



Configuring Application Visibility and Control in a Wired Network

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Finding Feature Information

Your software release may not support all of the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to <http://www.cisco.com/go/cfn>. An account on Cisco.com is not required.

Information About Application Visibility and Control in a Wired Network

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. Application Visibility and Control (AVC) classifies applications using deep packet inspection techniques with the Network-Based Application Recognition (NBAR2) engine. AVC can be configured on wired access ports for standalone switches as well as for a switch stack. NBAR2 can be activated either explicitly on the interface by enabling protocol-discovery or implicitly by attaching a QoS policy that contains **match protocol** classifier. Wired AVC Flexible NetFlow (FNF) can be configured 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

Supported AVC Class Map Format

Class Map Format	Class Map Example	Direction
match protocol <i>protocol name</i>	<code>class-map match-any NBAR-VOICE match protocol ms-lync-audio</code>	Both ingress and egress
Combination filters	<code>class-map match-any NBAR-VOICE match protocol ms-lync-audio match dscp ef</code>	Both ingress and egress

Supported AVC Policy Format

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 the detailed AVC policy format with an example:

AVC Policy Format	AVC Policy Example	Direction
Basic set	<code>policy-map MARKING-IN class NBAR-MM_CONFERENCING set dscp af41</code>	Ingress and egress
Basic police	<code>policy-map POLICING-IN class NBAR-MM_CONFERENCING police cir 600000 set dscp af41</code>	Ingress and egress
Basic set and police	<code>policy-map webex-policy class webex-class set dscp ef cos police 5000000</code>	Ingress and egress
Multiple set and police including default	<code>policy-map webex-policy class webex-class set dscp af31 cos police 4000000 class class-webex-category set dscp ef cos police 6000000 class class-default set dscp <></code>	Ingress and egress

AVC Policy Format	AVC Policy Example	Direction
Hierarchical police	<pre> 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 cos police 200000 </pre>	Ingress and egress
Hierarchical set and police	<pre> policy-map webex-policy class class-default police 1500000 service policy client-up-child policy-map webex-policy class webex-class police 100000 set dscp ef class class-webex-category police 200000 set dscp af31 </pre>	

Restrictions for Wired Application Visibility and Control

- NBAR based QoS policy configuration is allowed only on wired physical ports. Policy configuration is not supported on virtual interfaces, for example, VLAN, Port-Channel and other logical interfaces.
- 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.
 - Supports only physical interfaces.
 - 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.
- Wired AVC is not supported on LAN Base license.
- 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.
- Up to two wired AVC monitors with different records can be attached to an interface at the same time. Prior to Cisco IOS XE Fuji 16.9.1, only a single predefined record was supported with wired AVC FNF.
- Attachment should be done only on physical Layer2 (Access/Trunk) and Layer3 ports. Uplink can be attached as long as it is a single uplink and is not part of a port channel.
- Performance: Each switch member is able to handle 500 connections per second (CPS) at less than 50% CPU utilization.
- Scale: Able to handle up to 10,000 bi-directional flows per 48 access ports and 5000 bi-directional flows per 24 access ports. (~200 flows per access port).

How to Configure Application Visibility and Control

Configuring Application Visibility and Control in a Wired Network

To configure application visibility and control on wired ports, follow these steps:

Configuring 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 *Enabling Application Recognition on an Interface* section.

Configuring Control : Configure QoS policies based on application by

1. Creating an AVC QoS policy.
2. Applying AVC QoS policy to the interface.

Configuring application-based Flexible Netflow :

- Create a flow record by specifying key and non-key fields to the flow.
- Create a flow exporter to export the flow record.
- Create a flow monitor based on the flow record and the flow exporter.

- Attach the flow monitor to the interface.

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

Enabling Application Recognition on an interface

To enable application recognition on an interface, follow these 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 <i>interface-id</i> 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 AVC QoS Policy

To create AVC QoS policy, perform these general steps:

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 need to create a class map before configuring any match protocol filter. The QoS actions such as marking and policing can be applied 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. **configure terminal**
2. **class-map** *class-map-name*
3. **match protocol** *application-name*
4. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 2	class-map <i>class-map-name</i> Example: Device(config)# class-map webex-class	Creates a class map.
Step 3	match protocol <i>application-name</i> 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

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	<p>configure terminal</p> <p>Example:</p> <pre>Device# configure terminal</pre>	Enters global configuration mode.
Step 2	<p>policy-map <i>policy-map-name</i></p> <p>Example:</p> <pre>Device(config)# policy-map webex-policy</pre>	<p>Creates a policy map by entering the policy map name, and enters policy-map configuration mode.</p> <p>By default, no policy maps are defined.</p> <p>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.</p> <p>Note To delete an existing policy map, use the no policy-map <i>policy-map-name</i> global configuration command.</p>
Step 3	<p>class [<i>class-map-name</i> class-default]</p> <p>Example:</p> <pre>Device(config-pmap)# class webex-class</pre>	<p>Defines a traffic classification, and enters policy-map class configuration mode.</p> <p>By default, no policy map and class maps are defined.</p> <p>If a traffic class has already been defined by using the class-map global configuration command, specify its name for <i>class-map-name</i> in this command.</p> <p>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.</p> <p>Note To delete an existing class map, use the no class <i>class-map-name</i> policy-map configuration command.</p>
Step 4	<p>police <i>rate-bps burst-byte</i></p> <p>Example:</p> <pre>Device(config-pmap-c)# police 100000 80000</pre>	<p>Defines a policer for the classified traffic.</p> <p>By default, no policer is defined.</p> <ul style="list-style-type: none"> • For <i>rate-bps</i>, specify an average traffic rate in bits per second (b/s). The range is 8000 to 10000000000. • For <i>burst-byte</i>, specify the normal burst size in bytes. The range is 8000 to 1000000.
Step 5	<p>set {dscp <i>new-dscp</i> cos <i>cos-value</i>}</p> <p>Example:</p> <pre>Device(config-pmap-c)# set dscp 45</pre>	<p>Classifies IP traffic by setting a new value in the packet.</p> <ul style="list-style-type: none"> • For dscp <i>new-dscp</i>, 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

SUMMARY STEPS

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

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 2	interface <i>interface-id</i> Example: Device(config)# interface Gigabitethernet 1/0/1	Enters the interface configuration mode.
Step 3	service-policy input <i>polycymapname</i> 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.

Creating Attribute-based QoS (EasyQoS) Policy

Legacy wired AVC QoS defines classes based on specific NBAR protocols using the command **match protocol** *nbar-protocol-name*. This requires explicitly defining match statements and hence TCAM entries per relevant protocol. The number of match statements per class is limited, and specifically that the overall number of protocols that may be matched is limited to 255. These limitations in addition to the fact that relevant supported protocols might change between protocol pack releases, further jeopardizes the usefulness of QoS which is based on specific NBAR protocols.

To accommodate practically equivalent functionality, a much more useful and efficient, QoS NBAR defines a set of attributes that each protocol is classified to (with defaults, which may be overwritten in CLI as described

further in this chapter), e.g. business-relevance and traffic-class. QoS classes and policies may be defined based on such general NBAR attributes instead of specific protocols.

Starting with Cisco IOS XE Fuji 16.8.1a, support for defining QoS classes and policies based on such NBAR attributes is available, with a few limitations.

A class map can be defined according to certain NBAR attributes, using match-all or match-any, and a policy-map can be defined based on such a class-map. This policy-map can be attached to wired ports. Such classes and policies may be intermixed with other legacy match operations (e.g. packet fields, ACLs, etc.). Following are the limitations for defining class maps and policy maps.

Creating a Class Map

SUMMARY STEPS

1. **configure terminal**
2. **[no] class-map {match-all | match-any }**
3. **match protocol attribute** *attribute-type attribute-value*
4. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 2	[no] class-map {match-all match-any }	Creates a class map with NBAR attributes.
Step 3	match protocol attribute <i>attribute-type attribute-value</i>	Configures the specified protocol attribute as the match criterion.
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

SUMMARY STEPS

1. **configure terminal**
2. **[no] policy-map** *policy-map-name*
3. **[no] 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# <code>configure terminal</code>	Enters global configuration mode.
Step 2	[no] policy-map <i>policy-map-name</i>	Creates a policy map based on a class-map based on NBAR attributes.
Step 3	[no] class { <i>class-map-name</i> class-default } Example: Device(config-pmap)# <code>class webex-class</code>	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 <i>class-map-name</i> in this command.
Step 4	police <i>rate-bps burst-byte</i> Example: Device(config-pmap-c)# <code>police 100000 80000</code>	Defines a policer for the classified traffic. By default, no policer is defined. <ul style="list-style-type: none"> • For <i>rate-bps</i>, specify an average traffic rate in bits per second (b/s). The range is 8000 to 10000000000. • For <i>burst-byte</i>, specify the normal burst size in bytes. The range is 8000 to 1000000.
Step 5	set { dscp <i>new-dscp</i> cos <i>cos-value</i> } Example: Device(config-pmap-c)# <code>set dscp 45</code>	Classifies IP traffic by setting a new value in the packet. <ul style="list-style-type: none"> • For dscp <i>new-dscp</i>, enter a new DSCP value to be assigned to the classified traffic. The range is 0 to 63.
Step 6	end Example: Device(config)# <code>end</code>	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

SUMMARY STEPS

1. **configure terminal**
2. **interface** *interface-id*
3. **service-policy** {**input** | **output**} *policy-map-name*
4. **end**
5. **show class-map**
6. **show policy-map interface**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: Device# <code>configure terminal</code>	Enters global configuration mode.
Step 2	interface <i>interface-id</i> Example: Device(config)# <code>interface GigabitEthernet 1/0/1</code>	Enters the interface configuration mode.
Step 3	service-policy {input output} <i>policy-map-name</i> Example: Device(config-if)# <code>service-policy input MARKING_IN</code>	Applies local policy to interface.
Step 4	end Example: Device(config)# <code>end</code>	Returns to privileged EXEC mode. Alternatively, you can also press Ctrl-Z to exit global configuration mode.
Step 5	show class-map Example: Device# <code>show class-map</code>	Displays the class maps.
Step 6	show policy-map interface Example: Device# <code>show policy-map interface</code>	Displays the statistics status and the configured policy map on all the interfaces.

Creating NBAR Attribute Map

SUMMARY STEPS

1. `configure terminal`
2. `[no] ip nbar attribute-map attribute-map-name`
3. `[no] attribute attribute-type attribute-value`
4. `[no] ip nbar attribute-set protocol-name attribute-map-name`
5. `end`
6. `show ip nbar attribute`
7. `show ip nbar protocol-attribute`

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: Device# <code>configure terminal</code>	Enters global configuration mode.
Step 2	[no] ip nbar attribute-map attribute-map-name	Enters attribute configuration mode.
Step 3	[no] attribute attribute-type attribute-value	Defines an attribute-map that can be applied to specific protocols, in order to override their default attribute settings.
Step 4	[no] ip nbar attribute-set protocol-name attribute-map-name	Sets an attribute map to a specific protocol to override their default attribute settings.
Step 5	end Example: Device(config)# <code>end</code>	Returns to privileged EXEC mode. Alternatively, you can also press Ctrl-Z to exit global configuration mode.
Step 6	show ip nbar attribute	Displays overall attributes information.
Step 7	show ip nbar protocol-attribute	Displays the current protocol attribute settings.

Rules in the EasyQoS Policy Map

There are 24 rules in the EasyQoS policy map:

- 11 rules for the 10 Business Relevant Queues and Scavenger for applications that NBAR does not support and are defined through ACL.
- 11 rules for the 10 Business Relevant Queues and scavenger for NBAR defined through a combination of attributes.
- **class-default** to mark all the rest as DSCP 0.

Configuring Wired AVC Flexible Netflow

Creating a Flow Record

Wired AVC FNF supports two types of predefined flow records — Legacy Bidirectional flow records and Directional flow records (ingress and egress). A total of four different predefined flow records, two bidirectional flow records and two directional flow records, can be configured and associated with a flow monitor. The legacy bidirectional records are client/server application statistics records, and the new directional records are application-stats for input/output.

- [Bidirectional Flow Records, on page 12](#)
- [Directional Flow Records, on page 19](#)

Bidirectional Flow Records

Flow Record 1 - 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 <i>flow_record_name</i> Example: Device(config)# flow record fr-wdavic-1	Enters flow record configuration mode.
Step 3	description <i>description</i> Example: Device(config-flow-record)# description fr-wdavic-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:	Specifies a match to the IPv4 protocol.

	Command or Action	Purpose
	Device (config-flow-record)# match 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 this 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 step below. Depending on the value specified by the initiator keyword, the flow direction keyword takes the following values : <ul style="list-style-type: none"> • 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 12	collect connection initiator Example:	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

	Command or Action	Purpose
	<pre>Device (config-flow-record) # collect connection initiator</pre>	<p>keyword provides the following information about the direction of the flow :</p> <ul style="list-style-type: none"> • 0x01 = Initiator - the flow source is the initiator of the connection <p>For wired AVC, the initiator keyword is always set to initiator.</p>
Step 13	<p>collect connection new-connections</p> <p>Example:</p> <pre>Device (config-flow-record) # collect connection new-connections</pre>	Specifies to collect the number of connection initiations observed.
Step 14	<p>collect connection client counter packets long</p> <p>Example:</p> <pre>Device (config-flow-record) # collect connection client counter packets long</pre>	Specifies to collect the number of packets sent by the client.
Step 15	<p>collect connection client counter bytes network long</p> <p>Example:</p> <pre>Device (config-flow-record) # collect connection client counter bytes network long</pre>	Specifies to collect the total number of bytes transmitted by the client.
Step 16	<p>collect connection server counter packets long</p> <p>Example:</p> <pre>Device (config-flow-record) # collect connection server counter packets long</pre>	Specifies to collect the number of packets sent by the server.
Step 17	<p>collect connection server counter bytes network long</p> <p>Example:</p> <pre>Device (config-flow-record) # collect connection server counter bytes network long</pre>	Specifies to collect the total number of bytes transmitted by the server.
Step 18	<p>collect timestamp absolute first</p> <p>Example:</p> <pre>Device (config-flow-record) # collect timestamp absolute first</pre>	Specifies to collect the time, in milliseconds, when the first packet was seen in the flow.
Step 19	<p>collect timestamp absolute last</p> <p>Example:</p> <pre>Device (config-flow-record) # collect timestamp absolute last</pre>	Specifies to collect the time, in milliseconds, when the most recent packet was seen in the flow.
Step 20	<p>end</p> <p>Example:</p> <pre>Device (config) # end</pre>	Returns to privileged EXEC mode. Alternatively, you can also press Ctrl-Z to exit global configuration mode.

	Command or Action	Purpose
Step 21	show flow record Example: Device # <code>show flow record</code>	Displays information about all the flow records.

Flow Record 2 - 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. **collect timestamp absolute last**
21. **end**
22. **show flow record**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: Device# <code>configure terminal</code>	Enters global configuration mode.
Step 2	flow record <i>flow_record_name</i> Example: Device (config)# <code>flow record fr-wdavic-1</code>	Enters flow record configuration mode.

	Command or Action	Purpose
Step 3	description <i>description</i> Example: Device (config-flow-record) # description fr-wdavic-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 this 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: Device (config-flow-record) # match connection server transport port	Specifies a match to the transport port of the server.
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:	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

	Command or Action	Purpose
	Device (config-flow-record)# collect flow direction	keyword in the collect connection initiator command in the step below. Depending on the value specified by the initiator keyword, the flow direction keyword takes the following values : <ul style="list-style-type: none"> • 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 : <ul style="list-style-type: none"> • 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: Device (config-flow-record)# collect connection client counter bytes network long	Specifies to collect the total number of bytes transmitted by the client.
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:	Specifies to collect the total number of bytes transmitted by the server.

	Command or Action	Purpose
	Device (config-flow-record) # collect connection server counter bytes network long	
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	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 21	end Example: Device (config) # end	Returns to privileged EXEC mode. Alternatively, you can also press Ctrl-Z to exit global configuration mode.
Step 22	show flow record Example: Device # show flow record	Displays information about all the flow records.

Directional Flow Records

Flow Record 3 - Directional Flow Record - Ingress

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 <i>flow_record_name</i> Example: Device(config)# flow record fr-wdavic-3	Enters flow record configuration mode.
Step 3	description <i>description</i> 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 input Example:	Specifies a match to the input interface as a key field.

	Command or Action	Purpose
	Device (config-flow-record)# match interface input	
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.
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

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 <i>flow_record_name</i> Example: Device (config)# flow record fr-wdavic-4	Enters flow record configuration mode.
Step 3	description <i>description</i> 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.

	Command or Action	Purpose
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: Device (config-flow-record) # collect interface input	Specifies to collect the input 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.

	Command or Action	Purpose
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 Exporter

You can create a flow exporter to define the export parameters for a flow.

SUMMARY STEPS

1. **configure terminal**
2. **flow exporter** *flow_exporter_name*
3. **description** *description*
4. **destination** { *hostname* | *ipv4-address* | *ipv6-address* }
5. **option application-table** [**timeout** *seconds*]
6. **end**
7. **show flow exporter**
8. **show flow exporter statistics**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 2	flow exporter <i>flow_exporter_name</i> Example: Device(config)# flow exporter flow-exporter-1	Enters flow exporter configuration mode.
Step 3	description <i>description</i> Example: Device(config-flow-exporter)# description flow-exporter-1	(Optional) Creates a description for the flow exporter.

	Command or Action	Purpose
Step 4	destination { <i>hostname</i> <i>ipv4-address</i> <i>ipv6-address</i> } Example: Device (config-flow-exporter)# destination 10.10.1.1	Specifies the hostname, IPv4 or IPv6 address of the system to which the exporter sends data.
Step 5	option application-table [timeout <i>seconds</i>] Example: Device (config-flow-exporter)# option application-table timeout 500	(Optional) Configures the application table option for the flow exporter. The timeout option configures the resend time in seconds for the flow exporter. The valid range is from 1 to 86400 seconds.
Step 6	end Example: Device(config)# end	Returns to privileged EXEC mode. Alternatively, you can also press Ctrl-Z to exit global configuration mode.
Step 7	show flow exporter Example: Device # show flow exporter	Displays information about all the flow exporters.
Step 8	show flow exporter statistics Example: Device # show flow exporter statistics	Displays flow exporter statistics.

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 <i>monitor-name</i> Example: Device (config)# flow monitor flow-monitor-1	Creates a flow monitor and enters flow monitor configuration mode.
Step 3	description <i>description</i> Example: Device (config-flow-monitor)# description flow-monitor-1	(Optional) Creates a description for the flow monitor.
Step 4	record <i>record-name</i> Example: Device (config-flow-monitor)# record flow-record-1	Specifies the name of a record that was created previously.
Step 5	exporter <i>exporter-name</i> Example: Device (config-flow-monitor)# exporter flow-exporter-1	Specifies the name of an exporter that was created previously.
Step 6	cache { entries <i>number-of-entries</i> 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 <i>number-of-entries</i> — 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.
Step 8	show flow monitor Example: Device # show flow monitor	Displays information about all the flow monitors.
Step 9	show flow monitor <i>flow-monitor-name</i> Example:	Displays information about the specified wired AVC flow monitor.

	Command or Action	Purpose
	Device # <code>show flow monitor flow-monitor-1</code>	
Step 10	show flow monitor <i>flow-monitor-name</i> statistics Example: Device# <code>show flow monitor flow-monitor-1 statistics</code>	Displays statistics for wired AVC flow monitor.
Step 11	clear flow monitor <i>flow-monitor-name</i> statistics Example: Device# <code>clear flow monitor flow-monitor-1 statistics</code>	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 <i>flow-monitor-name</i> cache format table Example: Device# <code>show flow monitor flow-monitor-1 cache format table</code>	Displays flow cache contents in a tabular format.
Step 13	show flow monitor <i>flow-monitor-name</i> cache format record Example: Device# <code>show flow monitor flow-monitor-1 cache format record</code>	Displays flow cache contents in similar format as the flow record.
Step 14	show flow monitor <i>flow-monitor-name</i> cache format csv Example: Device# <code>show flow monitor flow-monitor-1 cache format csv</code>	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# <code>configure terminal</code>	Enters global configuration mode.

	Command or Action	Purpose
Step 2	interface <i>interface-id</i> Example: Device(config) # interface Gigabitethernet 1/0/1	Enters the interface configuration mode.
Step 3	ip flow monitor <i>monitor-name</i> { 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

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 mainly categorized as:

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

NBAR2 provides a way to manually customize such local applications. You can manually 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, user 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

HTTP customization could be based on a combination of HTTP fields from:

- **cookie** - HTTP Cookie
- **host** - Host name of Origin Server containing resource
- **method** - HTTP method
- **referrer** - Address the resource request was obtained from
- **url** - Uniform Resource Locator path
- **user-agent** - Software used by agent sending the request
- **version** - HTTP version
- **via** - HTTP via field

HTTP Customization

Custom application called MYHTTP using the HTTP host “*mydomain.com” with Selector ID 10.

```
Device# configure terminal
Device(config)# ip nbar custom MYHTTP http host *mydomain.com id 10
```

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/x-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
```

Examples: 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

```
WSW-157# 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/navigator.html> .

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 [Examples: Loading the NBAR2 Protocol Pack, on page 32](#) .

Loading 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. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	ip nbar protocol-pack <i>protocol-pack</i> [force] Example:	Loads the protocol pack. <ul style="list-style-type: none"> • Use the force keyword to specify and load a protocol pack of a lower version, which is different from the

	Command or Action	Purpose
	<pre>Device(config)# ip nbar protocol-pack flash:defProtoPack</pre> <p>Example:</p> <pre>Device(config)# default ip nbar protocol-pack</pre>	<p>base protocol pack version. This also removes the configuration that is not supported by the current protocol pack on the switch.</p> <p>For reverting to the built-in protocol pack, use the following command:</p>
Step 4	<p>exit</p> <p>Example:</p> <pre>Device(config)# exit</pre>	Returns to privileged EXEC mode.
Step 5	<p>show ip nbar protocol-pack {protocol-pack active} [detail]</p> <p>Example:</p> <pre>Device# show ip nbar protocol-pack active</pre>	<p>Displays the protocol pack information.</p> <ul style="list-style-type: none"> • Verify the loaded protocol pack version, publisher, and other details using this command. • Use the <i>protocol-pack</i> 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

Monitoring Application Visibility and Control (CLI)

This section describes the new commands for application visibility.

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

Table 1: Monitoring Application Visibility Commands on the

Command	Purpose
show ip nbar protocol-discovery [interface <i>interface-type interface-number</i>] [stats { byte-count bit-rate packet-count max-bit-rate }] [protocol <i>protocol-name</i> top-n <i>number</i>]	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 <i>interface-type interface-number</i>	Displays information about policy map applied to the interface.
show platform software fed switch <i>switch id</i> wdavc flows	Displays statistics about all flows on the specified switch.

Examples: Application Visibility and Control

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:

```
Deviceqos-cat9k-reg2-r1# show ip nbar protocol-discovery int GigabitEthernet1/0/1

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

Output	Input
-----	-----
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:

```
Deviceqos-cat9k-reg2-r1# 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 wdacv cache format record

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

```

Device# show flow monitor wdacv 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 them 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 are 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 stack 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 'unknown' and traffic will fall under the default queue.

Additional References for Application Visibility and Control

Related Documents

Related Topic	Document Title
QoS	<i>NBAR Configuration Guide, Cisco IOS XE Release 16..x</i>
NBAR2 Protocol Pack Hitless Upgrade	<i>NBAR Configuration Guide, Cisco IOS XE Release 16.x</i>

Technical Assistance

Description	Link
<p>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.</p> <p>To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds.</p> <p>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</p>	http://www.cisco.com/support

Feature History and Information For Application Visibility and Control in a Wired Network

Release	Feature Information
Cisco IOS XE Denali 16.3.2	Wired AVC Flexible NetFlow (FNF) — The feature uses a flow record with an application name as the key, to provide client, server and application statistics, per interface.
Cisco IOS XE Denali 16.3.1	This feature was introduced.

