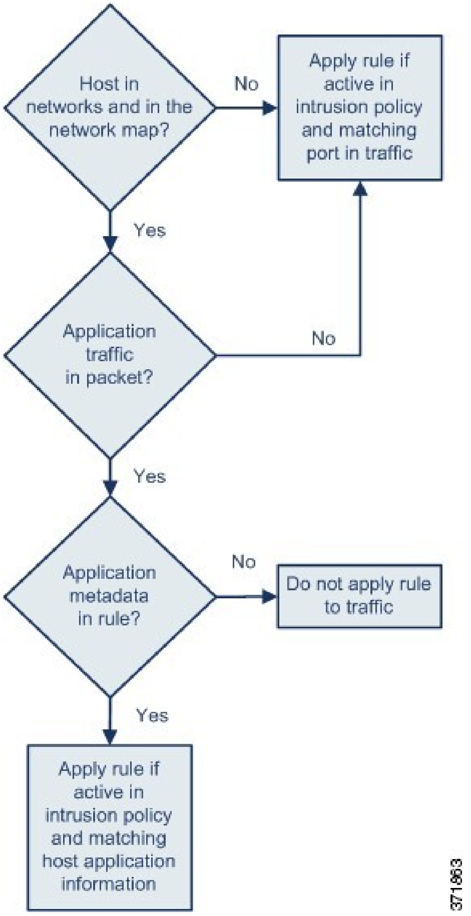
Consider the IMAP vulnerability described in CVE ID 2000-0284. This vulnerability exists in an implementation of IMAP, specifically in the LIST, LSUB, RENAME, FIND, and COPY commands. However, to take advantage of the vulnerability, the attacker must be logged into the IMAP server. Because the LOGIN confirmation from the IMAP server and the exploit that follows are necessarily in different packets, it is difficult to construct non-flow-based rules that catch this exploit. Using the `flowbits` keyword, you can cflowbitonstruct a series of rules that track whether the user is logged into the IMAP server and, if so, generate an event if one of the attacks is detected. If the user is not logged in, the attack cannot exploit the vulnerability and no event is generated.

The two rule fragments that follow illustrate this example. The first rule fragment looks for an IMAP login confirmation from the IMAP server:

```
alert tcp any 143 -> any any (msg:"IMAP login"; content:"OK

LOGIN"; flowbits:set,logged_in; flowbits:noalert;)
```

The following diagram illustrates the effect of the `flowbits` keyword in the preceding rule fragment:


Host in networks and in the network map?
No
Apply rule if active in intrusion policy and matching port in traffic
Yes
Application traffic in packet?
No
Yes
Application metadata in rule?
No
Do not apply rule to traffic
Yes
Apply rule if active in intrusion policy and matching host application information
371863

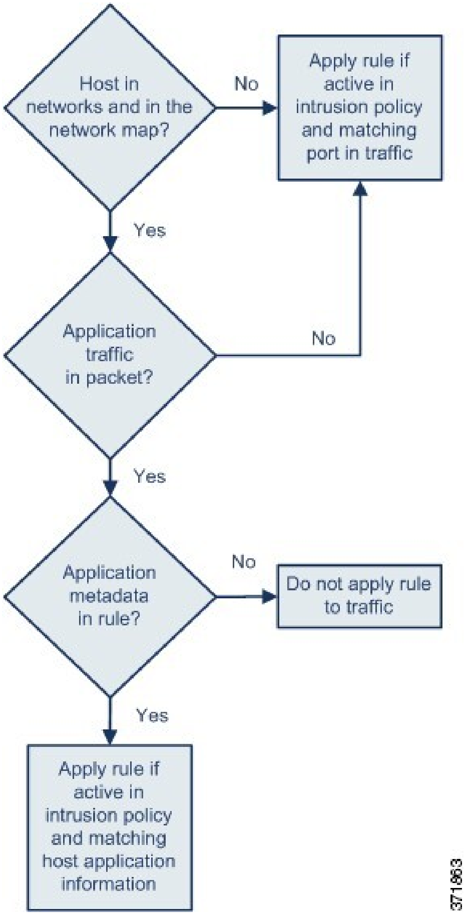
Note that `flowbits:set` sets a state of `logged_in`, while `flowbits:noalert` suppresses the alert because you are likely to see many innocuous login sessions on an IMAP server.

The next rule fragment looks for a LIST string, but does not generate an event unless the logged_in state has been set as a result of some previous packet in the session:

```
alert tcp any any -> any 143 (msg:"IMAP LIST";

content:"LIST"; flowbits:isset,logged_in;)
```

The following diagram illustrates the effect of the `flowbits` keyword in the preceding rule fragment:


Host in networks and in the network map?
No
Apply rule if active in intrusion policy and matching port in traffic
Yes
Application traffic in packet?
No
Yes
Application metadata in rule?
No
Do not apply rule to traffic
Yes
Apply rule if active in intrusion policy and matching host application information
371863

In this case, if a previous packet has caused a rule containing the first fragment to trigger, then a rule containing the second fragment triggers and generates an event.

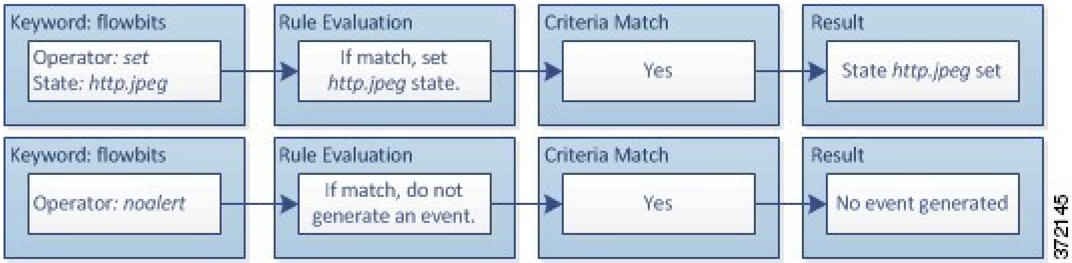
flowbits Keyword Example: A Configuration Resulting in False Positive Events

Including different state names that are set in different rules in a group can prevent false positive events that might otherwise occur when content in a subsequent packet matches a rule whose state is no longer valid. The following example illustrates how you can get false positives when you do not include multiple state names in a group.

Consider the case where the following three rule fragments trigger in the order shown during a single session:

```
(msg:"JPEG transfer";
content:"image/";pcre:"/^Content-?Type\x3a(\s*|\s*\r?\n\s+)image\x2fp?jpe?g/smi";
?flowbits:set,http.jpeg; flowbits:noalert;)
```

The following diagram illustrates the effect of the `flowbits` keyword in the preceding rule fragment:

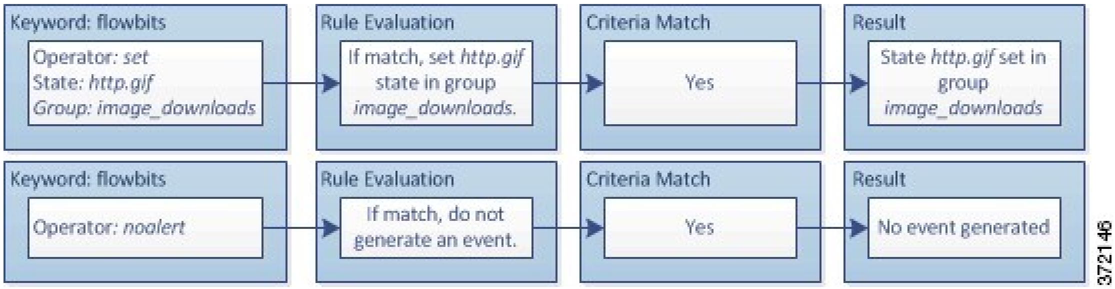


The `content` and `pcre` keywords in the first rule fragment match a JPEG file download, `flowbits:set,http.jpeg` sets the `http.jpeg flowbits` state, and `flowbits:noalert` stops the rule from generating events. No event is generated because the rule's purpose is to detect the file download and set the `flowbits` state so one or more companion rules can test for the state name in combination with malicious content and generate events when malicious content is detected.

The next rule fragment detects a GIF file download subsequent to the JPEG file download above:

```
(msg:"GIF transfer"; content:"image/";
pcre:"/^Content-?Type\x3a(\s*|\s*\r?\n\s+)image\x2fgif/smi";
?flowbits:set,http.jpg,image_downloads; flowbits:noalert;)
```

The following diagram illustrates the effect of the `flowbits` keyword in the preceding rule fragment:

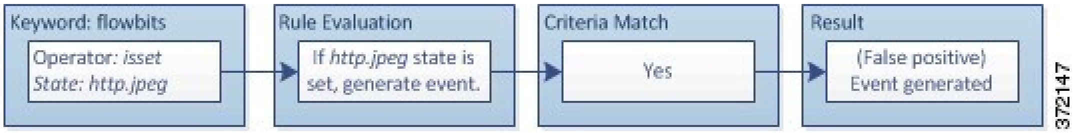


The `content` and `pcre` keywords in the second rule match the GIF file download, `flowbits:set,http.jpg` sets the `http.jpg` flowbit state, and `flowbits:noalert` stops the rule from generating an event. Note that the `http.jpeg` state set by the first rule fragment is still set even though it is no longer needed; this is because the JPEG download must have ended if a subsequent GIF download has been detected.

The third rule fragment is a companion to the first rule fragment:

```
(msg:"JPEG exploit";?flowbits:isset,http.jpeg;content:"|FF|";
pcre:"?/\xFF[\xE1\xE2\xED\xFE]\x00[\x00\x01]/";)
```

The following diagram illustrates the effect of the `flowbits` keyword in the preceding rule fragment:



In the third rule fragment, `flowbits:isset,http.jpeg` determines that the now-irrelevant `http.jpeg` state is set, and `content` and `pcre` match content that would be malicious in a JPEG file but not in a GIF file. The third rule fragment results in a false positive event for a nonexistent exploit in a JPEG file.

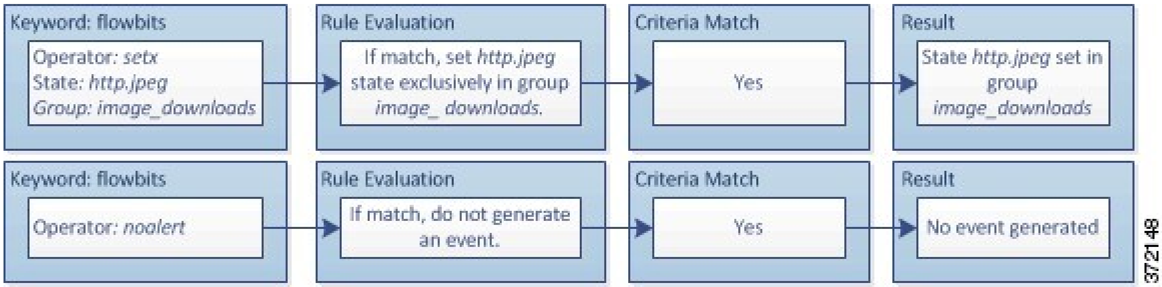
flowbits Keyword Example: A Configuration for Preventing False Positive Events

The following example illustrates how including state names in a group and using the `setx` operator can prevent false positives.

Consider the same case as the previous example, except that the first two rules now include their two different state names in the same state group.

```
(msg:"JPEG transfer";
content:"image/";pcre:"/^Content-?Type\x3a(\s*|\s*\r?\n\s+)image\x2fp?jpe?g/smi";
?flowbits:setx,http.jpeg,image_downloads; flowbits:noalert;)
```

The following diagram illustrates the effect of the `flowbits` keyword in the preceding rule fragment:

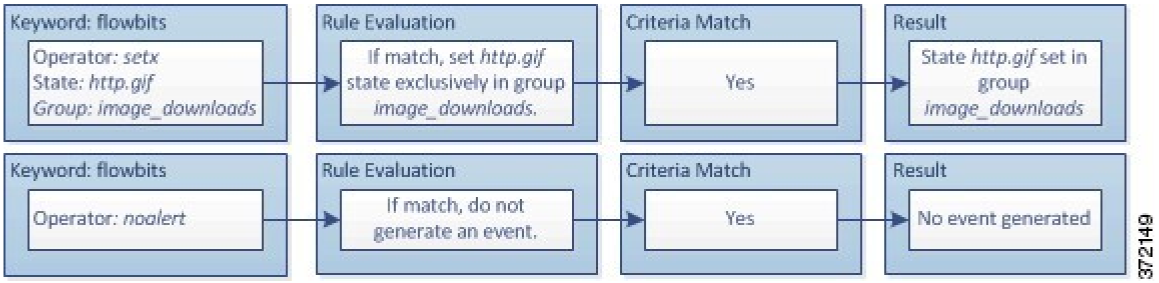


When the first rule fragment detects a JPEG file download, the `flowbits:setx,http.jpeg,image_downloads` keyword sets the `flowbits` state to `http.jpeg` and includes the state in the `image_downloads` group.

The next rule then detects a subsequent GIF file download:

```
(msg:"GIF transfer"; content:"image/";
pcre:"/^Content-?Type\x3a(\s*|\s*\r?\n\s+)image\x2fgif/smi";
?flowbits:setx,http.jpg,image_downloads; flowbits:noalert;)
```

The following diagram illustrates the effect of the `flowbits` keyword in the preceding rule fragment:

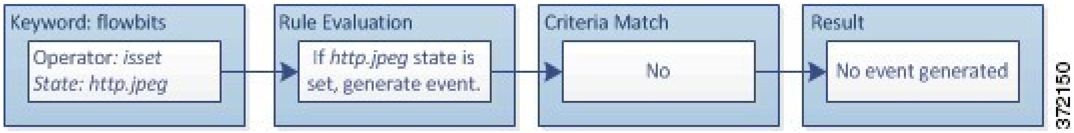


When the second rule fragment matches the GIF download, the `flowbits:setx,http.jpg,image_downloads` keyword sets the `http.jpg flowbits` state and unsets `http.jpeg`, the other state in the group.

The third rule fragment does not result in a false positive:

```
(msg:"JPEG exploit"; ?flowbits:isset,http.jpeg;content:"|FF|";
pcre:"/?\xFF[\xE1\xE2\xED\xFE]\x00[\x00\x01]/";)
```

The following diagram illustrates the effect of the `flowbits` keyword in the preceding rule fragment:



Because `flowbits:isset,http.jpeg` is false, the rules engine stops processing the rule and no event is generated, thus avoiding a false positive even in a case where content in the GIF file matches exploit content for a JPEG file.

The http_encode Keyword

You can use the `http_encode` keyword to generate events on the type of encoding in an HTTP request or response before normalization, either in the HTTP URI, in non-cookie data in an HTTP header, in cookies in HTTP requests headers, or set-cookie data in HTTP responses.

You must configure the HTTP Inspect preprocessor to inspect HTTP responses and HTTP cookies to return matches for rules using the `http_encode` keyword.

Also, you must enable both the decoding and alerting option for each specific encoding type in your HTTP Inspect preprocessor configuration so the `http_encode` keyword in an intrusion rule can trigger events on that encoding type.

The following table describes the encoding types this option can generate events for in HTTP URIs, headers, cookies, and set-cookies:

Table 67: http_encode Encoding Types

Encoding Type	Description
utf8	Detects UTF-8 encoding in the specified location when this encoding type is enabled for decoding by the HTTP Inspect preprocessor.
double_encode	Detects double encoding in the specified location when this encoding type is enabled for decoding by the HTTP Inspect preprocessor.
non_ascii	Detects non-ASCII characters in the specified location when non-ASCII characters are detected but the detected encoding type is not enabled.
uencode	Detects Microsoft %u encoding in the specified location when this encoding type is enabled for decoding by the HTTP Inspect preprocessor.
bare_byte	Detects bare byte encoding in the specified location when this encoding type is enabled for decoding by the HTTP Inspect preprocessor.

http_encode Keyword Syntax

Encoding Location

Specifies whether to search for the specified encoding type in an HTTP URI, header, or cookie, including a set-cookie.

Encoding Type

Specifies one or more encoding types using one of the following formats:

```
encode_type
encode_type|encode_type|encode_type...
```

where `encode_type` is one of the following:

```
utf8
double_encode
non_ascii
uencode
bare_byte.
```

Note that you cannot use the negation (!) and OR (|) operators together.

http_encode Keyword example: Using Two http_endcode Keywords to Search for Two Encodings

The following example uses two `http_encode` keywords in the same rule to search the HTTP URI for UTF-8 AND Microsoft IIS %u encoding:

First, the `http_encode` keyword:

- **Encoding Location**: `HTTP URI`
- **Encoding Type**: `utf8`

Then, the additional `http_encode` keyword:

- **Encoding Location**: `HTTP URI`
- **Encoding Type**: `uencode`

Overview: The file_type and file_group Keywords

The `file_type` and `file_group` keywords allow you to detect files transmitted via FTP, HTTP, SMTP, IMAP, POP3, and NetBIOS-ssn (SMB) based on their type and version. Do **not** use more than one `file_type` or `file_group` keyword in a single intrusion rule.

Tip Updating your vulnerability database (VDB) populates the intrusion rules editor with the most up-to-date file types, versions, and groups.

Note The system does not automatically enable preprocessors to accomodate the `file_type` and `file_group` keywords.

You **must** enable specific preprocessors if you want to generate events and, in an inline deployment, drop offending packets for traffic matching your `file_type` or `file_group` keywords.

Table 68: file_type and file_group Intrusion Event Generation

Protocol	Required Preprocessor or Preprocessor Option
FTP	FTP/Telnet preprocessor and the **Normalize TCP Payload** inline normalization preprocessor option
HTTP	HTTP Inspect preprocessor to generate intrusion events in HTTP traffic
SMTP	SMTP preprocessor to generate intrusion events in HTTP traffic
IMAP	IMAP preprocessor
POP3	POP preprocessor
Netbios-ssn (SMB)	The DCE/RPC preprocessor and the **SMB File Inspection** DCE/RPC preprocessor option

The file_type and file_group Keywords

file_type

The `file_type` keyword allows you to specify the file type and version of a file detected in traffic. File type arguments (for example, **JPEG** and **PDF**) identify the format of the file you want to find in traffic.

Note Do **not** use the `file_type` keyword with another `file_type` or `file_group` keyword in the same intrusion rule.

The system selects **Any Version** by default, but some file types allow you to select version options (for example, PDF version **1.7**) to identify specific file type versions you want to find in traffic.

file_group

The `file_group` keyword allows you to select a Cisco-defined group of similar file types to find in traffic (for example, **multimedia** or **audio**). File groups also include Cisco-defined versions for each file type in the group.

Note Do **not** use the `file_group` keyword with another `file_group` or `file_type` keyword in the same intrusion rule.

The file_data Keyword

The `file_data` keyword provides a pointer that serves as a reference for the positional arguments available for other keywords such as `content`, `byte_jump`, `byte_test`, and `pcre`. The detected traffic determines the type of data the `file_data` keyword points to. You can use the `file_data` keyword to point to the beginning of the following payload types:

- HTTP response body

To inspect HTTP response packets, the HTTP Inspect preprocessor must be enabled and you must configure the preprocessor to inspect HTTP responses. The `file_data` keyword matches if the HTTP Inspect preprocessor detects HTTP response body data.

- Uncompressed gzip file data

  To inspect uncompressed gzip files in the HTTP response body, the HTTP Inspect preprocessor must be enabled and you must configure the preprocessor to inspect HTTP responses and to decompress gzip-compressed files in the HTTP response body. For more information, see the **Inspect HTTP Responses** and **Inspect Compressed Data** Server-Level HTTP Normalization options. The `file_data` keyword matches if the HTTP Inspect preprocessor detects uncompressed gzip data in the HTTP response body.

- Normalized JavaScript

  To inspect normalized JavaScript data, the HTTP Inspect preprocessor must be enabled and you must configure the preprocessor to inspect HTTP responses. The `file_data` keyword matches if the HTTP Inspect preprocessor detects JavaScript in response body data.

- SMTP payload

  To inspect the SMTP payload, the SMTP preprocessor must be enabled. The `file_data` keyword matches if the SMTP preprocessor detects SMTP data.

- Encoded email attachments in SMTP, POP, or IMAP traffic

  To inspect email attachments in SMTP, POP, or IMAP traffic, the SMTP, POP, or IMAP preprocessor, respectively, must be enabled, alone or in any combination. Then, for each enabled preprocessor, you must ensure that the preprocessor is configured to decode each attachment encoding type that you want decoded. The attachment decoding options that you can configure for each preprocessor are: **Base64 Decoding Depth**, **7-Bit/8-Bit/Binary Decoding Depth**, **Quoted-Printable Decoding Depth**, and **Unix-to-Unix Decoding Depth**.

  You can use multiple `file_data` keywords in a rule.

The pkt_data Keyword

The `pkt_data` keyword provides a pointer that serves as a reference for the positional arguments available for other keywords such as `content`, `byte_jump`, `byte_test`, and `pcre`.

When normalized FTP, telnet, or SMTP traffic is detected, the `pkt_data` keyword points to the beginning of the normalized packet payload. When other traffic is detected, the `pkt_data` keyword points to the beginning of the raw TCP or UDP payload.

The following normalization options must be enabled for the system to normalize the corresponding traffic for inspection by intrusion rules:

- Enable the FTP & Telnet preprocessor **Detect Telnet Escape codes within FTP commands** option to normalize FTP traffic for inspection.
- Enable the FTP & Telnet preprocessor **Normalize** telnet option to normalize telnet traffic for inspection.
- Enable the SMTP preprocessor **Normalize** option to normalize SMTP traffic for inspection.

You can use multiple `pkt_data` keywords in a rule.

The base64_decode and base64_data Keywords

You can use the base64_decode and base64_data keywords in combination to instruct the rules engine to decode and inspect specified data as Base64 data. This can be useful, for example, for inspecting Base64-encoded HTTP Authentication request headers and Base64-encoded data in HTTP PUT and POST requests.

These keywords are particularly useful for decoding and inspecting Base64 data in HTTP requests. However, you can also use them with any protocol such as SMTP that uses the space and tab characters the same way HTTP uses these characters to extend a lengthy header line over multiple lines. When this line extension, which is known as folding, is not present in a protocol that uses it, inspection ends at any carriage return or line feed that is not followed with a space or tab.

base64_decode

The base64_decode keyword instructs the rules engine to decode packet data as Base64 data. Optional arguments let you specify the number of bytes to decode and where in the data to begin decoding.

You can use the base64_decode keyword once in a rule; it must precede at least one instance of the base64_data keyword.

Before decoding Base64 data, the rules engine unfolds lengthy headers that are folded across multiple lines. Decoding ends when the rules engine encounters any the following:

- the end of a header line
- the specified number of bytes to decode
- the end of the packet

The following table describes the arguments you can use with the base64_decode keyword.

Table 69: Optional base64_decode Arguments

Argument	Description
Bytes	Specifies the number of bytes to decode. When not specified, decoding continues to the end of a header line or the end of the packet payload, whichever comes first. You can specify a positive, non-zero value.
Offset	Determines the offset relative to the start of the packet payload or, when you also specify **Relative**, relative to the current inspection location. You can specify a positive, non-zero value.
Relative	Specifies inspection relative to the current inspection location.

base64_data

The base64_data keyword provides a reference for inspecting Base64 data decoded using the base64_decode keyword. The base64_data keyword sets inspection to begin at the start of the decoded Base64 data. Optionally, you can then use the positional arguments available for other keywords such as content or byte_test to further specify the location to inspect.

You must use the base64_data keyword at least once after using the base64_decode keyword; optionally, you can use base64_data multiple times to return to the beginning of the decoded Base64 data.

Note the following when inspecting Base64 data:

- You cannot use the fast pattern matcher.
- If you interrupt Base64 inspection in a rule with an intervening HTTP content argument, you must insert another `base64_data` keyword in the rule before further inspecting Base64 data.