System Management Configuration Guide, Cisco Catalyst IE9300 Rugged Series Switches

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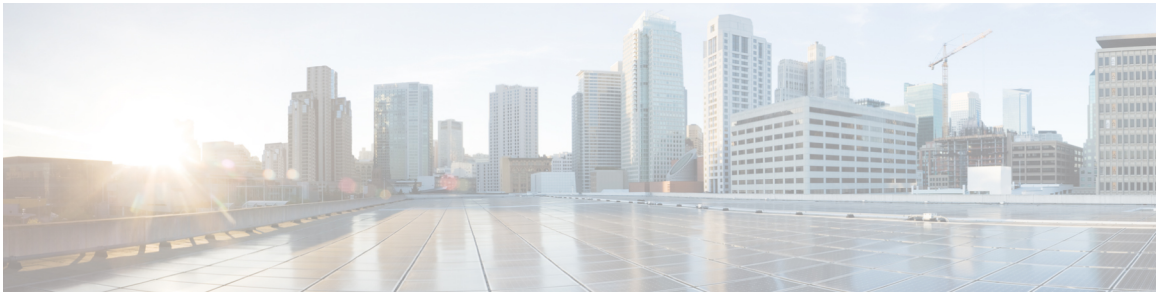
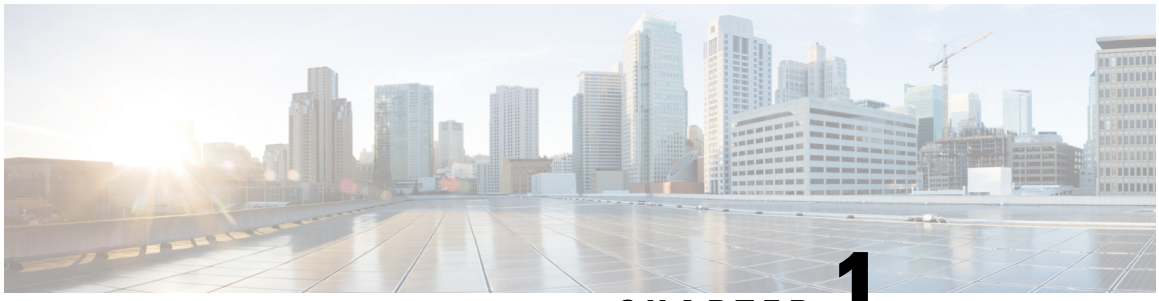


CONTENTS



CHAPTER 1

Application Visibility and Control in a Wired Network

Application Visibility and Control

Application Visibility and Control (AVC) is a critical part of Cisco's efforts to evolve its Branch and Campus solutions from being strictly packet and connection based to being application-aware and application-intelligent. AVC classifies applications using deep packet inspection techniques with the Network-Based Application Recognition (NBAR2) engine.

You can configure AVC on wired access ports for standalone switches. You can activate NBAR2 either explicitly on the interface by enabling protocol-discovery or implicitly by attaching a QoS policy that contains **match protocol** classifier.

You can configure wired AVC Flexible NetFlow (FNF) on an interface to provide client, server, and application statistics per interface. The record is similar to **application-client-server-stats** traffic monitor which is available in **application-statistics** and **application-performance** profiles in Easy Performance Monitor (Easy perf-mon or ezPM).

Supported AVC Class Map and Policy Map Formats

This section describes the supported AVC class maps and policy map formats.

Supported AVC Class Map Formats

Class Map Format	Class Map Example	Direction
match protocol *protocol name*	`class-map match-any NBAR-VOICE` `match protocol ms-lync-audio`	Both ingress and egress

Combination filters	`class-map match-any NBAR-VOICE`
	`match protocol ms-lync-audio`
	`match dscp ef`
		Both ingress and egress

Supported AVC Policy Formats

Policy Format	QoS Action
Egress policy based on match protocol filter	Mark and police
Ingress policy based on match protocol filter	Mark and police

The following table describes detailed AVC policy formats with examples:

AVC Policy Format	AVC Policy Example	Direction

Basic set	`policy-map MARKING-IN`
	`class NBAR-MM_CONFERENCING`
	`set dscp af41`
		Ingress and egress

Basic police	`policy-map POLICING-IN`
	`class NBAR-MM_CONFERENCING`
	`police cir 600000`
	`set dscp af41`
		Ingress and egress

Basic set and police	`policy-map webex-policy`
	` class webex-class`
	` set dscp ef`
	` police 5000000`
		Ingress and egress

Multiple set and police including default	`policy-map webex-policy`
	` class webex-class`
	` set dscp af31`
	` police 4000000`
	` class class-webex-category`
	` set dscp ef`
	`  police 6000000`
	` class class-default`
	` set dscp <>`
		Ingress and egress

AVC Policy Format	AVC Policy Example	Direction

Hierarchical police	`policy-map webex-policy`
	` class webex-class`
	` police 5000000`
	` service-policy client-in-police-only`
	
	` policy-map client-in-police-only`
	` class webex-class`
	` police 100000`
	` class class-webex-category`
	` set dscp ef`
	`  police 200000`
		Ingress and egress

Hierarchical set and police	`policy-map webex-policy`
	` class class-default`
	` police 1500000`
	` service policy client-up-child`
	` policy-map client-up-child`
	` class webex-class`
	` police 100000`
	` set dscp ef`
	` class class-webex-category`
	` police 200000`
	` set dscp af31`	

Restrictions for Wired Application Visibility and Control

- NBAR and transmit (Tx) Switched Port Analyzer (SPAN) is not supported on the same interface.
- Only one of the NBAR based QoS mechanisms are allowed to be attached to any port at the same time, either protocol based or attributes based. Only the following two attributes are supported:
  - traffic-class
  - business-relevance
- The legacy WDAVC QoS limitations are still applicable:
  - Only marking and policing are supported.
  - Only physical interfaces are supported.
  - There is a delay in the QoS classification since the application classification is done offline (while the initial packet/s of the flow are meanwhile forwarded before the correct QoS classification).
- NBAR2 based match criteria **match protocol** will be allowed only with marking or policing actions. NBAR2 match criteria will not be allowed in a policy that has queuing features configured.
- 'Match Protocol': Up to 255 concurrent different protocols in all policies (8 bits HW limitation).
- AVC is not supported on management port (Gig 0/0).
- IPv6 packet classification is not supported.
- Only IPv4 unicast (TCP/UDP) is supported.

- Web UI: You can configure application visibility and perform application monitoring from the Web UI. Application Control can only be done using the CLI. It is not supported on the Web UI.

  To manage and check wired AVC traffic on the Web UI, you must first configure **ip http authentication local** and **ip nbar http-service** commands using the CLI.

- NBAR and ACL logging cannot be configured together on the same switch.
- Protocol-discovery, application-based QoS, and wired AVC FNF cannot be configured together at the same time on the same interface with the non-application-based FNF. However, these wired AVC features can be configured with each other. For example, protocol-discovery, application-based QoS and wired AVC FNF can be configured together on the same interface at the same time.
- Attachment should be done only on physical Layer 2 and Layer 3 ports, and these ports cannot be part of a port channel. Attachment to trunk ports are not supported.
-

Configuring Application Visibility and Control in a Wired Network

This section provides an overview of the tasks required to configure application visibility and control on wired ports.

- Configure visibility:

  Activate NBAR2 engine by enabling protocol-discovery on the interface using the **ip nbar protocol-discovery** command in the interface configuration mode. See the section, "Enabling Application Recognition on an Interface."

- Configure control:
  - Create an AVC QoS policy as described in the section "Creating AVC QoS Policy."
  - Apply AVC QoS policy to the interface as described in the section "Applying a QoS Policy to the Switch Port."

- Configure application-based Flexible Netflow:
  - Create a flow record by specifying key and nonkey fields to the flow as described in the section "Creating a Flow Record."
  - Create a flow exporter to export the flow record as described in the section "Creating a Flow Exporter."
  - Create a flow monitor based on the flow record and the flow exporter as described in the section "Creating a Flow Monitor to an Interface."
  - Attach the flow monitor to the interface as described in the section "Associating a Flow Monitor to an Interface."

- Protocol-Discovery, application-based QoS and application-based FNF are all independent features. You can configure them independently or together on the same interface at the same time.

Enabling Application Recognition on an Interface

To enable application recognition on an interface, complete the following steps:

SUMMARY STEPS

1. **configure terminal**
2. **interface** *interface-id*
3. **ip nbar protocol-discovery**
4. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 2	**interface** *interface-id* **Example:** `Device(config)# interface gigabitethernet 1/0/1`	Specifies the interface for which you are enabling protocol-discovery and enters interface configuration mode.
Step 3	**ip nbar protocol-discovery** **Example:** `Device(config-if)# ip nbar protocol-discovery`	Enables application recognition on the interface by activating NBAR2 engine.
Step 4	**end** **Example:** `Device(config-if)# end`	Returns to privileged EXEC mode.

Creating Application Visibility and Control QoS Policy

This section provides an overview of the tasks required to create AVC Quality of Service (QoS) policy:

1. Create a class map with match protocol filters.
2. Create a policy map.
3. Apply the policy map to the interface.

Creating a Class Map

You must create a class map before configuring any match protocol filter. You can apply the QoS actions such as marking and policing to the traffic. The AVC match protocol filters are applied to the wired access ports. For more information about the protocols that are supported, see http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/qos_nbar/prot_lib/config_library/nbar-prot-pack-library.html.

SUMMARY STEPS

1. **terminal**
2. **class-map** *class-map-name*
3. **match protocol** *application-name*
4. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 2	**class-map** *class-map-name* **Example:** `Device(config)# class-map webex-class`	Creates a class map.

Step 3	**match protocol** *application-name*
	Example:
	`Device(config)# class-map webex-class`
	`Device(config-cmap)# match protocol webex-media`
		Specifies match to the application name.

Step 4	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Creating a Policy Map

Complete the following steps to create a policy map.

SUMMARY STEPS

1. **configure terminal**
2. **policy-map** *policy-map-name*
3. **class** [*class-map-name* | **class-default**]
4. **police** *rate-bps burst-byte*
5. **set** {**dscp** *new-dscp* | **cos** *cos-value*}
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 2	**policy-map** *policy-map-name* **Example:** `Device(config)# policy-map webex-policy`	Creates a policy map by entering the policy map name, and enters policy-map configuration mode. By default, no policy maps are defined. The default behavior of a policy map is to set the DSCP to 0 if the packet is an IP packet and to set the CoS to 0 if the packet is tagged. No policing is performed. **Note** To delete an existing policy map, use the **no policy-map** *policy-map-name* global configuration command.
Step 3	**class** [*class-map-name* | **class-default**] **Example:** `Device(config-pmap)# class webex-class`	Defines a traffic classification, and enters policy-map class configuration mode. By default, no policy map and class maps are defined. If a traffic class has already been defined by using the **class-map** global configuration command, specify its name for *class-map-name* in this command. A **class-default** traffic class is predefined and can be added to any policy. It is always placed at the end of a policy map. With an implied **match any** is included in the **class-default** class, all packets that have not already matched the other traffic classes will match **class-default**. **Note** To delete an existing class map, use the **no class** *class-map-name* policy-map configuration command.
Step 4	**police** *rate-bps burst-byte* **Example:** `Device(config-pmap-c)# police 100000 80000`	Defines a policer for the classified traffic. By default, no policer is defined. • For *rate-bps*, specify an average traffic rate in bits per second (b/s). The range is 8000 to 10000000000. • For *burst-byte*, specify the normal burst size in bytes. The range is 1000 to 512000000.
Step 5	**set** {**dscp** *new-dscp* | **cos** *cos-value*} **Example:** `Device(config-pmap-c)# set dscp 45`	Classifies IP traffic by setting a new value in the packet. • For **dscp** *new-dscp*, enter a new DSCP value to be assigned to the classified traffic. The range is 0 to 63.

	Command or Action	Purpose
Step 6	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Applying a QoS Policy to the Switch Port

Complete the following steps to applya QoS policy to the switch port.

SUMMARY STEPS

1. **configure terminal**
2. **interface** *interface-id*
3. **service-policy input** *policymapname*
4. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 2	**interface** *interface-id* **Example:** `Device(config)# interface Gigabitethernet 1/0/1`	Enters the interface configuration mode.
Step 3	**service-policy input** *policymapname* **Example:** `Device(config-if)# service-policy input MARKING_IN`	Applies local policy to interface.
Step 4	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Configuring Wired AVC Flexible NetFlow

Creating a Flow Record

Wired AVC Flexible Netflow (FNF) supports two types of predefined flow records—legacy bidirectional flow records and directional flow records (ingress and egress).

You can configure the following predefined flow records and associate them with a flow monitor:

- Two bidirectional flow records
- Two directional flow records

The legacy bidirectional records are client/server application statistics records, and the new directional records are application-stats for input/output.

Flow Record 1: Bidirectional Flow Record

Complete the following steps to create a bidirectional flow record.

SUMMARY STEPS

1. **configure terminal**
2. **flow record** *flow_record_name*
3. **description** *description*
4. **match ipv4 version**
5. **match ipv4 protocol**
6. **match application name**
7. **match connection client ipv4 address**
8. **match connection server ipv4 address**
9. **match connection server transport port**
10. **match flow observation point**
11. **collect flow direction**
12. **collect connection initiator**
13. **collect connection new-connections**
14. **collect connection client counter packets long**
15. **collect connection client counter bytes network long**
16. **collect connection server counter packets long**
17. **collect connection server counter bytes network long**
18. **collect timestamp absolute first**
19. **collect timestamp absolute last**
20. **end**
21. **show flow record**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 2	**flow record** *flow_record_name* **Example:** `Device(config)# flow record fr-wdavc-1`	Enters flow record configuration mode.

	Command or Action	Purpose
Step 3	**description** *description* **Example:** `Device(config-flow-record)# description fr-wdavc-1`	(Optional) Creates a description for the flow record.
Step 4	**match ipv4 version** **Example:** `Device(config-flow-record)# match ipv4 version`	Specifies a match to the IP version from the IPv4 header.
Step 5	**match ipv4 protocol** **Example:** `DEvice(config-flow-record)# match ipv4 protocol`	Specifies a match to the IPv4 protocol.
Step 6	**match application name** **Example:** `Device(config-flow-record)# match application name`	Specifies a match to the application name. **Note** This action is mandatory for AVC support, as the action allows the flow to be matched against the application.
Step 7	**match connection client ipv4 address** **Example:** `Device(config-flow-record)# match connection client ipv4 address`	Specifies a match to the IPv4 address of the client (flow initiator).
Step 8	**match connection server ipv4 address** **Example:** `Device(config-flow-record)# match connection server ipv4 address`	Specifies a match to the IPv4 address of the server (flow responder).
Step 9	**match connection server transport port** **Example:** `Device(config-flow-record)# match connection server transport port`	Specifies a match to the transport port of the server.
Step 10	**match flow observation point** **Example:** `Device(config-flow-record)# match flow observation point`	Specifies a match to the observation point ID for flow observation metrics.
Step 11	**collect flow direction** **Example:** `Device(config-flow-record)# collect flow direction`	Specifies to collect the direction — Ingress or Egress — of the relevant side — Initiator or Responder — of the bi-directional flow that is specified by the **initiator** keyword in the **collect connection initiator** command in the following step. Depending on the value specified by the **initiator** keyword, the **flow direction** keyword takes the following values : • 0x01 = Ingress Flow

	Command or Action	Purpose
		• 0x02 = Egress Flow When the **initiator** keyword is set to initiator, the flow direction is specified from the initiator side of the flow. When the initiator keyword is set to responder, the flow direction is specified from the responder side of the flow. For wired AVC, the **initiator** keyword is always set to initiator.
Step 12	**collect connection initiator** **Example:** `Device(config-flow-record)# collect connection initiator`	Specifies to collect the side of the flow — Initiator or Responder — relevant to the direction of the flow specified by the **collect flow direction** command. The **initiator** keyword provides the following information about the direction of the flow: • 0x01 = Initiator - the flow source is the initiator of the connection. For wired AVC, the **initiator** keyword is always set to initiator.
Step 13	**collect connection new-connections** **Example:** `Device(config-flow-record)# collect connection new-connections`	Specifies to collect the number of connection initiations observed.
Step 14	**collect connection client counter packets long** **Example:** `Device(config-flow-record)# collect connection client counter packets long`	Specifies to collect the number of packets sent by the client.
Step 15	**collect connection client counter bytes network long** **Example:** `Device(config-flow-record)# collect connection client counter bytes network long`	Specifies to collect the total number of bytes transmitted by the client.
Step 16	**collect connection server counter packets long** **Example:** `Device(config-flow-record)# collect connection server counter packets long`	Specifies to collect the number of packets sent by the server.
Step 17	**collect connection server counter bytes network long** **Example:** `Device(config-flow-record)# collect connection server counter bytes network long`	Specifies to collect the total number of bytes transmitted by the server.
Step 18	**collect timestamp absolute first** **Example:**	Specifies to collect the time, in milliseconds, when the first packet was seen in the flow.

	Command or Action	Purpose
	`Device(config-flow-record)# collect timestamp absolute first`	
Step 19	**collect timestamp absolute last** **Example:** `Device(config-flow-record)# collect timestamp absolute last`	Specifies to collect the time, in milliseconds, when the most recent packet was seen in the flow.
Step 20	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.
Step 21	**show flow record** **Example:** `Device# show flow record`	Displays information about all the flow records.

Flow Record 2: Bidirectional Flow Record

Complete the following steps to create a bidirectional flow record.

SUMMARY STEPS

1. **configure terminal**
2. **flow record** *flow_record_name*
3. **description** *description*
4. **match ipv4 version**
5. **match ipv4 protocol**
6. **match application name**
7. **match connection client ipv4 address**
8. **match connection client transport port**
9. **match connection server ipv4 address**
10. **match connection server transport port**
11. **match flow observation point**
12. **collect flow direction**
13. **collect connection initiator**
14. **collect connection new-connections**
15. **collect connection client counter packets long**
16. **collect connection client counter bytes network long**
17. **collect connection server counter packets long**
18. **collect connection server counter bytes network long**
19. **collect timestamp absolute first**
20.
21. **collect timestamp absolute last**
22. **end**
23. **show flow record**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 2	**flow record** *flow_record_name* **Example:** `Device(config)# flow record fr-wdavc-1`	Enters flow record configuration mode.
Step 3	**description** *description* **Example:** `Device(config-flow-record)# description fr-wdavc-1`	(Optional) Creates a description for the flow record.
Step 4	**match ipv4 version** **Example:** `Device(config-flow-record)# match ipv4 version`	Specifies a match to the IP version from the IPv4 header.
Step 5	**match ipv4 protocol** **Example:** `Device(config-flow-record)# match ipv4 protocol`	Specifies a match to the IPv4 protocol.
Step 6	**match application name** **Example:** `Device(config-flow-record)# match application name`	Specifies a match to the application name. **Note** This action is mandatory for AVC support, as the action allows the flow to be matched against the application.
Step 7	**match connection client ipv4 address** **Example:** `Device(config-flow-record)# match connection client ipv4 address`	Specifies a match to the IPv4 address of the client (flow initiator).
Step 8	**match connection client transport port** **Example:** `Device(config-flow-record)# match connection client transport port`	(Optional) Specifies a match to the connection port of the client as a key field for a flow record.
Step 9	**match connection server ipv4 address** **Example:** `Device(config-flow-record)# match connection server ipv4 address`	Specifies a match to the IPv4 address of the server (flow responder).
Step 10	**match connection server transport port** **Example:**	Specifies a match to the transport port of the server.

	Command or Action	Purpose
	`Device(config-flow-record)# match connection server transport port`	
Step 11	**match flow observation point** **Example:** `Device(config-flow-record)# match flow observation point`	Specifies a match to the observation point ID for flow observation metrics.
Step 12	**collect flow direction** **Example:** `Device(config-flow-record)# collect flow direction`	Specifies to collect the direction—Ingress or Egress —of the relevant side—Initiator or Responder—of the bi-directional flow that is specified by the **initiator** keyword in the **collect connection initiator** command in the following step. Depending on the value specified by the **initiator** keyword, the **flow direction** keyword takes the following values : • 0x01 = Ingress Flow • 0x02 = Egress Flow When the **initiator** keyword is set to initiator, the flow direction is specified from the initiator side of the flow. When the initiator keyword is set to responder, the flow direction is specified from the responder side of the flow. For wired AVC, the **initiator** keyword is always set to initiator.
Step 13	**collect connection initiator** **Example:** `Device(config-flow-record)# collect connection initiator`	Specifies to collect the side of the flow—Initiator or Responder—relevant to the direction of the flow specified by the **collect flow direction** command. The **initiator** keyword provides the following information about the direction of the flow: • 0x01 = Initiator - the flow source is the initiator of the connection. For wired AVC, the **initiator** keyword is always set to initiator.
Step 14	**collect connection new-connections** **Example:** `Device(config-flow-record)# collect connection new-connections`	Specifies to collect the number of connection initiations observed.
Step 15	**collect connection client counter packets long** **Example:** `Device(config-flow-record)# collect connection client counter packets long`	Specifies to collect the number of packets sent by the client.
Step 16	**collect connection client counter bytes network long** **Example:**	Specifies to collect the total number of bytes transmitted by the client.

	Command or Action	Purpose
	`Device(config-flow-record)# collect connection client counter bytes network long`	
Step 17	**collect connection server counter packets long** **Example:** `Device(config-flow-record)# collect connection server counter packets long`	Specifies to collect the number of packets sent by the server.
Step 18	**collect connection server counter bytes network long** **Example:** `Device(config-flow-record)# collect connection server counter bytes network long`	Specifies to collect the total number of bytes transmitted by the server.
Step 19	**collect timestamp absolute first** **Example:** `Device(config-flow-record)# collect timestamp absolute first`	Specifies to collect the time, in milliseconds, when the first packet was seen in the flow.
Step 20		
Step 21	**collect timestamp absolute last** **Example:** `Device(config-flow-record)# collect timestamp absolute last`	Specifies to collect the time, in milliseconds, when the most recent packet was seen in the flow.
Step 22	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.
Step 23	**show flow record** **Example:** `Device# show flow record`	Displays information about all the flow records.

Flow Record 3: Directional Flow Record—Ingress

Complete the following steps to create an ingress directional flow record:

SUMMARY STEPS

1. **configure terminal**
2. **flow record** *flow_record_name*
3. **description** *description*
4. **match ipv4 version**
5. **match ipv4 protocol**
6. **match ipv4 source address**
7. **match ipv4 destination address**
8. **match transport source-port**

9. **match transport destination-port**
10. **match interface input**
11. **match application name**
12. **collect interface output**
13. **collect counter bytes long**
14. **collect counter packets long**
15. **collect timestamp absolute first**
16. **collect timestamp absolute last**
17. **end**
18. **show flow record**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 2	**flow record** *flow_record_name* **Example:** `Device(config)# flow record fr-wdavc-3`	Enters flow record configuration mode.
Step 3	**description** *description* **Example:** `Device(config-flow-record)# description flow-record-1`	(Optional) Creates a description for the flow record.
Step 4	**match ipv4 version** **Example:** `Device(config-flow-record)# match ipv4 version`	Specifies a match to the IP version from the IPv4 header.
Step 5	**match ipv4 protocol** **Example:** `Device(config-flow-record)# match ipv4 protocol`	Specifies a match to the IPv4 protocol.
Step 6	**match ipv4 source address** **Example:** `Device(config-flow-record)# match ipv4 source address`	Specifies a match to the IPv4 source address as a key field.
Step 7	**match ipv4 destination address** **Example:** `Device(config-flow-record)# match ipv4 destination address`	Specifies a match to the IPv4 destination address as a key field.

	Command or Action	Purpose
Step 8	**match transport source-port** **Example:** `Device(config-flow-record)# match transport source-port`	Specifies a match to the transport source port as a key field.
Step 9	**match transport destination-port** **Example:** `Device(config-flow-record)# match transport destination-port`	Specifies a match to the transport destination port as a key field.
Step 10	**match interface input** **Example:** `Device(config-flow-record)# match interface input`	Specifies a match to the input interface as a key field.
Step 11	**match application name** **Example:** `Device(config-flow-record)# match application name`	Specifies a match to the application name. **Note** This action is mandatory for AVC support, as this allows the flow to be matched against the application.
Step 12	**collect interface output** **Example:** `Device(config-flow-record)# collect interface output`	Specifies to collect the output interface from the flows.
Step 13	**collect counter bytes long** **Example:** `Device(config-flow-record)# collect counter bytes long`	Specifies to collect the number of bytes in a flow.
Step 14	**collect counter packets long** **Example:** `Device(config-flow-record)# collect counter packets long`	Specifies to collect the number of packets in a flow.
Step 15	**collect timestamp absolute first** **Example:** `Device(config-flow-record)# collect timestamp absolute first`	Specifies to collect the time, in milliseconds, when the first packet was seen in the flow.
Step 16	**collect timestamp absolute last** **Example:** `Device(config-flow-record)# collect timestamp absolute last`	Specifies to collect the time, in milliseconds, when the most recent packet was seen in the flow.

	Command or Action	Purpose
Step 17	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.
Step 18	**show flow record** **Example:** `Device# show flow record`	Displays information about all the flow records.

Flow Record 4: Directional Flow Record—Egress

Complete the following steps to configure an egress directional flow record:

SUMMARY STEPS

1. **configure terminal**
2. **flow record** *flow_record_name*
3. **description** *description*
4. **match ipv4 version**
5. **match ipv4 protocol**
6. **match ipv4 source address**
7. **match ipv4 destination address**
8. **match transport source-port**
9. **match transport destination-port**
10. **match interface output**
11. **match application name**
12. **collect interface input**
13. **collect counter bytes long**
14. **collect counter packets long**
15. **collect timestamp absolute first**
16. **collect timestamp absolute last**
17. **end**
18. **show flow record**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 2	**flow record** *flow_record_name* **Example:** `Device(config)# flow record fr-wdavc-4`	Enters flow record configuration mode.

	Command or Action	Purpose
Step 3	**description** *description* **Example:** `Device(config-flow-record)# description flow-record-1`	(Optional) Creates a description for the flow record.
Step 4	**match ipv4 version** **Example:** `Device(config-flow-record)# match ipv4 version`	Specifies a match to the IP version from the IPv4 header.
Step 5	**match ipv4 protocol** **Example:** `Device(config-flow-record)# match ipv4 protocol`	Specifies a match to the IPv4 protocol.
Step 6	**match ipv4 source address** **Example:** `Device(config-flow-record)# match ipv4 source address`	Specifies a match to the IPv4 source address as a key field.
Step 7	**match ipv4 destination address** **Example:** `Device(config-flow-record)# match ipv4 destination address`	Specifies a match to the IPv4 destination address as a key field.
Step 8	**match transport source-port** **Example:** `Device(config-flow-record)# match transport source-port`	Specifies a match to the transport source port as a key field.
Step 9	**match transport destination-port** **Example:** `Device(config-flow-record)# match transport destination-port`	Specifies a match to the transport destination port as a key field.
Step 10	**match interface output** **Example:** `Device(config-flow-record)# match interface output`	Specifies a match to the output interface as a key field.
Step 11	**match application name** **Example:** `Device(config-flow-record)# match application name`	Specifies a match to the application name. **Note** This action is mandatory for AVC support, as this allows the flow to be matched against the application.
Step 12	**collect interface input** **Example:**	Specifies to collect the input interface from the flows.

	Command or Action	Purpose
	`Device(config-flow-record)# collect interface input`	
Step 13	**collect counter bytes long** **Example:** `Device(config-flow-record)# collect counter bytes long`	Specifies to collect the number of bytes in a flow.
Step 14	**collect counter packets long** **Example:** `Device(config-flow-record)# collect counter packets long`	Specifies to collect the number of packets in a flow.
Step 15	**collect timestamp absolute first** **Example:** `Device(config-flow-record)# collect timestamp absolute first`	Specifies to collect the time, in milliseconds, when the first packet was seen in the flow.
Step 16	**collect timestamp absolute last** **Example:** `Device(config-flow-record)# collect timestamp absolute last`	Specifies to collect the time, in milliseconds, when the most recent packet was seen in the flow.
Step 17	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.
Step 18	**show flow record** **Example:** `Device# show flow record`	Displays information about all the flow records.

Creating a Flow Monitor

You can create a flow monitor and associate it with a flow record.

SUMMARY STEPS

1. **configure terminal**
2. **flow monitor** *monitor-name*
3. **description** *description*
4. **record** *record-name*
5. **exporter** *exporter-name*
6. **cache** { **entries** *number-of-entries* | **timeout** {**active** | **inactive**} | **type normal** }
7. **end**
8. **show flow monitor**

9. **show flow monitor** *flow-monitor-name*
10. **show flow monitor** *flow-monitor-name* **statistics**
11. **clear flow monitor** *flow-monitor-name* **statistics**
12. **show flow monitor** *flow-monitor-name* **cache format table**
13. **show flow monitor** *flow-monitor-name* **cache format record**
14. **show flow monitor** *flow-monitor-name* **cache format csv**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 2	**flow monitor** *monitor-name* **Example:** `Device(config)# flow monitor flow-monitor-1`	Creates a flow monitor and enters flow monitor configuration mode.
Step 3	**description** *description* **Example:** `Device(config-flow-monitor)# description flow-monitor-1`	(Optional) Creates a description for the flow monitor.
Step 4	**record** *record-name* **Example:** `Device(config-flow-monitor)# record flow-record-1`	Specifies the name of a record that was created previously.
Step 5	**exporter** *exporter-name* **Example:** `Device(config-flow-monitor)# exporter flow-exporter-1`	Specifies the name of an exporter that was created previously.

Step 6	**cache** { **entries** *number-of-entries* | **timeout** {**active** | **inactive**} | **type normal** }
	Example:
	`Device(config-flow-monitor)# cache timeout active 1800`
	Example:
	`Device(config-flow-monitor)# cache timeout inactive 200`
	Example:
	`Device(config-flow-monitor)# cache type normal`
		(Optional) Specifies to configure flow cache parameters.
		• **entries** *number-of-entries* — Specifies the maximum number of flow entries in the flow cache in the range from 16 to 65536.
		Note Only normal cache type is supported.

Step 7	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

	Command or Action	Purpose
Step 8	**show flow monitor** **Example:** `Device# show flow monitor`	Displays information about all the flow monitors.
Step 9	**show flow monitor** *flow-monitor-name* **Example:** `Device# show flow monitor flow-monitor-1`	Displays information about the specified wired AVC flow monitor.
Step 10	**show flow monitor** *flow-monitor-name* **statistics** **Example:** `Device# show flow monitor flow-monitor-1 statistics`	Displays statistics for wired AVC flow monitor.
Step 11	**clear flow monitor** *flow-monitor-name* **statistics** **Example:** `Device# clear flow monitor flow-monitor-1 statistics`	Clears the statistics of the specified flow monitor. Use the **show flow monitor flow-monitor-1 statistics** command after using the **clear flow monitor flow-monitor-1 statistics** to verify that all the statistics have been reset.
Step 12	**show flow monitor** *flow-monitor-name* **cache format table** **Example:** `Device# show flow monitor flow-monitor-1 cache format table`	Displays flow cache contents in a tabular format.
Step 13	**show flow monitor** *flow-monitor-name* **cache format record** **Example:** `Device# show flow monitor flow-monitor-1 cache format record`	Displays flow cache contents in similar format as the flow record.
Step 14	**show flow monitor** *flow-monitor-name* **cache format csv** **Example:** `Device# show flow monitor flow-monitor-1 cache format csv`	Displays flow cache contents in CSV format.

Associating Flow Monitor to an Interface

You can attach two different wired AVC monitors with different predefined records to an interface at the same time.

SUMMARY STEPS

1. **configure terminal**
2. **interface** *interface-id*
3. **ip flow monitor** *monitor-name* { **input** | **output** }
4. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 2	**interface** *interface-id* **Example:** `Device(config)# interface Gigabitethernet 1/0/1`	Enters the interface configuration mode.
Step 3	**ip flow monitor** *monitor-name* { **input** | **output** } **Example:** `Device(config-if) # ip flow monitor flow-monitor-1 input`	Associates a flow monitor to the interface for input and/or output packets.
Step 4	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

NBAR2 Custom Applications

Network Based Application Recognition 2 (NBAR2) supports the use of custom protocols to identify custom applications. Custom protocols support protocols and applications that NBAR2 does not currently support.

In every deployment, there are local and specific applications which are not covered by the NBAR2 protocol pack provided by Cisco. Local applications are categorized as:

- Specific applications to an organization
- Applications specific to a geography

NBAR2 provides a way to customize such local applications. You can customize applications using the command **ip nbar custom** *myappname* in global configuration mode. Custom applications take precedence over built-in protocols. For each custom protocol, you can define a selector ID that can be used for reporting purposes.

There are various types of application customization:

Generic protocol customization

- HTTP
- SSL
- DNS

Composite: Customization based on multiple underlying protocols–**server-name**.

Layer3/Layer4 customization

- IPv4 address
- DSCP values
- TCP/UDP ports
- Flow source or destination direction

Byte Offset: Customization based on specific byte values in the payload.

HTTP Customization

-

SSL Customization

Customization can be done for SSL encrypted traffic using information extracted from the SSL Server Name Indication (SNI) or Common Name (CN).

SSL Customization

Custom application called MYSSL using SSL unique-name “mydomain.com” with selector ID 11.

```
Device# configure terminal
Device(config)#ip nbar custom MYSSL ssl unique-name *mydomain.com id 11
```

DNS Customization

NBAR2 examines DNS request and response traffic, and can correlate the DNS response to an application. The IP address returned from the DNS response is cached and used for later packet flows associated with that specific application.

The command **ip nbar custom** *application-name* **dns** *domain-name* **id** *application-id* is used for DNS customization. To extend an existing application, use the command **ip nbar custom** *application-name* **dns domain-name** *domain-name* **extends** *existing-application*.

For more information on DNS-based customization, see http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/qos_nbar/configuration/xe-3s/asr1000/qos-nbar-xe-3s-asr-1000-book/nbar-custapp-dns-xe.html.

DNS Customization

Custom application called MYDNS using the DNS domain name “mydomain.com” with selector ID 12.

```
Device# configure terminal
Device(config)# ip nbar custom MYDNS dns domain-name *mydomain.com id 12
```

Composite Customization

NBAR2 provides a way to customize applications based on domain names appearing in HTTP, SSL, or DNS.

Composite Customization

Custom application called MYDOMAIN using HTTP, SSL, or DNS domain name “mydomain.com” with selector ID 13.

```
Device# configure terminal
Device(config)# ip nbar custom MYDOMAIN composite server-name *mydomain.com id 13
```

L3/L4 Customization

Layer3/Layer4 customization is based on the packet tuple and is always matched on the first packet of a flow.

L3/L4 Customization

Custom application called LAYER4CUSTOM matching IP addresses 10.56.1.10 and 10.56.1.11, TCP and DSCP ef with selector ID 14.

```
Device# configure terminal
Device(config)# ip nbar custom LAYER4CUSTOM transport tcp id 14
Device(config-custom)# ip address 10.56.1.10 10.56.1.11
Device(config-custom)# dscp ef
```

Example: Monitoring Custom Applications

Show Commands for Monitoring Custom Applications

show ip nbar protocol-id | inc Custom

```
Device# show ip nbar  protocol-id | inc Custom
LAYER4CUSTOM              14             Custom
MYDNS                     12             Custom
MYDOMAIN                  13             Custom
MYHTTP                    10             Custom
MYSSL                     11             Custom
```

show ip nbar protocol-discovery protocol *CUSTOM_APP*

```
Device# show ip nbar  protocol-id MYSSL
Protocol Name              id             type
-----------------------------------------------
MYSSL                     11             Custom
```

NBAR2 Dynamic Hitless Protocol Pack Upgrade

Protocol packs are software packages that update the NBAR2 protocol support on a device without replacing the Cisco software on the device. A protocol pack contains information on applications officially supported by NBAR2 which are compiled and packed together. For each application, the protocol-pack includes information on application signatures and application attributes. Each software release has a built-in protocol-pack bundled with it.

Protocol packs provide the following features:

- They are easy and fast to load.
- They are easy to upgrade to a higher version protocol pack or revert to a lower version protocol pack.
- They do not require the switch to be reloaded.

NBAR2 protocol packs are available for download on Cisco Software Center from this URL: https://software.cisco.com/download/home.

Prerequisites for the NBAR2 Protocol Pack

Before loading a new protocol pack, you must copy the protocol pack to the flash on all the switch members.

To load a protocol pack, see Loading the NBAR2 Protocol Pack.

Loading the NBAR2 Protocol Pack

Complete the following steps to load the NBAR2 protocol pack.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip nbar protocol-pack** *protocol-pack* [**force**]
4. **exit**
5. **show ip nbar protocol-pack** {protocol-pack | **active**} [**detail**]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.

Step 3	**ip nbar protocol-pack** *protocol-pack* [**force**]
	Example:
	`Device(config)# ip nbar protocol-pack flash:defProtoPack`
	Example:
	`Device(config)# default ip nbar protocol-pack`
		Loads the protocol pack.
		• Use the **force** keyword to specify and load a protocol pack of a lower version, which is different from the base protocol pack version. Doing so also removes the configuration that is not supported by the current protocol pack on the switch.
		For reverting to the built-in protocol pack, use the following command:

	Command or Action	Purpose
Step 4	**exit** **Example:** `Device(config)# exit`	Returns to privileged EXEC mode.
Step 5	**show ip nbar protocol-pack** {protocol-pack | **active**} [**detail**] **Example:** `Device# show ip nbar protocol-pack active`	Displays the protocol pack information. • Verify the loaded protocol pack version, publisher, and other details using this command. • Use the *protocol-pack* argument to display information about the specified protocol pack. • Use the **active** keyword to display active protocol pack information. • Use the **detail** keyword to display detailed protocol pack information.

Examples: Loading the NBAR2 Protocol Pack

The following example shows how to load a new protocol pack:

```
Device> enable
Device# configure terminal
Device(config)# ip nbar protocol-pack flash:newDefProtoPack
Device(config)# exit
```

The following example shows how to use the **force** keyword to load a protocol pack of a lower version:

```
Device> enable
Device# configure terminal
Device(config)# ip nbar protocol-pack flash:OldDefProtoPack force
Device(config)# exit
```

The following example shows how to revert to the built-in protocol pack:

```
Device> enable
Device# configure terminal
Device(config)# default ip nbar protocol-pack
Device(config)# exit
```

Monitoring Application Visibility and Control

This section describes the new commands for application visibility.

The following commands can be used to monitor application visibility on the switch and access ports.

Table 1: Monitoring Application Visibility Commands on the Switch

Command	Purpose

show ip nbar protocol-discovery [**interface** *interface-type interface-number*] [**stats**{**byte-count** | **bit-rate** | **packet-count** | **max-bit-rate**}] [**protocol** *protocol-name* | **top-n** *number*]	Displays the statistics gathered by the NBAR Protocol Discovery feature. • (Optional) Enter keywords and arguments to fine-tune the statistics displayed. For more information on each of the keywords, refer to the **show ip nbar protocol-discovery**command in Cisco IOS Quality of Service Solutions Command Reference.
show policy-map interface *interface-type interface-number*	Displays information about policy map applied to the interface.

Examples: Application Visibility and Control Configuration

This example shows how to create class maps with apply match protocol filters for application name:

```
Device# configure terminal
Device(config)# class-map match-any NBAR-VOICE
Device(config-cmap)# match protocol ms-lync-audio
Device(config-cmap)#end
```

This example shows how to create policy maps and define existing class maps for egress QoS:

```
Device # configure terminal
Device(config)# policy-map test-avc-up
Device(config-pmap)# class cat-browsing
Device(config-pmap-c)# police 150000
Device(config-pmap-c)# set dscp 12
Device(config-pmap-c)#end
```

This example shows how to create policy maps and define existing class maps for ingress QoS:

```
Device# configure terminal
Device(config)# policy-map test-avc-down
Device(config-pmap)# class cat-browsing
Device(config-pmap-c)# police 200000
Device(config-pmap-c)# set dscp 10
Device(config-pmap-c)#end
```

This example shows how to apply policy maps to a switch port:

```
Device# configure terminal
Device(config)# interface GigabitEthernet 1/0/1
Device(config-if)# switchport mode access
Device(config-if)# switchport access vlan 20
Device(config-if)# service-policy input POLICING_IN
Device(config-if)#end
```

This example shows how to create class maps based on NBAR attributes.

```
Device# configure terminal
Device(config)# class-map match-all rel-relevant
Device(config-cmap)# match protocol attribute business-relevance business-relevant

Device(config)# class-map match-all rel-irrelevant
Device(config-cmap)# match protocol attribute business-relevance business-irrelevant

Device(config)# class-map match-all rel-default
Device(config-cmap)# match protocol attribute business-relevance default
```

```
Device(config)# class-map match-all class--ops-admin-and-rel
Device(config-cmap)# match protocol attribute traffic-class ops-admin-mgmt
Device(config-cmap)# match protocol attribute business-relevance business-relevant
```

This example shows how to create policy maps based on class maps based on NBAR attributes.

```
Device# configure terminal
Device(config)# policy-map attrib--rel-types
Device(config-pmap)# class rel-relevant
Device(config-pmap-c)# set dscp ef
Device(config-pmap-c)# class rel-irrelevant
Device(config-pmap-c)# set dscp af11
Device(config-pmap-c)# class rel-default
Device(config-pmap-c)# set dscp default

Device(config)# policy-map attrib--ops-admin-and-rel
Device(config-pmap)# class class--ops-admin-and-rel
Device(config-pmap-c)# set dscp cs5
```

This example shows how to attach a policy map based on NBAR attributes to a wired port:

```
Device# configure terminal
Device(config)# interface GigabitEthernet1/0/2
Device(config-if)# service-policy input attrib--rel-types
```

Show Commands for Viewing the Configuration

show ip nbar protocol-discovery

Displays a report of the Protocol Discovery statistics per interface.

The following is a sample output for the statistics per interface:

```
Device# show ip nbar protocol-discovery int GigabitEthernet1/0/1


GigabitEthernet1/0/1
Last clearing of "show ip nbar protocol-discovery" counters 00:03:16

                                    Input
Output
                                    -----
------
Protocol                            Packet Count
Packet Count
                                    Byte Count
Byte Count
                                    30sec Bit Rate (bps)
30sec Bit Rate (bps)
                                    30sec Max Bit Rate (bps)
30sec Max Bit Rate (bps)
----------------------- ------------------------
-------------------------------------------------
ms-lync                             60580
55911
                                    31174777
28774864
                                    3613000
```

```
93000
                                    3613000
3437000
Total                               60580
55911
                                    31174777
28774864
                                    3613000
93000
                                    3613000
3437000
```

show policy-map interface

Displays the QoS statistics and the configured policy maps on all interfaces.

The following is a sample output for the policy-maps configured on all the interfaces:

```
Device# show policy-map int


GigabitEthernet1/0/1
 Service-policy input: MARKING-IN

   Class-map: NBAR-VOICE (match-any)
     718 packets
     Match: protocol ms-lync-audio
       0 packets, 0 bytes
       30 second rate 0 bps
     QoS Set
       dscp ef

   Class-map: NBAR-MM_CONFERENCING (match-any)
     6451 packets
     Match: protocol ms-lync
       0 packets, 0 bytes
       30 second rate 0 bps
     Match: protocol ms-lync-video
       0 packets, 0 bytes
       30 second rate 0 bps
     QoS Set
       dscp af41

   Class-map: class-default (match-any)
     34 packets
     Match: any
```

Show Commands for Viewing Attributes-based QoS Configuration

show policy-map interface

Displays the attribute-based QoS statistics and the configured policy maps on all interfaces.

The following is a sample output for the policy-maps configured on all the interfaces:

```
Device# show policy-map interface gigabitEthernet 1/0/2
 GigabitEthernet1/0/2

  Service-policy input: attrib--rel-types

    Class-map: rel-relevant (match-all)
      20 packets
      Match: protocol attribute business-relevance business-relevant
      QoS Set
        dscp ef

    Class-map: rel-irrelevant (match-all)
      0 packets
      Match: protocol attribute business-relevance business-irrelevant
      QoS Set
        dscp af11

    Class-map: rel-default (match-all)
      14 packets
      Match: protocol attribute business-relevance default
      QoS Set
        dscp default

    Class-map: class-default (match-any)
      0 packets
      Match: any
```

show ip nbar protocol-attribute

Displays all the protocol attributes used by NBAR.

The following shows sample output for some of the attributes:

```
Device# show ip nbar protocol-attribute cisco-jabber-im
           Protocol Name : cisco-jabber-im
                encrypted : encrypted-yes
                   tunnel : tunnel-no
                 category : voice-and-video
             sub-category : enterprise-media-conferencing
        application-group : cisco-jabber-group
           p2p-technology : p2p-tech-no
            traffic-class : transactional-data
       business-relevance : business-relevant
          application-set : collaboration-apps

Device# show ip nbar protocol-attribute google-services
            Protocol Name : google-services
                encrypted : encrypted-yes
                   tunnel : tunnel-no
                 category : other
             sub-category : other
        application-group : google-group
           p2p-technology : p2p-tech-yes
            traffic-class : transactional-data
```

```
      business-relevance : default
         application-set : general-browsing

Device# show ip nbar protocol-attribute dns
            Protocol Name : google-services
                encrypted : encrypted-yes
                   tunnel : tunnel-no
                 category : other
             sub-category : other
        application-group : google-group
           p2p-technology : p2p-tech-yes
            traffic-class : transactional-data
      business-relevance : default
         application-set : general-browsing

Device# show ip nbar protocol-attribute unknown
            Protocol Name : unknown
                encrypted : encrypted-no
                   tunnel : tunnel-no
                 category : other
             sub-category : other
        application-group : other
           p2p-technology : p2p-tech-no
            traffic-class : bulk-data
      business-relevance : default
         application-set : general-misc
```

Show Commands for Viewing Flow Monitor Configuration

show flow monitor wdavc

Displays information about the specified wired AVC flow monitor.

```
Device # show flow monitor wdavc

Flow Monitor wdavc:
  Description:       User defined
  Flow Record:       wdavc
  Flow Exporter:     wdavc-exp (inactive)
  Cache:
    Type:                normal (Platform cache)
    Status:              not allocated
    Size:                12000 entries
    Inactive Timeout:    15 secs
    Active Timeout:      1800 secs
```

show flow monitor wdavc statistics

Displays statistics for wired AVC flow monitor.

```
Device# show flow monitor wdavc statistics
  Cache type:                                 Normal (Platform cache)
  Cache size:                                  12000
  Current entries:                                13

  Flows added:                                    26
```

```
  Flows aged:                                   13
    - Active timeout      (  1800 secs)          1
    - Inactive timeout    (    15 secs)         12
```

clear flow monitor wdavc statistics

Clears the statistics of the specified flow monitor. Use the **show flow monitor wdavc statistics** command after using the **clear flow monitor wdavc statistics** to verify that all the statistics have been reset. The following is a sample output of the **show flow monitor wdavc statistics** command after clearing flow monitor statistics.

```
Device# show flow monitor wdavc statistics
  Cache type:                                Normal (Platform cache)
  Cache size:                                 12000
  Current entries:                                0

  Flows added:                                    0
  Flows aged:                                     0
```

Show Commands for Viewing Cache Contents

show flow monitor wdavc cache format table

Displays flow cache contents in a tabular format.

```
Device# show flow monitor wdavc cache format table
  Cache type:                                Normal (Platform cache)
  Cache size:                                 12000
  Current entries:                               13

  Flows added:                                   26
  Flows aged:                                    13
    - Active timeout      (  1800 secs)          1
    - Inactive timeout    (    15 secs)         12

CONN IPV4 INITIATOR ADDR  CONN IPV4 RESPONDER ADDR  CONN RESPONDER PORT
 FLOW OBSPOINT ID  IP VERSION  IP PROT  APP NAME                     flow
 dirn ...................
------------------------  ------------------------  --------------------
 ----------------  ----------  -------  --------------------------
---------
64.103.125.147            144.254.71.184                              53
      4294967305           4       17  port dns                    Input
     ......................
64.103.121.103            10.1.1.2                                    67
      4294967305           4       17  layer7 dhcp                 Input
     ....contd............
64.103.125.3              64.103.125.97                               68
      4294967305           4       17  layer7 dhcp                 Input
     ......................
10.0.2.6                  157.55.40.149                               443
      4294967305           4        6  layer7 ms-lync              Input
     ......................
64.103.126.28             66.163.36.139                               443
      4294967305           4        6  layer7 cisco-jabber-im      Input
```

```
     ....contd...........
64.103.125.2              64.103.125.29                             68
       4294967305          4       17  layer7 dhcp                 Input
     ....................
64.103.125.97             64.103.101.181                            67
       4294967305          4       17  layer7 dhcp                 Input
     ....................
192.168.100.6             10.10.20.1                                5060
       4294967305          4       17  layer7 cisco-jabber-control Input
     ....contd...........
64.103.125.3              64.103.125.29                             68
       4294967305          4       17  layer7 dhcp                 Input
     ....................
10.80.101.18              10.80.101.6                               5060
       4294967305          4        6  layer7 cisco-collab-control Input
     ....................
10.1.11.4                 66.102.11.99                              80
       4294967305          4        6  layer7 google-services      Input
     ....contd...........
64.103.125.2              64.103.125.97                             68
       4294967305          4       17  layer7 dhcp                 Input
     ....................
64.103.125.29             64.103.101.181                            67
       4294967305          4       17  layer7 dhcp                 Input
     ....................
```

show flow monitor wdavc cache format record

Displays flow cache contents in similar format as the flow record.

```
Device# show flow monitor wdavc cache format record
  Cache type:                                 Normal (Platform cache)
  Cache size:                                  12000
  Current entries:                                13

  Flows added:                                    26
  Flows aged:                                     13
    - Active timeout      (  1800 secs)           1
    - Inactive timeout    (    15 secs)          12

CONNECTION IPV4 INITIATOR ADDRESS:        64.103.125.147
CONNECTION IPV4 RESPONDER ADDRESS:        144.254.71.184
CONNECTION RESPONDER PORT:                53
FLOW OBSPOINT ID:                         4294967305
IP VERSION:                               4
IP PROTOCOL:                              17
APPLICATION NAME:                         port dns
flow direction:                           Input
timestamp abs first:                      08:55:46.917
timestamp abs last:                       08:55:46.917
connection initiator:                     Initiator
connection count new:                     2
connection server packets counter:        1
```

```
connection client packets counter:        1
connection server network bytes counter:  190
connection client network bytes counter:  106

CONNECTION IPV4 INITIATOR ADDRESS:        64.103.121.103
CONNECTION IPV4 RESPONDER ADDRESS:        10.1.1.2
CONNECTION RESPONDER PORT:                67
FLOW OBSPOINT ID:                         4294967305
IP VERSION:                               4
IP PROTOCOL:                              17
APPLICATION NAME:                         layer7 dhcp
flow direction:                           Input
timestamp abs first:                      08:55:47.917
timestamp abs last:                       08:55:47.917
connection initiator:                     Initiator
connection count new:                     1
connection server packets counter:        0
connection client packets counter:        1
connection server network bytes counter:  0
connection client network bytes counter:  350

CONNECTION IPV4 INITIATOR ADDRESS:        64.103.125.3
CONNECTION IPV4 RESPONDER ADDRESS:        64.103.125.97
CONNECTION RESPONDER PORT:                68
FLOW OBSPOINT ID:                         4294967305
IP VERSION:                               4
IP PROTOCOL:                              17
APPLICATION NAME:                         layer7 dhcp
flow direction:                           Input
timestamp abs first:                      08:55:47.917
timestamp abs last:                       08:55:53.917
connection initiator:                     Initiator
connection count new:                     1
connection server packets counter:        0
connection client packets counter:        4
connection server network bytes counter:  0
connection client network bytes counter:  1412

CONNECTION IPV4 INITIATOR ADDRESS:        10.0.2.6
CONNECTION IPV4 RESPONDER ADDRESS:        157.55.40.149
CONNECTION RESPONDER PORT:                443
FLOW OBSPOINT ID:                         4294967305
IP VERSION:                               4
IP PROTOCOL:                              6
APPLICATION NAME:                         layer7 ms-lync
flow direction:                           Input
timestamp abs first:                      08:55:46.917
timestamp abs last:                       08:55:46.917
connection initiator:                     Initiator
connection count new:                     2
connection server packets counter:        10
```

```
connection client packets counter:        14
connection server network bytes counter:  6490
connection client network bytes counter:  1639

CONNECTION IPV4 INITIATOR ADDRESS:        64.103.126.28
CONNECTION IPV4 RESPONDER ADDRESS:        66.163.36.139
CONNECTION RESPONDER PORT:                443
FLOW OBSPOINT ID:                         4294967305
IP VERSION:                               4
IP PROTOCOL:                              6
APPLICATION NAME:                         layer7 cisco-jabber-im
flow direction:                           Input
timestamp abs first:                      08:55:46.917
timestamp abs last:                       08:55:46.917
connection initiator:                     Initiator
connection count new:                     2
connection server packets counter:        12
connection client packets counter:        10
connection server network bytes counter:  5871
connection client network bytes counter:  2088

CONNECTION IPV4 INITIATOR ADDRESS:        64.103.125.2
CONNECTION IPV4 RESPONDER ADDRESS:        64.103.125.29
CONNECTION RESPONDER PORT:                68
FLOW OBSPOINT ID:                         4294967305
IP VERSION:                               4
IP PROTOCOL:                              17
APPLICATION NAME:                         layer7 dhcp
flow direction:                           Input
timestamp abs first:                      08:55:47.917
timestamp abs last:                       08:55:47.917
connection initiator:                     Initiator
connection count new:                     1
connection server packets counter:        0
connection client packets counter:        2
connection server network bytes counter:  0
connection client network bytes counter:  712

CONNECTION IPV4 INITIATOR ADDRESS:        64.103.125.97
CONNECTION IPV4 RESPONDER ADDRESS:        64.103.101.181
CONNECTION RESPONDER PORT:                67
FLOW OBSPOINT ID:                         4294967305
IP VERSION:                               4
IP PROTOCOL:                              17
APPLICATION NAME:                         layer7 dhcp
flow direction:                           Input
timestamp abs first:                      08:55:47.917
timestamp abs last:                       08:55:47.917
connection initiator:                     Initiator
connection count new:                     1
connection server packets counter:        0
```

```
connection client packets counter:        1
connection server network bytes counter:  0
connection client network bytes counter:  350

CONNECTION IPV4 INITIATOR ADDRESS:        192.168.100.6
CONNECTION IPV4 RESPONDER ADDRESS:        10.10.20.1
CONNECTION RESPONDER PORT:                5060
FLOW OBSPOINT ID:                         4294967305
IP VERSION:                               4
IP PROTOCOL:                              17
APPLICATION NAME:                         layer7 cisco-jabber-control
flow direction:                           Input
timestamp abs first:                      08:55:46.917
timestamp abs last:                       08:55:46.917
connection initiator:                     Initiator
connection count new:                     1
connection server packets counter:        0
connection client packets counter:        2
connection server network bytes counter:  0
connection client network bytes counter:  2046

CONNECTION IPV4 INITIATOR ADDRESS:        64.103.125.3
CONNECTION IPV4 RESPONDER ADDRESS:        64.103.125.29
CONNECTION RESPONDER PORT:                68
FLOW OBSPOINT ID:                         4294967305
IP VERSION:                               4
IP PROTOCOL:                              17
APPLICATION NAME:                         layer7 dhcp
flow direction:                           Input
timestamp abs first:                      08:55:47.917
timestamp abs last:                       08:55:47.917
connection initiator:                     Initiator
connection count new:                     1
connection server packets counter:        0
connection client packets counter:        2
connection server network bytes counter:  0
connection client network bytes counter:  712

CONNECTION IPV4 INITIATOR ADDRESS:        10.80.101.18
CONNECTION IPV4 RESPONDER ADDRESS:        10.80.101.6
CONNECTION RESPONDER PORT:                5060
FLOW OBSPOINT ID:                         4294967305
IP VERSION:                               4
IP PROTOCOL:                              6
APPLICATION NAME:                         layer7 cisco-collab-control
flow direction:                           Input
timestamp abs first:                      08:55:46.917
timestamp abs last:                       08:55:47.917
connection initiator:                     Initiator
connection count new:                     2
connection server packets counter:        23
```

```
connection client packets counter:        27
connection server network bytes counter:  12752
connection client network bytes counter:  8773

CONNECTION IPV4 INITIATOR ADDRESS:        10.1.11.4
CONNECTION IPV4 RESPONDER ADDRESS:        66.102.11.99
CONNECTION RESPONDER PORT:                80
FLOW OBSPOINT ID:                         4294967305
IP VERSION:                               4
IP PROTOCOL:                              6
APPLICATION NAME:                         layer7 google-services
flow direction:                           Input
timestamp abs first:                      08:55:46.917
timestamp abs last:                       08:55:46.917
connection initiator:                     Initiator
connection count new:                     2
connection server packets counter:        3
connection client packets counter:        5
connection server network bytes counter:  1733
connection client network bytes counter:  663

CONNECTION IPV4 INITIATOR ADDRESS:        64.103.125.2
CONNECTION IPV4 RESPONDER ADDRESS:        64.103.125.97
CONNECTION RESPONDER PORT:                68
FLOW OBSPOINT ID:                         4294967305
IP VERSION:                               4
IP PROTOCOL:                              17
APPLICATION NAME:                         layer7 dhcp
flow direction:                           Input
timestamp abs first:                      08:55:47.917
timestamp abs last:                       08:55:53.917
connection initiator:                     Initiator
connection count new:                     1
connection server packets counter:        0
connection client packets counter:        4
connection server network bytes counter:  0
connection client network bytes counter:  1412

CONNECTION IPV4 INITIATOR ADDRESS:        64.103.125.29
CONNECTION IPV4 RESPONDER ADDRESS:        64.103.101.181
CONNECTION RESPONDER PORT:                67
FLOW OBSPOINT ID:                         4294967305
IP VERSION:                               4
IP PROTOCOL:                              17
APPLICATION NAME:                         layer7 dhcp
flow direction:                           Input
timestamp abs first:                      08:55:47.917
timestamp abs last:                       08:55:47.917
connection initiator:                     Initiator
connection count new:                     1
connection server packets counter:        0
```

```
connection client packets counter:        1
connection server network bytes counter:  0
connection client network bytes counter:  350
```

show flow monitor wdavc cache format csv

Displays flow cache contents in CSV format.

```
Device# show flow monitor wdavc cache format csv
  Cache type:                                 Normal (Platform cache)
  Cache size:                                  12000
  Current entries:                                13

  Flows added:                                    26
  Flows aged:                                     13
    - Active timeout      (  1800 secs)           1
    - Inactive timeout    (    15 secs)          12

CONN IPV4 INITIATOR ADDR,CONN IPV4 RESPONDER ADDR,CONN RESPONDER PORT,FLOW
 OBSPOINT ID,IP VERSION,IP
PROT,APP NAME,flow dirn,time abs first,time abs last,conn initiator,conn
 count new,conn server packets
cnt,conn client packets cnt,conn server network bytes cnt,conn client
network bytes cnt
64.103.125.147,144.254.71.184,53,4294967305,4,17,port
dns,Input,08:55:46.917,08:55:46.917,Initiator,2,1,1,190,106
64.103.121.103,10.1.1.2,67,4294967305,4,17,layer7
dhcp,Input,08:55:47.917,08:55:47.917,Initiator,1,0,1,0,350
64.103.125.3,64.103.125.97,68,4294967305,4,17,layer7
dhcp,Input,08:55:47.917,08:55:53.917,Initiator,1,0,4,0,1412
10.0.2.6,157.55.40.149,443,4294967305,4,6,layer7 ms-
lync,Input,08:55:46.917,08:55:46.917,Initiator,2,10,14,6490,1639
64.103.126.28,66.163.36.139,443,4294967305,4,6,layer7 cisco-jabber-
im,Input,08:55:46.917,08:55:46.917,Initiator,2,12,10,5871,2088
64.103.125.2,64.103.125.29,68,4294967305,4,17,layer7
dhcp,Input,08:55:47.917,08:55:47.917,Initiator,1,0,2,0,712
64.103.125.97,64.103.101.181,67,4294967305,4,17,layer7
dhcp,Input,08:55:47.917,08:55:47.917,Initiator,1,0,1,0,350
192.168.100.6,10.10.20.1,5060,4294967305,4,17,layer7 cisco-jabber-
control,Input,08:55:46.917,08:55:46.917,Initiator,1,0,2,0,2046
64.103.125.3,64.103.125.29,68,4294967305,4,17,layer7
dhcp,Input,08:55:47.917,08:55:47.917,Initiator,1,0,2,0,712
10.80.101.18,10.80.101.6,5060,4294967305,4,6,layer7 cisco-collab-
control,Input,08:55:46.917,08:55:47.917,Initiator,2,23,27,12752,8773
10.1.11.4,66.102.11.99,80,4294967305,4,6,layer7 google-
services,Input,08:55:46.917,08:55:46.917,Initiator,2,3,5,1733,663
64.103.125.2,64.103.125.97,68,4294967305,4,17,layer7
dhcp,Input,08:55:47.917,08:55:53.917,Initiator,1,0,4,0,1412
64.103.125.29,64.103.101.181,67,4294967305,4,17,layer7
dhcp,Input,08:55:47.917,08:55:47.917,Initiator,1,0,1,0,350
```

Basic Troubleshooting: Questions and Answers

Following are the basic questions and answers for troubleshooting wired Application Visibility and Control:

1. **Question:** My IPv6 traffic is not being classified.

   Answer: Currently only IPv4 traffic is supported.

2. **Question:** My multicast traffic is not being classified.

   Answer: Currently only unicast traffic is supported.

3. **Question:** I send ping but I don’t see ttraffic being classified.

   Answer: Only TCP/UDP protocols are supported.

4. **Question:** Why can’t I attach NBAR to an SVI?

   Answer: NBAR is only supported on physical interfaces.

5. **Question:** I see that most of my traffic is CAPWAP traffic, why?

   Answer: Make sure that you have enabled NBAR on an access port that is not connected to a wireless access port. All traffic coming from APs will be classified as capwap. Actual classification in this case happens either on the AP or WLC.

6. **Question:** In protocol-discovery, I see traffic only on one side. Along with that, there is a lot of unknown traffic.

   Answer: This usually indicates that NBAR sees asymmetric traffic: one side of the traffic is classified in one switch member and the other on a different member. The recommendation is to attach NBAR only on access ports where we see both sides of the traffic. If you have multiple uplinks, you can’t attach NBAR on them due to this issue. Similar issue happens if you configure NBAR on an interface that is part of a port channel.

7. **Question:** With protocol-discovery, I see an aggregate view of all application. How can I see traffic distribution over time?

   Answer: WebUI will give you view of traffic over time for the last 48 hours.

8. **Question:** I can't configure queue-based egress policy with **match protocol** *protocol-name* command.

   Answer: Only **shape** and **set DSCP** are supported in a policy with NBAR2 based classifiers. Common practice is to set DSCP on ingress and perform shaping on egress based on DSCP.

9. **Question:** I don’t have NBAR2 attached to any interface but I still see that NBAR2 is activated.

   Answer: If you have any class-map with **match protocol** *protocol-name*, NBAR will be globally activated on the but no traffic will be subjected to NBAR classification. This is an expected behavior and it does not consume any resources.

10. **Question:** I see some traffic under the default QOS queue. Why?

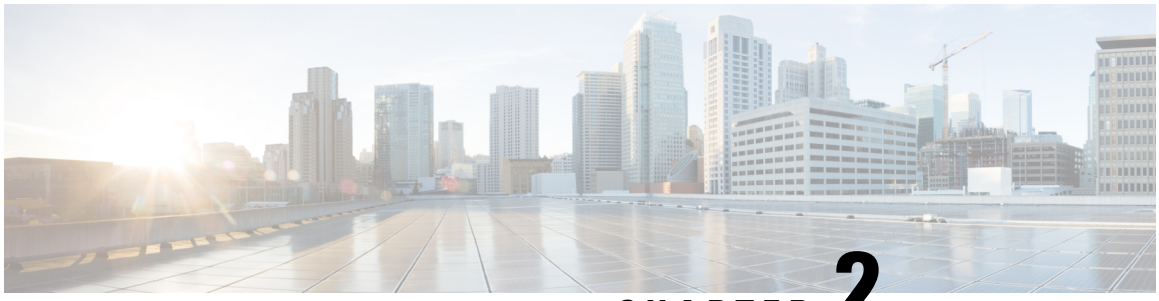
    Answer: For each new flow, it takes a few packets to classify it and install the result in the hardware. During this time, the classification would be 'un-known' and traffic will fall under the default queue.

Feature History for Application Visibility and Control in a Wired Network

This table provides release and related information for features explained in this module.

These features are available on all releases subsequent to the one they were introduced in, unless noted otherwise.

Use Cisco Feature Navigator to find information about platform and software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn.



CHAPTER 2

Configuring Swap Drive

Swapping the External Drive

Swap Drive and Disaster Recovery

The swap drive feature enables you to replace a failed switch quickly and easily. You simply move an external secure digital (SD) card or USB drive with a backup of the original switch to the new. After you turn on the new switch, it comes up with the same image and configuration as the original switch.

The swap drive feature is available for Cisco Catalyst IE9300 Rugged Series Switches beginning in Cisco IOS XE Cupertino 17.9.1. Each Cisco Catalyst IE9300 Rugged Series Switch has a secure digital (SD) cardslot and a USB-A port. See the *Cisco Catalyst IE9300 Rugged Series Switch Hardware Installation Guide* on Cisco.com for information about the switch SD cardslot and USB port.

In order to restore the settings to the new switch, you must have previously synchronized the original switch with the SD card or USB drive. Although you can run synchronization at any time manually, we recommend that you configure synchronization to occur automatically at set times.

When you request synchronization—either manually or automatically—the switch checks for any discrepancies between the internal flash drive on the switch and the SD card.

When an SD card is formatted on the switch, the card is formatted with the Disk Operating System Filing System (DOSFS), a platform-independent industry-standard file system that is supported on various Cisco switches and routers. The switch does not support third-party SD cards or SD High Capacity (SDHC) cards

If the write-protect switch on the SD card is in the lock position, the switch can read data on the card and use files on the SD card during the boot process, but cannot write updates and files to the card.

You can use a USB 2.0 drive as you would use an SD card for the swap drive feature.

Note For the swap drive feature to work, Cisco IOS XE Cupertino 17.9.1. must be installed on both the original switch and the replacement switch.

How Swap Drive Works

Swap drive consists of two main stages: backup of the original switch and recovery of the image and configuration on the new switch.

Backup duplicates the entire system in the external SD card or USB drive. You trigger backup by entering a CLI command, either to do a one-time sync or to set up automatic periodic syncs. If the switch has already been backed up, only changes since the last backup are duplicated in the external drive.

Restore occurs automatically, when you insert the external drive in the new switch and then power on the switch. The new switch looks for an SD card and scans it to see if an image and configuration are present. If they are present, the switch then copies them to internal flash and comes up with the image and configuration of the original system.

If an SD card isn't present or doesn't have the original switch's image and configuration, the switch then looks for and scans the USB drive. If they are present on the USB drive, the switch comes up with the original switch's image and configuration. If the image and configuration are not present on any external media, the system asks the user whether to continue with the initial configuration on the new switch.

For swap drive instructions, see Swap the External Drive; for a list of CLI commands, see Swap Drive CLI Commands. Both sections are in this guide.

Swap the External Drive

You remove the SD drive from the failed switch, and insert it into the new switch, then power on the new switch. A new switch is a switch without a startup configuration file. This is the case if the new switch has never been deployed before.

Before you begin

Cable the new switch correctly and make sure that it is powered off before you transfer the SD card or USB drive.

Step 1 On the failed switch, remove the SD card or USB drive.

Note The SD card and USB drive are hot-swappable, but do not remove it from the switch while sdflash write is in progress.

Step 2 On the new switch, ensure that the SD card or USB drive is oriented properly, and then press it into the slot on the switch until it is seated.

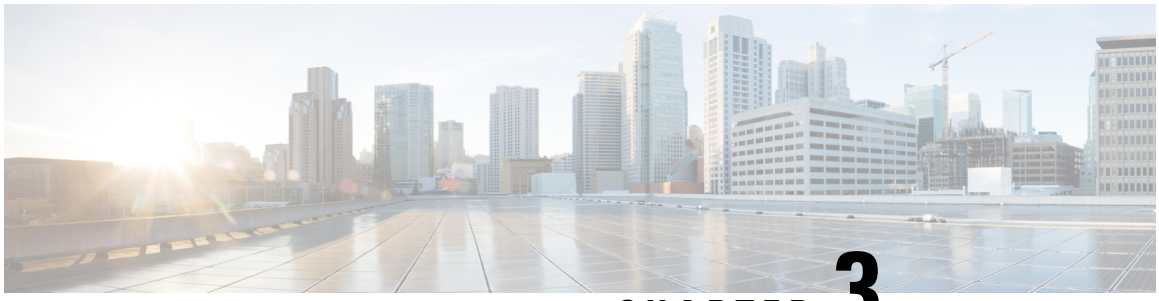
Step 3 Power on the new switch.
The image and configuration of the failed switch are transferred to the new one.

Swap Drive CLI Commands

The following table lists the CLI commands for the swap drive feature.

Note Perform all **auto sync** commands in configuration mode.

Command	Description
• **sync sdflash:** • **sync usbflash1:**	Syncs the switch image and configuration files from internal flash to the SD or USB drive.
• **sync sdflash: ios-image** • **sync usbflash1: ios-image**	Syncs the switch image from the internal flash to the SD or USB drive.
• **sync sdflash:skip config** • **sync usbflash1: skip config**	Syncs the switch image from the internal flash to the SD or USB drive but does not sync the configuration.
• **sync sdflash:skip ios-image** • **sync usbflash1: skip ios-image**	Syncs the configuration files om the internal flash to the SD or USB drive but does not sync the image.
sync restore-bundle	Copies the bundle image in the new switch instead of installing it during restore.
[no] auto sync enable	Enables or disables the auto sync feature. **Note** Auto sync is disabled by default. Unless you enable it, you cannot use other options for the feature.
auto sync config [usbflash1|sdflash]:	Sets the configuration to run during the sync.
[no] auto sync run time: [hh:mm:ss]	The time when sync is performed. The default is 00:00:00.
show sync status	Displays the last sync time and status. **Note** If a type-6 password is configured, the status shows the configuration as out of sync with the message that type-6 passwords are not synced.
show auto sync configuration	Displays all the configuration settings.
show auto sync status	Displays the last auto sync time and status.



CHAPTER 3

Dying Gasp

Dying Gasp

The dying gasp feature provides a warning when the power to a network device fails, enabling a temporary power supply. When the host network detects a complete power failure or the removal of a power supply cable, it sends a messsage or signal to the network management system (NMS) through an SNMP trap.

Network devices rely on a temporary backup power supply on a capacitor, which allows for a graceful shutdown and the generation of the dying-gasp message. This temporary power supply is designed to last from 5 to 10 milliseconds to perform these tasks.

Dying gasp packets can be sent to a maximum number of five servers for each notification type.

You configure dying gasp using the following CLI commands:

- **dying-gasp**: Configures the host to create and send dying-gasp packets.
- **show dying-gasp packets**: Displays detailed information about the created packets.
- **snmp-server host**: Specifies the SNMP server for the dying-gasp message.
- **logging host hostname-or-ipaddress transport udp**: Specifies the syslog server sending the syslog dying gasp message.

For further information about dying gasp configuration commands, see the remaining sections of this chapter.

Note The Dying Gasp feature works only in standalone Cisco Catalyst IE9300 Rugged Series Switches.

Configuring Dying Gasp

dying-gasp

To enable dying-gasp notification through syslog, SNMP trap, or Ethernet OAM, use the dying-gasp command:

Command Syntax	Description
dying-gasp primary {syslog | snmp-trap | ethernet-oam} secondary {syslog | snmp-trap | ethernet-oam}	• **dying-gasp**: Dying-gasp configuration command • **primary**: Dying-gasp primary notification • **secondary**: Dying-gasp secondary notification • **ethernet-oam**: Enable Ethernet-OAM notification command • **snmp-trap**: Send trap notification to SNMP server command • **syslog**: Enable system logger

Note **ethernet-oam** is not supported on Cisco Catalyst IE9300 Rugged Series Switches.

The following example shows how to configure SNMP traps as primary notification and syslog as secondary notification:

```
switch(config)# dying-gasp primary snmp-trap secondary syslog
```

show dying-gasp

This section provides descriptions of the **show dying-gasp** command keywords:

Command Syntax	Description
show dying-gasp {status | packets [snmp-trap | syslog | ethernet-oam]}	• **dying-gasp**: Dying-Gasp information • **status**: Dying-Gasp configuration status • **packets**: Detailed information about the created packets • **snmp-trap**: Dying-gasp SNMP trap information • **syslog**: Dying-gasp syslog message information • **ethernet-oam**: Dying-gasp Ethernet OAM message information

Note **ethernet-oam** is not supported on Cisco Catalyst IE9300 Rugged Series Switches.

show dying-gasp Output Examples

The following text is an example of the **dying gasp packets** command and its output:

```
IE9300#show dying-gasp packets
SNMP Trap packet for server 192.168.0.2, link type IP
  interface, via GigabitEthernet1/0/24, local IP address 12.1.1.40
  encap type is ARPA, local hardware address 6c03.09e7.23c0
  next hop IP address 12.1.1.200, next hop hardware address 6c03.09e7.23c0
Syslog errmsg packet for server 192.168.0.2, link type IP
  interface, via GigabitEthernet1/0/24, local IP address 12.1.1.40
  encap type is ARPA, local hardware address 6c03.09e7.23c0
  next hop IP address 12.1.1.200, next hop hardware address 6c03.09e7.23c0
```

The following is sample output for the **show dying-gasp status** command:

```
IE9300#show dying-gasp status
Dying Gasp Configuration
        SNMP Trap             Enabled (secondary)
        Syslog                Enabled (primary)
```

The following is sample output for the **show dying-gasp packets snmp-trap** command:

```
IE9300#show dying-gasp packets snmp-trap
SNMP Trap packet for server 192.168.0.2, link type IP
  interface, via GigabitEthernet1/0/24, local IP address 12.1.1.40
  encap type is ARPA, local hardware address 6c03.09e7.23c0
  next hop IP address 12.1.1.200, next hop hardware address 6c03.09e7.23c0
```

The following is sample output for the **show dying-gasp packets syslog** command:

```
IE9300#show dying-gasp packets syslog
Syslog errmsg packet for server 192.168.0.2, link type IP
  interface, via GigabitEthernet1/0/24, local IP address 12.1.1.40
  encap type is ARPA, local hardware address 6c03.09e7.23c0
  next hop IP address 12.1.1.200, next hop hardware address 6c03.09e7.23c0
```