

Elephant Flow Detection

Elephant flows are extremely large (in total bytes), continuous flows set up by a TCP (or other protocols) flow measured over a network link. By default, elephant flows are those larger than 1 GB/10 seconds. They can cause performance duress in Snort cores. Elephant flows are not numerous, but they can occupy a disproportionate share of the total bandwidth over a period of time. They can lead to problems, such as high CPU utilization, packet drops, and other issues.

From Firewall Management Center 7.2.0 onwards (Snort 3 devices only), you can use the elephant flow feature to detect and remediate elephant flows, which helps to reduce system stress and resolve the mentioned issues.

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Elephant flow detection and remediation

Elephant flow detection and remediation is a feature that

- detects elephant flows in network traffic,
- applies remediation actions to manage these flows, and
- requires Snort 3 as the detection engine to function.

Remediation actions

These remediation actions can be applied:

- **Bypass elephant flow**—You can configure elephant flow to bypass Snort inspection. If this is configured, Snort does not receive any packet from that flow.
- **Throttle elephant flow**—You can apply rate-limit to the flow and continue to inspect flows. The flow rate is calculated dynamically, and the system reduces the flow rate by 10 percent. Snort sends the verdict (with QoS flow reduced by 10 percent) to the firewall engine. If you choose to bypass all applications, including unidentified applications, you cannot configure the throttle action (rate-limit) for any flow.

Elephant flow upgrade from Intelligent Application Bypass

For devices running 7.2.0 or later, you must configure elephant flow settings under the **Elephant Flow Settings** section in the access control policy (Advanced settings tab) because Intelligent Application Bypass (IAB) is deprecated from version 7.2.0 onwards for Snort 3 devices.

Post-upgrade to 7.2.0 (or later), if you are using a Snort 3 device, the elephant flow configuration settings will be picked and deployed from the **Elephant Flow Settings** section and not from the **Intelligent Application Bypass Settings** section, so if you have not migrated to Elephant Flow configuration settings, your device will lose the elephant flow configuration upon the next deployment.

This table shows the IAB or elephant flow configurations that can be applied to version 7.2.0 or later and to version 7.1.0 or earlier that are running Snort 3 or Snort 2 engines.

Firewall Management Center	Firewall Threat Defense	Elephant Flow or IAB Configuration
Firewall Management Center 7.0 or 7.1	Snort 2 device	Configuration from IAB is applicable.
	Snort 3 device	Configuration from IAB is applicable.
Firewall Management Center 7.2.0	Snort 2 device	Configuration from IAB is applicable.
	Snort 3 device (7.1.0 and earlier)	Configuration from IAB is applicable.
	Snort 3 device (7.2.0 and later)	Configuration from Elephant Flow is applicable.

Configure elephant flow detection

Configure elephant flow detection to take actions on elephant flows. This helps resolve issues such as system duress, high CPU utilization, packet drops and related performance problems.

Attention Elephant flow detection is not applicable for prefiltered, trusted, or fast-forwarded flows, which do not process through Snort. As elephant flows are detected by Snort, elephant flow detection is not applicable for encrypted traffic.

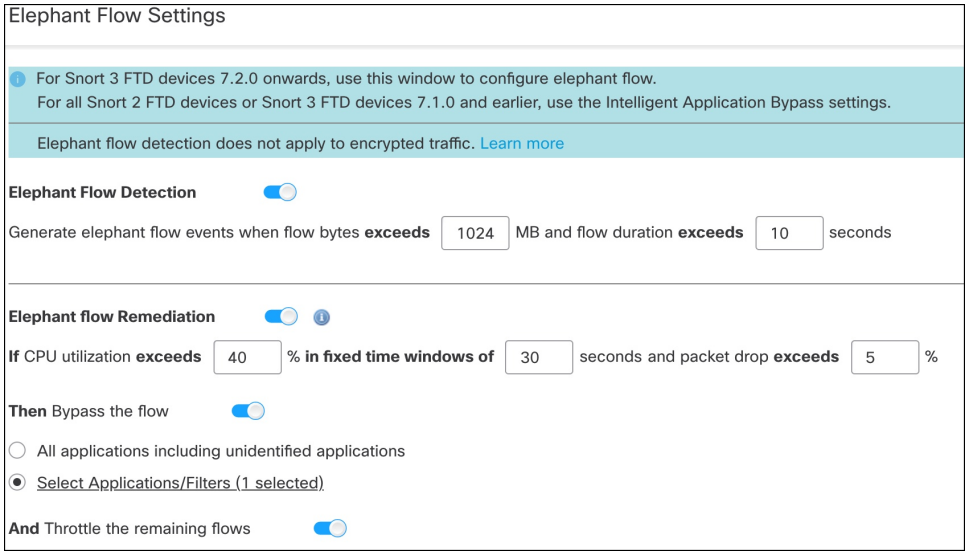
Procedure

Step 1 In the access control policy editor, click **Advanced Settings** from the **More** drop-down arrow at the end of the packet flow line. Then, click **Edit** ( ) next to **Elephant Flow Settings**.

If **View** ( ) appears instead, settings are inherited from an ancestor policy, or you do not have permission to modify the settings. If the configuration is unlocked, uncheck **Inherit from base policy** to enable editing.

Figure 1: Configure elephant flow detection

Figure 2: Configure elephant flow detection



Step 2 Configure the values for flow bytes and flow duration for the **Elephant Flow Detection** toggle button that is enabled by default.

When they exceed your configured values, elephant flow events are generated.

Step 3 To remediate elephant flows, enable the **Elephant Flow Remediation** toggle button.

Step 4 To set the criteria for remediation of the elephant flow, configure the values for CPU utilization percentage, duration of fixed time windows, and packet drop %.

CPU utilization is calculated per elephant flow and is derived from the flow latency. If the CPU utilization crosses the configured threshold and other configurations, such as fixed time windows and packet drops, are also matched, the elephant flow remediation actions are applied. Similarly, packet drop calculation is based on the packets dropped per CPU. After the packet drop percentage exceeds the configured value on a specific CPU, the remediation actions are applied. For example, consider that configurations are set to the default, that is, CPU utilization of 40%, fixed time window of 30 seconds, and packet drop of 5%. On a specific CPU, if more than 5% of packet drops are detected and the CPU utilization per flow exceeds 40% in the fixed time frame of 30 seconds, then the flows are either bypassed or throttled.

Step 5 Configure the actions for elephant flow remediation when it meets the configured criteria.

a. **Bypass the flow**—Enable this button to bypass Snort inspection for selected applications or filters. Choose from:

- **All applications including unidentified applications**—Select this option to bypass all the application traffic. If you configure this option, you cannot configure the throttle action (rate-limit) for any flow.
- **Select Applications/Filters**—Select this option to select the applications or filters whose traffic you want to bypass; see the topic *Configuring Application Conditions and Filters* in the *Access Control Rules* chapter in the Cisco Secure Firewall Management Center Device Configuration Guide.

b. **Throttle the flow**—Enable this button to apply rate-limit to the flow and continue to inspect flows. Note that you can select the applications or filters to bypass Snort inspection and throttle the remaining flows.

Note
Automatic removal of throttle from a throttled elephant flow occurs when the system is out of duress, that is, the percentage of Snort packet drops is less than your configured threshold. Consequently, rate limiting is also removed.

You can also manually remove throttling from a throttled elephant flow, using these threat defense commands:

- **clear efd-throttle <5-tuple/all> bypass**—This command removes throttling from the throttled elephant flow and bypasses Snort inspection.
- **clear efd-throttle <5-tuple/all>**—This command removes throttling from the throttled elephant flow and Snort inspection continues. Elephant flow remediation is skipped after using this command.

  For more information about these commands, refer to the Cisco Secure Firewall Threat Defense Command Reference.

Note
Taking action on elephant flows (bypass and throttle the flow) is not supported on Cisco Firepower 2100 series devices.

Step 6 In the **Remediation Exemption Rule** section, click **Add Rule** to configure L4 access control list (ACL) rules for flows that must be exempted from remediation.

a) In the **Add Rule** window, use the **Networks** tab to add the network details, that is the source network and the destination network. Use the **Ports** tab to add the source port and the destination port.

   If an elephant flow is detected and it matches the rules that are defined, an event is generated with the reason as **Elephant Flow Exempted** in the **Reason** column header of **Connection Events**.

b) In the **Remediation Exemption Rule** section, you can view the flows that are exempt from the remediation action.

c) Click **OK** to save the elephant flow settings.

Step 7 Click **Save** to save the policy.

What to do next

Deploy configuration changes; see Deploy configuration changes.

After configuring your elephant flow settings, monitor your connection events to see if any flows are detected, bypassed, or throttled. You can view this in the **Reason** field of your connection event. The three reasons for elephant flow connections are:

- Elephant Flow
- Elephant Flow Throttled
- Elephant Flow Trusted

Attention Enabling elephant flow detection alone does not cause generation of connection events for elephant flows. If a connection event is already logged for another reason and the flow is also an elephant flow, then the **Reason** field contains this information. However, to ensure that you are logging all elephant flows, you must enable connection logging in the applicable access control rules.

Refer to Cisco Secure Firewall Elephant Flow Detection for more information.

Use case - Configure Elephant Flow Detection Outcomes

This use case provides a sample scenario for configuring outcomes and system responses that detect elephant flows in network traffic to optimize performance and resource usage.

Elephant flows

An elephant flow is an extremely large network connection that

- consists of long-running connections set up by TCP or other protocols measured over a network link,
- measures larger than 1 GB per 10 seconds by default, and
- can cause performance duress or issues in Snort cores by consuming excessive CPU resources.

Impact on system performance

Elephant flows can potentially consume an excessive amount of CPU resources and impact other competing flows for detection resources and cause issues, such as increased latency or packet drops.

Benefits of elephant flow detection and remediation

- Elephant flow configuration allows customization and the option to bypass or even throttle elephant flows.
- You can choose to bypass or throttle flows that are based on your chosen applications to provide Snort inspection of suspect traffic, while bypassing more trusted traffic.
- Elephant flow remediation helps prioritize and free up more bandwidth for your internal applications, depending on your specific requirements.

How elephant flows work

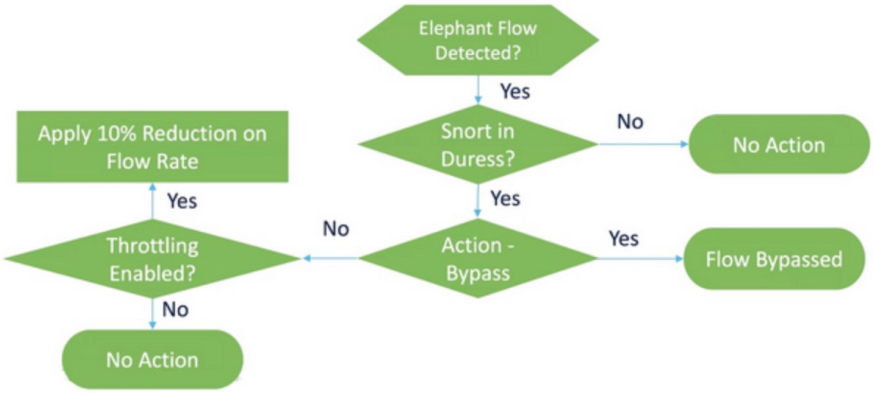
Summary

The key components involved in the elephant flow process are:

- System detection: Monitors for Snort duress conditions based on configured parameters.
- Flow identification: Determines when a flow qualifies as an elephant flow.
- CPU monitoring: Tracks CPU utilization against configured thresholds.
- Bypass action: Allows traffic for trusted applications to pass without Snort inspection.
- Throttle action: Reduces the flow throughput in 10 percent increments until CPU utilization drops below the threshold.

Workflow

Figure 3: Elephant flow workflow



These stages describe how elephant flows are processed:

1. The system continuously monitors traffic flows and applies intrusion policy processing to all flows, including potential elephant flows, ensuring that attacks are detected early in connections.
2. When an elephant flow is detected based on configured parameters, the system evaluates whether a Snort duress condition exists by checking CPU utilization and time window parameters.

   No action is taken unless the system detects a Snort duress condition (performance issue). The system does not throttle or bypass a flow just because it is large.
3. If duress conditions are met, the system determines whether to bypass or throttle the elephant flow based on configuration settings.

   The actions of throttle and bypass are mutually exclusive. This means that you can either bypass or throttle a flow, but not both.
4. For bypass actions, if configured for specific applications only, the system allows trusted application flows to pass without Snort inspection while throttling remaining flows causing duress.

   This ensures that other non-trusted application flows still receive full Snort inspection, although their bandwidth is reduced.
5. For throttle actions, the system reduces flow throughput in 10 percent increments until CPU utilization reduces to below the configured threshold.

Sample business scenarios

In a data center, several activities are happening, such as replication of data between clusters, virtual machine integration, and database backup. Users in an organization could be watching videos on an OTT service or downloading them. Bandwidth utilization for such activities might result in elephant flows that slow down the network and impact the performance of important tasks. As a network administrator (and depending on your specific requirements), you want visibility into such large flows that are causing bandwidth issues and remediate them.

As an example, let's see how you can configure elephant flow parameters to bypass Snort inspection for WebEx traffic (which your organization uses for real-time video conferencing) and throttle the remaining applications or connections, including videos, movies, and so on.

Prerequisites

Ensure that you are running management center 7.2.0 or later and that the managed threat defense is also 7.2.0 or later.

When you enable only elephant flow detection, no additional connection events are generated. The system adds the Elephant Flow notation to matching connections that are already logged to the management center. **To log these events, you must enable connection logging in your access control policy.** You can do that for specific rules or add a Monitor rule that logs all connections, including elephant flows.

Configure elephant flow parameters

Configure elephant flow detection and remediation settings to identify high-bandwidth connections, and manage them through bypassing or throttling to maintain optimal system performance during high CPU utilization.

Elephant flows are high-bandwidth, long-duration connections that can impact system performance. By configuring elephant flow parameters, you can detect these flows and apply appropriate remediation actions such as bypassing trusted applications from inspection or throttling flows that cause system duress.

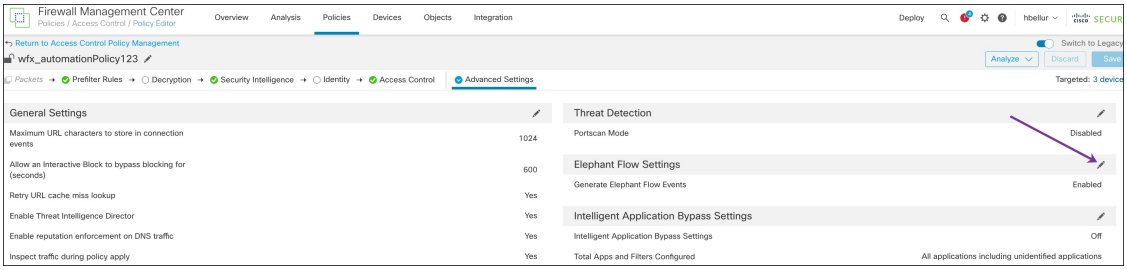
Procedure

Step 1 Choose **Policies** > **Access Control heading** > **Access Control**.

Step 2 Click **Edit** (✎) next to the access control policy that you want to edit.

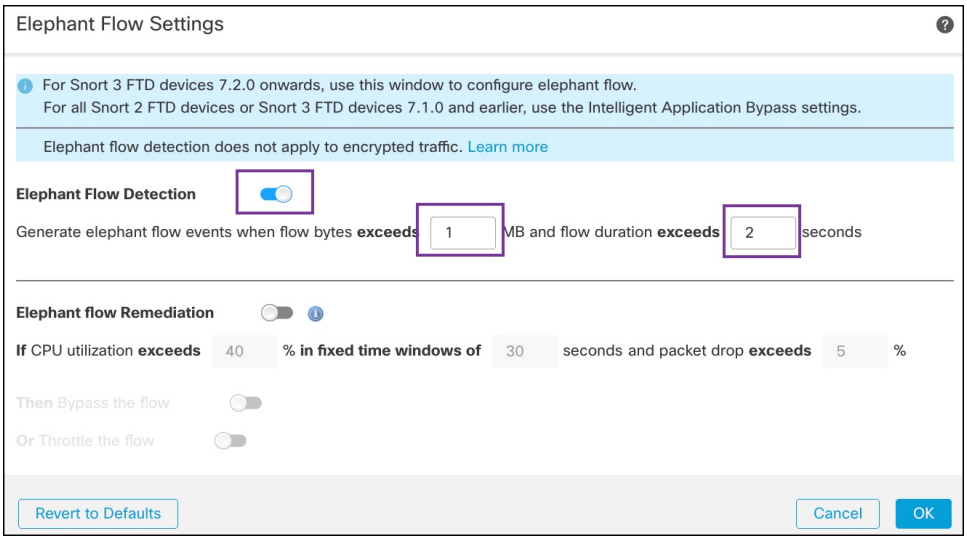
Step 3 Choose **Advanced Settings** from the **More** drop-down arrow at the end of the packet flow line.

Step 4 Click **Edit** (✎) next to **Elephant Flow Settings**.



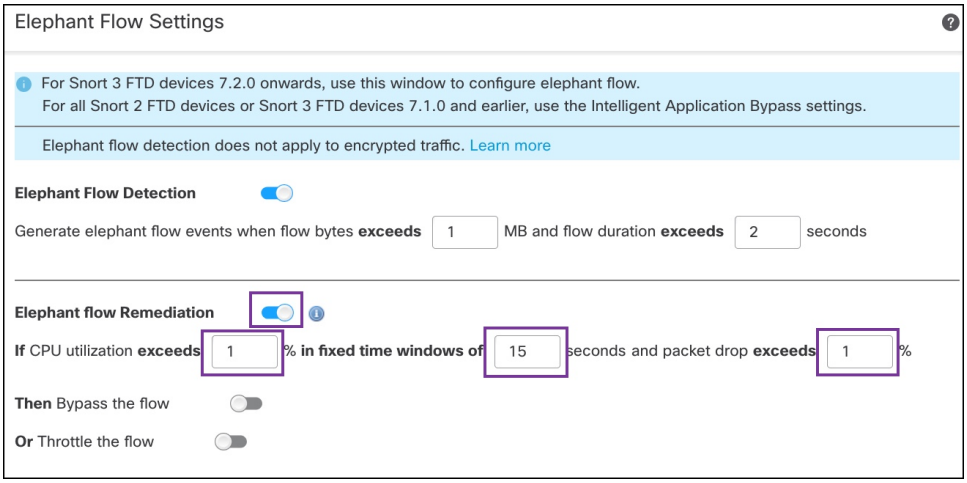
Step 5 The **Elephant Flow Detection** toggle button is enabled by default. The default setting enables detection only and no default action is configured. The detection settings allow you to adjust the flow bytes and duration so that you can identify the elephant flows in your system.

As a test setting, configure the flow bytes and duration parameters, as shown in the following figure.

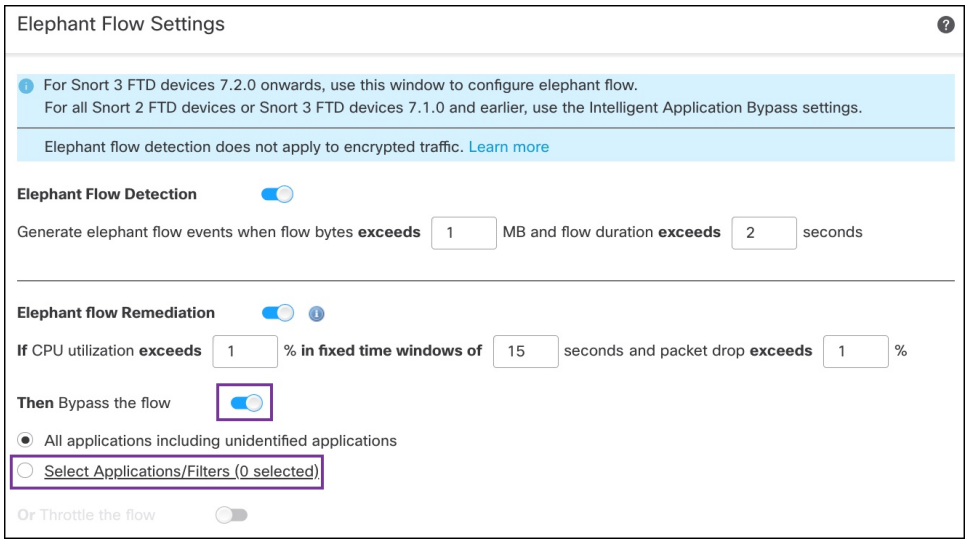


Step 6 Enable the **Elephant Flow Remediation** toggle button. When an elephant flow is detected, you can choose to bypass or throttle the flow. Bypassing a flow means that the traffic is allowed to pass without Snort inspection. Throttling indicates that the flow throughput is reduced. This rate reduction is done in 10 percent increments until the CPU utilization decreases to less than the configured threshold.

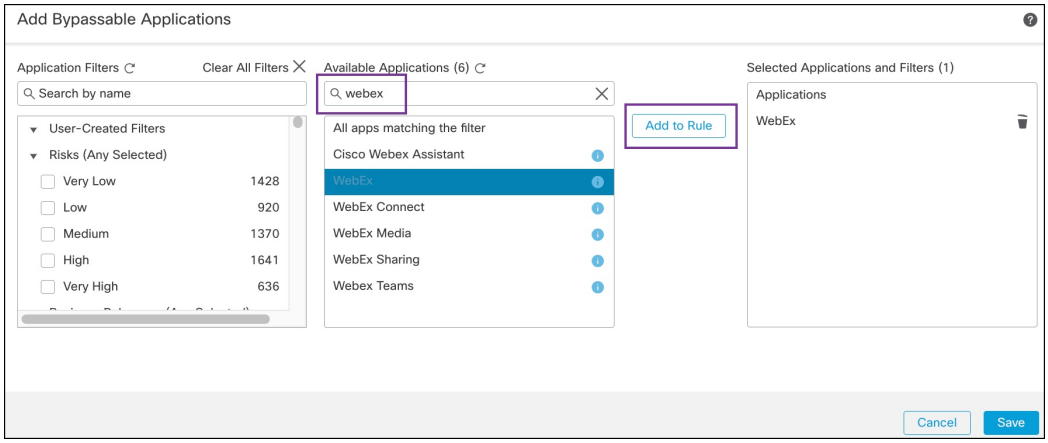
As a test setting, configure the elephant flow remediation parameters as shown in the following figure.



Step 7 Enable the **Bypass the flow** toggle button and click the **Select Applications/Filters** radio button.



Step 8 Under **Application Filters**, search for and select the **WebEx** application, add it to the rule, and click **Save**. This means that WebEx connections are trusted and prioritized. These connections will skip Snort inspection if detected as elephant flows based on the configured parameters.



Step 9 Enable the **Throttle** toggle button to throttle the remaining flows (causing duress). This ensures that all the other flows are slowed down in 10 percent increments until the Snort duress condition is met.

Click **OK** and then **Save**.

What to do next

Deploy configuration changes.

View events for elephant flows

This task enables you to monitor elephant flow connection events to track flow detection, bypass, and throttling activities through the Reason field in connection events.

After configuring your elephant flow settings, monitor your connection events to see if any flows are detected, bypassed, or throttled. You can see this information in the **Reason** field of your connection events. The three types for elephant flow connections are:

- Elephant Flow
- Elephant Flow Throttled
- Elephant Flow Trusted

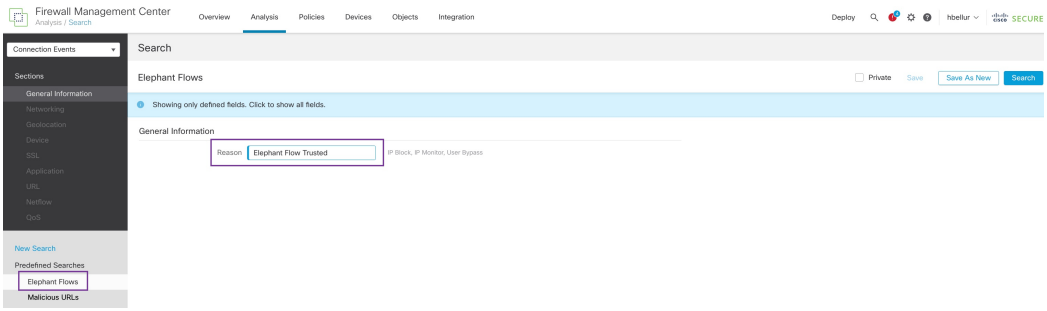
Procedure

Step 1 Choose **Analysis** > **Connections** > **Events**. You can also view the events from the **Unified Events** viewer.

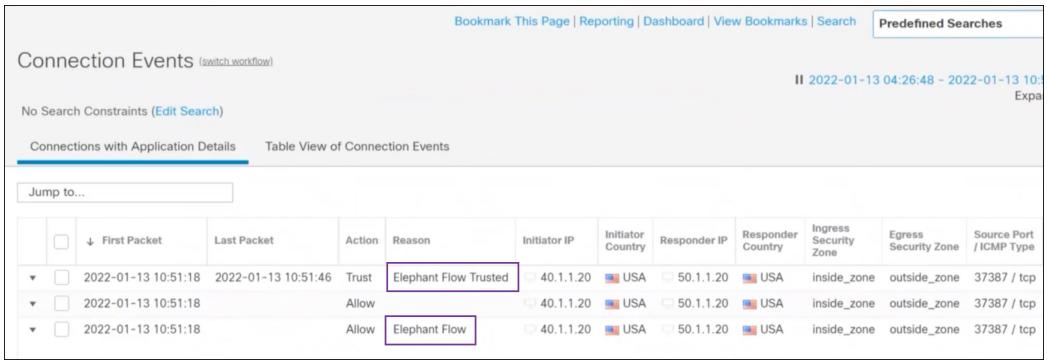
Step 2 In the **Connection Events** page, from the **Predefined Search** drop-down list, choose **Elephant Flows** to display elephant flow events.



Tip
To see **Elephant Flow Trusted** or **Elephant Flow Throttled** event types, click the **Edit Search** link on the top-left corner of the page and in the **Reason** field, choose **Elephant Flows** in the left panel. Enter **Elephant Flow Trusted** or **Elephant Flow Throttled**, depending on what you want to search.



Step 3 View the elephant flow that was detected mid-flow and the **Reason** field shows **Elephant Flow**. At the end of the flow, it was bypassed and the **Reason** field shows **Elephant Flow Trusted**.



Configure elephant flow remediation exemption

This task allows you to create exemption rules for specific flows that should not be subject to remediation actions even when detected as elephant flows.

You can configure L4 access control list (ACL) rules for flows that must be exempted from remediation. If a flow is detected as an elephant flow and it matches the rules that are defined, that flow is exempted from remediation.

Before you begin

You must be running management center version 7.4.0 or later and the managed threat defense must also be on version 7.4.0 or later.

Follow these steps to configure elephant flow remediation exemption.

Procedure

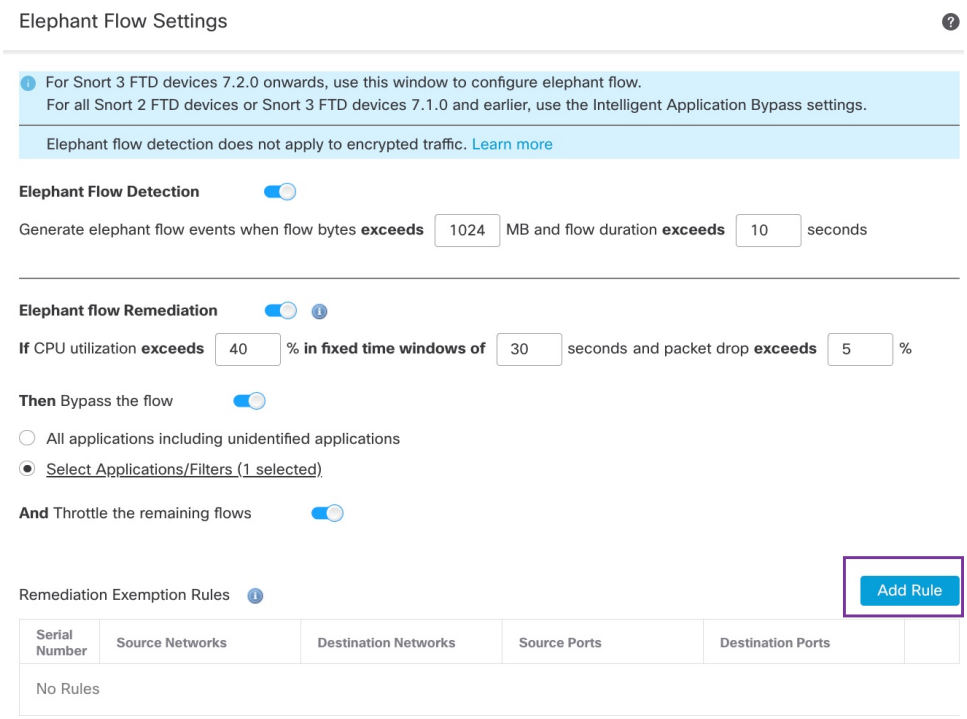
Step 1 Choose **Policies** > **Access Control heading** > **Access Control**.

Step 2 Click **Edit** (✎) next to the access control policy you want to edit.

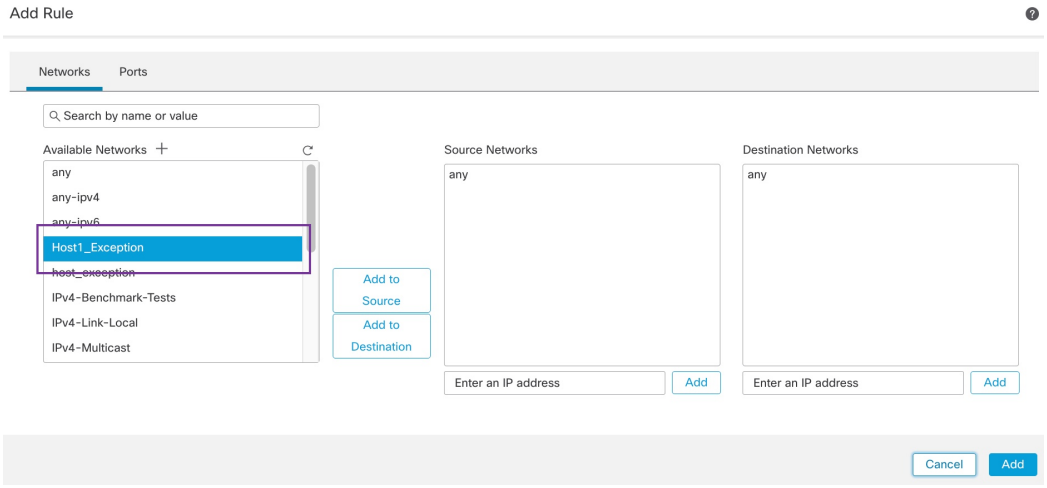
Step 3 Choose **Advanced Settings** from the **More** drop-down arrow at the end of the packet flow line.

Step 4 Click **Edit** (✎) next to **Elephant Flow Settings**. Ensure that you have configured the elephant flow detection and remediation parameters. See Configure elephant flow parameters, on page 7.

Step 5 Click the **Add Rule** button next to **Remediation Exemption Rules**.



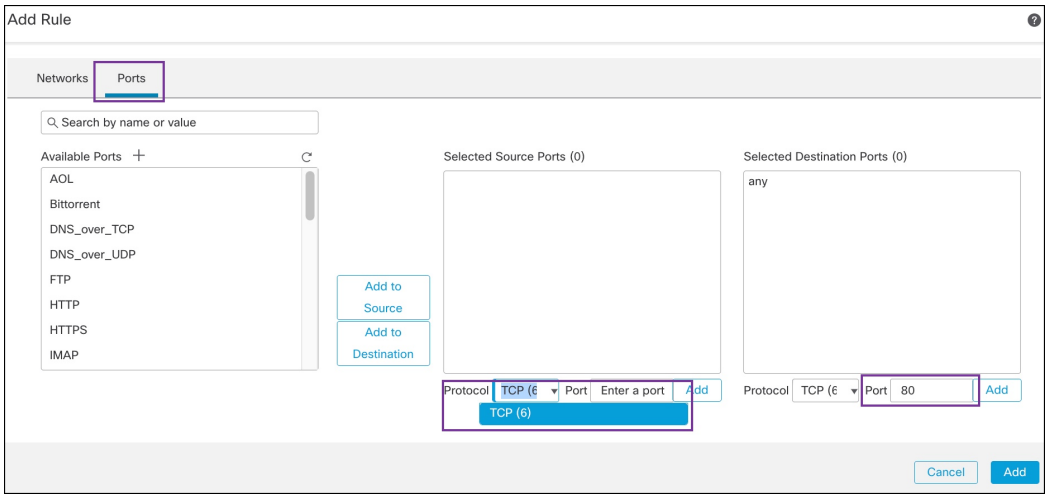
Step 6 From the list of **Available Networks**, choose the configured host to exempt from elephant flow remediation. For the purposes of this example, we have created a host called "Host1_Exception."



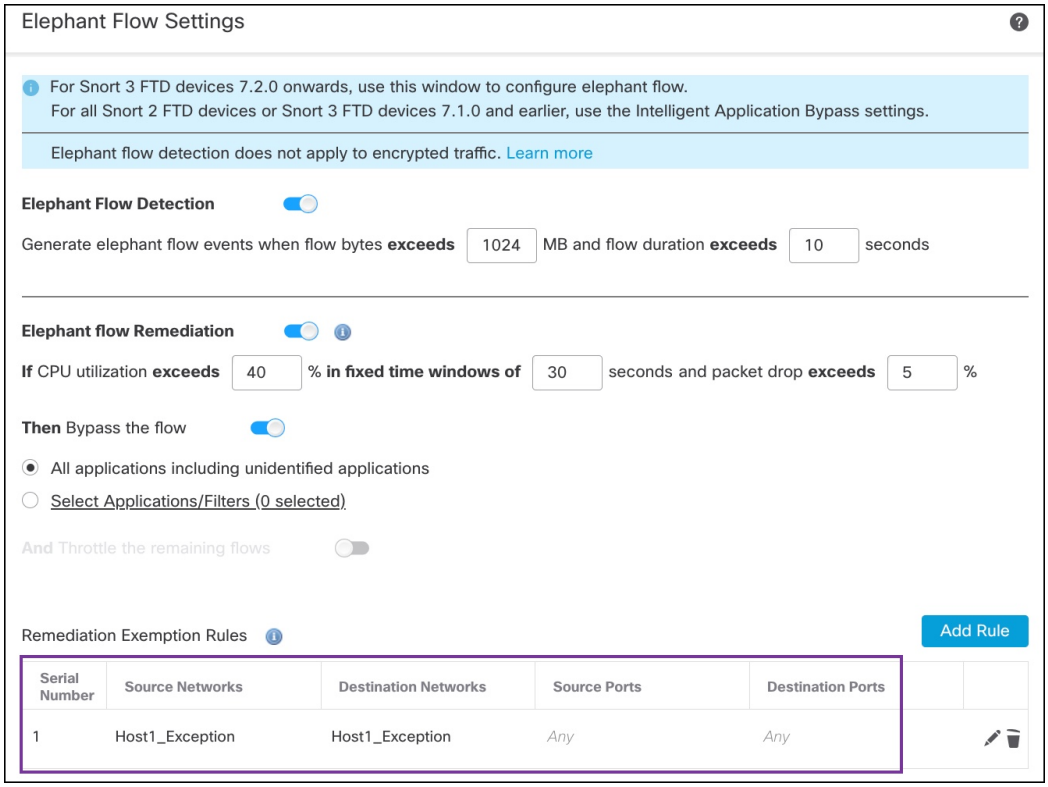
Step 7 Click **Add to Source** or **Add to Destination** as needed to add this host to the source or destination.

Step 8 Click the **Ports** tab.

a) For the source port, choose **Protocol** as TCP, enter **80** as the destination port, then click **Add**.



b) Click **OK**.



Step 9 Click **Save**.

What to do next

Deploy configuration changes.

View events for elephant flow remediation exemption

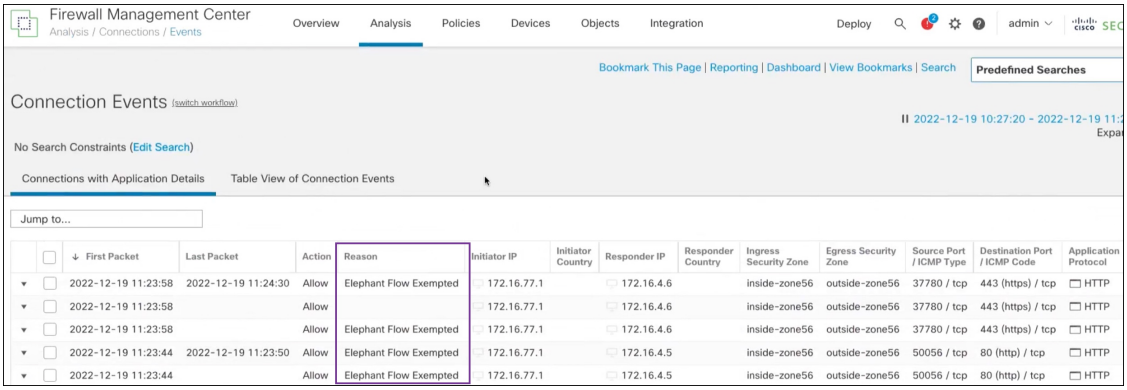
This task allows you to monitor and review elephant flows that have been exempted from remediation to understand network traffic patterns and exemption reasons.

Elephant flows are high-volume network connections that may require special handling. When these flows are exempted from remediation, you can view the exemption events to track and analyze the decision.

Procedure

Step 1 Choose **Analysis** > **Connections** > **Events**. You can also view the events from the **Unified Events** viewer.

Step 2 View the elephant flows that were exempted from remediation. The **Reason** field shows **Elephant Flow Exempted**.



Additional references

For detailed conceptual information, see the Elephant Flow Detection for Snort 3 chapter in this guide or the content in the following link:

- Elephant Flow Detection