Cisco Application Visibility and Control User Guide

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Cisco Application Visibility and Control User Guide

CONTENTS

Preface

This preface describes the objectives, audience, organization, and conventions used in this guide and describes related documents that have additional information. It contains the following sections:

Objective

Scope

This guide provides an overview of Cisco Application Visibility and Control (AVC) and explains how to configure various Cisco AVC features for routers operating Cisco IOS or Cisco IOS XE.

Some information may not apply to your particular router model.

This guide does not provide step-by-step setup procedures for operating AVC with each management and reporting package. Refer to the documentation for your management and reporting tools, such as Cisco Prime Infrastructure or third-party tools, for step-by-step setup information.

Audience

This guide is intended for Cisco equipment providers, partners, and networking teams who are technically knowledgeable and familiar with Cisco routers and Cisco IOS software and features.

Organization

This guide is organized into the following sections.

Table 1 Organization

Chapter	Name	Description
Chapter 1	Business Overview	Describes how the Cisco AVC solution can address challenges faced by enterprise network administrators.
Chapter 2	Technology Overview	Overview of the Cisco AVC solution, including benefits, features, architecture, and interoperability.
Chapter 3	AVC Licensing and Feature Activation	Describes Cisco AVC licensing and feature activation, including temporary feature activation without a license.
Chapter 4	AVC Configuration	Describes configuration within the Cisco AVC solution, including examples.
Chapter 5	Troubleshooting	Procedures for resolving configuration issues.
Chapter 6	AVC Notes, Limitations, and Caveats	Important limitations and caveats.
Appendix A	AVC Supported Platforms, Interfaces, and Networking Modes	Platforms that support Cisco AVC, and interfaces that AVC supports.
Appendix B	AVC Feature History	Highlights of new features and optimizations in recent AVC releases.
Appendix C	References	Related documentation.
Glossary	Glossary	Glossary of terms used in this guide.

Conventions

Table 2 lists the command conventions used in this documentations to convey instructions and information.

Table 2 Command Conventions

Convention	Description
bold font	Commands and keywords.
italic font	Variables for which you supply values.
[ ]	Optional keywords or arguments appear in square brackets.
{x | y | z}	Choice of required keywords appear in braces separated by vertical bars. You have to select one.
`screen font`	Examples of information displayed on the screen.
`boldface screen font`	Examples of information you have to enter.
< >	Nonprinting characters, for example: passwords, appear in angle brackets in contexts where italics are note available.
[ ]	Default responses to system prompts appear in square brackets.

Note Means *reader take note*. Notes contain helpful suggestions or references to additional information and material.

Caution This symbol means *reader be careful*. In this situation, you might do something that could result in equipment damage or loss of data.

Tip Means *the following information will help you solve a problem*. The tips information might not be troubleshooting or even an action, but could be useful information, similar to a Timesaver.

Related Documentation

For more information, see Appendix D, "References," or see: http://www.cisco.com/go/avc

Obtaining Documentation and Submitting a Service Request

For information on obtaining documentation, submitting a service request, and gathering additional information, see the monthly *What's New in Cisco Product Documentation*, which also lists all new and revised Cisco technical documentation:

http://www.cisco.com/en/US/docs/general/whatsnew/whatsnew.html

Subscribe to the *What's New in Cisco Product Documentation* as an RSS feed and set content to be delivered directly to your desktop using a reader application. The RSS feeds are a free service. Cisco currently supports RSS Version 2.0.

Business Overview

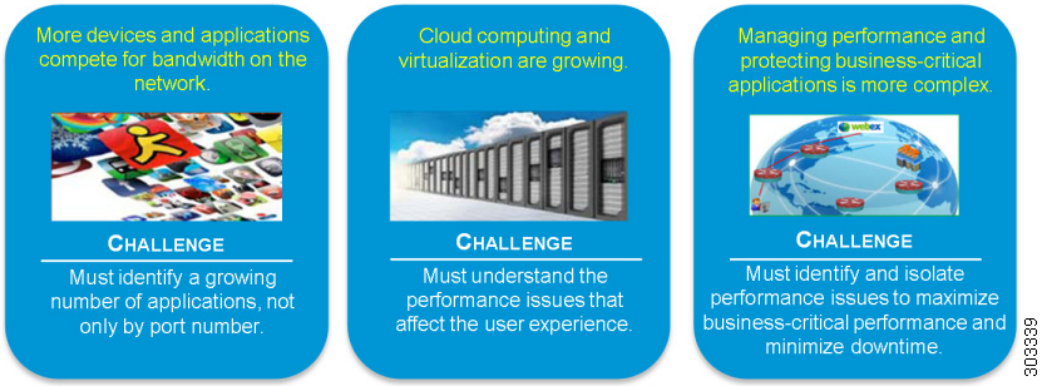
Introduction

Enterprise networks are carrying a growing volume of both business and recreational web traffic. Often business applications, including cloud applications such as Cisco WebEx, use the same HTTP and HTTPS protocols used by recreational web traffic. This complicates the task of optimizing network performance.Cisco Application Visibility and Control User Guide

To optimize network performance and define policy for each of the applications utilizing the network, administrators need detailed visibility into the different types of applications running on the network.

The Cisco Application Visibility and Control (AVC) solution offers truly innovative and powerful capabilities of application awareness in enterprise networks. AVC incorporates into the routing devices application recognition and performance monitoring capabilities traditionally available as dedicated appliances. This integrated approach simplifies network operations, maximizes the return on network investments, and reduces the total cost of ownership.

With application awareness built into the network infrastructure, plus visibility into the performance of applications running on the network, AVC enables per-application policy for granular control of application bandwidth use, resulting in a better end user experience.



Business Use Case

The following use case illustrates how Cisco AVC can improve the user experience.

A user asks: “Why is Exchange running so slowly?”

IT engineers need answers to questions such as:

- Is Exchange actually running slowly? What are the users seeing?
- Where is the delay: branch LAN, WAN, data center LAN, or server?
- If the delay is in the network, why?
  - Is there a problem with network quality?

    or
  - Are less critical types of traffic, such as device software upgrades or even streaming sporting events, crowding out the important business traffic?

To solve the problem, IT engineers need to determine the best option. Cisco AVC offers tools to help find the best option.

- De-prioritize or block competing non-critical traffic.

  Cisco QoS tools can help.
- Send different applications over different routes.

  Cisco Performance Routing (PfR) can help.
- Squeeze more traffic over the same WAN links.

  Cisco Wide Area Application Services (WAAS) WAN optimization can help.
- Reduce apparent application latency over the WAN.

  Cisco Wide Area Application Services (WAAS) application acceleration can help.

  Or...
- Need to add more capacity?

  Cisco AVC integration with management and reporting tools, such as Cisco Prime Infrastructure, can help provide the data needed for planning new capacity.

Technology Overview

This overview of AVC technology includes the following topics:

Overview

The Cisco Application Visibility and Control (AVC) solution leverages multiple technologies to recognize, analyze, and control over 1000 applications, including voice and video, email, file sharing, gaming, peer-to-peer (P2P), and cloud-based applications. AVC combines several Cisco IOS/IOS XE components, as well as communicating with external tools, to integrate the following functions into a powerful solution.

- **Application Recognition**

  Operating on Cisco IOS and Cisco IOS XE, NBAR2 utilizes innovative deep packet inspection (DPI) technology to identify a wide variety of applications within the network traffic flow, using L3 to L7 data.

  NBAR2 can monitor over 1000 applications, and supports Protocol Pack updates for expanding application recognition, without requiring IOS upgrade or router reload.

- **Metrics Collection and Exporting**

  Metric providers, an embedded monitoring agent, and Flexible NetFlow combine to provide a wide variety of network metrics data. The monitoring agent collects:

  - TCP performance metrics such as bandwidth usage, response time, and latency.
  - RTP performance metrics such as packet loss and jitter.

  Performance metrics can be measured at multiple points within the router.

  Metrics are aggregated and exported in NetFlow v9 or IPFIX format to a management and reporting package. Metrics records are sent out directly from the data plane when possible, to maximize system performance. When more complex processing is required, such as when the router is maintaining a history of exported records, records may be exported by the route processor, which is slower than direct export from the data plane.

- **Management and Reporting Systems**

  Management and reporting systems, such as Cisco Prime Infrastructure or third-party tools, receive the network metrics data in Netflow v9 or IPFIX format, and provide a wide variety of system management and reporting functions. These functions include configuring metrics reporting, creating application and network performance reports, system provisioning, configuring alerts, and assisting in troubleshooting.

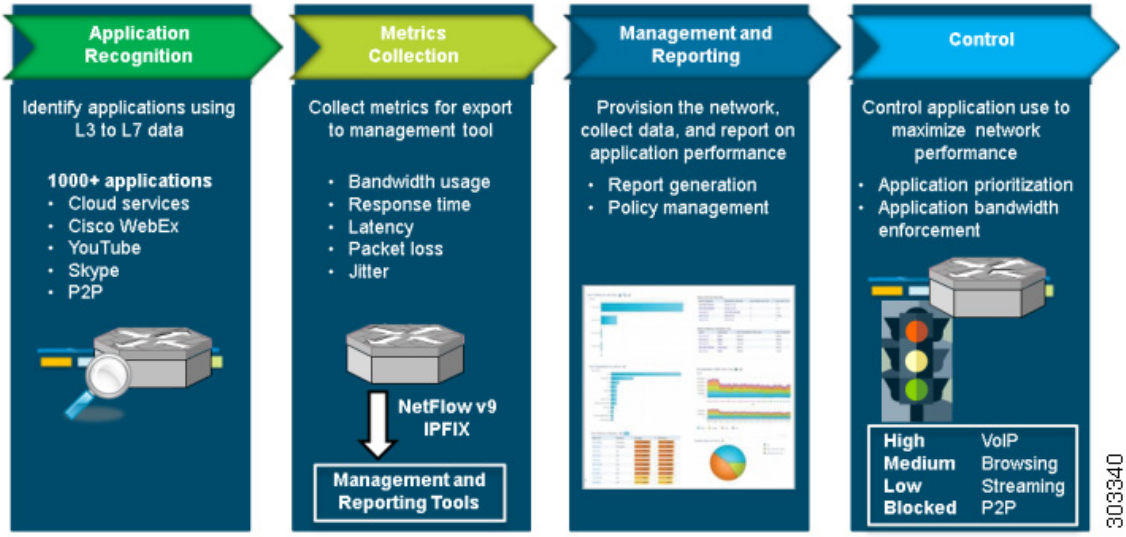
  Using the Cisco Prime Infrastructure management console, an administrator can configure each router in the network remotely using a GUI.

- **Control**

  Administrators can use industry-leading Quality of Service (QoS) capabilities to control application prioritization, manage application bandwidth, and so on. Cisco QoS employs the same deep packet inspection (DPI) technology used by NBAR2, to enable Cisco routers to reprioritize critical applications and enforce application bandwidth use.

Figure 2-1 provides a high level overview the functions of the Cisco AVC solution.

Figure 2-1 Functional Overview of the Cisco AVC Solution



AVC Features and Capabilities

Table 2-1 describes individual Cisco AVC solution features and their availability on Cisco IOS and Cisco IOS XE platforms. For a release-by-release history of AVC features and enhancements, see Appendix B, "AVC Feature History".

Table 2-1 AVC Features

Feature	Description	Available on IOS Platforms[1]	Available on IOS XE Platforms[2]
General			
Unified Solution	Cisco AVC combines application recognition, advanced metrics collection, sophisticated reporting, and network traffic control and optimization technologies into a unified solution.	Yes	Release 3.4S and later
Native IPv6 Support	Cisco AVC supports both IPv4 and IPv6.	Yes	Release 3.5S and later
Tunneled IPv6 Support	Support for tunneled IPv6 traffic.	Yes	Yes
Support on a wide range of Cisco routers operating with Cisco IOS and Cisco IOS XE	For details about supported platforms and feature activation, see: AVC Supported Platforms, page A-1 AVC Licensed Features (Legacy), page C-1	Yes	Yes
NBAR Interoperability with Cisco GET VPN	For information, see NBAR Interoperability with Cisco GET VPN, page 2-15.	—	Release 3.11S and later
AVC Interoperability with Cisco GET VPN	For information, see AVC Interoperability with Cisco GET VPN, page 2-16.	—	Release 3.12S and later
Adaptive AVC	Provides a mode with more limited application classification and reporting, for performance optimization. For information, see Adaptive AVC Reporting, page 2-17.	Release 15.4(3)T and later	Release 3.13S and later
Compatibility with L2 Transparent Mode (Local Switching)	A router operating in layer 2 transparent mode (local switching) bridges two interfaces, transparently forwarding packets directly from one interface to the other, without any other routing functionality. AVC can operate on a device configured in this mode, providing full AVC functionality on the bridged traffic. See AVC Compatibility with Layer 2 Transparent Mode, page A-3.	—	3.15S
Application Recognition			
Network Based Application Recognition 2 (NBAR2)	Provides application recognition. Uses an innovative deep packet inspection (DPI) technology to identify a wide variety of applications within the network traffic flow, using L3 to L7 data. NBAR2 can monitor over 1000 applications.	Yes	3.4S

Feature	Description	Available on IOS Platforms[1]	Available on IOS XE Platforms[2]
Protocol Pack updates	Expands NBAR2 application recognition without requiring IOS upgrade or router reload.	Yes	3.4S
Two levels of NBAR operation	NBAR2 can operate in fine-grain or coarse-grain modes. Fine-grain mode provides NBAR's full application recognition capabilities. Coarse-grain mode offers a performance advantage by minimizing deep packet inspection, and can be used in scenarios where the full power of fine-grain classification is not required. For information, see NBAR2 Fine-grain and Coarse-grain Modes, page 4-19.	Release 15.5(1)T and later	Release 3.14S and later
Metrics Collection			
Accounting	• Accounting of all metrics is performed by Flexible NetFlow (FNF) and the IPFIX exporter. • Multiple parallel monitors with overlapping data for the same traffic are permitted. • Flexible record keys provide different aggregation schemes for different traffic types.	Yes	3.4S
Account on Resolution (AOR)	Account-On-Resolution configures FNF to collect data in a temporary memory location until the record key fields are resolved. After resolution of the record key fields, FNF combines the temporary data collected with the standard FNF records. Account-on-resolution is useful when the field used as a key is not available at the time that FNF receives the first packet. When using Account-On-Resolution: • Flows ended before resolution are not reported. • On Cisco IOS XE platforms, FNF packet/octet counters, timestamp, and TCP performance metrics are collected until resolution. All other field values are taken from the packet that provides resolution or the following packets.	Yes	3.4S
Traffic Filtering	A policy-map defined in Cisco Common Classification Policy Language (C3PL) filters the traffic to be reported. Traffic filters operate separately from other types of policy-maps employed in the system.	Yes	3.4S
Interoperability with Cisco AppNav	Cisco AppNav is the Wide Area Application Services (WAAS) diversion mechanism. AVC provides statistics before and after the AppNav WAAS service controller (AppNav SC), as well as inspecting and reporting application information on optimized traffic. For more information about Cisco AppNav, see: http://www.cisco.com/en/US/prod/collateral/contnetw/ps5680/ps6474/white_paper_c11-705318.html	—	3.4S

Feature	Description	Available on IOS Platforms[1]	Available on IOS XE Platforms[2]
Packet Capture	Cisco Embedded Packet Capture (EPC) technology performs packet capture. For more information about Cisco EPC, see: http://www.cisco.com/en/US/products/ps9913/products_ios_protocol_group_home.html	—	3.4S
Reporting on Individual Transactions	Flexible NetFlow (FNF) monitors can report on individual transactions within a flow. This enables greater resolution for traffic metrics. For more information, see: Connection/Transaction Metrics, page 4-43	—	3.9S
QoS Metrics	Cisco AVC provides monitors to collect metrics related to Quality of Service (QoS) policy. Monitors can indicate: • Packets dropped on an interface, per QoS queue, due to a QoS policy that limits resources available to a specific type of traffic. • Class hierarchy (indicating traffic priority) of a reported flow, as determined by the QoS policy map. For more information, see: QoS Metrics: Cisco IOS XE Platforms, page 4-37	Yes	3.4S
Easy Performance Monitor Configuration	The Easy Performance Monitor ("Easy perf-mon" or "ezPM") feature provides an "express" method of provisioning monitors. Easy perf-mon provides "profiles" that represent typical deployment or use-case scenarios. After a user selects a profile and specifies a small number of parameters, Easy perf-mon provides the remaining provisioning details. For more information, see: Easy Performance Monitor (ezPM), page 4-4	15.4(1)T	3.10S
Customizing attribute values	See Customizing Attribute Values, page 4-30.	15.4(1)T	3.11S
Management and Reporting			
Cisco Prime Infrastructure 2.0 or later	The Cisco Prime Infrastructure management and reporting system is an integral part of the Cisco AVC solution and provides extensive management and reporting features, including provisioning the system, storing exported data, and generating reports. For more information about Cisco Prime Infrastructure, see: http://www.cisco.com/en/US/products/ps12239/index.html	Yes	3.4S

Feature	Description	Available on IOS Platforms[1]	Available on IOS XE Platforms[2]
Management and reporting products available from Cisco certified partners.	For information, see the Cisco Developer Network Solutions Catalog: http://marketplace.cisco.com/catalog 1. Select **Technology**. 2. In the **Technologies** list, select **Application Visibility and Control**. 3. Click **Find Solution**. A list of partner solutions appears. A **Cisco Compatible** logo indicates that the solution has passed compatibility tests with AVC. **Note** Operation of Solutions Catalog page is subject to change.	Yes	Yes

Feature	Description	Available on IOS Platforms[1]	Available on IOS XE Platforms[2]
Control			
Cisco Quality of Service (QoS)	See: • Cisco Quality of Service (QoS) • QoS Example 1: Control and Throttle Traffic, page 4-55 • QoS Example 2: Assigning Priority and Allocating Bandwidth, page 4-55	Yes	Yes

1. Applicable prior to Cisco IOS release 15.4(1)T where not specified.
2. Applicable prior to Cisco IOS XE release 3.11S where not specified.

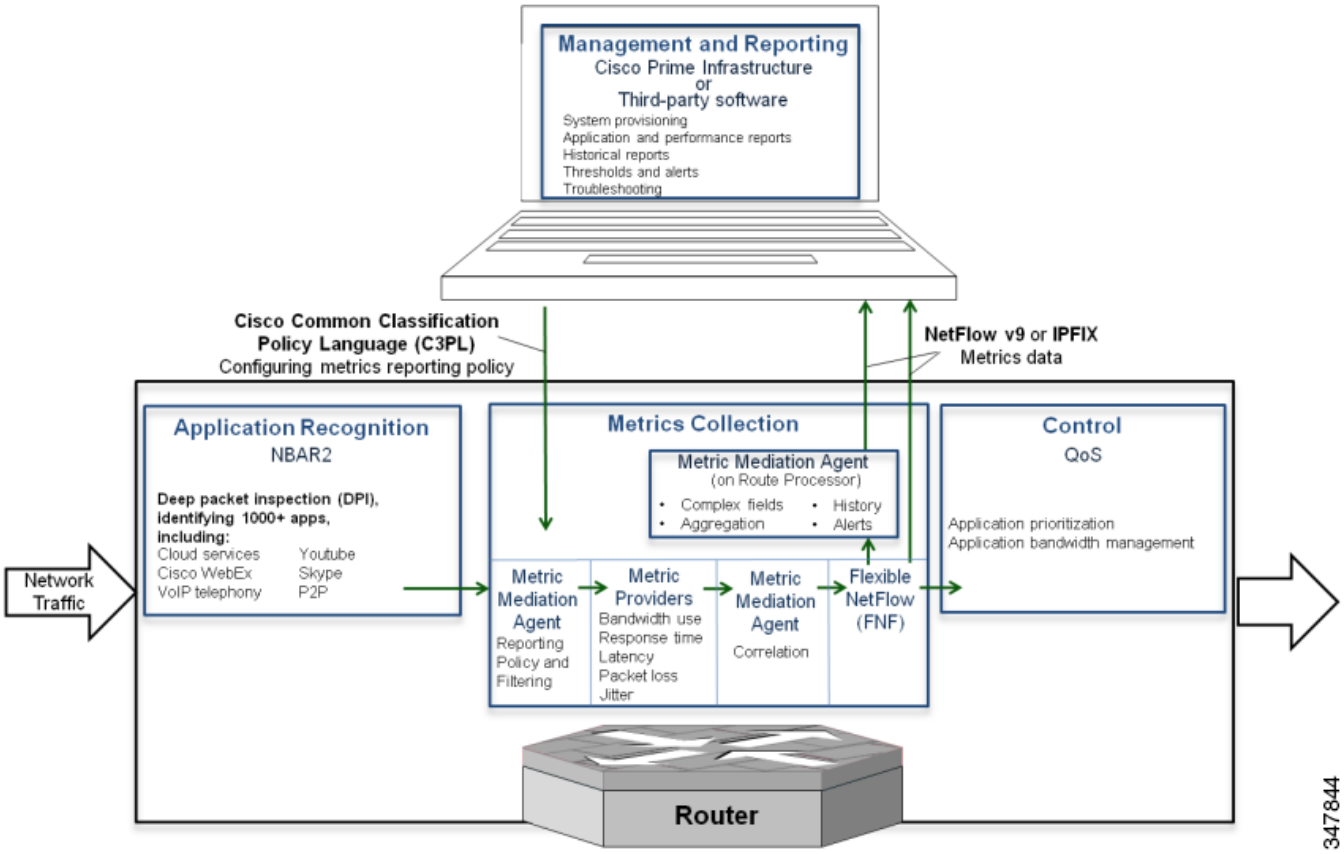
AVC Architecture

The following Cisco AVC components are described in this section:

- NBAR2, page 2-8
- Metric Mediation Agent, page 2-9
- Metric Providers, page 2-9
- Flexible NetFlow, page 2-10
- QoS, page 2-10
- Embedded Packet Capture, page 2-10
- Common Flow Table, page 2-10
- Management and Reporting Systems, page 2-11

Figure 2-2 describes the components in the Cisco AVC architecture.

Figure 2-2 AVC Architecture for Cisco IOS and Cisco IOS XE



NBAR2

Network Based Application Recognition 2 (NBAR2) provides native stateful deep packet inspection (DPI) capabilities. NBAR2 is the next generation of NBAR, enhancing the application recognition engine to support more than 1000 applications.

Note NBAR2 functionality requires an advanced license. See AVC Licensed Features (Legacy), page C-1.

NBAR2 provides powerful capabilities, including:

- Categorizing applications into meaningful terms, such as category, sub-category, application group, and so on. This categorization simplifies report aggregation and control configuration.
- Field extraction of data such as HTTP URL, SIP domain, mail server, and so on. The extracted application information can be used for classification or can be exported by IPFIX to the collector for creating reports.
- Customized definition of applications, based on ports, payload values, or URL/Host of HTTP traffic.
- The set of attributes for each protocol can be customized.

Additional Application Protocol Definitions

With NBAR2 Protocol Packs, new and updated application signatures can be loaded into a router without upgrading the software image. Major protocol packs providing new and updated signatures are released periodically. Minor protocol packs are released between major releases; they provide updates and bug fixes. For information about protocol pack support, see: http://www.cisco.com/en/US/docs/ios-xml/ios/qos_nbar/prot_lib/config_library/nbar-prot-pack-library.html

In addition to the predefined application protocols, you can create customized application definitions based on ports, payload values, or URL/Host of the HTTP traffic. Protocol attributes, such as application categorization, sub-categorization, application group, and so on, can also be customized.

For more information, see: http://www.cisco.com/go/nbar

Metric Mediation Agent

Cisco IOS Platforms	Cisco IOS XE Platforms
Added in release 15.4(1)T. Prior to this release, on Cisco IOS platforms, Cisco AVC made use of the Measurement, Aggregation, and Correlation Engine (MACE). Beginning with the current release, MMA replaces MACE functionality. AVC continues to support MACE, but users are encouraged to migrate to MMA. For links to information about MACE configuration, see Appendix D, "References".	Added in release 3.8S.

The Metric Mediation Agent (MMA) manages, correlates, and aggregates metrics from different metric providers. It provides the following functions:

- Controls traffic monitoring and filtering policy.
- Correlates data from multiple metric providers (see Metric Providers, page 2-9) into the same record.
- Aggregates metrics.
- Supports history and alert functions. This requires sending the metrics records to the route processor (RP) before exporting them to the management and reporting tools.

Metric Providers

Metric providers collect and calculate metrics and provide them to the Metric Mediation Agent (MMA) for correlation. There are a variety of metric providers: some collect simple, stateless metrics per packet, while other more complex metric providers track states and collect metrics per flow, transforming the metrics at the time of export and making sophisticated calculations. These transformations may require punting of records to the route processor (RP) before the metrics are exported to the management and reporting system.

The MMA compiles multiple metric providers of different types into the same record (see Metric Mediation Agent, page 2-9).

Flexible NetFlow

Netflow/IPFIX is the industry standard for acquiring operational data from IP networks to enable network planning, monitoring traffic analysis, and IP accounting. Flexible NetFlow (FNF) enables customizing traffic analysis parameters according to specific requirements. The AVC solution is compatible with NetFlow v9 (RFC-3954) and IPFIX (RFC-5101).

For more information, see: http://www.cisco.com/go/fnf

QoS

Cisco Quality of Service (QoS) provides prioritization, shaping, and rate-limiting of traffic. QoS can place designated applications into specific QoS classes/queues. This enables:

- Placing high priority, latency-sensitive traffic into a priority queue.
- Guaranteeing a minimum bandwidth for an individual application or for a group of applications within a QoS traffic class.

Similarly, QoS can also be used for "policing" or managing non-enterprise, recreational applications such as YouTube and Facebook.

The Cisco AVC solution integrates QoS functionality with NBAR2. QoS can use application information provided by NBAR2 in managing network traffic. The QoS class-map statements enable matching to NBAR2-supported applications and L7 application fields (such as HTTP URL or Host), as well as to NBAR2 attributes. Class-map statements can coexist with all other traditional QoS match attributes, such as IP, subnet, and DSCP.

For more information, see: http://www.cisco.com/go/qos

Embedded Packet Capture

Cisco IOS Platforms	Cisco IOS XE Platforms
Not available	Added in release 3.8S

Embedded Packet Capture (EPC) enables capturing the entire traffic for a given traffic class. The capture is limited only by available memory. The management and reporting system can read packets captured as a packet capture (pcap) file.

For more information, see: http://www.cisco.com/go/epc

Common Flow Table

The Common Flow Table (CFT) manages L4 connections and enables storing and retrieving states for each flow. Using a common flow table optimizes use of system memory and improves performance by storing and running data for each flow only once. The CFT standardizes flow management across the entire system.

Management and Reporting Systems

Cisco AVC operates with a variety of management and reporting systems.

- **Cisco Prime Infrastructure Management and Reporting**—For additional information, see Cisco Prime Infrastructure, page 2-11.
- **Third-Party Management and Reporting Solutions**—Cisco certifies solutions for AVC through the Cisco Developer Network. For a list of certified third-party management solutions, see the Cisco Developer Network Solutions Catalog:

  1. Navigate to http://marketplace.cisco.com/catalog
  2. Select **Technology**.
  3. In the **Technologies** list, select **Application Visibility and Control**.
  4. Click **Find Solution**. A list of partner solutions appears. A **Cisco Compatible** logo indicates that the solution has passed compatibility tests with AVC.

Note Operation of the Solutions Catalog page is subject to change.

Cisco Prime Infrastructure

Cisco Prime Infrastructure provides infrastructure lifecycle management and end-to-end visibility of services and applications for improved troubleshooting. It combines the solution lifecycle from design phase to monitor and troubleshooting phase.

For configuration, Cisco Prime Infrastructure has a provisioning GUI and built-in templates for enabling AVC capabilities on network devices.

For monitoring, Cisco Prime Infrastructure leverages the rich information provided by the network infrastructure, such as routers, and provides network administrators with a single tool for monitoring both network and application performance.

Network administrators can use Cisco Prime Infrastructure to drill down from an enterprise-wide network view to an individual user at a site, to proactively monitor and troubleshoot network and application performance problems.

For more information, see: http://www.cisco.com/go/primeinfrastructure

Interoperability of AVC with other Services

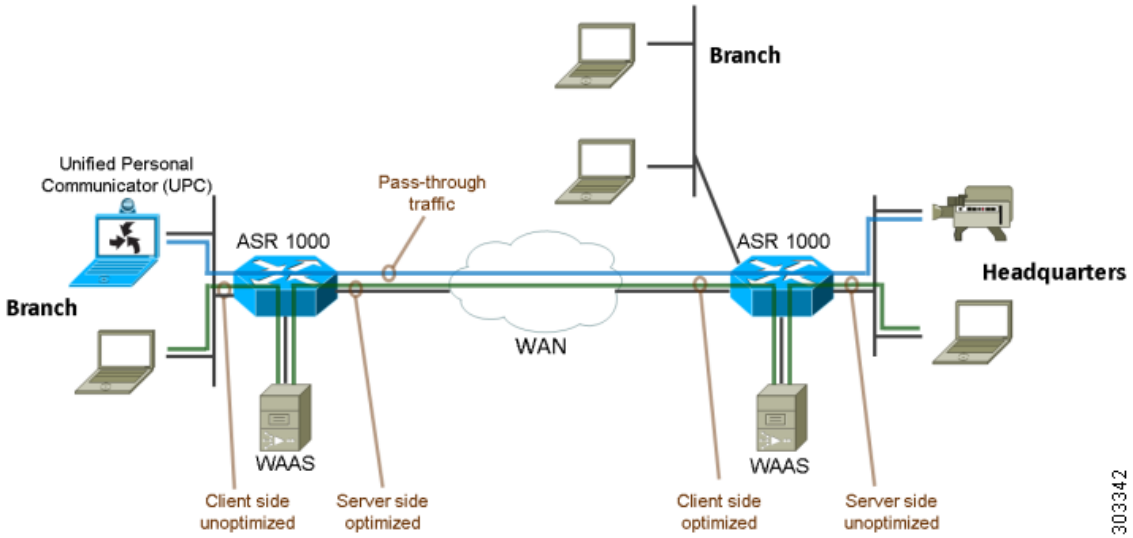
Cisco AVC is interoperable with many router features and services. This section provides additional information about AVC integration with AppNav WAAS, NAT, and VRF.

Interoperability with AppNav WAAS

Cisco IOS Platforms	Cisco IOS XE Platforms
Not available	Added in release 3.8S

Figure 2-3 shows a typical deployment scenario for Cisco AVC, demonstrating the integration with WAAS and the combination of optimized and pass-through traffic.

Figure 2-3 Typical AVC Deployment

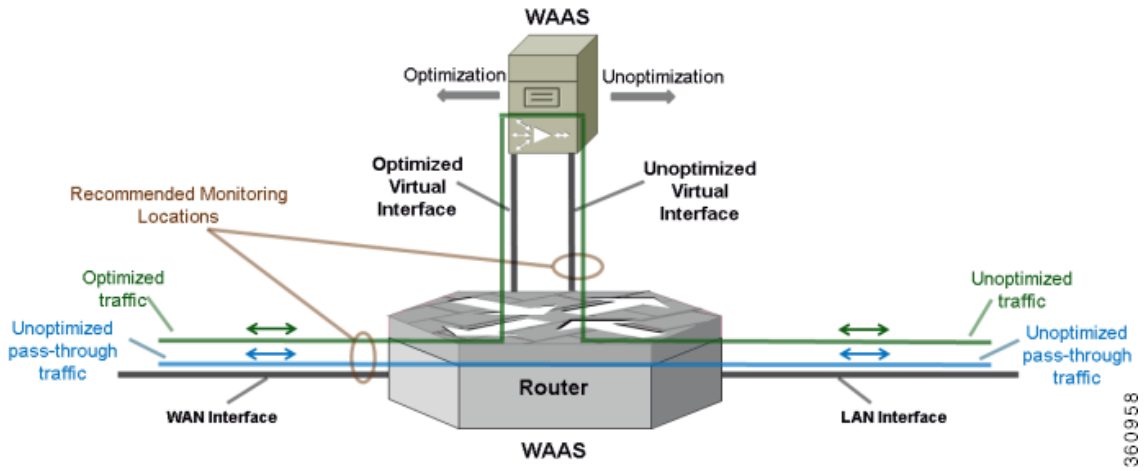


Attachment to a WAAS-Enabled Interface

Cisco Wide Area Application Services (WAAS) provides WAN optimization and application acceleration. The Cisco AVC solution operates closely with Cisco WAAS, reporting performance on both optimized and unoptimized traffic.

Figure 2-4 shows two recommended locations for metric collection. The monitoring location on the WAN interface collects metrics for optimized and unoptimized traffic. The monitoring location on the unoptimized virtual interface collects metrics for unoptimized traffic.

Figure 2-4 Recommended WAAS Monitoring Points



Because optimized traffic may be exported twice (pre/post WAAS), a new segment field, servicesWaasSegment, is exported within the record in order to describe the type of traffic at the monitoring location. Table 2-2 describes the segment definitions.

Table 2-2 AppNav "servicesWaasSegment" Field Values

Value	Description
0	Unknown
1	Client unoptimized
2	Server optimized
4	Client optimized
8	Server unoptimized
16	Pass-through

For pass-through traffic (bypassing WAAS), the servicesWaasPassThroughReason field indicates the reason for pass-through. See the *Cisco Application Visibility and Control Field Definition Guide for Third-Party Customers* for a description of this field.

Application Recognition on Optimized Traffic

The interoperability of Cisco AVC and WAAS enables executing traffic policies and monitoring on optimized traffic, utilizing NBAR2 application recognition.

Note When using WAAS, application L7 fields are only supported on unoptimized traffic. URL records must be attached on the unoptimized AppNav virtual interface.

Reported Input/Output Interfaces

Table 2-3 describes the input/output interface field values used by AppNav when a monitor is attached to the WAN, LAN, or an AppNav virtual interface.

Table 2-3 AppNav Exported Interfaces

Interface	Direction	Input interface value	Output interface value
WAN	Ingress	WAN	LAN
WAN	Egress	LAN	WAN
Optimized VI	Ingress	Optimized VI	LAN
Optimized VI	Egress	WAN	Optimized VI
UnOptimized VI	Ingress	UnOptimized VI	LAN
UnOptimized VI	Egress	LAN	UnOptimized VI
LAN	Ingress	LAN	WAN
LAN	Egress	WAN	LAN

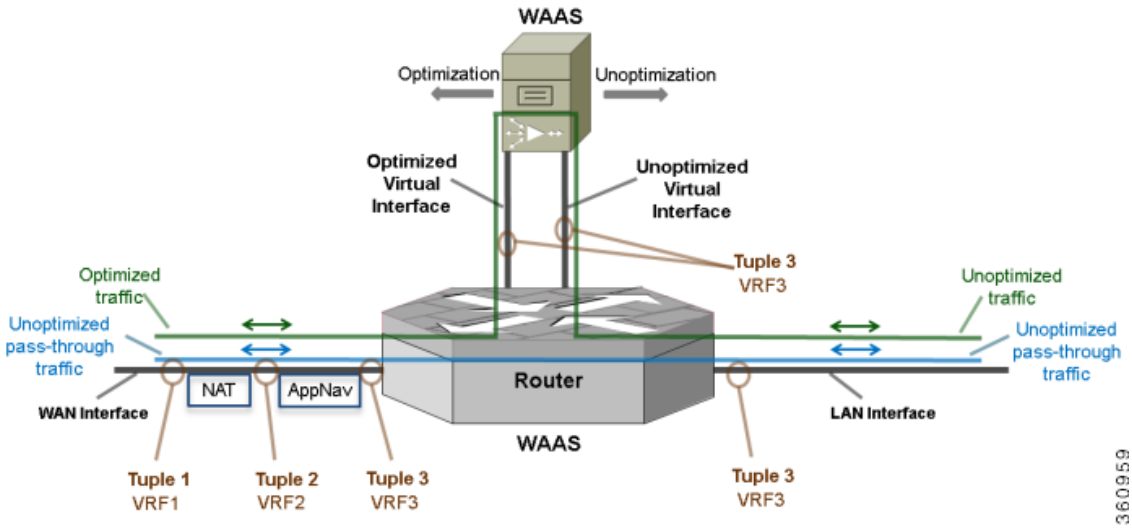
AppNav Interoperability with NAT and VRF

Cisco IOS Platforms	Cisco IOS XE Platforms
Not available	Added in release 3.8S

When AppNav is enabled, it uses the virtual routing and forwarding (VRF) configuration of the LAN interface although it is installed on the WAN interface. AppNav uses the LAN VRF to divert traffic to WAAS, based on local addresses.

Up to three tuples can be used per flow. Figure 2-5 shows an example. Using more than one tuple can be necessary because of different VRF configurations and/or NAT translation. The NBAR/FNF/AppNav features in the path interact together using the same flow.

Figure 2-5 AppNav Interaction in VRF/NAT Cases



NBAR Interoperability with Cisco GET VPN

Cisco IOS Platforms	Cisco IOS XE Platforms
Not available	Added in release 3.11S

Background

Cisco Group Encrypted Transport VPN (GET VPN) is a tunnel-less VPN technology designed to provide the security of encrypted communication, with high media performance, such as lower audio/video latency, and advanced provisioning and management abilities. When using GET VPN, the router performs the encryption and decryption of the VPN traffic.

Encrypted Traffic and NBAR Functionality

Prior to IOS XE release 3.11S, for encrypted traffic, the NBAR component operated on the traffic in its encrypted form. As a result, NBAR was not able to provide deep packet inspection of GET VPN traffic.

Beginning with release 3.11S, NBAR operates on clear traffic (after decryption for ingress, before encryption for egress). This enables running output QoS on inspected applications. In this release, input QoS and reporting in this release continue to operate on encrypted traffic.

To revert to the NBAR functionality that existed prior to release 3.11S, use the following command:

```
ip nbar disable classification encrypted-app
```

Note Enabling NBAR to operate on encrypted traffic requires additional processing, which may impact overall performance.

Limitations

The following limitations apply to NBAR interoperability with GET VPN:

- As in previous releases, QoS continues to operate on ingress traffic in its encrypted form, utilizing application identification information provided by the NBAR legacy component.
- In this release, only the operation of NBAR and QoS output have changed. AVC visibility functionality is not supported for GET VPN encrypted traffic.

Related Topics

- For more information about Cisco GET VPN, see Group Encrypted Transport VPN.
- AVC Interoperability with Cisco GET VPN, page 2-16

AVC Interoperability with Cisco GET VPN

Cisco IOS Platforms	Cisco IOS XE Platforms
Not available	Added in release 3.12S

Background

Cisco Group Encrypted Transport VPN (GET VPN) is a tunnel-less VPN technology designed to provide the security of encrypted communication, with high media performance, such as lower audio/video latency, and advanced provisioning and management abilities. When using GET VPN, the router performs the encryption and decryption of the VPN traffic.

Encrypted Traffic and AVC Functionality

Beginning with Cisco IOS XE 3.12S, when GET VPN is configured, AVC operates on clear text traffic (after decryption for ingress to the interface, before encryption for egress from the interface).

This clear text functionality applies to the following traffic types:

- IPv4 unicast
- IPv4 multicast
- IPv6 unicast
- IPv6 multicast

The feature does not apply to the following:

- Virtual (tunnel) interfaces
- Native FNF monitors attached to the same interface

FNF Native Monitors

FNF native monitors continue to operate in the same way as prior to release 3.12S, operating on traffic on the encrypted side.

Overriding AVC Operation on Clear Text

The default behavior when using GET VPN is for AVC to operate on clear text.

In special circumstances, it may be useful to disable the feature enabling AVC to operate on clear text. To revert to the AVC functionality that existed prior to release 3.12S, use the following command (in general configuration mode):

```
performance monitor observation-point encrypted-text
```

Example

To disable the feature on all policies attached to interfaces configured with GET VPN:

```
Device# configure t
Device(conf)# performance monitor observation-point encrypted-text
```

Limitations

The following limitations apply to AVC interoperability with GET VPN:

- For performance monitors, FNF on the egress side operates on traffic before encryption. Consequently, the accounting includes egress traffic that might be dropped later by other features, such as QoS and ACL.
- For performance monitors, FNF on the egress side operates before QoS. Consequently, QoS class hierarchy and QoS queue ID cannot be collected.
- The following L2 fields cannot be matched or collected:
  - datalink destination-vlan-id
  - datalink mac source address output
- When Perf-mon and native FNF are configured on an interface and operating in full GET VPN interoperability mode, native FNF monitors do not support account on resolution (AOR). Do not configure AOR on these monitors.
- AVC cannot operate on both clear and encrypted traffic.
- AVC interoperability with GET VPN is not supported on tunnel interfaces.

Related Topics

- For more information about Cisco GET VPN, see Group Encrypted Transport VPN.
- NBAR Interoperability with Cisco GET VPN, page 2-15

Adaptive AVC Reporting

Cisco IOS Platforms	Cisco IOS XE Platforms
Coarse-grain reporting added in release 15.4(3)T	Coarse-grain reporting added in release 3.13S

The Cisco AVC solution can operate in different modes—“working points”—to adapt to various deployments and use cases. This feature, known as Adaptive AVC Reporting, provides options to operate in a more powerful “fine grain” mode, with more extensive, granular application reporting, or in a “coarse grain” mode with application-level statistics reporting in place of detailed flow-level metrics.

Note Prior to Cisco IOS 15.4(3)T and IOS XE 3.13S, AVC operated only in the fine grain mode.

Selecting a Mode

Selecting the AVC mode to use depends on use case objectives. Easy Performance Monitor (ezPM) provides an "express" method for configuring AVC in one of these modes. (See Easy Performance Monitor (ezPM), page 4-4.)

- Fine-grain mode: The ezPM "Application Experience" profile provides extensive, fine-grain reporting, including flow-level performance monitoring metrics. (See Application Experience Profile, page 4-5.)
- Coarse-grain mode: The ezPM "Application Statistics" profile provides a simpler level of AVC functionality, especially suitable to the common use cases of capacity planning and troubleshooting network congestion. This mode reports top application usage and the bandwidth utilized by each application. (See Application Statistics Profile, page 4-10.)

Comparison of Fine-Grain and Coarse-Grain AVC Functionality

Table 2-4 compares fine-grain and coarse-grain AVC functionality.

Table 2-4 Comparison: Fine-Grain and Coarse-Grain Functionality

	Fine-Grain AVC Functionality "Application Experience" ezPM Profile	Coarse-Grain AVC Functionality "Application Statistics" ezPM Profile
Use Cases		
	All AVC use cases, including detailed reporting of all flows. Includes: • Performance metrics per application • Field extraction (Host/URL)	Optimized for common use cases, such as capacity planning or troubleshooting network congestion. Provides information on top applications in the network and the bandwidth utilized by those applications. Detailed flow-level metrics or performance metrics are not in the scope of coarse-grain reporting. Includes: • Network/Site/Device/Link planning • Top applications • Clients/servers

	Fine-Grain AVC Functionality "Application Experience" ezPM Profile	Coarse-Grain AVC Functionality "Application Statistics" ezPM Profile
Reporting		
Functionality	Reporting includes: • ART and media performance metrics • URL and other field extraction • Ability to filter a subset of interface traffic and use different reports for different traffic types • Account-On-Resolution (AOR)	Reporting includes: • Bytes, packets, flows reported per application, interface, direction, protocol, and IP version • Top clients/servers per application (optional) • All interface traffic—no option to filter the monitored traffic

Combining Fine and Coarse-Grain Working Points

Some use cases may require a combination of fine and coarse-grain working points. For example, it may be necessary to configure coarse-grain monitoring for all interface traffic, with fine-grain monitoring for a small subset of the traffic.

To achieve this, it is possible to define multiple contexts operating in parallel: one for a coarse-grain working point and another for fine-grain.

Note It is not possible to combine two fine-grain contexts on the same interface.

Example Use Case

As an example use case, it may be necessary to define a configuration that:

- Provides coarse-grain monitoring for all traffic on an interface.
- Reports performance metrics for specific critical applications. This would require defining fine-grain monitoring for that application traffic.

Configuration Example

For an examples of configuring two contexts on a single interface, one for fine-grain reporting and another for coarse-grain, see ezPM Configuration Example 5: Fine-grain and Coarse-grain Contexts Configured on a Single Interface, page 4-53.

Notes and Limitations

Cisco IOS Platforms

- Defining multiple contexts to combine fine and coarse-grain monitoring is not available in this release.

Cisco IOS XE Platforms

- It is possible to combine one fine-grain and one coarse-grain context on a single interface, but not two fine-grain contexts.

AVC Licensing and Feature Activation

This chapter addresses Cisco AVC feature licensing and includes the following topic(s):

Overview

Activating full AVC functionality requires feature licensing. License and activation details vary according to the platform and OS.

Table 3-1 Licensing Information

Device	See...
Devices using Cisco IOS XE Gibraltar 16.10.1	AVC and Cisco Smart Licensing, page 3-1
Devices using Cisco IOS XE releases earlier than IOS XE Gibraltar 16.10.1	Legacy: AVC Licensing and Feature Activation, page C-1
Devices using Cisco IOS	Legacy: AVC Licensing and Feature Activation, page C-1

AVC and Cisco Smart Licensing

Beginning with Cisco IOS XE Gibraltar 16.10.1, the feature licensing model for Cisco routers moved to Cisco Smart Software Licensing (SL). For information about activating Cisco Smart Software Licensing, see Cisco Smart Licensing Client.

Smart Software Licensing offers a simple, flexible approach to feature licensing. The following table summarizes the typical license requirements for Cisco AVC functionality, before and after the IOS XE Gibraltar 16.10.1 release.

Table 3-2 Before and After Smart Software Licensing

	Required OS Image	Image License	Required Feature License
Before Smart Software Licensing (pre-16.10.1)	Universal	Standard/Base, Advanced (AIS/AES), Premium	Application Experience (AppX)
Smart Software Licensing (16.10.1 and later)	Universal	Standard/Base	Not Recommended. No support for advanced NBAR or AVC features, or for Cisco SD-AVC.
	Universal	Advanced (AIS/AES), Premium	Smart Software Licensing Supports advanced NBAR and AVC features, and supports Cisco SD-AVC.

Upgrading to Cisco IOS XE Gibraltar 16.10.1 or Later

If you are planning to upgrade a device that operates with AVC, from a pre- Cisco IOS XE 16.10.1 release to 16.10.1 or later, check the table above for license requirements. Obtain the required licenses to support AVC functionality.

Note Because of the specific license requirements for devices using IOS XE Gibraltar 16.10.1, upgrading to 16.10.1 or later without the correct license can cause problems with AVC functionality.

Licensing Requirements for Cisco SD-AVC

Cisco SD-AVC system requirements are different for:

- The device hosting the SD-AVC network service component
- The SD-AVC agent components operating on devices in the network

For devices operating with IOS XE Gibraltar 16.10.1 or later, the following table shows license requirements for SD-AVC components,

Table 3-3 SD-AVC License Requirements, IOS XE 16.10.1 or Later

Device	Image License	Feature License
Device hosting the SD-AVC network service	No license requirements	No license requirements
Network devices running the SD-AVC agent	Advanced (AIS/AES) or Premium	Smart Software Licensing

AVC Configuration

This chapter addresses Cisco AVC configuration and includes the following topics:

Recent Configuration Enhancements and Limitations

Table 4-1 describes select configuration features added in recent releases, and limitations. It does not include all configuration features or limitations.

Table 4-1 Configuration Features and Enhancements

Feature	IOS Platforms	IOS XE Platforms	Information/Limitations
Easy Performance Monitor "express" method of provisioning monitors	Added in IOS 15.4(1)T	Added in IOS XE 3.10S	For information, see Easy Performance Monitor (ezPM), page 4-4
Support for configuring 40 fields for each FNF record	Not applicable	Added in IOS XE 3.10S	For limitations, see: Downgrading to an IOS XE Version that Does Not Support More than 32 Fields, page 6-5
CLI field aliases	Added in IOS 15.4(1)T	Added in IOS XE 3.10S	For limitations, see: Removing Aliases before Downgrading from Cisco IOS 15.4(1)T / Cisco IOS XE 3.10 or Later, page 6-5
Export Spreading	Added in IOS 15.4(1)T	Added in IOS XE 3.11S	For information, see NetFlow/IPFIX Flow Monitor, page 4-23
ezPM Application Statistics profile	Added in IOS 15.4(3)T	Added in IOS XE 3.13S	For information, see Application Statistics Profile, page 4-10 For limitations, see Notes and Limitations, page 4-12
ezPM Application Performance profile	Added in IOS 15.5(1)T	Added in IOX XE 3.14S	For information, see Application Performance Profile, page 4-8 For limitations, see: Notes and Limitations, page 4-10
Support for multiple policies on an interface	Added in IOS 15.5(2)T	Added in IOS XE 3.14S	For information, see Configuring Multiple Policies on an Interface, page 4-17 For limitations, see: Exceeding Supported Number of Policies, page 4-18
NBAR2 fine-grain and coarse-grain modes	Added in IOS 15.5(1)T	Added in IOX XE 3.14S	For information, see NBAR2 Fine-grain and Coarse-grain Modes, page 4-19
Option to specify the cache timeout (exporting interval), for exporting cached NetFlow records.	Added in IOS 15.5(2)T	Added in IOX XE 3.15S	For information, see the interval-timeout parameter at ezPM Configuration Options, page 4-14

Configuring Monitors: Full-featured vs. Express Methods

Cisco AVC provides two methods for configuring monitors:

- Performance Monitor—Full-featured
- Easy Performance Monitor (ezPM)—Simplified method

See Table 4-2 for details.

Table 4-2 Comparison: Performance Monitor and ezPM

	Performance Monitor	Easy Performance Monitor (ezPM)
Advantages	Full-featured, offering complete control of policy and class maps	Simplified express configuration method
Configuration Steps	1. Define class maps. 2. Define policy maps. 3. Attach one or more policies to an interface. (For limitations, see Configuring Multiple Policies on an Interface, page 4-17.)	1. Select a preconfigured ezPM profile. 2. Select monitor types. 3. Attach one or more ezPM "contexts" to an interface. (For limitations, see Configuring Multiple Policies on an Interface, page 4-17.)
Details	*Application Visibility and Control Configuration Guide, Cisco IOS Release 15M&T* *Application Visibility and Control Configuration Guide, Cisco IOS XE Release 3S*	Easy Performance Monitor (ezPM), page 4-4
Configuration Examples	Performance Monitor Configuration Examples, page 4-48	ezPM Configuration Examples, page 4-50

Easy Performance Monitor (ezPM)

Cisco IOS Platforms	Cisco IOS XE Platforms
Added in release 15.4(1)T	Added in release 3.10S
In release 15.4(3)T added: • Application Statistics profile. See Application Statistics Profile, page 4-10. • cache-type parameter. See ezPM Configuration Options, page 4-14.	In release 3.13S added: • Application Statistics profile. See Application Statistics Profile, page 4-10. • cache-type parameter. See ezPM Configuration Options, page 4-14.
In release 15.5(1)T added: • Application Performance profile. See Application Performance Profile, page 4-8. • Application Experience profile: support for waas segment id	In release 3.14S added: • Application Performance profile. See Application Performance Profile, page 4-8.
In release IOS 15.5(2)T added: • interval-timeout parameter. See ezPM Configuration Options, page 4-14.	In release 3.15S added: • interval-timeout parameter. See ezPM Configuration Options, page 4-14.

Note Before downgrading to an earlier Cisco IOS XE release, review ISSU Limitations, page 6-5. Configurations that employ features introduced in a later Cisco IOS XE release are not compatible with earlier releases.

Overview

The Easy Performance Monitor (“Easy perf-mon” or “ezPM”) feature provides an “express” method of provisioning monitors. ezPM adds functionality without affecting the traditional, full-featured perf-mon configuration model for provisioning monitors.

Profiles

ezPM does not provide the full flexibility of the traditional perf-mon configuration model. ezPM provides “profiles” that represent typical deployment scenarios. See Profiles, page 4-5. ezPM profiles include:

- Application Experience (legacy only)
- Application Performance
- Application Statistics

After selecting a profile and specifying a small number of parameters, ezPM provides the remaining provisioning details.

For additional information about configuring ezPM, see:
Easy Performance Monitor

Multiple Policies

It is possible to configure multiple ezPM policies on a single interface. Multiple policies enable additional flexibility in metrics collection. Policies may overlap, collecting some of the same varieties of metrics, or different metrics altogether. One use case is to configure two policies on an interface, one collecting "coarse-grain" metrics and the other collecting "fine-grain" metrics. For information, see Configuring Multiple Policies on an Interface, page 4-17.

Profiles

The following sections describe ezPM profiles:

Application Experience Profile

Note Application Experience remains available only to support legacy configurations, but it is recommended to use the improved Application Performance profile for new configurations.

The Application Experience profile enables use of five different traffic monitors, described in Table 4-3.

Application Experience implements the improved data exporting model introduced in Cisco IOS XE 3.10S, which is optimized for maximum performance, exporting the maximum possible amount of available information for monitored traffic. Based on the requirements of the reports that have been defined:

- For each type of traffic, the exported record contains all of the collected data required for the defined reports, with the required granularity.
- Exported records do not contain unnecessary data, such as data redundant with previously exported records or data that is not required for the defined reports.
- Exported records include server information.

Monitor Details

Table 4-3 Application Experience Traffic Monitors

	Monitor Name	Default Traffic Classification
1	Application-Response-Time (ART)	All TCP
2	URL	HTTP applications[1]
3	Media	RTP applications over UDP
4	Conversation-Traffic-Stats	Remaining traffic not matching other classifications
5	Application-Traffic-Stats	DNS and DHT

1. The ezPM URL monitor is configured by default with a pre-defined class that contains a subset of HTTP-based protocols. To modify the list of monitored HTTP protocols, use the **class-replace** command (see Configuring Easy Performance Monitor) or configure the monitor manually. In the Application Performance profile, the URL monitor automatically supports all HTTP-based protocols supported by the protocol pack; no modification by CLI is required.

For the monitor parameters shown in Table 4-4, default values can be overridden to configure the monitors differently. For an example of how to configure parameters in the Application Experience profile, see ezPM Configuration Example 2: Application Performance Profile, page 4-50. (The example describes the Application Performance profile, but the configuration details are otherwise applicable to the Application Experience profile.)

Table 4-4 Application Experience Traffic Monitors: Configurable Parameters

Configurable Parameters	Monitor Name				
	Application-Response-Time (ART)	URL	Media	Conversation-traffic-stats	Application-stats
IPv4/IPv6	Y	Y	Y	Y	N
ingress/egress	N	N	Y	N	N
Traffic Class	class-and for application only class-replace	class-and for application only class-replace	class-and for application only class-replace	N	N
Sampler	N	Sampling Rate	N	N	N
Cache Size	Y	Y	Y	Y	Y
Cache Type	Y	N	N	Y	N
Interval Timeout	Y	Y	Y	Y	Y

Notes and Limitations

Cisco IOS Platforms

- **Context Limitation**—On Cisco IOS platforms, only one context can be attached to any single interface. The context can be from any currently available profile, such as Application Experience, Application Performance, or Application Statistics.

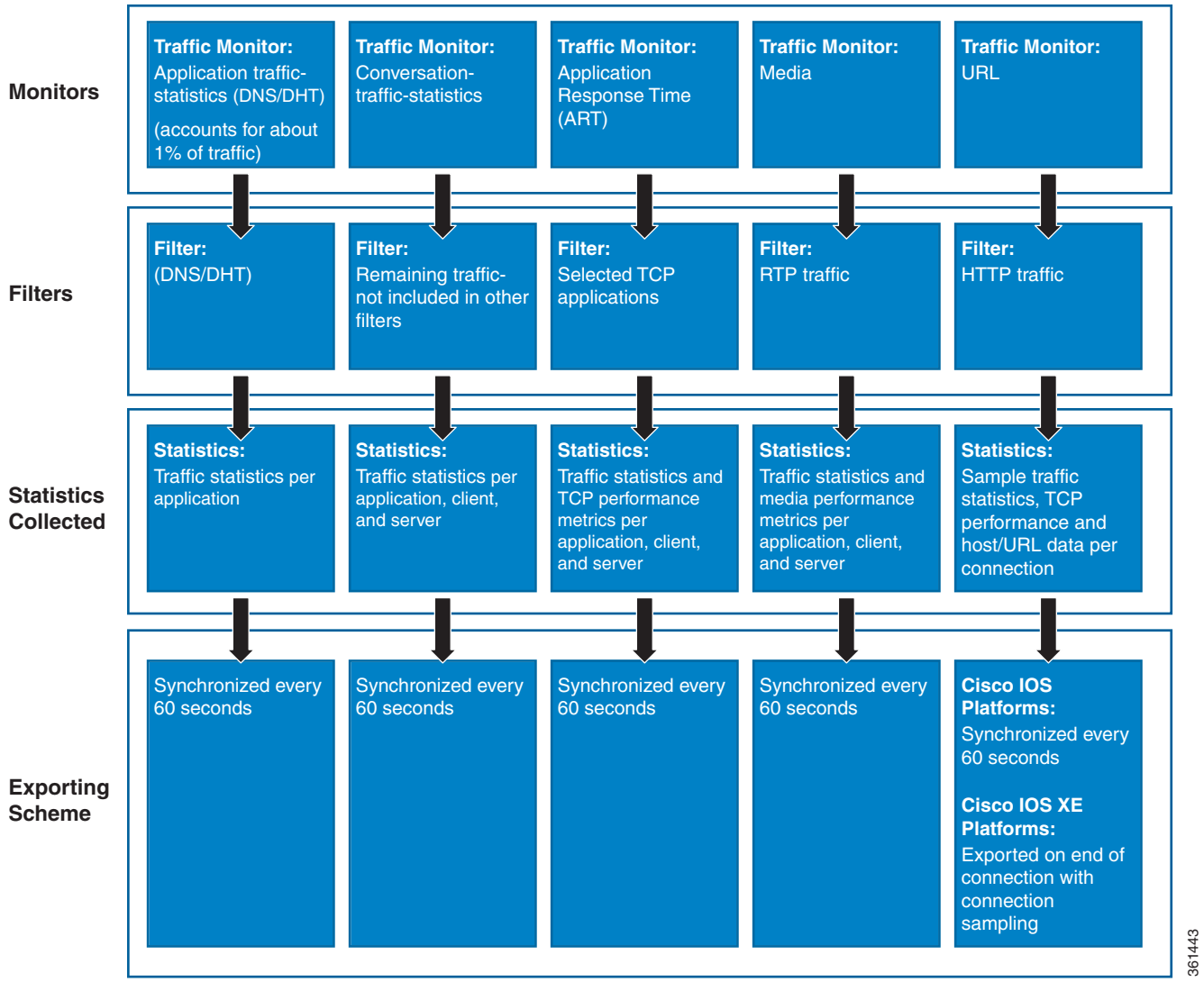
Cisco IOS XE Platforms

- **Infrastructure**—The Application Experience profile operates by provisioning performance monitor CLIs. It utilizes the performance monitor infrastructure, including performance monitor policy maps, performance monitor records, and so on.
- **Context Limitation**—For information about the total number of contexts that can be attached to a single interface, see Configuring Multiple Policies on an Interface, page 4-17.

Export Model

Figure 4-1 illustrates how the Application Experience profile exports different types of traffic statistics.

Figure 4-1 Export Model—Application Experience Profile



Application Performance Profile

Note The Application Performance profile is an improved form of the earlier Application Experience profile. Application Experience remains available to support legacy configurations, but it is recommended to use the Application Performance profile for new configurations. Table 4-6 describes the differences between the two profiles, including the improvements provided by the Application Performance profile.

The Application Performance profile enables use of five different traffic monitors, described in Table 4-6.

Application Performance implements the improved data exporting model introduced in Cisco IOS XE 3.10S, which is optimized for maximum performance, exporting the maximum possible amount of available information for monitored traffic. Based on the requirements of the reports that have been defined:

- For each type of traffic, the exported record contains all of the collected data required for the defined reports, with the required granularity.
- Exported records do not contain unnecessary data, such as data redundant with previously exported records or data that is not required for the defined reports.
- Exported records include server information.

Comparison with Application Experience Profile

The Application Performance profile is an improved form of the earlier Application Experience profile. Table 4-6 describes the differences.

Table 4-5 Application Experience vs. Application Performance Profiles

	Application Experience (legacy)	Application Performance
Handling of asymmetric routes within the router (a flow seen on different interfaces)	Monitors collect total interface output. Irregularities may occur in metrics for asymmetric routes.	Monitors collect all traffic per observation-point. This improves metrics accuracy in the case of asymmetric routes.
Traffic monitors using L3 vs. L4 bytes per packet	Traffic monitor counters relate only to the L4 information (and do not include L3).	Traffic monitor counters relate to the complete L3 information.
Defining HTTP/RTP traffic	URL and Media monitors rely on a list of specific applications to define HTTP/RTP traffic.	URL and Media traffic monitors use the NBAR class-hierarchy feature, which identifies all HTTP/RTP traffic without requiring a list of specific applications.
Specificity of URL traffic monitoring	URL monitor includes ART traffic.	Improved URL monitor specificity—does not include ART traffic.
ART metrics	—	Includes new ART metrics for 'long lived flows' and 'client/server retransmissions'.

	Application Experience (legacy)	Application Performance
Collecting host name and SSL	No	Yes[1] ART and application-client-server monitors include 'host name' and 'SSL common-name'
Monitoring non-TCP/UDP traffic	Conversation-Traffic-Stats monitor: Will have NULL in the IP addresses	Application-Stats
Cache type	Conversation-Traffic-Stats monitor: Cache type is **Synchronized**	Application-Client-Server-Stats monitor: Cache type is: • **Normal** (Cisco IOS XE platforms) • **Synchronized** (Cisco IOS platforms)
VRF	Part of the entries key	VRF is collected
Timestamp	—	Includes absolute interval start timestamp.

1. Cisco IOS XE platforms only

Monitor Details

Table 4-6 Application Performance Traffic Monitors

	Monitor Name	Default Traffic Classification
1	Application-Response-Time (ART)	All TCP
2	URL	HTTP applications
3	Media	RTP applications over UDP using transport hierarchy
4	Application-Client-Server-Stats	Remaining TCP/UDP traffic not matching other classifications
5	Application-Stats	Cisco IOS: Remaining TCP/UDP/ICMP traffic Cisco IOS XE: Remaining IP traffic

For the monitor parameters shown in Table 4-7, default values can be overridden to configure the monitors differently. For an example of how to configure parameters in the Application Performance profile, see ezPM Configuration Example 2: Application Performance Profile, page 4-50.

Table 4-7 Application Performance Traffic Monitors: Configurable Parameters

Configurable Parameters	Monitor Name				
	Application-Response-Time (ART)	URL	Media	Application-client-server-stats	Application-stats
IPv4/IPv6	Y	Y	Y	Y	N
ingress/egress	N	N	Y	N	N
Traffic Class	class-and for application only class-replace	class-and for application only class-replace	class-and for application only class-replace	N	N
Sampler	N	Sampling Rate[1]	N	N	N
Cache Size	Y	Y	Y	Y	Y
Cache Type	Y	N	N	Y	N
Interval Timeout	Y	Y	Y	Y	Y

1. Cisco IOS XE platforms only

Notes and Limitations

Cisco IOS Platforms

- **Context Limitation**—On Cisco IOS platforms, only a one context can be attached to any single interface. The context can be from any currently available profile, such as Application Performance or Application Statistics.
- **Interface Limitation**—When using ART, URL, or Application-Client-Server-Stats monitors, apply the ezPM Application Performance profile only to WAN interfaces.

Cisco IOS XE Platforms

- **Infrastructure**—The Application Performance profile operates by provisioning performance monitor CLIs. It utilizes the performance monitor infrastructure, including performance monitor policy maps, performance monitor records, and so on.
- **Context Limitation**—For information about the total number of contexts that can be attached to a single interface, see Configuring Multiple Policies on an Interface, page 4-17.

Application Statistics Profile

Application Statistics is a simpler profile than Application Performance (or the legacy Application Experience). In contrast to the Application Performance profile, it provides only application statistics and does not report performance statistics.

The Application Statistics profile provides two different traffic monitors, application-stats and application-client-server-stats, described in Table 4-8. The monitors operate on all IPv4 and IPv6 traffic.

Selecting a Monitor

The Application Statistics profile includes two monitors, but operates with only one or the other of the two monitors. It is not possible to run both monitors simultaneously, and doing so would not be useful because the **application-client-server-stats** monitor reports all of the same information as the **application-stats** monitor, plus additional information.

Consequently, when configuring this profile, the **traffic monitor all** command is not available.

Monitor Details

Table 4-8 Application Statistics Traffic Monitors

	Monitor Name	Traffic Classification
1	application-stats	All IPv4 and IPv6 traffic
2	application-client-server-stats	All IPv4 and IPv6 traffic

Table 4-9 indicates the parameters that can be set differently from the default values when configuring monitors in the Application Statistics profile.

Table 4-9 Application Statistics Traffic Monitors: Configurable Parameters

	Monitor Name	
Configurable Parameters	application-stats	application-client-server-stats
IPv4/IPv6	N	N
ingress/egress	Y	N
Traffic Class	N/A	N/A
Sampler	N	N
Cache Size	Y	Y
Cache Type	Y	Y
Interval Timeout	Y	Y

Notes and Limitations

Cisco IOS Platforms

- **Context Limitation**—On Cisco IOS platforms, only one context can be attached to any single interface. The context can be from any currently available profile, such as Application Performance or Application Statistics.
- **AOR**—Account on Resolution (AOR) is supported.
- **Infrastructure—**On Cisco IOS platforms, the Application Statistics profile operates by provisioning in the performance monitor infrastructure, similarly to the Application Performance (or Application Experience) profile.

  Although the Application Statistics profile operates using a different infrastructure on Cisco IOS XE platforms, provisioning is handled in the same way and the infrastructure differences are essentially transparent to the user.

Cisco IOS XE Platforms

- **AOR**—Account on Resolution (AOR) is not supported.
- **Infrastructure—**To provide maximum performance, on Cisco IOS XE platforms the Application Statistics profile operates by provisioning native FNF monitors on the interface. The profile does not include the complexity and flexibility of the performance monitor infrastructure, such as policy maps and so on.

  Although the Application Statistics profile operates using a different infrastructure on Cisco IOS platforms, provisioning is handled in the same way and the infrastructure differences are essentially transparent to the user.
- **GETVPN Interoperability**—Because the Application Statistics profile operates on Cisco IOS XE platforms using native FNF, and FNF monitors encrypted traffic, GETVPN interoperability is not supported on these platforms.
- **Context Limitation**—For information about the total number of contexts that can be attached to a single interface, see Configuring Multiple Policies on an Interface, page 4-17.

Configuring Easy Performance Monitor

Usage Guidelines

- Only traffic monitors available in the profile can be activated.
- Each traffic monitor is configured on a separate line. If only the traffic-monitor name is specified, the monitor is activated with the default configuration defined in the profile.

Configuration Steps

Note See Table 4-10 for information about which releases support each option.

1. **enable**
2. **configure terminal**
3. **performance monitor context** *context-name* **profile** *profile-name*

4. **exporter destination** {*hostname* | *ipaddress*} **source interface** *interface-type number* [**port** *port-value* **transport udp vrf** *vrf-name*]
5. (Optional) Repeat Step 4 to configure up to three (3) exporters.
6. **traffic monitor** {*traffic-monitor-name* [**ingress** | **egress**] } [[**cache-size** *max-entries*] | [**cache-type** {**normal** | **synchronized**}] | [{**class-and** | **class-replace**[1]} *class-name*] | **ipv4** | **ipv6**] [**sampling-rate** *number*] [**interval-timeout** *timeout*][2]
7. To configure additional traffic monitor parameters, repeat Step 6.
8. **exit**
9. **interface** *interface-type number*
10. **performance monitor context** *context-name*
11. **exit**

1. **class-and** and **class-replace** not applicable to Application Statistics profile
2. ezPM Configuration Options, page 4-14 indicates which traffic monitors support interval-timeout.

ezPM Configuration Options

Table 4-10 Easy Performance Monitor Configuration Options

Option	Description	Added in Release
profile *profile-name*	Profile type. Options include the following: • application-experience • application-performance • application-statistics	Application Experience profile: IOS 15.4(1)T IOS XE 3.10S Application Performance profile: IOS 15.5(1)T IOS XE 3.14S Application Statistics profile: IOS 15.4(3)T IOS XE 3.13S
traffic monitor *traffic-monitor-name*	Traffic monitor type. Options include the following: Application Experience profile: • url • application-response-time • application-traffic-stats • conversation-traffic-stats • media Application Statistics profile: • application-stats • application-client-server-stats	Application Experience profile: IOS 15.4(1)T IOS XE 3.10S Application Statistics profile: IOS 15.4(3)T IOS XE 3.13S
ingress **egress**	Selects whether monitor is active for ingress or egress traffic. If not specified, it is applied to both.	IOS 15.4(1)T IOS XE 3.10S

Option	Description	Added in Release

cache-size *max-entries*	Cache size: Maximum aggregate number of entries for all monitors.
	
	Examples
	The following example includes four monitors: IPv4 in, IPv4 out, IPv6 in, IPv6 out. Each monitor can have a maximum of 1000 entries.
	`traffic-monitor media cache-size 4000`
	
	The following example includes two monitors: IPv4 in, IPv4 out. Each monitor can have a maximum of 2000 entries.
	`traffic-monitor media ipv4 cache-size 4000`
		IOS 15.4(1)T
		IOS XE 3.10S

cache-type	Specifies the cache type as one of the following: • synchronized • normal	IOS 15.4(3)T IOS XE 3.13S
class-and *class-name*	Restrict the default traffic classification. *class-name* represents a user defined class-map. **Note**: Not applicable to the Application Statistics profile.	IOS 15.4(1)T IOS XE 3.10S
class-replace *class-name*	Replace the entire class hierarchy with a user pre-defined class. *class-name* represents a user defined class-map. **Note**: Not applicable to the Application Statistics profile.	IOS 15.4(1)T IOS XE 3.11S
ipv4 **ipv6**	Selects whether monitor is active for IPv4 or IPv6. Default: both	IOS 15.4(1)T IOS XE 3.10S

Option	Description	Added in Release
sampling-rate *number*	Optionally overrides the default traffic-monitor sampling rate. The range of possible sampling-rate values is determined by the platform. A value of 1 disables the sampler.	IOS: Not supported IOS XE 3.11S IOS XE 3.12S: Added option to enter 1 as a value.
interval-timeout *timeout*	Specifies the cache timeout (exporting interval) in seconds. At this interval, the cached NetFlow records are exported. Dependence on **cache-type**: • If **cache-type** is **normal**, this parameter defines the **active timeout**. • If **cache-type** is **synchronized**, this parameter defines the **synchronized timeout**. **Note (on Cisco IOS platforms)**: Within a single context, configure all timeouts to the same value. Default: 60 **Traffic Monitor Support** The following traffic monitors support **interval-timeout**: • Application Experience profile: – application-response-time – application-traffic-stats – conversation-traffic-stats – media – url (on Cisco IOS platforms only) • Application Statistics profile: – application-stats – application-client-server-stats • Application Performance profile: – application-client-server-stats – application-response-time – application-stats – media – url (on Cisco IOS platforms only) See ezPM Configuration Example 6: Configuring Cache Type and Interval Timeout, page 4-53.	IOS 15.5(2)T (see important note in the Description) IOS XE 3.15S

Configuration Examples

See: ezPM Configuration Examples, page 4-50.

Related Topics

For additional information about configuring ezPM, see:

Easy Performance Monitor

Configuring Multiple Policies on an Interface

Cisco IOS Platforms	Cisco IOS XE Platforms
Added in IOS 15.5(2)T	Added in release 3.14S

Multiple policies can be configured simultaneously on an interface. Policy types:

- ezPM “express” configuration
- Performance Monitor

Table 4-11 describes the number of policies that can be configured on an interface, according to platform type and IOS/IOS XE release.

Table 4-11 Number of Policies Possible to Configure on an Interface

Release	Maximum Policies Per Interface (per direction)[1]
Cisco IOS XE Platforms	
Cisco IOS XE 3.14S and later	Up to 3 ezPM policies Up to 3 Performance Monitor policies **Maximum total: 4**
Cisco IOS XE 3.10S (introduction of ezPM) to 3.13S	1 ezPM policy + 1 Performance Monitor policy **Maximum total: 2**
Cisco IOS Platforms	
All Cisco IOS releases	Up to 3 ezPM policies Up to 3 Performance Monitor policies **Maximum total: 6 ingress, 6 egress**

1. Configuring more than the maximum number of polices indicated here is not supported and causes unpredictable results. See Exceeding Supported Number of Policies, page 4-18.

No Change in Method of Configuration

Configuring multiply policies on an interface does not require any change in the configuration process. This is true even if more than one policy collects some of the same metrics.

Usefulness of Multiple Policies

Configuring multiple policies enables additional flexibility in metrics collection:

- Different provisioning clients can monitor the same target.
- A single client can create multiple contexts/policies.
- Each client receives monitor statistics separately.

Note Applying multiple policies to an interface causes some degradation of performance.

Use Cases

Use Case: Coarse-grain and Fine-grain Metrics

One use case is to configure two policies on an interface, one collecting “coarse-grain” metrics and the other collecting “fine-grain” metrics. The results are reported separately and can be used for entirely separate purposes.

Use Case: Diagnosing Network Problems

To diagnose network problems, a policy designed for troubleshooting can be added to an interface with an existing policy. The troubleshooting metrics are reported separately from the metrics collected by the existing policy.

Limitations

Exceeding Supported Number of Policies

The system does not prevent attempts to configure more than the total supported number of policies (see Table 4-11), such as configuring five (5) policies for a single direction on an interface. No error message is displayed. However, this is not supported and leads to unpredictable results.

Error Caused By Downgrading from Cisco IOS XE 3.14

For platforms operating with Cisco IOS XE 3.14S, ISSU downgrade to an earlier release when multiple policies have been configured on a single interface is not supported. Doing so causes a router error. For more information, see Error Caused By Downgrading from Cisco IOS XE 3.14, page 6-7.

NBAR2 Fine-grain and Coarse-grain Modes

Cisco IOS Platforms	Cisco IOS XE Platforms
Added in release 15.5(1)T	Added in release 3.14S
Beginning in 15.5(3)T, NBAR does not operate in fine-grain mode by default.	Beginning in 3.16S, NBAR does not operate in fine-grain mode by default.

NBAR provides two levels of application recognition—coarse-grain and fine-grain. Fine-grain mode provides NBAR's full application recognition capabilities.

Backward Compatibility

NBAR fine-grain mode is equivalent to NBAR functionality and performance prior to introduction of separate fine-grain and coarse-grain modes. This provides full backward compatibility for existing configurations.

Coarse-grain Mode: Features and Limitations

Features

By minimizing deep packet inspection, coarse-grain mode offers a performance advantage and reduces memory resource demands. This mode can be used in scenarios where the full power of fine-grain classification is not required. (See Recommended Usage, page 4-20.)

- **Simplified classification**: Coarse-grain mode employs a simplified mode of classification, minimizing deep packet inspection. NBAR caches classification decisions made for earlier packets, then classifies later packets from the same server similarly.
- **Media protocols**: Media protocol classification is identical to that of fine-grain mode.
- **Optimization**: The performance optimization provided by coarse-grain mode applies primarily to server-based and port-based protocols, including:
  - Protocols used in local deployments
  - Protocols used in cloud deployments
  - Encrypted traffic

Limitations

Coarse-grain mode limitations in metric reporting detail:

- **Field extraction** and **sub-classification**: Only partially supported. In coarse-grain mode, the reported results of field extraction and sub-classification are less accurate and may be sampled.
- **Granularity**: Caching may result in some reduction in the granularity. For example, NBAR might classify some traffic as **ms-office-365** instead of as the more specific **ms-office-web-apps**.
- **Evasive applications**: Classification of evasive applications, such as BitTorrent, eMule, and Skype, may be less effective than in fine-grain mode. Consequently, blocking or throttling may not work as well for these applications.

Recommended Usage

Use fine-grain mode when per-packet reporting is required. For any use case that does not require specific per-packet operations, coarse-grain mode is recommended, as it offers a performance and memory advantages.

Comparison of Fine-grain and Coarse-grain Modes

Table 4-12 compares fine-grain and coarse-grain modes.

Table 4-12 NBAR Fine-grain and Coarse-grain Modes

	Fine-Grain Mode	Coarse-Grain Mode
Classification	Full power of deep packet inspection	Simplified classification. Some classification according to similar earlier packets. See Limitations, page 4-19.
Performance	Slower	Faster
Memory Resources	Higher memory demands	Lower memory demands
Sub-classification	Full support	Partial support
Field Extraction	Full support	Partial support
Ideal Use Cases	Per packet policy **Example** class-map that looks for specific url	Any use case that does not require specific per-packet operations

Determining the Mode

The mode is determined by either of the following (#1 has higher priority):

1. CLIs to configure NBAR classification mode. These commands can override the mode selected by other means.

```
Device(config)#ip nbar classification granularity coarse-grain
Device(config)#ip nbar classification granularity fine-grain
```

2. Granularity selected by an NBAR client.

   Example:

   In this example, configuring an ezPM policy using the Application Statistics profile invokes the coarse-grain NBAR mode.

```
Device(config)#performance monitor context xyz profile application-statistics
Device(config-perf-mon)#traffic-monitor application-client-server-stats
Device(config)#int gigabitEthernet 0/2/2
Device(config-if)#performance monitor context xyz
```

Viewing the Configured NBAR Mode

The following CLI shows the currently configured mode (coarse-grain in the example output):

```
Device #show ip nbar classification granularity
NBAR classification granularity mode: coarse-grain
```

For details, see *NBAR Configuration Guide*.

Unified Policy CLI

Cisco IOS Platforms	Cisco IOS XE Platforms
Added in release 15.4(1)T	Added in release 3.8S

Monitoring a configuration is done using performance-monitor unified monitor and policy.

Configuration Format

```
policy-map type performance-monitor <policy-name>
   [no] parameter default account-on-resolution
   class <class-map name>
      flow monitor <monitor-name> [sampler <sampler name>]
      [sampler <sampler name>]
      monitor metric rtp
```

Usage Guidelines

- Supports:
  - Multiple flow monitors under a class-map
  - Up to 5 monitors per attached class-map
  - Up to 256 classes per performance-monitor policy
- No support for:
  - Hierarchical policy
  - Inline policy
- Metric producer parameters are optional.
- Account-on-resolution (AOR) configuration causes all classes in the policy-map to work in AOR mode, which delays the action until the class-map results are finalized (the application is determined by NBAR2).

Attaching a Policy

Attach a policy to the interface using following command:

```
interface <interface-name>
    service-policy type performance-monitor <policy-name> {input|output}
```

Displaying Policy Map Performance Monitor Data

Display policy map performance monitor data using the command below. Example output is shown here.

- On Cisco IOS platforms, the data is reported once per flow, either for the first packet of the flow or for the packet of resolution if AOR is enabled.
- On Cisco IOS XE platforms, the data is reported for all packets that match the policy map.

```
Router# show policy-map type performance-monitor interface
 Ethernet1/0

  Service-policy performance-monitor input: policy

    Class-map: classmap (match-all)
      20 packets, 1280 bytes
      5 minute offered rate 0000 bps, drop rate 0000 bps
      Match: access-group name seawolf_acl_ipv4_tcp

    Class-map: class-default (match-any)
      0 packets, 0 bytes
      5 minute offered rate 0000 bps, drop rate 0000 bps
      Match: any

  Service-policy performance-monitor output: policy

    Class-map: classmap (match-all)
      20 packets, 1160 bytes
      5 minute offered rate 0000 bps, drop rate 0000 bps
      Match: access-group name seawolf_acl_ipv4_tcp

    Class-map: class-default (match-any)
      0 packets, 0 bytes
      5 minute offered rate 0000 bps, drop rate 0000 bps
      Match: any
```

Metric Producer Parameters

Metric producer-specific parameters are optional and can be defined for each metric producer for each class-map.

Configuration Format

```
monitor metric rtp
    clock-rate {type-number| type-name | default} rate
    max-dropout number
    max-reorder number
    min-sequential number
    ssrc maximum number
```

Reacts

The **react** CLI defines the alerts applied to a flow monitor. The **react** CLI has a performance impact on the router. When possible, send the monitor records directly to the Management and Reporting system and apply the network alerts in the Management and Reporting system.

Note **Cisco IOS XE Platforms**: Applying reacts on the device requires punting the monitor records to the route processor (RP) for alert processing. To avoid the performance reduction of punting the monitor records to the RP, send the monitor records directly to the Management and Reporting system, as described above.

Configuration Format

```
react <id> [media-stop|mrv|rtp-jitter-average|transport-packets-lost-rate]
```

NetFlow/IPFIX Flow Monitor

Cisco IOS Platforms	Cisco IOS XE Platforms
export-spread feature added in IOS 15.4(1)T	**export-spread** feature added in IOS XE 3.11S

Flow monitor defines monitor parameters, such as record, exporter, and other cache parameters.

Configuration Format: Cisco IOS Platforms

```
flow monitor type performance-monitor <monitor-name>
    record <name | default-rtp | default-tcp>
    exporter <exporter-name>
    history size <size> [timeout <interval>]
    cache entries <num>
    cache timeout {{active | inactive} <value> | synchronized <value> {export-spread
    <interval>}}
    cache type {permanent | normal | immediate}
    react-map <react-map-name>
```

Configuration Format: Cisco IOS XE Platforms

```
flow monitor type performance-monitor <monitor-name>
    record <name | default-rtp | default-tcp>
    exporter <exporter-name>
    history size <size> [timeout <interval>]
    cache entries <num>
    cache timeout {{active | inactive} <value> | synchronized <value>
    {export-spread <interval>} event transaction end}
    cache type {permanent | normal | immediate}
    react-map <react-map-name>
```

Usage Guidelines

- The **react-map** CLI is allowed under the class in the policy-map. In this case, the monitor must include the exporting of the class-id in the flow record. The route processor (RP) correlates the class-id in the monitor with the class-id where the react is configured.
- Applying history or a react requires punting the record to the RP.

- Export on the “event transaction end” is used to export the records when the connection or transaction is terminated. In this case, the records are not exported based on timeout. Exporting on the event transaction end should be used when detailed connection/transaction granularity is required, and has the following advantages:
  - Sends the record close to the time that it has ended.
  - Exports only one record on true termination.
  - Conserves memory in the cache and reduces the load on the Management and Reporting system.
  - Enables exporting multiple transactions of the same flow. (This requires a protocol pack that supports multi-transaction.)
- Export spreading—In a case of synchronized cache, all network devices export records from the monitor cache at the same time. If multiple network devices are configured with the same monitor interval and synchronized cache, the collector may receive all records from all devices at the same time, which can impact the collector performance. The export-spreading feature spreads out the export over a time interval, which is automatically set by MMA or specified by the user.

NetFlow/IPFIX Flow Record

The flow record defines the record fields. With each Cisco IOS release, the Cisco AVC solution supports a more extensive set of metrics.

The sections that follow list commonly used AVC-specific fields organized by functional groups. These sections do not provide detailed command reference information, but highlight important usage guidelines.

In addition to the fields described below, a record can include any NetFlow field supported by the platform.

A detailed description of NetFlow fields appears in the *Cisco IOS Flexible NetFlow Command Reference*.

Note On Cisco IOS XE platforms, the record size is limited to 40 fields (key and non-key fields or match and collect fields).

L3/L4 Fields

The following are L3/L4 fields commonly used by AVC.

```
[collect | match] connection [client|server] [ipv4|ipv6] address
[collect | match] connection [client|server] transport port
[collect | match] [ipv4|ipv6] [source|destination] address
[collect | match] transport [source-port|destination-port]
[collect | match] [ipv4|ipv6] version
[collect | match] [ipv4|ipv6] protocol
[collect | match] routing vrf [input|output]
[collect | match] [ipv4|ipv6] dscp
[collect | match] ipv4 ttl
[collect | match] ipv6 hop-limit
collect           transport tcp option map
collect           transport tcp window-size [minimum|maximum|sum]
collect           transport tcp maximum-segment-size
```

Usage Guidelines

The client is determined according to the initiator of the connection.

The **client** and **server** fields are bi-directional. The **source** and **destination** fields are uni-directional.

L7 Fields

The following are L7 fields commonly used by the Cisco AVC solution.

```
[collect | match] application name [account-on-resolution]
collect application http url
collect application http uri statistics
collect application http host
collect application http user-agent
collect application http referer
collect application rtsp host-name
collect application smtp server
collect application smtp sender
collect application pop3 server
collect application nntp group-name
collect application sip source
collect application sip destination
```

Usage Guidelines

- The application ID is exported according to RFC-6759.
- Account-On-Resolution configures FNF to collect data in a temporary memory location until the record key fields are resolved. After resolution of the record key fields, FNF combines the temporary data collected with the standard FNF records. Use the **account-on-resolution** option when the field used as a key is not available at the time that FNF receives the first packet.

  The following limitations apply when using Account-On-Resolution:

  - Flows ended before resolution are not reported.
  - On Cisco IOS XE platforms, FNF packet/octet counters, timestamp, and TCP performance metrics are collected until resolution. All other field values are taken from the packet that provides resolution or the following packets.
- For information about extracted fields, including the formats in which they are exported, see: *Cisco Application Visibility and Control Field Definition Guide for Third-Party Customers*

Interfaces and Directions

The following are interface and direction fields commonly used by the Cisco AVC solution:

```
[collect | match] interface [input|output]
[collect | match] flow direction
collect connection initiator
```

Counters and Timers

The following are counter and timer fields commonly used by the Cisco AVC solution.

Note Two aliases provide backward compatibility for configurations created on earlier releases:

- **connection client bytes transport long** is an alias for **connection client bytes long**.
- **connection server bytes transport long** is an alias for **connection server bytes long**.

```
collect connection server counter bytes network long
collect connection server counter bytes transport long
collect connection server counter bytes long
collect connection server counter packets long

collect connection client counter bytes network long
collect connection client counter bytes transport long
collect connection client counter bytes long
collect connection client counter packets long

collect counter bytes rate
collect connection server counter responses
collect connection client counter packets retransmitted
collect connection transaction duration {sum, min, max}
collect connection transaction counter complete
collect connection new-connections
collect connection sum-duration
collect timestamp sys-uptime first
collect timestamp sys-uptime last
```

On Cisco IOS platforms:

```
collect counter packets long
collect counter bytes long
```

On Cisco IOS XE platforms:

```
collect counter packets [long]
collect counter bytes [long]
```

TCP Performance Metrics

The following are fields commonly used for TCP performance metrics by the Cisco AVC solution:

```
collect           connection delay network to-server         {sum, min, max}
collect           connection delay network to-client         {sum, min, max}
collect           connection delay network client-to-server  {sum, min, max}
collect           connection delay response to-server        {sum, min, max}
collect           connection delay response to-server histogram
                                             [bucket1 ... bucket7 | late]
collect           connection delay response client-to-server {sum, min, max}
collect           connection delay application              {sum, min, max}
```

Usage Guidelines

The following limitations apply to TCP performance metrics:

- All TCP performance metrics must observe bi-directional traffic.
- The policy-map must be applied in both directions.

Figure 4-2 provides an overview of network response time metrics.

Figure 4-2 Network Response Times

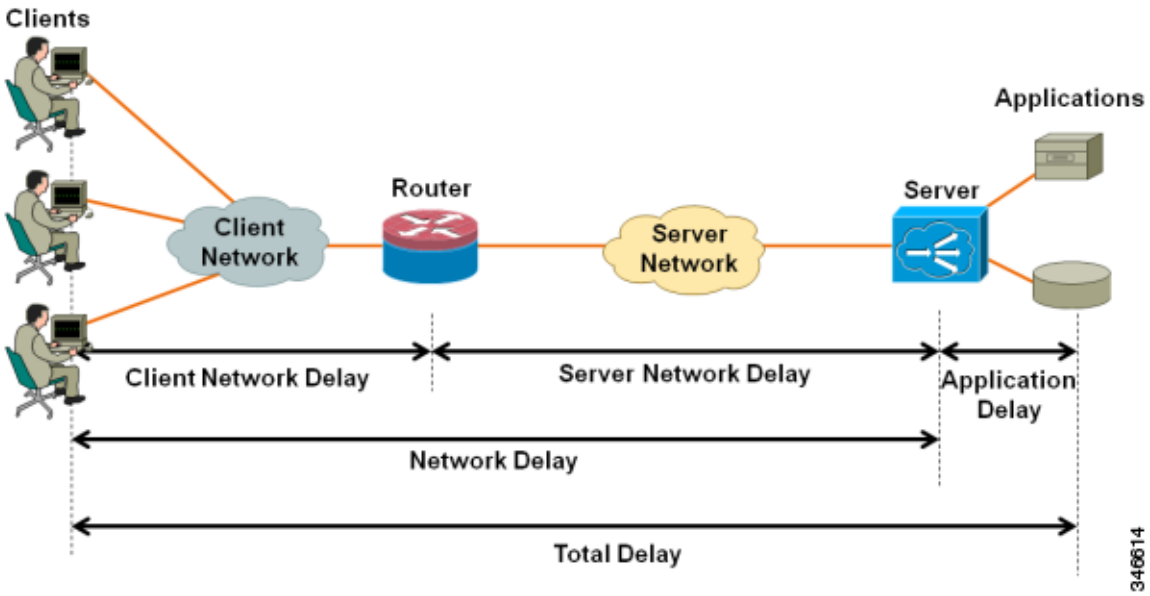
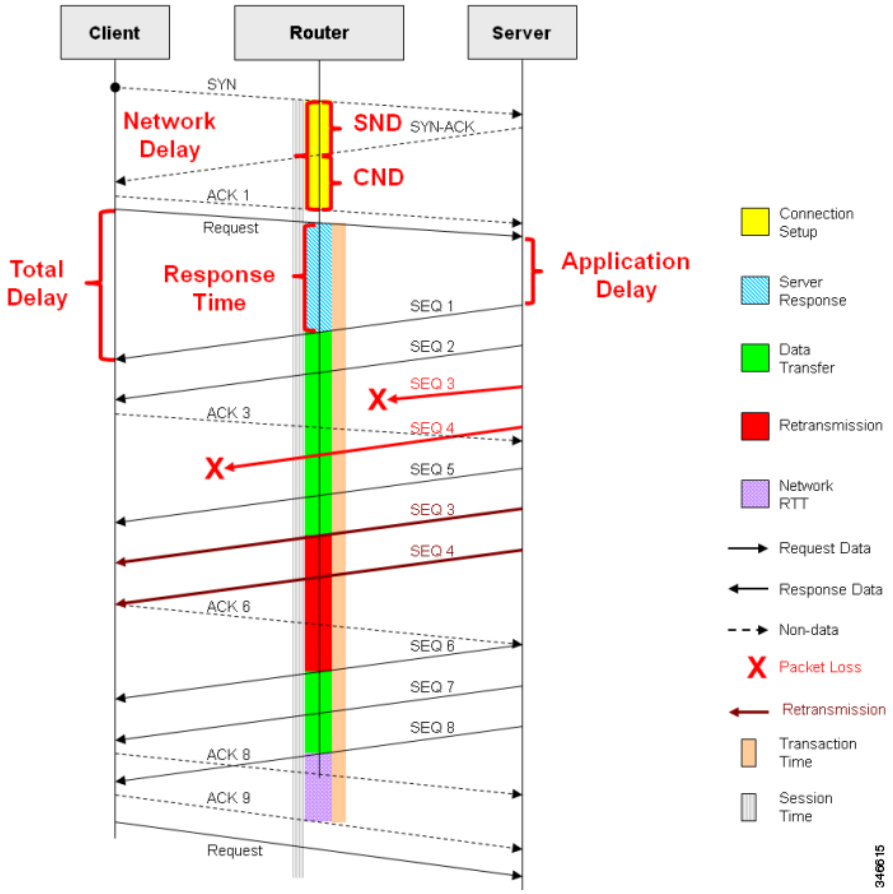


Figure 4-3 provides details of network response time metrics.

Figure 4-3 Network Response Time Metrics in Detail



Media Performance Metrics

The following are fields commonly used for media performance metrics by the Cisco AVC solution:

```
[collect | match] match transport rtp ssrc
collect  transport rtp payload-type
collect  transport rtp jitter mean sum
collect  transport rtp jitter [minimum | maximum]
collect  transport packets lost counter
collect  transport packets expected counter
collect  transport packets lost counter
collect  transport packets lost rate
collect  transport event packet-loss counter
collect  counter packets dropped
collect  application media bytes counter
collect  application media bytes rate
collect  application media packets counter
collect  application media packets rate
collect  application media event
collect  monitor event
```

Usage Guidelines

Some of the media performance fields require punt to the route processor (RP). For more information, see *Cisco Application Visibility and Control Field Definition Guide for Third-Party Customers*.

L2 Information

The following are L2 fields commonly used by the Cisco AVC solution:

```
[collect | match] datalink [source-vlan-id | destination-vlan-id]
[collect | match] datalink mac [source | destination] address [input | output]
```

WAAS Interoperability

Cisco IOS Platforms	Cisco IOS XE Platforms
Not available	Available

The following are WAAS fields commonly used by the Cisco AVC solution:

```
[collect | match] services waas segment [account-on-resolution]
collect services waas passthrough-reason
```

Usage Guidelines

Account-On-Resolution configures FNF to collect data in a temporary memory location until the record key fields are resolved. After resolution of the record key fields, FNF combines the temporary data collected with the standard FNF records. Use this option (**account-on-resolution**) when the field used as a key is not available at the time that FNF receives the first packet.

The following limitations apply when using Account-On-Resolution:

- Flows ended before resolution are not reported.
- FNF packet/octet counters, timestamp and TCP performance metrics are collected until resolution. All other field values are taken from the packet that provides resolution or the following packets.

Classification

The following are classification fields commonly used by the Cisco AVC solution:

```
[collect | match]  policy performance-monitor classification hierarchy
```

Usage Guidelines

Use this field to report the matched class for the performance-monitor policy-map.

NetFlow/IPFIX Option Templates

NetFlow option templates map IDs to string names and descriptions:

```
flow exporter my-exporter
  export-protocol ipfix
  template data timeout <timeout>
```

```
option interface-table timeout <timeout>
option vrf-table timeout <timeout>
option sampler-table timeout <timeout>
option application-table timeout <timeout>
option application-attributes timeout <timeout>
option sub-application-table timeout <timeout>
option c3pl-class-table timeout <timeout>
option c3pl-policy-table timeout <timeout>
```

NetFlow/IPFIX Show commands

Use the following commands to show NetFlow/IPFIX information:

```
show flow monitor type performance-monitor [<name> [cache [raw]]]
show flow record type performance-monitor
show policy-map type performance-monitor [<name> | interface]
```

Customizing NBAR Attributes

Use the following commands to customize the NBAR attributes:

```
[no] ip nbar attribute-map <attribute-map-name>
   attribute category <category>
   attribute sub-category <sub-category>
   attribute application-group <application-group>
   attribute tunnel <tunnel-info>
   attribute encrypted <encrypted-info>
   attribute p2p-technology <p2p-technology-info>
[no] ip nbar attribute-set <protocol-name> <attribute-map-name>
```

Note These commands support all attributes defined by the NBAR2 Protocol Pack, including custom-category, custom-sub-category, and custom-group available in Protocol Pack 3.1 and later.

Customizing Attribute Values

Cisco IOS Platforms	Cisco IOS XE Platforms
Added in IOS 15.4(1)T	Added in IOS XE 3.11

Background

Attribute maps enable users to map various attribute values to protocols, changing the built-in grouping of protocols. The “custom attributes value” feature enables users to add new values to existing attributes.

For example, when using custom protocols to define enterprise specific protocols, it can be useful to classify the custom protocols as a new group (example: my-db-protocols-group). Beginning in the current release, new values can be defined for:

- category
- sub-category
- application-group

Customized attributes can be used for QoS matching, and the customized values appear in AVC reports.

Future Protocol Pack versions may enable defining additional attributes. For information about viewing which attributes can be customized and how many new groups can be defined, see Additional Usage Guidelines, page 4-31.

Basic Usage

CLI

```
[no] ip nbar attribute <attribute name> custom  <user-defined value>  [<user-defined help string>]
```

Backward Compatibility

Previous releases of AVC included the following pre-defined attribute values, which could not be user-customized:

- For the category attribute: **custom-category**
- For the sub-category attribute: **custom-sub-category**
- For the application-group attribute: **custom-application-group**

To provide backward compatibility with existing configurations, the current release supports configurations that were created for earlier releases and that include one or more of these attributes.

Examples—Defining Values

The following examples define custom values for the category and sub-category attributes, and provide the optional explanatory help string:

```
ip nbar attribute category custom dc_backup_category "Data center backup traffic"
ip nbar attribute sub-category custom hr_sub_category "HR custom applications traffic"
ip nbar attribute application-group custom Home_grown_finance_group "our finance tools network traffic"
```

Example—Removing Custom Values

The following example removes the custom value (“XYZ-app-group”) that had been assigned for the application-group attribute:

```
no ip nbar attribute application-group custom XYZ-app-group
```

Additional Usage Guidelines

Help

The following command provides help, indicating which attributes can have custom values.

```
ip nbar attribute ?
```

Displaying Customizable Attributes and Custom Values

The following command indicates which attributes can be defined with custom values (depends on the Protocol Pack version installed on the device), and displays the currently defined custom values.

```
show ip nbar attribute-custom
```

Customizing NBAR Protocols

Use the following commands to customize NBAR protocols and assign a protocol ID. A protocol can be matched based on HTTP URL/Host or other parameters:

```
ip nbar custom <protocol-name> [http {[url <urlregexp>]  [host <hostregexp>]}] [offset
[format value]] [variable field-name field-length] [source | destination] [tcp | udp ]
[range start end | port-number ] [id <id>]
```

Packet Capture Configuration

Cisco IOS Platforms	Cisco IOS XE Platforms
Not available	Available

Use the following commands to enable packet capture:

```
policy-map type packet-services <policy-name>
    class <class-name>
        capture limit packet-per-sec <pps> allow-nth-pak <np> duration <duration>
            packets <packets>  packet-length <len>
        buffer size <size> type <type>

interface <interface-name>
    service-policy type packet-services <policy-name> [input|output]
```

QoS Metrics: Cisco IOS Platforms

This section applies to Cisco IOS platforms. (For information about QoS Metrics configuration for Cisco IOS XE platforms, see QoS Metrics: Cisco IOS XE Platforms, page 4-37.)

This section describes how to configure a performance monitor to include Quality of Service (QoS) metrics.

Background—QoS

QoS configuration is based on **class maps** and **policy maps**. Class maps categorize traffic; policy maps determine how to handle the traffic. Based on the policy identified for each packet, the packet is placed into a specific **QoS queue**, which determines the priority and pattern of transmission. Each queue is identified by a Queue ID field.

For additional information about QoS, see: http://www.cisco.com/go/qos

Exported Metrics

AVC enables configuration of QoS Packet Drop and QoS Class Hierarchy monitors on an interface, using one or more of the following QoS metrics, which can be included in exported performance monitor records:

- Queue ID—Identifies a QoS queue.
- Queue Packet Drops—Packets dropped (on the monitored interface) per QoS queue, due to a QoS policy that limits resources available to a specific type of traffic.
- Class Hierarchy—Class hierarchy of the reported flow. The class hierarchy is determined by the QoS policy map and determines the traffic priority.

QoS Packet Drop Monitor Output in Exported Record

When a QoS Packet Drop monitor is configured, the performance monitor record includes packet drop data per QoS queue in the following format:

Queue id	Queue packet drops
1	100
2	20

QoS Class Hierarchy Information Included in Exported Record

QoS class hierarchy information is exported using the following performance monitor fields:

- Hierarchy policy for each flow (defined by the policy map)
- Queue ID for each flow

This section provides an example of a QoS policy map configuration, followed by the information provided in a performance monitor record for three flows governed by this configuration.

The example includes two levels of policy map hierarchy. In the example, the `service-policy P11` statement in **bold** type creates a hierarchy with the P11 policy map as a child of the P1 policy map.

Note QoS class hierarchy reporting supports a hierarchy of five levels.

Based on the configuration, the following applies to a packet with, for example, a DSCP value of “ef” in the IP header:

1. The C1 class definition includes the packet by the `match any` statement.
2. The C11 class definition includes the packet by the `match ip dscp ef` statement.
3. Because the packet is included in class C1, policy map P1 defines the policy for the packet with the `shaping average` statement.
4. Policy map P1 invokes policy map P11 for class C1 with the `service-policy P11` statement.

5. Because the packet is included in class C11, policy map P11 assigns the packet to a queue which has been allocated 10% of remaining bandwidth.

```
class-map match-all C1
    match any
class-map match-all C11
    match ip dscp ef
class-map match-all C12
    match ip dscp cs2
!
policy-map P11
    class C11
        bandwidth remaining percent 10
    class C12
        bandwidth remaining percent 70
    class class-default
        bandwidth remaining percent 20

policy-map P1
    class C1
        shaping average 16000000
        service-policy P11
```

Table 4-13 shows an example of the information provided in an FNF record for three flows governed by this configuration.

Table 4-13 QoS Class Hierarchy Information in the Flow Record

Flow	Hierarchy	Queue id
Flow 1	P1, C1, C11	1
Flow 2	P1, C1, C11	1
Flow 3	P1, C1, C12	2

In Table 4-13, policy and class information is shown using the true policy and class names, such as P1 and C1. However, the record exports policy and class names using numerical identifiers in place of policy and class names. The monitor periodically outputs a “policy option template” and a “class option template” indicating the policy names and class names that correspond to the numbers used in the exported records. These option templates are defined in the exporter configuration, using statements such as the following, which create the option templates and indicate the time interval at which the monitor outputs the option template information:

```
option c3pl-class-table timeout <timeout>
option c3pl-policy-table timeout <timeout>
```

Configuration

Configuring a QoS Packet Drop Monitor

A QoS Packet Drop monitor can only export the Queue ID and Queue Packet Drop fields. It cannot be combined with other monitors to export additional fields. At the given reporting interval, the monitor reports only on queues that have dropped packets (does not report value of 0).

Step 1: Create the QoS Packet Drop Monitor

Use the following performance monitor configuration to create a QoS Packet Drop monitor. The process specifies a flow record of type performance monitor named "qos-record" and attaches the record to a monitor of type performance monitor named "qos-monitor." In the steps that follow, the qos-monitor is attached to the desired policy map.

```
flow record type performance monitor qos-record
    match policy qos queue index
    collect policy qos queue drops
flow monitor type performance monitor qos-monitor
    exporter my-exporter
    record qos-record
    cache timeout synchronized 60
```

Step 2: Configure the QoS Policy

The following example shows configuration of a QoS policy map. It includes a hierarchy of three policies: avc, avc-parent, and avc-gparent. Note that avc-gparent includes avc-parent, and avc-parent includes avc.

```
policy-map avc
    class prec4
        bandwidth remaining ratio 3
    class class-default
        bandwidth remaining ratio 1
policy-map avc-parent
    class class-default
        shape average 10000000
        service-policy avc
policy-map avc-gparent
    class class-default
        shape average 100000000
        service-policy avc-parent
```

Step 3: Create the QoS Class Hierarchy Record

To correlate the queue drops collected from the QoS Drops monitor, create a flow record that includes the class hierarchy and Queue id and flow key fields. The data exported by this monitor indicates which flows are assigned to which QoS Queue Id.

The following example configuration creates a QoS class record. The process specifies a record of type performance monitor named "qos-class-record."

```
flow record type performance-monitor qos-class-record
    match connection client ipv4 (or ipv6) address
    match connection server ipv4 (or ipv6) address
    match connection server transport port
    collect policy qos class hierarchy
    collect policy qos queue id
```

Step 4: Create the QoS Class Hierarchy Monitor

Use the following performance monitor configuration to create a QoS Class Hierarchy monitor. The process specifies a monitor of type "class-hier-monitor." In the steps that follow, the monitor is attached to the desired interface.

```
flow monitor type performance-monitor class-hier-monitor
    exporter my-exporter
    record qos-class-record
    cache timeout synchronized 60
```

Step 5: Create the Performance Monitor Policy

Use the following configuration to create a policy-map that will collect both monitors.

```
policy-map type performance monitor pm-qos
    class http
        flow monitor qos-monitor
        flow monitor qos-class-record
```

Step 6: Attach the Performance Monitor and QoS Policy to an Interface

Use the following to attach the monitor to the desired interface. For <*interface*>, specify the interface type—for example: GigabitEthernet0/2/1

Specify the IP address of the interface in IPv4 or IPv6 format.

```
interface <interface>
    ip address <interface_IP_address>
    service-policy type performance monitor output pm-qos
    service-policy output avc-gparent
```

Verifying the QoS Packet Drop Monitor Configuration

This section provides commands that are useful for verifying or troubleshooting a QoS Packet Drop Monitor configuration.

Verifying that the Monitor is Allocated

Use the following command to verify that the QoS monitor exists:

```
show flow monitor type performance monitor
```

Use the following commands to verify additional monitor details:

```
show flow monitor type performance monitor qos-monitor
show flow monitor type performance monitor qos-class-monitor
```

Verifying QoS Queue IDs, Queue Drops, and Class Hierarchies

The following show command displays the record collected:

```
show performance monitor history interval all
```

QoS Metrics: Cisco IOS XE Platforms

This section applies to Cisco IOS XE platforms. (For information about QoS Metrics configuration for Cisco IOS platforms, see QoS Metrics: Cisco IOS Platforms, page 4-32.)

This section describes how to configure Flexible NetFlow (FNF) monitors to include Quality of Service (QoS) metrics.

Background—FNF and QoS

FNF Monitors

Flexible NetFlow (FNF) enables monitoring traffic on router interfaces. FNF monitors are configured for a specific interface to monitor the traffic on that interface. At defined intervals, the monitor sends collected traffic data to a "collector," which can be a component within the router or an external component.

Beginning with Cisco AVC for IOS XE release 3.9, FNF records include new fields for QoS metrics.

QoS

QoS configuration is based on **class maps** and **policy maps**. Class maps categorize traffic; policy maps determine how to handle the traffic. Based on the policy identified for each packet, the packet is placed into a specific **QoS queue**, which determines the priority and pattern of transmission. Each queue is identified by a Queue ID field.

For additional information about QoS, see: http://www.cisco.com/go/qos

Exported Metrics

AVC enables configuration of QoS Packet Drop and QoS Class Hierarchy monitors on an interface, using one or more of the following QoS metrics, which can be included in exported FNF records:

- Queue ID—Identifies a QoS queue.
- Queue Packet Drops—Packets dropped (on the monitored interface) per QoS queue, due to a QoS policy that limits resources available to a specific type of traffic.
- Class Hierarchy—Class hierarchy of the reported flow. The class hierarchy is determined by the QoS policy map and determines the traffic priority.

QoS Packet Drop Monitor Output in Exported Record

When a QoS Packet Drop monitor is configured, the FNF record includes packet drop data per QoS queue in the following format:

Queue id	Queue packet drops
1	100
2	20

QoS Class Hierarchy Information Included in Exported Record

QoS class hierarchy information is exported using the following FNF fields:

- Hierarchy policy for each flow (defined by the policy map)
- Queue ID for each flow

This section provides an example of a QoS policy map configuration, followed by the information provided in an FNF record for three flows governed by this configuration.

The example includes two levels of policy map hierarchy. In the example, the `service-policy P11` statement in **bold** type creates a hierarchy with the P11 policy map as a child of the P1 policy map.

Note QoS class hierarchy reporting supports a hierarchy of five levels.

Based on the configuration, the following applies to a packet with, for example, a DSCP value of "ef" in the IP header:

1. The C1 class definition includes the packet by the `match any` statement.
2. The C11 class definition includes the packet by the `match ip dscp ef` statement.
3. Because the packet is included in class C1, policy map P1 defines the policy for the packet with the `shaping average` statement.
4. Policy map P1 invokes policy map P11 for class C1 with the `service-policy P11` statement.
5. Because the packet is included in class C11, policy map P11 assigns the packet to a queue which has been allocated 10% of remaining bandwidth.

```
class-map match-all C1
    match any
class-map match-all C11
    match ip dscp ef
class-map match-all C12
    match ip dscp cs2
!
policy-map P11
    class C11
        bandwidth remaining percent 10
    class C12
        bandwidth remaining percent 70
    class class-default
        bandwidth remaining percent 20

policy-map P1
    class C1
        shaping average 16000000
        service-policy P11
```

Table 4-14 shows an example of the information provided in an FNF record for three flows governed by this configuration.

Table 4-14 QoS Class Hierarchy Information in the FNF record

Flow	Hierarchy	Queue id
Flow 1	P1, C1, C11	1
Flow 2	P1, C1, C11	1
Flow 3	P1, C1, C12	2

In Table 4-14, policy and class information is shown using the true policy and class names, such as P1 and C1. However, the FNF record exports policy and class names using numerical identifiers in place of policy and class names. The monitor periodically outputs a “policy option template” and a “class option template” indicating the policy names and class names that correspond to the numbers used in the exported FNF records. These option templates are defined in the exporter configuration, using statements such as the following, which create the option templates and indicate the time interval at which the monitor outputs the option template information:

```
option c3pl-class-table timeout <timeout>
option c3pl-policy-table timeout <timeout>
```

Configuration

Enabling QoS Metric Collection

Enabling

To enable the QoS metrics collection feature for the platform, enter global configuration mode using `configure terminal`, then use the following QoS configuration command. The command causes QoS to begin collecting QoS metrics for FNF.

Note Enabling QoS metrics collection requires resetting all performance monitors on the device.

```
platform qos performance-monitor
```

Verifying

To verify that QoS metrics collection is enabled, use the following command:

```
show platform hardware qfp active feature qos config global
```

The following is an example of the output of the command:

```
Marker statistics are: disabled
Match per-filter statistics are: disabled
Match per-ace statistics are: disabled
Performance-Monitor statistics are: enabled
```

Configuring a QoS Packet Drop Monitor

A QoS Packet Drop monitor can only export the Queue ID and Queue Packet Drop fields. It cannot be combined with other monitors to export additional fields. At the given reporting interval, the monitor reports only on queues that have dropped packets (does not report value of 0).

Step 1: Create the QoS Packet Drop FNF Monitor

Use the following FNF configuration to create a QoS Packet Drop monitor. The process specifies a flow record of type “qos-record” and attaches the record to a monitor of type “qos-monitor.” In the steps that follow, the qos-monitor is attached to the desired interface.

Note Ensure that QoS metrics collection is enabled. See Enabling QoS Metric Collection, page 4-39.

```
flow record qos-record
    match policy qos queue index
    collect policy qos queue drops
flow monitor qos-monitor
    exporter my-exporter
    record qos-record
```

Step 2: Configure the QoS Policy

The following example shows configuration of a QoS policy map. It includes a hierarchy of three policies: avc, avc-parent, and avc-gparent. Note that avc-gparent includes avc-parent, and avc-parent includes avc.

```
policy-map avc
    class prec4
        bandwidth remaining ratio 3
    class class-default
        bandwidth remaining ratio 1
policy-map avc-parent
    class class-default
        shape average 10000000
        service-policy avc
policy-map avc-gparent
    class class-default
        shape average 100000000
        service-policy avc-parent
```

Step 3: Attach the FNF Monitor and QoS Policy to an Interface

Use the following to attach the monitor to the desired interface. For <*interface*>, specify the interface type—for example: GigabitEthernet0/2/1

Specify the IP address of the interface in IPv4 or IPv6 format.

```
interface <interface>
    ip address <interface_IP_address>
    ip flow monitor qos-monitor output
    service-policy output avc-gparent
```

Verifying the QoS Packet Drop Monitor Configuration

This section provides commands that are useful for verifying or troubleshooting a QoS Packet Drop Monitor configuration.

Verifying that the Monitor is Allocated

Use the following command to verify that the QoS monitor exists:

```
show flow monitor
```

Use the following commands to verify additional monitor details:

```
show flow monitor qos-monitor
show flow monitor qos-monitor cache
show flow monitor qos-monitor statistics
show platform hardware qfp active feature fnf client flowdef name qos-record
show platform hardware qfp active feature fnf client monitor name qos-monitor
```

Verifying QoS queues and Class-Hierarchies

The following **show** commands display the statistics that QoS has collected. “gigX/X/X” refers to the interface for which the monitor has been configured.

```
show policy-map int gigX/X/X
show platform hardware qfp active feature qos queue output all
```

Verifying FNF-QOS FIA Activation

Use the following **show** command to verify that the FNF-QoS FIA (feature activation array) is enabled on the interface (GigabitEthernet0/2/1 in this example):

```
show platform hardware qfp active interface if-name GigabitEthernet0/2/1
```

Verifying the FNF Monitor and Record

Use the following **debug** commands to verify that the FNF monitor and record have been created:

```
debug platform software flow flow-def errors
debug platform software flow monitor errors
debug platform software flow interface errors


debug platform hardware qfp active feature fnf server trace
debug platform hardware qfp active feature fnf server info
debug platform hardware qfp active feature fnf server error
```

Configuring a QoS Class Hierarchy Monitor

In contrast to the QoS Packet Drop monitor, a QoS Class Hierarchy monitor can be combined with another monitor to export additional metrics.

Step 1: Create the QoS Class Record

The following example configuration creates a QoS class record. The process specifies a record of type “qos-class-record.” The example specifies “ipv4 source” and “ipv4 destination” addresses, but you can configure the record to match according to other criteria.

Note Ensure that QoS metrics collection is enabled. See Enabling QoS Metric Collection, page 4-39.

```
flow record qos-class-record
    match ipv4 source address
    match ipv4 destination address
    collect counter bytes
    collect counter packets
    collect policy qos classification hierarchy
    collect policy qos queue index
```

Step 2: Create the QoS Class Hierarchy Monitor

Use the following FNF configuration to create a QoS Class Hierarchy monitor. The process specifies a monitor of type “class-hier-monitor.” In the steps that follow, the monitor is attached to the desired interface.

```
flow monitor class-hier-monitor
    exporter my-exporter
    record qos-class-record
```

Step 3: Attach the QoS Class Hierarchy Monitor to an Interface

Use the following to attach the monitor to the desired interface. For <*interface*>, specify the interface type—for example: GigabitEthernet0/2/1

Specify the IP address of the interface in IPv4 or IPv6 format.

Note Attaching the service-policy to the interface, as indicated by the "service-policy" statement below, is a required step.

```
interface <interface>
    ip address <interface_IP_address>
    ip flow monitor class-hier-monitor output
    service-policy output avc-gparent
```

Verifying the QoS Class Hierarchy Monitor Configuration

This section provides commands that are useful for verifying or troubleshooting a QoS Class Hierarchy Monitor configuration.

Verifying that the Monitor is Allocated

Use the following command to verify that the QoS monitor exists:

```
show flow monitor
```

Use the following commands to verify additional details:

```
show flow monitor class-hier-monitor
show flow monitor class-hier-monitor cache
show flow monitor class-hier-monitor statistics

show platform hardware qfp active feature fnf client flowdef name qos-class-record
show platform hardware qfp active feature fnf client monitor name qos-monitor
```

Verifying FNF-QOS FIA Activation

In the following feature invocation array (FIA) verification example, the interface is GigabitEthernet0/2/1.

```
show platform hardware qfp active interface if-name GigabitEthernet0/2/1
```

Verifying the FNF Monitor and Record

Use the following **debug** commands to verify that the FNF monitor and record have been created:

```
debug platform software flow flow-def errors
debug platform software flow monitor errors
debug platform software flow interface errors

debug platform hardware qfp active feature fnf server trace
debug platform hardware qfp active feature fnf server info
debug platform hardware qfp active feature fnf server error
```

Connection/Transaction Metrics

Cisco IOS Platforms	Cisco IOS XE Platforms
Not available	Added in release 3.9S

Flexible NetFlow (FNF) monitors can report on individual transactions within a flow. This enables greater resolution for traffic metrics. This section describes how to configure connection and transaction metrics, including **transaction-id** and **connection id**, for FNF monitors. The connection/transaction monitoring feature is referred to as "Multi-transaction."

Note The Multi-transaction feature requires an NBAR protocol pack that supports the feature. The protocol pack provided with Cisco AVC for IOS XE release 3.9S and later protocol packs support this feature.

Introduction

Flexible NetFlow (FNF) monitors typically report traffic metrics per flow. (A flow is defined as a connection between a specific source address/port and destination address/port.) A single flow can include multiple HTTP transactions. Enabling the Multi Transaction feature for a monitor enables reporting metrics for each transaction individually.

You can configure the FNF record to identify the flow or the flow+transaction, using one of the following two metrics:

- connection id—A 4-byte metric identifying the flow.
- transaction-id—An 8-byte metric composed of two parts:
  - MSB—Identifies the flow and is equivalent to the connection id metric.
  - LSB—Identifies the transaction. The value is a sequential index of the transaction, beginning with 0.

Configuration

The following subsections describe the Multi-transaction feature:

- Requirements, page 4-44
- Configuring Exporter, Record, and Monitor in Performance Monitor Mode, page 4-44
- Verifying and Troubleshooting the Configuration, page 4-45

Requirements

The following requirements apply when using the Multi-transaction feature:

- The record configuration must use **match**, not **collect**.
- Specify only “connection id” or “transaction-id,” but not both.
- Include “application name” in the record.
- Include “cache timeout event transaction-end” which specifies that the record is transmitted immediately and not stored in the monitor cache.

Configuring Exporter, Record, and Monitor in Performance Monitor Mode

Flexible Netflow (FNF) performance monitor (perf-monitor) mode enables configuring monitors with advanced filtering options that filter data before reporting it. Options for configuring filtering include IP access list, policy-map, and so on.

The following perf-monitor example configures a monitor and specifies the **transaction-id** metric for the FNF record, as shown in **bold**. Alternatively, you can specify the **connection id** metric.

Note See Configuring Exporter, Record, and Monitor in Performance Monitor Mode, page 4-44 for additional configuration information.

```
ip access-list extended mt_perf_acl
    permit ip any any

class-map match-all mt_perf_class
    match access-group name mt_perf_acl
    match protocol http

flow exporter mt_perf_exporter
    destination 64.128.128.128
    transport udp 2055

flow record type performance-monitor mt_perf_record
    match connection transaction-id
    collect counter packets
    collect application name
    collect application http url

flow monitor type performance-monitor mt_perf_monitor
    record mt_perf_record
    exporter mt_perf_exporter
    cache type normal
    cache timeout event transaction-end

policy-map type performance-monitor mt_perf_policy
    parameter default account-on-resolution
    class mt_perf_class
    flow monitor mt_perf_monitor

interface GigabitEthernet0/0/2
    service-policy type performance-monitor input mt_perf_policy
```

Verifying and Troubleshooting the Configuration

This section describes commands useful for verification and troubleshooting the FNF configuration. There are subsections for:

Note For information about the **show** commands in the sections below, see the FNF command reference guide: http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/fnetflow/command/fnf-cr-book.html

Native or Performance Monitor Mode

Verifying Multi-transaction Status

Display the Multi-transaction status:

```
show plat soft nbar statistics | inc is_multi_trs_enable
```

If Multi-transaction is enabled, the value is: `is_multi_trs_enable==1`

Native FNF Mode

Validating the Configuration

Use the following **show** commands to validate the configuration.

```
show flow exporter <exporter_name> templates
show flow monitor <monitor_name>
show platform hardware qfp active feature fnf client flowdef name <record_name>
show platform hardware qfp active feature fnf client monitor name <monitor_name>
```

Viewing Collected FNF Data and Statistics

Use the following **show** commands to view the collected FNF data and statistics.

```
show flow monitor <monitor_name> cache
show flow monitor <monitor_name> statistics
show flow exporter <exporter_name> statistics
show platform hardware qfp active feature fnf datapath aor
```

Performance Monitor Mode

Validating the Configuration

Use the following **show** commands to validate the configuration.

```
show flow exporter <exporter_name> templates
show flow record type performance-monitor <record_name>
show platform hardware qfp active feature fnf client monitor name <monitor_name>
```

Viewing Collected FNF Data and Statistics

Use the following **show** commands to view the FNF collected data and statistics.

```
show performance monitor cache monitor <monitor_name> detail
show flow exporter <exporter_name> statistics
show platform hardware qfp active feature fnf datapath aor
```

CLI Field Aliases

Cisco IOS Platforms	Cisco IOS XE Platforms
Added in release 15.4(1)T	Added in release 3.10S

Aliases provide a mechanism for simplifying configuration statements. The **all** alias refers to the set of all fields possible for a given statement. For example, "`collect connection delay` **`all`**" configures all fields that are possible to configure by the "`collect connection delay`" statement.

The following are examples:

```
collect connection delay all
collect connection transaction all
collect connection client all
collect connection server all
collect connection delay response to-server histogram all
```

Caution When using aliases, see Removing Aliases before Downgrading from Cisco IOS 15.4(1)T / Cisco IOS XE 3.10 or Later, page 6-5 before downgrading from Cisco IOS release 15.4(1)T or later, or from Cisco IOS XE release 3.10S or later.

Additional information

For detailed information about metrics, see Cisco AVC Field Definition Guide for Third-Party Customers.

Identifying the Monitored Interface

Cisco IOS Platforms	Cisco IOS XE Platforms
Added in release 15.5(1)T	Added in release 3.11S

The "observation point id" metric identifies a monitored interface for traffic in both directions (ingress and egress). A single flow definition using this metric can be used in place of **match interface input** and **match interface output**, making configuration more compact and enabling a single record collected on an interface to include metrics for traffic in both directions.

The metric may be collected from LAN or WAN interfaces.

Usage Guidelines

Configure the monitor on both the ingress and egress directions.

Example

In the following example configuration, a single monitor identifies the interface for traffic in both directions:

```
flow record my-application-record
    match application name account-on-resolution
    match flow observation point
    match flow direction
    collect counter packets
    collect counter bytes
```

Pass-through Tunneled IPv6 Traffic: Classification and Reporting

Cisco IOS Platforms	Cisco IOS XE Platforms
Supported	Supported

NBAR can be configured to classify and report on tunneled IPv6 traffic. NBAR, QoS, and performance metric calculations support IPv6 pass-through tunneling.

Enabling the Feature

The following NBAR command displays the options for enabling the feature:

```
Device(config)#ip nbar classification tunneled-traffic ?
ipv6inip Tunnel type IPv6 in IPv4
teredo Tunnel type TEREDO
```

Status	Behavior
Not enabled (Default)	NBAR classifies tunneled traffic as one of the IPv6 tunneling protocols, such as: • Teredo • isatap-ipv6-tunneled • ayiya-ipv6-tunneled • ipv6inip
Enabled	• NBAR classifies and reports the IPv6 traffic

Performance Impact

Enabling NBAR application classification and reporting of tunneled IPv6 traffic involves a performance impact, depending on the amount of tunneled traffic. Handling more tunneled packets causes a greater performance penalty.

Limitations

Reported Tuple

When using the ezPM Application Experience profile and IPv6-over-IPv4 tunneling:

- Teredo protocol: Reports the tuple correctly
- Non-Teredo protocol: Reports the external IPv4 tunnel header

The issue is not relevant for the ezPM Application Statistics profile, which does not report the tuple.

Configuration Examples

This section contains AVC configuration examples. These examples provide a general view of a variety of configuration scenarios, combining multiple AVC features. Configuration is flexible and supports different types of record configurations.

Performance Monitor Configuration Examples

This section describes attaching policies to an interface using the full-featured Performance Monitor configuration method. Alternatively, use the ezPM “express” method (ezPM Configuration Examples, page 4-50).

Additional information

For detailed information about metrics, see Cisco AVC Field Definition Guide for Third-Party Customers.

Performance Monitor Configuration Example 1: Multiple Policies on a Single Interface

The following configuration defines two policies, VM_POLICY and VM_POLICY_RTP_ONLY (shown in bold), then attaches them both to the Ethernet0/0 interface.

Note For details about support for multiple policies on an interface, including limitations, see Configuring Multiple Policies on an Interface, page 4-17.

```
flow record type performance-traffic VM_RECORD
    match ipv4 protocol
    match ipv4 source address
```

```
    match ipv4 destination address
    match transport source-port
    match transport destination-port
    match transport rtp ssrc

match policy performance-monitor classification hierarchy
    collect ipv4 ttl
    collect transport packets lost rate
    collect transport rtp jitter mean
    collect transport rtp jitter minimum
    collect transport rtp jitter maximum
    collect application media packets rate variation
    collect  application media event

flow exporter VM_EXPORTER
    destination 172.27.250.176
    transport udp 11111
    export-protocol netflow-v9

flow monitor type performance-traffic VM_MONITOR
    record VM_RECORD
    exporter VM_EXPORTER
    cache type synchronized
    Cache entries 2000
    Cache timeout synchronized 20
    History size 10 timeout 5

access-list 101 permit udp host 1.1.1.1 host 2.2.2.2

class-map VM_CLASS
    Match access-group 101

policy-map type performance-traffic VM_POLICY
    class VM_CLASS
    flow monitor VM_MONITOR
    monitor metric rtp
        min-sequential 10
        max-dropout 10
        max-reorder 10
        ssrc maximum 50
        clock-rate default 89000
        monitor metric ip-cbr
        rate layer3 packet 500
        react 1 rtp-lost-fraction
        threshold value range 0.50 0.65
        alarm type discrete
        alarm severity error
        action syslog

policy-map type performance-traffic VM_POLICY_RTP_ONLY
    class VM_CLASS
        flow monitor VM_MONITOR
        monitor metric rtp
          min-sequential 10
          max-dropout 10
          max-reorder 10
          ssrc maximum 50
          clock-rate default 89000

interface Ethernet0/0
    Service-policy type performance-traffic input VM_POLICY
    Service-policy type performance-traffic input VM_POLICY_RTP_ONLY
```

ezPM Configuration Examples

This section describes attaching ezPM contexts to an interface using the Easy Performance Monitor (ezPM) express configuration method. Alternatively, use the full-featured Performance Monitor method (Performance Monitor Configuration Examples, page 4-48).

ezPM Configuration Example 1

The following ezPM configuration example activates all traffic monitors in the profile and attaches the policy-maps, both ingress and egress, to the GigabitEthernet0/0/1 interface:

```
!
! Easy performance monitor context
! --------------------------------
!
performance monitor context my-avc profile application-performance
   exporter destination 1.2.3.4 source GigabitEthernet0/0/1 port 4739
   traffic-monitor all
!
!
! Interface attachments
! ---------------------
interface GigabitEthernet0/0/1
  performance monitor context my-avc
```

ezPM Configuration Example 2: Application Performance Profile

The following ezPM Application Performance profile configuration example activates three traffic monitors, and specifies monitoring only IPv4 traffic. The context is then attached to two interfaces.

Note Beginning with Cisco IOS XE 3.14, it is possible to configure multiple contexts on the same interface. See Configuring Multiple Policies on an Interface, page 4-17.

```
!
! Easy performance monitor context
! --------------------------------
!
performance monitor context my-visibility profile application-performance
    exporter destination 1.2.3.4 source GigabitEthernet0/0/1 port 4739

    traffic-monitor application-response-time ipv4
    traffic-monitor application-client-server-stats ipv4
    traffic-monitor media ipv4
!
! Interface attachments
! ---------------------
interface GigabitEthernet0/0/1
    performance monitor context my-visibility
interface GigabitEthernet0/0/2
    performance monitor context my-visibility
```

ezPM Configuration Example 3: Application Statistics Profile

The following ezPM Application Statistics profile configuration example uses the “app-usage” context and activates one traffic monitor: application-stats.

The application-stats monitor provides per interface/application/direction/protocol and IP version traffic (bytes/packets) and flow (new flows/concurrent flows) statistics.

```
performance monitor context app-usage profile application-statistics
    exporter destination 1.2.3.4 source GigabitEthernet0/0/1 port 4739
    traffic-monitor application-stats

interface GigabitEthernet0/0/1
    performance monitor context app-usage
```

ezPM Configuration Example 4: Two Contexts Configured on a Single Interface

The following configuration attaches two contexts, **my-visibility** and **my-visibility-troubleshooting**, to the GigabitEthernet0/0/0 interface using the "express" ezPM configuration method.

The predefined traffic monitors used for each context reflect the different roles of the two contexts.

- The **my-visibility** context:
  - application response-time
  - conversation-traffic-statistics
  - url
  - media
- The **my-visibility-troubleshooting** context:
  - troubleshooting

```
! Performance monitor contexts
! ----------------------------
performance monitor context my-visibility \
        profile application-experience
    ! Exporter
        exporter destination 10.56.216.41 source GigabitEthernet0 \
        transport udp port 9911 vrf Mgmt-int

    ! Traffic monitors
    traffic-monitor application-response-time
    traffic-monitor conversation-traffic-statistics
    traffic-monitor url
    traffic-monitor media

performance monitor context my-visibility-troubleshooting \
        profile application-experience
    ! Exporter
    exporter destination 10.56.216.41 source GigabitEthernet0 \
    transport udp port 9911 vrf Mgmt-int

    ! Traffic monitors
    traffic-monitor troubleshooting

! Interfaces attachment
! ---------------------
interface GigabitEthernet0/0/0
    performance monitor context my-visibility
    performance monitor context my-visibility-troubleshooting
```

ezPM Configuration Example 5: Fine-grain and Coarse-grain Contexts Configured on a Single Interface

The following ezPM configuration example combines two contexts on the GigabitEthernet0/0/1 interface:

- One context applies the Application Performance profile, referred to as **fg** (fine grain). In the example, this context configures detailed reporting for critical applications.
- One context applies the Application Statistics profile, referred to as **cg** (coarse grain). This context configures more general reporting of application metrics for all traffic.

```
class-map match-any my-critical-apps
match protocol citrix

performance monitor context fg profile application-performance
    traffic-monitor application-response-time class-replace my-critical-apps

performance monitor context cg profile application-statistics
    traffic-monitor application-stats

interface GigabitEthernet0/0/1
    performance monitor context fg
    performance monitor context cg
```

Notes

- Defining multiple contexts to combine fine-grain and coarse-grain monitoring is currently available on Cisco IOS XE platforms only.
- It is possible to combine one fine-grain and one coarse-grain context on a single interface, but not two fine-grain contexts.

ezPM Configuration Example 6: Configuring Cache Type and Interval Timeout

Background

Cache Type

The cache type setting for each monitor of an ezPM profile is determined by one of the following:

- The default setting defined for the monitor by the profile. The ezPM profile provides the default cache type for each traffic monitor. Specifying a value using the cache-type option (see below) overrides the default.
- Explicitly, using the **cache-type** option:
  - **cache-type normal**
  - **cache-type synchronized**

  Example:

  traffic-monitor application-client-server-stats cache-type synchronized

Interval Timeout

The functionality of the **interval-timeout** parameter depends on the cache type.

- If the cache type is **normal**, the parameter defines the **active timeout**.
- If the cache type is **synchronized**, the parameter defines the **synchronized timeout**.

Examples

A. Cache Type: Normal

The default cache type for the application-client-server-stats monitor used in this example is **normal**, so the **interval-timeout** parameter defines the **active timeout**.

The following line configures the interval timeout (seconds):

```
traffic-monitor application-client-server-stats interval-timeout 300
```

The output of **show performance monitor context perf** includes the following, showing the **active timeout** as 300 seconds (bold added):

```
Cache:
    Type:                 normal (Platform cache)
    Status:               allocated
    Size:                 312500 entries
    Inactive Timeout:     15 secs
    Active Timeout:       300 secs
    Trans end aging:   off
```

B. Cache Type: Synchronized

The default cache type for the application-response-time monitor used in this example is **synchronized**, so the **interval-timeout** parameter defines the **synchronized timeout**.

The following line configures the interval timeout (seconds):

```
traffic-monitor application-response-time interval-timeout 100
```

The output of **show performance monitor context perf** includes the following, showing the **synchronized timeout** as 100 seconds (bold added):

```
Cache:
    Type:                 synchronized (Platform cache)
    Status:               allocated
    Size:                 112500 entries
    Synchronized Timeout: 100 secs
    Trans end aging:   off
```

QoS Configuration Examples

Additional information

For detailed information about metrics, see Cisco AVC Field Definition Guide for Third-Party Customers.

QoS Example 1: Control and Throttle Traffic

The following QoS configuration example illustrates how to control and throttle the peer-to-peer (P2P) traffic in the network to 1 megabit per second:

```
class-map match-all p2p-class-map
  match protocol attribute sub-category p2p-file-transfer

policy-map p2p-attribute-policy
    class p2p-class-map
        police 1000000
interface Gig0/0/3
    service-policy input p2p-attribute- policy
```

QoS Example 2: Assigning Priority and Allocating Bandwidth

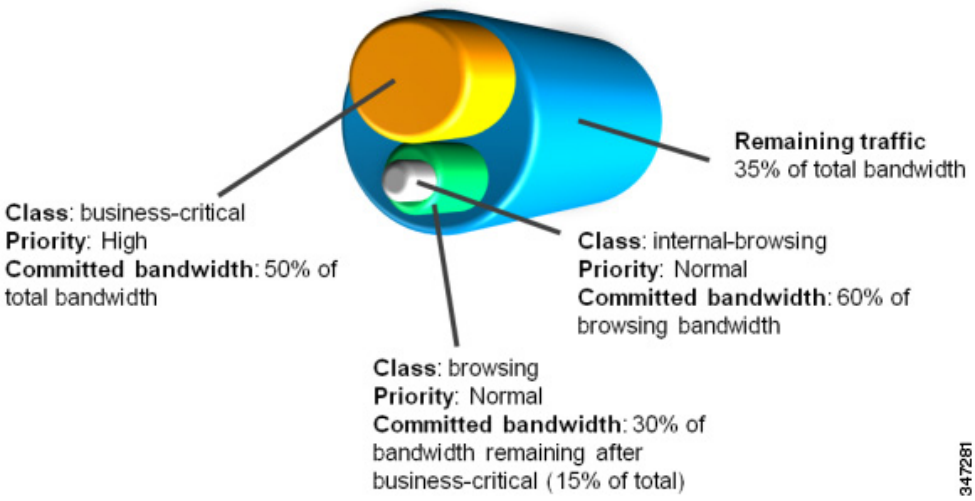
The following QoS configuration example illustrates how to allocate available bandwidth on the eth0/0 interface to different types of traffic. The allocations are as follows:

- Business-critical Citrix application traffic for "access-group 101" users receives highest priority, with 50% of available bandwidth committed and traffic assigned to a priority queue. The `police` statement limits the bandwidth of business-critical traffic to 50% in the example.
- Web browsing receives a committed 30% of the remaining bandwidth after the business-critical traffic. This is a commitment of 15% of the total bandwidth available on the interface.
- Internal browsing, as defined by a specific domain (myserver.com in the example), receives a committed 60% of the browsing bandwidth.
- All remaining traffic uses the remaining 35% of the total bandwidth.

The policy statements commit minimum bandwidth in the percentages described for situations of congestion. When bandwidth is available, traffic can receive more than the "committed" amount. For example, if there is no business-critical traffic at a given time, more bandwidth is available to browsing and other traffic.

Figure 4-4 illustrates the priority and bandwidth allocation for each class. "Remaining traffic" refers to all traffic not specifically defined by the class mapping.

Figure 4-4 Bandwidth Allocation



In class-map definition statements:

- **match-all** restricts the definition to traffic meeting all of the "match" conditions that follow. For example, the "business-critical" class only includes Citrix protocol traffic from IP addresses in "access-group 101."
- **match-any** includes traffic meeting one or more of the "match" conditions that follow.

```
class-map match-all business-critical
    match protocol citrix
    match access-group 101
class-map match-any browsing
    match protocol attribute category browsing

class-map match-any internal-browsing
    match protocol http url "*myserver.com*"

policy-map internal-browsing-policy
    class internal-browsing
        bandwidth remaining percent 60

policy-map my-network-policy
    class business-critical
        priority
        police cir percent 50
    class browsing
        bandwidth remaining percent 30
        service-policy internal-browsing-policy

interface eth0/0
    service-policy output my-network-policy
```

Conversation Based Records—Omitting the Source Port

The monitor configured in the following examples sends traffic reports based on conversation aggregation. For performance and scale reasons, it is preferable to send TCP performance metrics only for traffic that requires TCP performance measurements. It is recommended to configure two similar monitors:

- One monitor includes the required TCP performance metrics. In place of the line shown in **bold** in the example below (collect <any TCP performance metric>), include a line for each TCP metric for the monitor to collect.
- One monitor does not include TCP performance metrics.

The configuration is for IPv4 traffic. Similar monitors should be configured for IPv6.

Additional information

For detailed information about metrics, see Cisco AVC Field Definition Guide for Third-Party Customers.

Example 1: For Cisco IOS Platforms

```
flow record type performance-monitor conversation-record
    match connection client ipv4 (or ipv6) address
    match connection server ipv4 (or ipv6) address
    match connection server transport port
```

```
    match ipv4 (or ipv6) protocol
    match application name account-on-resolution
    collect interface input
    collect interface output
    collect connection server counter bytes long
    collect connection client counter bytes long
    collect connection server counter packets long
    collect connection client counter packets long
    collect connection sum-duration
    collect connection new-connections
    collect policy qos class hierarchy
    collect policy qos queue id
    collect <any TCP performance metric>


flow monitor type performance-monitor conversation-monitor
    record conversation-record
    exporter my-exporter
    history size 0
    cache type synchronized
    cache timeout synchronized 60
    cache entries <cache size>

flow record qos-record
    match policy qos queue index
    collect policy qos queue drops
flow monitor qos-monitor
    exporter my-exporter
    record qos-record
```

Example 2: For Cisco IOS XE Platforms

```
flow record type performance-monitor conversation-record
    match services waas segment account-on-resolution
    match connection client ipv4 (or ipv6) address
    match connection server ipv4 (or ipv6) address
    match connection server transport port
    match ipv4 (or ipv6) protocol
    match application name account-on-resolution
    collect interface input
    collect interface output
    collect connection server counter bytes long
    collect connection client counter bytes long
    collect connection server counter packets long
    collect connection client counter packets long
    collect connection sum-duration
    collect connection new-connections
    collect policy qos class hierarchy
    collect policy qos queue id
    collect <any TCP performance metric>


flow monitor type performance-monitor conversation-monitor
    record conversation-record
    exporter my-exporter
    history size 0
    cache type synchronized
    cache timeout synchronized 60
    cache entries <cache size>
```

HTTP URL

The monitor configured in the following example sends the HTTP host and URL. If the URL is not required, the host can be sent as part of the conversation record (see Conversation Based Records—Omitting the Source Port, page 4-56).

```
flow record type performance-monitor url-record
    match transaction-id
    collect application name
    collect connection client ipv4 (or ipv6) address
    collect routing vrf input
    collect application http url
    collect application http host
    <other metrics could be added here if needed.
    For example bytes/packets to calculate BW per URL
    Or performance metrics per URL>

flow monitor type performance-monitor url-monitor
    record url-record
    exporter my-exporter
    history size 0
    cache type normal
    cache timeout event transaction-end
    cache entries <cache size>
```

Additional information

For detailed information about metrics, see Cisco AVC Field Definition Guide for Third-Party Customers.

HTTP URI

The **uri statistics** command enables exporting the first level of a parsed URI address. The command exports the value in the URI statistics field, which contains the depth 1 URI value, followed by a URI hit count value.

Note **Cisco IOS XE Platforms**: The URI hit count value is always 1 because the URI statistics field can only be configured per connection or transaction.

If no backslash exists at all after the URL, a zero length field is exported.

If the depth 1 value of the parsed URI exceeds a maximum number of characters, the value is truncated to the maximum length.

Note **Cisco IOS XE Platforms**: The **uri statistics** command must be configured with either the **connection id** or **transaction-id** commands.

Configuration Example

```
flow record er_uri_stat_record_1
    match connection transaction-id
    collect application name
    collect counter packets
    collect application http uri statistics
```

Example of Exported Value—Typical Address

Address: http://usr:pwd@www.test.com:81/dir/dir.2/index.htm?q1=0&&test1&test2=value#top

The **uri statistics** command exports: **/dir:1**

- **/dir** is the URI depth 1 level value.
- The "**:**" indicates a null character, followed by a URI hit count value of **1**.

Example of Exported Value—No Backslash after URL

Address: http://usr:pwd@www.test.com

The **uri statistics** command exports a zero length field.

Additional information

For detailed information about metrics, see Cisco AVC Field Definition Guide for Third-Party Customers.

Application Traffic Statistics

The monitor configured in the following examples collect application traffic statistics.

Additional information

For detailed information about metrics, see Cisco AVC Field Definition Guide for Third-Party Customers.

Example 1: For Cisco IOS Platforms

```
flow record type performance-monitor application-traffic-stats
    match ipv4 protocol
    match application name account-on-resolution
    match ipv4 version
    match flow direction
    collect connection initiator
    collect counter packets
    collect counter bytes long
    collect connection new-connections
    collect connection concurrent-connections
    collect connection sum-duration

flow monitor type application-traffic-stats
    record application-traffic-stats
    exporter my-exporter
    history size 0
    cache type synchronized
    cache timeout synchronized 60
    cache entries <cache size>
```

Notes

- For detailed information about metrics, see Cisco AVC Field Definition Guide for Third-Party Customers.

- The example includes a line to collect the **concurrent-connections** metric, a feature currently available only on Cisco IOS platforms. The metric indicates the number of connections that existed at the beginning of the time interval being reported. The value does not include new connections created during the time interval. The **show performance monitor history** CLI output includes the results of the concurrent-connections metric.

Example 2: For Cisco IOS XE Platforms

```
flow record type performance-monitor application-traffic-stats
    match ipv4 protocol
    match application name account-on-resolution
    match ipv4 version
    match flow direction
    collect connection initiator
    collect counter packets
    collect counter bytes long
    collect connection new-connections
    collect connection sum-duration

flow monitor type application-traffic-stats
    record application-traffic-stats
    exporter my-exporter
    history size 0
    cache type synchronized
    cache timeout synchronized 60
    cache entries <cache size>
```

Media RTP Report

The monitor configured in the following example reports on media traffic:

```
flow record type performance-monitor media-record
    match ipv4(or ipv6) protocol
    match ipv4(or ipv6) source address
    match ipv4(or ipv6) destination address
    match transport source-port
    match transport destination-port
    match transport rtp ssrc
    match routing vrf input
    collect transport rtp payload-type
    collect application name
    collect counter packets long
    collect counter bytes long
    collect transport rtp jitter mean sum
    collect transport rtp payload-type
    collect <other media metrics>

flow monitor type media-monitor
    record media-record
    exporter my-exporter
    history size 10 // default history
    cache type synchronized
    cache timeout synchronized 60
    cache entries <cache size>
```

Additional information

For detailed information about metrics, see Cisco AVC Field Definition Guide for Third-Party Customers.

Troubleshooting

This troubleshooting section includes the following topics:

Report Is Not Displayed Correctly

The following may be helpful for troubleshooting a report that is not displayed correctly:

- Verify that your flow exporter is configured with the correct destination IP.
- If you are using a VRF, ensure that it is added at the destination.

```
(config-flow-exporter)# destination 1.1.1.1 vrf myVrf
```

- Check whether samplers are configured correctly.
- Check the flow exporter statistics for errors.

```
# show flow exporter statistics
Flow Exporter my_exporter:
Packet send statistics (last cleared 4d00h ago):
  Successfully sent:         203808                (280136412 bytes)
Client send statistics:
  Client: Option options interface-table
Records added:           18528
   - sent:                18528
 Bytes added:             1852800
   - sent:                1852800
 Client: Option options vrf-id-name-table
   Records added:           3474
     - sent:                3474
 Bytes added:             125064
     - sent:                125064
 Client: Option options sampler-table
   Records added:           0
   Bytes added:             0
Client: Option options application-name
   Records added:           1213584
```

- Check the cache output and verify that the specific monitor is not empty.

```
# show performance monitor cache detail [format record]
# show performance monitor history
```

- Verify policy and class-map hits (counters should increase).

```
# show policy-map type performance-monitor interface g0/0/2
 GigabitEthernet0/0/2
  Service-policy performance-monitor input: mymon_in
    Class-map: select_ipv4_tcpperf (match-all)
      354704 packets, 75729623 bytes
      30 second offered rate 1000 bps, drop rate 0000 bps
      Match: protocol ip
      Match: access-group name ipv4_tcpperf
    Class-map: class-default (match-any)
      0 packets, 0 bytes
      30 second offered rate 0000 bps, drop rate 0000 bps
      Match: any
```

- Review the running-config and verify that nothing is missing or misconfigured. The problem can be caused by even a single access-list missing.
- **Cisco IOS XE Platforms**: Verify that account-on-resolution (AOR) is active.
  - If AOR is active, handles will have a non-zero value, as shown in the following example:

```
# show platform hardware qfp active feature fnf datapath aor
 CFT:  ConfigAddress 0x8a1e16a0, Instance 0x8a1de760, Feat ID 1, FlowObj ID 1
 CVLA: handle 0x97f00000 epoch 0x4
```

  - If AOR is inactive, handles will have the value of zero, as shown in the following example:

```
# show platform hardware qfp active feature fnf datapath aor
 CFT:  ConfigAddress 0x8a1e16a0, Instance 0x00000000, Feat ID 0, FlowObj ID 0
 CVLA: handle 0x0 epoch 0x4
```

Incorrect TCP Performance Statistics

The following may be helpful for troubleshooting incorrect TCP performance statistics:

- Verify that the monitor that includes TCP performance metrics is applied to only one interface.
- For that interface, service-policy must be attached in both directions.
- Check for asymmetric routing.
- Verify that routes/route-maps are configured correctly.
- If filtering applications, ensure that the appropriate class-map has hits.
- Verify that account-on-resolution (AOR) is active. For details about verifying AOR, see Report Is Not Displayed Correctly, page 5-1.
- Enable IP NBAR Protocol Discovery on the interface to determine whether the protocol of interest is identified.

```
Router(config-if)# ip nbar protocol-discovery
Router# show ip nbar protocol-discovery interface g0/0/3
```

```
GigabitEthernet0/0/3
Last clearing of "show ip nbar protocol-discovery" counters 00:00:10
                           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)
  ------------------------ ------------------------- -------------------------
  http                     7                         8
                           3472                      1740
                           0                         0
                           0                         0
```

Memory/Cache Warning

An error message typically occurs if the total memory consumed by all monitors exceeds 25% of the total available memory. If the memory required for all enabled features exceeds the memory available, the following may be helpful for troubleshooting:

- Review the configuration. If there are mismatches, remove the configuration and reapply it.
- Reduce the FNF monitor cache size.

Also see Cache Size Recommendation, page 6-1.

Cache Warning on Cisco IOS Platforms

On Cisco IOS platforms, the following type of MMA warning can occur:

```
7310: 2013-09-17T00:32:02: %SCRIPT-6-DIAG: Sep 16 23:55:56.459 PDT: %MMA-3-CACHE_OVERFLOW:
The number of flows has exceeded 95% of the configured size, monitor testing-url_ipv4,
please increase cache size
```

Memory Warning on Cisco IOS XE Platforms

On Cisco IOS XE platforms, the following type of FNF warning can occur:

```
Oct 28 14:44:10.358 IST: %QFP_FNF-4-FNF_MEM_UPLIMIT_WARN: F0: cpp_cp:  Netflow and
Flexible Netflow configuration is using (140199440) bytes of data plane DRAM which exceeds
the recommended maximum of (134217728) bytes.
```

This warning message indicates that a large amount of memory is allocated to Flexible NetFlow (FNF) monitors. Allocating this amount of memory to FNF monitors is acceptable, but the total memory required by all other enabled features must not exceed the available memory.

More Than 32 Matches per Class

The following may be helpful for troubleshooting the following type of error message regarding configuring more than 32 matching statements:

```
cannot configure more than 32 matching statements per class-map for the interface
```

- Review your class-map configuration.

  ```
  # show class-map
  ```

- Make sure every class-map has no more than 32 match instructions, including hierarchical classes. Remove redundant match instructions

More Than Five Monitors per Class

The following may be helpful if you receive the following type of error message regarding the limit of five (5) monitors per policy per class:

```
%Only 5 monitors allowed per policy per class
```

- Review the class-map configuration.

  # **show class-map**

- Verify that every class-map has no more than five monitors, including FNF monitors which are applied directly on the interface. Remove any redundant monitors and retry.

AVC Notes, Limitations, and Caveats

This section includes the following topics:

Notes

Hidden Fields

Two hidden fields (first/last timestamp) are implicitly added to each record, even when these fields are not explicitly configured. When the fields are not explicitly configured, the fields are not exported and are not displayed using **show** commands. Because of these two hidden fields, the effective maximum number of supported fields is the upper limit defined for the release, minus two.

Cache Size Recommendation

The cache size to configure is determined by the traffic profile. The cache should be large enough to store all traffic records, but not excessively large. A warning message may appear if the configured cache exceeds 25% of DRAM. For troubleshooting information, see Memory/Cache Warning, page 5-3.

Fragmented Packets

AVC handles fragmented packets as follows:

The first fragment packet is treated normally. AVC treats and reports subsequent fragments as non-TCP/UDP packets.

Limitations

General Limitations

Multicast

AVC support for multicast is as follows:

- Supported:
  - MediaMonitoring (Calculates and reports media (RTP) performance metrics)
- Not supported:
  - Account on Resolution (AOR)
  - Application Response Time (ART) metric collection
  - NBAR

NBAR Handling of Traffic From or To the Router Itself

NBAR handling of traffic that originates from or is targeted to the router is not supported. Behavior may vary.

Examples:

- SNMP
- Telnet
- SSH
- Netflow

Delay Before New NBAR Configuration Is Activated

Cisco IOS Platforms	Cisco IOS XE Platforms
15.4(2)T	3.12S

After updating an NBAR configuration, there is a delay before the new configuration is active on the data path.

When you update a configuration, a parallel configuration (the previous) operates during the changeover of configuration to prevent any impact on classification during the transition from one configuration to the next.

After changing a configuration, it takes some time before NBAR classifies traffic according to the new configuration.

The following query indicates the status of the new configuration:

```
Device# show platform software nbar statistics | i NBAR
NBAR state is ACTIVATED
NBAR config send mode is ASYNC
NBAR config state is READY
```

Possible output:

- NBAR State—Status of NBAR component.
  - ACTIVATED
  - DEACTIVATED
- NBAR Configuration Send Mode
  - ASYNC—In normal operation, the NBAR configuration send mode is asynchronous.
- NBAR Configuration State
  - Ready—The new configuration is active.
  - Pending—The new configuration is not yet active. The previous configuration remains active until the new configuration becomes active.
  - Error—The new configuration is not active in the data path due to an error. In this error state, the previous configuration may or may not be active.

Do Not Use the Management Interface for Exporting Records

Cisco IOS Platforms	Cisco IOS XE Platforms
Not applicable	Applicable to all Cisco IOS XE platforms operating with AVC.

Applicable To

All Cisco IOS XE platforms operating with AVC.

Description

Do not use the management interface (typically GigabitEthernet0) as the source interface of the exporter. The management interface can be identified by the “MGMT ETHERNET” or “GigE” labeling of the physical port. Not following this guideline may cause unexpected behavior, including system crash.

Minimum Interval Between Assigning and Removing a Performance Monitor

A minimum interval of approximately 5 seconds is required between assigning a performance monitor and removing it, or between removing and assigning again.

Specifically:

- After assigning an AVC performance monitor to an interface, wait approximately 5 seconds before removing the performance monitor from the interface.
- After removing an AVC performance monitor from an interface, wait approximately 5 seconds before re-assigning the same performance monitor to the interface.

Not waiting the required time interval may cause some AVC functionality to fail; waiting the required 5 seconds and attempting the configuration again typically resolves the issue. In extreme cases, AVC may stop functioning; to resolve this, restart the router.

Limitations for Encapsulated or Encrypted Traffic

Supported Protocols

AVC supports some types of encapsulation and encryption, such as:

- IPv6 pass-through tunneling

  (see Pass-through Tunneled IPv6 Traffic: Classification and Reporting, page 4-47)
- SSL encryption. Support for:
  - Application recognition for many applications
  - Sub-classification
  - Custom protocols

Unsupported Protocols

On traffic that uses unsupported encapsulation protocols, AVC cannot perform deep packet inspection on the traffic. On such traffic:

- AVC classifies the tunnel flow as belonging to the tunnel protocol, but cannot access the flows within the tunnel. As a result, AVC classification is at the tunnel level, and not at the application level.
- Extraction and sub-classification do not work for these flows.

Unsupported pass-through tunneling protocols include the following (and others):

- CAPWAP
- Layer 2 Tunneling Protocol (L2TP)
- Internet Protocol Security (IPsec)

Additional Information

- Logical Interface and VPN Support in AVC, page A-2

ISSU Limitations

Cisco In-Service Software Upgrade (ISSU) provides transparent router software upgrade or downgrade. ISSU enables bug fixes, deployment of new features, and even complete upgrade of the Cisco IOS software image. For more information, see: *In-Service Software Upgrade*.

This section describes ISSU limitations for AVC.

Removing Aliases before Downgrading from Cisco IOS 15.4(1)T / Cisco IOS XE 3.10 or Later

Cisco IOS Platforms	Cisco IOS XE Platforms
Applicable to release 15.4(1)T and later	Applicable to release 3.10S and later

In Cisco IOS XE release 3.10S and Cisco IOS release 15.4(1)T, aliases were introduced to the AVC monitor configuration syntax. Using the **all** alias simplifies configuration statements and optimizes performance. (See CLI Field Aliases, page 4-46.)

Before downgrading from one of these releases, or a later release, to a version that does not support aliases, remove the aliases and manually expand the statements to specify each of the required fields explicitly. Failure to remove aliases before downgrading will result in undesired behavior, including possible system crash.

Downgrading to an IOS XE Version that Does Not Support More than 32 Fields

Cisco IOS Platforms	Cisco IOS XE Platforms
Not applicable	Applicable to release 3.10S and later

AVC for Cisco IOS XE 3.10 introduced support for configuring records containing 40 fields. If a record configuration includes more than 32 fields, downgrading to an IOS XE version that does not support more than 32 fields is not supported.

Before downgrading from Cisco IOS XE 3.10 or later, to a version, such as IOS XE 3.9, that does not support more than 32 fields, remove any record configuration of more than 32 fields.

Note Some record configurations include hidden fields. Hidden fields count toward the total supported number of fields. See Hidden Fields, page 6-1.

Note Upgrading from a version that does not support more than 32 fields to a version that does support more than 32 fields is supported.

Downgrading to an IOS XE Version that Does Not Support Some ezPM Features

Cisco IOS Platforms	Cisco IOS XE Platforms
Not applicable	Applicable to release 3.11S and later

AVC for Cisco IOS XE 3.10 introduced Easy Performance Monitor ("Easy perf-mon" or "ezPM"), which provides an "express" method of provisioning monitors. Later releases have introduced additional features to ezPM. For details, see Easy Performance Monitor (ezPM), page 4-4.

Caution Before performing an ISSU downgrade to an earlier Cisco IOS XE release, verify that any existing ezPM configurations employ only features (such as configurable parameters) supported by the earlier release. If a configuration includes a feature not supported by the earlier release, downgrading will result in a complete procedure failure and loss of router functionality. The failure may require a router reload to return the router to service.

For example, this may occur in the following ISSU downgrades:

- Cisco IOS XE 3.13 to Cisco IOS XE 3.12
- Cisco IOS XE 3.12 to Cisco IOS XE 3.11
- Cisco IOS XE 3.11 to Cisco IOS XE 3.10

Error Caused By Using a Performance Monitor With Default Cache Size

Cisco IOS Platforms	Cisco IOS XE Platforms
Not applicable	Applicable to release 3.11S and later

Symptom

Using a performance monitor when the cache size is set to its default value may cause an error during the Cisco In-Service Software Upgrade (ISSU) process. An error in the console log will indicate a failure to update the monitor cache size.

Conditions

1. Applicable to all Cisco IOS XE platforms.
2. Occurs when running ISSU, which provides transparent router software upgrade or downgrade.
3. May occur when doing either one of the following:
   - Upgrading from Cisco IOS XE 3.10 or earlier to IOS XE 3.11 or later version
   - Downgrading from IOS XE 3.11 (or later) to a version earlier than 3.11

Workaround

A preventive workaround and typical use case is to configure the cache size manually rather than using the default.

If using the default cache size, use the following workaround to avoid the error:

1. Remove the service policy.
2. Run the system upgrade or downgrade.
3. Re-attach the service policy.

Error Caused By Downgrading from Cisco IOS XE 3.14

Cisco IOS Platforms	Cisco IOS XE Platforms
Not applicable	Applicable to release 3.14S

Currently, ISSU downgrade from Cisco IOS XE 3.14 is not supported. This issue is described in caveat **CSCuq63670**, available through the Bug Search Tool.

Symptom

Router begins reboot loop.

Conditions

Attempting ISSU downgrade from Cisco IOS XE 3.14 to an earlier release when multiple policies have been configured on a single interface.

Workaround

No workaround.

Recommendation

Do not perform ISSU downgrade from 3.14.

Performance Monitor Limitations

- Effect of Specific Metrics on Performance, page 6-7

Effect of Specific Metrics on Performance

Cisco IOS Platforms	Cisco IOS XE Platforms
Applicable	This limitation is not applicable.

Performance monitors operate in different modes, depending on the metrics that they are configured to collect. For maximum performance, any of the following metrics may be used. Including other metrics may impact performance.

- Match Fields
  - match application name [account-on-resolution]
  - match connection client ipv4 (or ipv6) address
  - match connection server ipv4 (or ipv6) address
  - match connection client transport port
  - match connection server transport port
  - match ipv4 protocol
  - match policy qos index
  - match routing vrf input
- Collect Fields
  - collect application http host
  - collect application http uri statistics
  - collect connection all
  - collect datalink mac source address
  - collect interface [input/output]
  - collect ip dscp
  - collect ipv4 ttl (or ipv6 hop-limit)
  - collect policy qos classification hierarchy
  - collect policy qos queue [drops/index]
  - collect timestamp sys-uptime first
  - collect timestamp sys-uptime last

Example of Record Including Metrics That Do Not Reduce Performance

```
flow record type performance-monitor Conversation-Traffic-Stats-IPv4(6)
    match ipv4 protocol
    match application name account-on-resolution
    match connection client ipv4 (or ipv6) address
    match connection server ipv4 (or ipv6) address
    match connection server transport port
    match routing vrf input
    collect interface input
    collect interface output
    collect ipv4 dscp
    collect connection client counter packets long
    collect connection server counter packets long
    collect connection client counter bytes long
    collect connection server counter bytes long
    collect connection new-connections
    collect connection sum-duration
    collect ipv4 ttl   (or ipv6 hop-limit)
    collect timestamp sys-uptime first
    collect timestamp sys-uptime last

flow record type performance-monitor Application-Response-Time-IPv4(6)
    match ipv4 protocol
    match application name account-on-resolution
    match connection client ipv4 (or ipv6) address
    match connection server ipv4 (or ipv6) address
    match connection server transport port
```

```
    match routing vrf input
    collect interface input
    collect interface output
    collect ipv4 dscp
    collect connection client counter packets long
    collect connection server counter packets long
    collect connection client counter bytes long
    collect connection server counter bytes long
    collect connection new-connections
    collect connection sum-duration
    collect ipv4 ttl   (or ipv6 hop-limit)
    collect connection delay application sum
    collect connection delay application max
    collect connection delay response to-server sum
    collect connection delay response client-to-server sum
    collect connection delay network client-to-server sum
    collect connection delay network to-client sum
    collect connection delay network to-server sum
    collect connection transaction duration sum
    collect connection transaction counter complete
    collect connection client counter packets retransmitted
    collect connection server counter responses
    collect connection delay response to-server histogram late
    collect timestamp sys-uptime first
    collect timestamp sys-uptime last

flow record type performance-monitor URL-IPv4(6)
    match ipv4 protocol
    match application name account-on-resolution
    match connection client ipv4 (or ipv6) address
    match connection server ipv4 (or ipv6) address
    match connection server transport port
    match routing vrf input
    collect interface input
    collect interface output
    collect ipv4 dscp
    collect connection client counter packets long
    collect connection server counter packets long
    collect connection client counter bytes long
    collect connection server counter bytes long
    collect connection new-connections
    collect connection sum-duration
    collect ipv4 ttl   (or ipv6 hop-limit)
    collect connection delay application sum
    collect connection delay application max
    collect connection delay response to-server sum
    collect connection delay response client-to-server sum
    collect connection delay network client-to-server sum
    collect connection delay network to-client sum
    collect connection delay network to-server sum
    collect connection transaction duration sum
    collect connection transaction counter complete
    collect connection client counter packets retransmitted
    collect connection server counter responses
    collect connection delay response to-server histogram late
    collect timestamp sys-uptime first
    collect timestamp sys-uptime last
    collect application http uri statistics
    collect application http host
```

Caveats

Caveats describe unexpected behavior. Severity 1 caveats are the most serious caveats. Severity 2 caveats are less serious. Severity 3 caveats are moderate caveats.

To view caveats related to the use of AVC, see the release notes for your platform.

If you have an account on Cisco.com, you can also use the Bug Search tool to find select caveats of any severity. See: https://tools.cisco.com/bugsearch/search

(If the defect that you have requested is not displayed, it may be that the defect number does not exist, the defect does not have a customer-visible description, or the defect is for internal Cisco use.)

Derived Fields Caveat

Cisco IOS Platforms	Cisco IOS XE Platforms
Not applicable	Releases prior to 3.10S

Caveat **CSCue53207**, described in the *Cisco ASR 1000 Series Aggregation Services Routers Release Notes*, describes a bug in some earlier releases, in which a record that contains certain derived fields (listed below) may be punted incorrectly to the route processor (RP) and lost. When using any of the **connection delay** fields listed in the Workaround description below, downgrading to a release that contains this bug is not recommended.

The following is a description of the bug:

Symptom

A record that contains certain derived fields (listed below) may be punted incorrectly to the route processor (RP) and lost.

Conditions

Records can collect "derived" fields; calculating derived fields is dependent on the values of other fields. The fields listed below are incorrectly defined as derived and dependent on other fields. When a record contains one of these fields and does not include its dependent fields, the record is punted to the route processor (RP) to complete the record processing. Punting these records might lead to record loss.

Workaround

When configuring a monitor to collect one of the fields listed below, collect each of the dependent fields also. The list indicates the dependencies:

1. “connection delay application sum” is dependent on:
   - connection delay response to-server sum
   - connection delay network to-server sum
   - connection server response sum
2. “connection delay application min” is dependent on:
   - connection delay response to-server min
   - connection delay network to-server sum
3. “connection delay application max” is dependent on:
   - connection delay response to-server max
   - connection delay network to-server sum
4. “connection delay response client-to-server sum” is dependent on:
   - connection delay response to-server sum
   - connection delay network to-server sum
   - connection server response sum
5. “connection delay response client-to-server min” is dependent on:
   - connection delay response to-server min
   - connection delay network to-server sum
   - connection server response sum
   - connection delay response to-server sum
   - connection delay network to-server min
6. “connection delay response client-to-server max” is dependent on:
   - connection delay response to-server max
   - connection delay network to-server sum
   - connection server response sum
   - connection delay response to-server sum
   - connection delay network to-server max

Oversubscribed FNF Monitor Caveat

Cisco IOS Platforms	Cisco IOS XE Platforms
Not applicable	Releases prior to 3.10S

Caveat **CSCud15949**, described in the *Cisco ASR 1000 Series Aggregation Services Routers Release Notes*, describes a bug affecting releases prior to IOS XE 3.10S. For these releases, you can attach up to two policies per interface and direction. The total number of monitors included in the two policies should not exceed 10. In calculating the total number of monitors:

- Each policy is considered to include at least five monitors, even if fewer than five monitors are configured for the policy.
- An FNF static monitor is counted as 1 monitor.

The bug may occur (on the affected releases) if these limits are exceeded on any interface, either for ingress or egress traffic on the interface. This condition is called "oversubscribed."

When a system is oversubscribed, downgrading to a release that contains this bug is not recommended. For oversubscribed systems, Cisco In-Service Software Upgrade (ISSU) does not enable downgrading to a release prior to 3.10S.

The following is a description of the bug:

Symptom

The CPP traceback notifying monitor cannot be reserved.

Conditions

The issue was seen when the MMA policy, mediatrace policy, and one FNF monitor were attached to an interface.

Workaround

Ensure that the total number of monitors does not exceed the limits outlined above, in the description of this bug.

Use Synchronized Cache for Optimized Monitors

Cisco IOS Platforms	Cisco IOS XE Platforms
Release 15.4(1)T	Not applicable

Caveat **CSCuh87789** describes a limitation affecting routers running Cisco IOS 15.4(1)T. On affected releases, use "synchronized cache" when configuring optimized monitors. Do not use, for example, the "normal cache" option. Synchronized cache is the default cache mode for the router.

Using a cache option other than synchronized may result in failure to export certain metrics, resulting in incomplete records.

Incorrect Record Metric Values When FNF Cache Is Full

Cisco IOS Platforms	Cisco IOS XE Platforms
Not applicable	3.11.0 3.11.1 3.12

Caveat **CSCum52041** describes a problem that may occur when the FNF cache reaches a full state.

Symptom

Updating of some records in the FNF cache may fail intermittently. Metrics in these records may not reflect complete router traffic.

Conditions

1. A large number of match keys are defined in the configuration: total length of all key fields is more than 32 bytes.

2. The FNF record cache is full.

Workaround

None.

Further Problem Description

To determine if the FNF cache was full at some time during record collection, use one of the following commands. A value greater than 0 for the flows-not-added counter indicates that the cache reached the full state at some point.

For native FNF:

```
show flow monitor MONITOR-NAME cache
```

For a performance monitor:

```
show performance monitor cache MONITOR-NAME
```

Clock Mismatch Between QFP and Operating System Causes Records To Be Dropped

Cisco IOS Platforms	Cisco IOS XE Platforms
Not affected	Affects the following releases: • 3.10S: all releases • 3.11.0S Issue resolved in: • 3.11.1S and later • 3.12S: all releases

Caveat **CSCul27478** describes a problem that may occur due to a clock mismatch between the IOS XE operating system and the router's QuantumFlow Processor (QFP). When this occurs, records punted from the QFP to IOS may be identified as late records, and incorrectly dropped instead of being exported.

Symptom

Records are dropped (not exported).

Conditions

The problem may occur when there is a clock mismatch between QFP and the IOS XE operating system.

Workaround

A workaround for this issue may be to configure an NTP server that allows the IOS clock to be synchronized with network time.

Alternatively, upgrade to a release that resolves this issue.

Further Problem Description

If the following CLI shows that there are late records, this problem may be occurring:

```
Device# show performance monitor statistics <monitor name>
MMA Internal Stats:
Agg Record Stats:
================
  Record total recv : 41
  Record dropped Gen      : 0
  Record dropped late : 0
  Record total processed : 0
  Malloc failed (low memory)    : 0
  Others : 1
Per Monitor Record Stats:
========================
```

It is also possible to compare timestamps between QFP and IOS XE to determine whether there is a clock mismatch. This may be done by comparing timestamps in an RP platform debug log.

Related Topics

- Caveat **CSCul00248**. If you have an account on Cisco.com, you can use the Bug Search tool to view this caveat.
- Caveat **CSCum07636**. If you have an account on Cisco.com, you can use the Bug Search tool to view this caveat.

CSR1000V Platform: Large Jitter Value Reported for Voice/Video Flow

Cisco IOS Platforms	Cisco IOS XE Platforms
Not affected	Affects CSR1000V platforms only. Affects the following releases: • 3.9S: all releases • 3.10S: all releases • 3.11.0S, 3.11.1S • 3.12S

Caveat **CSCun33822** describes a problem affecting jitter values reported on CSR1000V platforms.

Symptom

Jitter values for voice/video flows are reported inaccurately, often in the hundreds of milliseconds.

Conditions

Relevant for a voice/video RTP flow on a CSR1000V platform.

A Medianet performance monitor is configured to monitor and report RTP statistics, such as jitter and packet-loss.

Workaround

None.

Incorrect Jitter Value Reported for RTP Streams

Cisco IOS Platforms	Cisco IOS XE Platforms
Not affected	All releases, beginning with 3.8S

Symptom

The jitter measurement for RTP streams with a dynamic payload type (96-127) may be incorrect.

There is no dynamically learned mapping between the payload type and the clock frequency used in the specific RTP stream. The frequency is always set to 90 KHz.

Conditions

Affects RTP streams with a dynamic payload type.

Workaround

None.

After Route Processor Switchover, ezPM Record Export May Fail

Cisco IOS Platforms	Cisco IOS XE Platforms
Not affected	3.11.0
	3.11.1

Caveat **CSCun24943** describes a problem affecting ezPM record export after a route processor switchover.

Symptom

After route processor (RP) switchover, ezPM does not operate on the newly active RP. Records are not exported.

Conditions

Stateful switchover (SSO) is configured. Switchover occurs.

Workaround

Re-apply the ezPM configuration or switchover to the original RP after it recovers from failure.

QOS Class Hierarchy and Queue Index Causes Crash

Cisco IOS Platforms	Cisco IOS XE Platforms
Not affected	3.15S

Caveat **CSCut28045** describes a problem that arises when an FNF monitor configured with both a QoS class hierarchy and a queue index is attached to an interface.

Symptom

When an FNF monitor configured with both a QoS class hierarchy and a queue index is attached to an interface, the router crashes.

The following is an example of a configuration that crashes the router:

```
flow record qos
match ipv4 destination address
collect policy qos classification hierarchy
collect policy qos queue index
!
flow monitor qos
  record qos
!
interface gig0/0/1
service-policy test output
ip flow monitor qos output
end
```

Conditions

1. The problem occurs when running Cisco IOS XE 3.15S, also called Cisco IOS XE 15.5(2)S.
2. QoS class hierarchy and QoS queue index fields are configured on the flow record.

Workaround

It is possible to collect the QoS class hierarchy if no queue index is configured in the record.

AVC Supported Platforms, Interfaces, and Networking Modes

This chapter addresses the following topics:

AVC Supported Platforms

Cisco AVC is supported on the following platforms:

- Cisco IOS Platforms (Cisco ISR G2 and ESR Routers)
  - Cisco 800 Series: C881-K9, C886VA-K9, C887VA-K9, C888-K9, C892FSP-K9, C896VA-K9, C897VA-K9, C897VAW-A-K9, C897VA-M-K9, C898EA-K9, C897VAW-E-K9, C897VAM-W-E-K9.
  - Cisco C1921-AX/K9
  - Cisco C1941-AX/K9
  - Cisco C2901-AX/K9
  - Cisco C2911-AX/K9
  - Cisco C2921-AX/K9
  - Cisco C2951-AX/K9
  - Cisco C3925-AX/K9
  - Cisco C3925E-AX/K9
  - Cisco C3945-AX/K9
  - Cisco C3945E-AX/K9
  - Cisco 5915, 5921, 5930, 5940
- Cisco IOS XE Platforms
  - Cisco ASR1000 Series Aggregation Services Routers
  - Cisco ISR4000 Series Integrated Services Routers
  - Cisco CSR 1000V Cloud Services Routers

For information about licensing and features for supported platforms, see:
AVC Licensed Features (Legacy), page C-1

Logical Interface and VPN Support in AVC

Unsupported Logical Interfaces

Logical interfaces *not* supported by Cisco AVC in the current release:

- Dialer interfaces

  Supported on Cisco IOS platforms. Support was added for Cisco IOS XE platforms beginning with Cisco IOS XE 3.16.3, 15.5(3)S3; not supported in prior releases.

- Multiprotocol Label Switching (MPLS)
- Overlay Transport Virtualization (OTV) overlay interfaces
- IPv6 tunnels that terminate on the device

  Also see Pass-through Tunneled IPv6 Traffic: Classification and Reporting, page 4-47.

Partially Supported Logical Interfaces

Logical interfaces *partially* supported by Cisco AVC in the current release:

- Virtual template interface

  Only ezPM monitors can be configured on the virtual template. Static performance monitors (non-ezPM monitors) cannot be configured on the virtual template.

- Example of *supported* configuration:

```
interface virtual-template 1
    performance monitor context xyz
```

- Example of an *unsupported* configuration:

```
service-policy type Performance monitor input/output  xyz
```

VPN Support

AVC support for VPN modes in the current release:

- FLEXVPN

  Supports spoke-to-spoke and hub-to-spoke topologies.

  FLEXVPN does not support IPv6.

  Only ezPM monitors can be configured for FLEXVPN. Static performance monitors (non-ezPM monitors) cannot be configured for FLEXVPN.

- EzVPN

  Only ezPM monitors can be configured for ezVPN. Static performance monitors (non-ezPM monitors) cannot be configured for EzVPN.

Support for Specific Networking Modes

AVC Compatibility with Layer 2 Transparent Mode

Cisco IOS Platforms	Cisco IOS XE Platforms
Not available	Added in release 3.15S

Background

A router operating in layer 2 transparent mode (also called local switching) bridges two interfaces, transparently forwarding packets directly from one interface to the other. The device does not provide typical router functionality; it is sometimes referred to as operating as a "bump in the wire."

For more information, see Layer 2 Local Switching.

AVC Support

AVC supports Layer 2 transparent mode scenarios, providing full AVC functionality.

Configuration

Bridging the Interfaces

To bridge the interfaces:

connect *connection-name interface1 interface2*

Example:

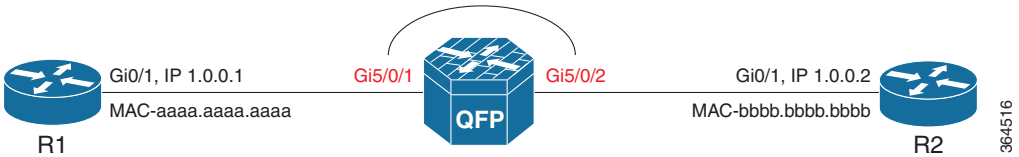
```
connect xyz Gi5/0/1 Gi5/0/2
```

For detailed information, see the configuration guide for your device.

Configure AVC

In the following example, an AVC performance monitor is configured on a device operating in Layer 2 transparent mode. The monitor operates on the bridged traffic.

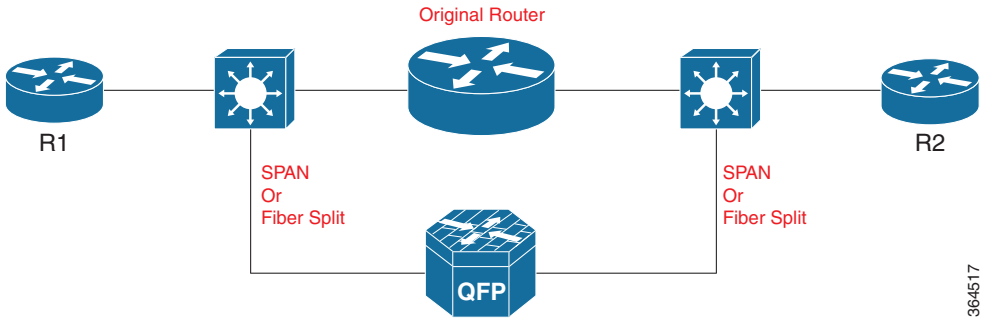
```
Interface Gi5/0/1
  Ip nbar protocol-discovery
  Performance monitor context xyz
```



Use Cases

Case 1: Evaluating AVC Before Full Deployment

Layer 2 transparent mode (local switching) can be used to bypass a router by bridging two interfaces in the network, diverting traffic through a device operating with Cisco AVC. This enables isolation and testing of AVC functionality in the network to evaluate before wider deployment.



Case 2: Standalone AVC-Only Device

Layer 2 transparent mode (local switching) can be used to configure a router to act as a dedicated AVC device, used without routing. A router, such as the comparatively low-cost Cisco ASR1002-X, can serve as the platform for the standalone AVC-enabled device.

Limitations

When operating AVC on a device in Layer 2 transparent mode, the following limitations apply:

- The following MAC addresses are reported as 00:00:00:00:00:00:
  - fields datalink mac source address output
  - datalink mac destination address output
- The per-packet time-to-live (TTL) value may be reported as 1 higher than the actual value.

AVC Feature History

This chapter addresses the following topic:

Feature History

The sections below describe highlights of new features and optimizations in recent AVC releases. They do not provide a full feature history of Cisco AVC.

AVC Features in Cisco IOS Releases

Table B-1 AVC Feature History for Cisco IOS Releases

Feature	Description
Cisco IOS 15.5(3)T	
Added support for Cisco 5000 Series routers	Added support for Cisco 5915, 5921, 5930, 5940 routers For more information, see: AVC Supported Platforms, page A-1
Cisco IOS 15.5(2)T	
Configurable export interval in ezPM	Option to specify the cache timeout (exporting interval) in seconds. At this interval, the cached NetFlow records are exported. For more information, see: ezPM Configuration Options, page 4-14
Cisco IOS 15.5(1)T	
Easy Performance Monitor (ezPM) enhancement: • Application Performance profile added	The Application Performance profile is an improved form of the existing Application Experience profile. Application Experience remains available to support legacy configurations, but it is recommended to use the Application Performance profile for new configurations. For more information, see: Application Performance Profile, page 4-8

Feature	Description
Easy Performance Monitor (ezPM) enhancement: • Improved identification of HTTP traffic	Due to an improvement in NBAR (class-hierarchy feature), URL and Media traffic monitors can more accurately identify HTTP traffic. For more information, see: Easy Performance Monitor (ezPM), page 4-4
NBAR coarse-grain mode added	NBAR provides two levels of application recognition: fine-grain and coarse-grain. Fine-grain mode provides NBAR's full application recognition capabilities. Coarse-grain mode offers a performance advantage by minimizing deep packet inspection, and can be used in scenarios where the full power of fine-grain classification is not required. For more information, see: NBAR2 Fine-grain and Coarse-grain Modes, page 4-19
Cisco IOS 15.4(3)T	
Easy Performance Monitor (ezPM) enhancements: • Application Statistics profile added to Easy Performance Monitor • Added the cache-type parameter to ezPM configuration	The Application Statistics profile collects application statistics on all IPv4 and IPv6 traffic. It is a simpler profile than the Application Experience profile introduced in an earlier release. A new cache-type parameter enables specifying the type of cache for a monitor. For more information, see: Easy Performance Monitor (ezPM), page 4-4
Cisco IOS 15.4(1)T	
Convergence of Cisco AVC Architecture Across Platform Types	The convergence of AVC architecture brings together the strongest AVC features from IOS and IOS XE platforms, providing powerful features and greater standardization of configuration tasks across different Cisco platforms. Metrics, such as ART, HTTP, and QoS metrics, that were available in earlier releases can now be configured in the same way as on Cisco IOS XE platforms. Additional metrics are also newly available for Cisco IOS.
Metric Mediation Agent (MMA)	The Metric Mediation Agent (MMA) introduces an enhancement to Cisco AVC infrastructure, enabling addition of stateful and derived parameters with dynamic registration. The MMA provides aggregation of connections, history, and alarms from the route processor. The aggregated data is exported at a lower speed than the data path export. For more information about the MMA, see: Metric Mediation Agent, page 2-9
QoS Metrics	This Cisco AVC release provides new monitors for collecting metrics related to Quality of Service (QoS) policy. Monitors can indicate: • Packets dropped on an interface, per QoS queue, due to a QoS policy that limits resources available to a specific type of traffic. • Class hierarchy (indicating traffic priority) of a reported flow, as determined by the QoS policy map. For more information, see: QoS Metrics: Cisco IOS Platforms, page 4-32

Feature	Description
Easy Performance Monitor (ezPM) Configuration	Easy Performance Monitor "express" method of provisioning monitors. Easy perf-mon provides "profiles" that represent typical deployment scenarios. After a user selects a profile and specifies a small number of parameters, Easy perf-mon provides the remaining provisioning details. This release provides one profile, which includes five different traffic monitors. Future releases will provide additional options. For more information, see: Easy Performance Monitor (ezPM), page 4-4
Customizing attribute values	See Customizing Attribute Values, page 4-30.
Export Spreading	The export-spreading feature spreads out the export of records from the monitor cache over a time interval, to improve collector performance. For more information, see: NetFlow/IPFIX Flow Monitor, page 4-23
IPv6 Support	The Cisco AVC solution supports both IPv4 and IPv6.

Features Available Prior to Cisco IOS 15.4(1)T

Unified Solution	Unifies the technologies of several reporting/control solutions. AVC technologies include the configuration mechanism, metrics, and reports of such components as TCP performance, and so on.
Media Metrics	For an overview of the metrics collected by Cisco routers, both for Cisco IOS and for Cisco IOS XE, see: *Cisco Application Visibility and Control Field Definition Guide for Third-Party Customers*
Cisco Performance Agent (MACE) Metrics, including: • Application response (ART) • FNF • HTTP • QoS	For information about using these metrics, see *Configuring AVC to Monitor MACE Metrics*.
TCP Performance Metrics	AVC includes several TCP performance measurements for traffic performance reporting.
Cisco Prime Infrastructure	The Cisco Prime Infrastructure management and reporting system is an integral part of the Cisco AVC solution and provides extensive management and reporting features, including provisioning the system, storing exported data, and generating reports.

AVC Features in Cisco IOS XE Releases

Table B-2 AVC Feature History for Cisco IOS XE Releases

Feature	Description
Cisco IOS XE 3.15S	
AVC in L2 Transparent mode	A router operating in layer 2 transparent mode (local switching) bridges two interfaces, transparently forwarding packets directly from one interface to the other, without any other routing functionality. AVC can operate on a device configured in this mode, providing full AVC functionality on the bridged traffic. For more information, see: AVC Compatibility with Layer 2 Transparent Mode, page A-3
Configurable export interval in ezPM	Option to specify the cache timeout (exporting interval) in seconds. At this interval, the cached NetFlow records are exported. For more information, see: ezPM Configuration Options, page 4-14
Cisco IOS XE 3.14S	
Easy Performance Monitor (ezPM) enhancement: • Application Performance profile added	The Application Performance profile is an improved form of the existing Application Experience profile. Application Experience remains available to support legacy configurations, but it is recommended to use the Application Performance profile for new configurations. For more information, see: Application Performance Profile, page 4-8
Easy Performance Monitor (ezPM) enhancement: • Improved identification of HTTP traffic	Due to an improvement in NBAR (class-hierarchy feature), URL and Media traffic monitors can more accurately identify HTTP traffic. For more information, see: Easy Performance Monitor (ezPM), page 4-4
Configuring Multiple Policies on an Interface	Multiple policies can be configured simultaneously on an interface, enabling additional flexibility in metrics collection. For more information, see: Configuring Multiple Policies on an Interface, page 4-17
NBAR coarse-grain mode added	NBAR provides two levels of application recognition: fine-grain and coarse-grain. Fine-grain mode provides NBAR's full application recognition capabilities. Coarse-grain mode offers a performance advantage by minimizing deep packet inspection, and can be used in scenarios where the full power of fine-grain classification is not required. For more information, see: NBAR2 Fine-grain and Coarse-grain Modes, page 4-19

Feature	Description
Cisco IOS XE 3.13S	
Easy Performance Monitor (ezPM) enhancements: • Application Statistics profile added to Easy Performance Monitor • Added the cache-type parameter to ezPM configuration	The Application Statistics profile collects application statistics on all IPv4 and IPv6 traffic. It is a simpler profile than the Application Experience profile introduced in an earlier release. A new cache-type parameter enables specifying the type of cache for a monitor. For more information, see: Easy Performance Monitor (ezPM), page 4-4
Cisco IOS XE 3.12S	
New sampling-rate option added to Easy Performance Monitor configuration.	Added option of entering value of 1 for **sampling-rate** in Easy Performance Monitor configuration, to disable the sampler feature. For more information, see: Easy Performance Monitor (ezPM), page 4-4
AVC interoperability with GETVPN	AVC interoperability with Group Encrypted Transport VPN (GETVPN). For more information, see AVC Interoperability with Cisco GET VPN, page 2-16.
Support for virtual template interface	Support for configuring ezPM monitors on virtual template interfaces. For more information, see: Logical Interface and VPN Support in AVC, page A-2
Additional support for FLEXVPN	Added support for hub-to-spoke topologies. For more information, see: Logical Interface and VPN Support in AVC, page A-2
Performance improvements	This release includes optimization changes that improve AVC performance.
NBAR protocol pack hitless upgrade	When updating an NBAR protocol pack or any NBAR configuration, the previous configuration remains active until the new configuration becomes active. This ensures that NBAR continues to classify traffic in the data path.
Cisco IOS XE 3.11S	
New metric added to track information about the interface being monitored	The **observation point id** metric provides the physical port number of the interface to which the monitor is attached.
Customizing attribute values	See Customizing Attribute Values, page 4-30.
Interoperability with Cisco GET VPN	See NBAR Interoperability with Cisco GET VPN, page 2-15.
Cisco IOS XE 3.10S	
Improved Exporting Model	An improved and optimized exporting configuration model includes: • Exporting only a single record per packet, reducing duplicate data. • Optimizing monitor assignment. • Filtering low-bandwidth traffic. • Per server reports. The improved exporting model is used as part of the Easy Performance Monitor profile included in this release.

Feature	Description
Easy Performance Monitor Configuration	Easy Performance Monitor "express" method of provisioning monitors. Easy perf-mon provides "profiles" that represent typical deployment scenarios. After a user selects a profile and specifies a small number of parameters, Easy perf-mon provides the remaining provisioning details. This release provides one profile, which includes five different traffic monitors. Future releases will provide additional options. For more information, see: Easy Performance Monitor (ezPM), page 4-4
Performance Improvements	This release includes changes, such as an improved exporting model, predefined monitors, and MMA optimization, that improve performance by up to 30%.
Parsing URI Address	This release introduces the ability to parse URI addresses, enabling AVC to report depth 1 of the URI and filter traffic according to that value. For more information, see: HTTP URI, page 4-58
Support for Records with 40 Fields	This release introduces support for configuring records containing 40 fields.
Cisco IOS XE 3.9S	
Enhanced Connection/Transaction Metrics	Beginning with IOS XE release 3.9S, Flexible NetFlow (FNF) monitors can report on individual transactions within a flow. This enables greater resolution for traffic metrics. For more information, see: Connection/Transaction Metrics, page 4-43
QoS Metrics	This Cisco AVC release provides new monitors for collecting metrics related to Quality of Service (QoS) policy. Monitors can indicate: • Packets dropped on an interface, per QoS queue, due to a QoS policy that limits resources available to a specific type of traffic. • Class hierarchy (indicating traffic priority) of a reported flow, as determined by the QoS policy map. For more information, see: QoS Metrics: Cisco IOS XE Platforms, page 4-37
Cisco IOS XE 3.8S	
Interoperability with Cisco AppNav	Cisco AppNav is the Wide Area Application Services (WAAS) diversion mechanism. Beginning with IOS XE release 3.8S, AVC provides statistics before and after the AppNav WAAS service controller (AppNav SC), as well as inspecting and reporting application information on optimized traffic.
Unified Solution	Unifies the technologies of several reporting/control solutions. AVC technologies include the configuration mechanism, metrics, and reports of such components as TCP performance, and so on.
Metric Mediation Agent (MMA)	The Metric Mediation Agent (MMA) is a new infrastructure element developed in the IOS XE 3.8 release to manage, correlate, and aggregate metrics from different metric providers. MMA provides the following functions: • Controls traffic monitoring and filtering policy. • Correlates data from multiple metric providers (see Metric Providers, page 2-9) into the same record. • Aggregates metrics. • Supports history and alert functions. This requires sending the metrics records to the route processor (RP) before exporting them to the management and reporting tools.

Feature	Description
TCP Performance Metrics	This release adds several TCP performance measurements for traffic performance reporting.
Interoperability with AppNav	AppNav is the Wide Area Application Services (WAAS) diversion mechanism. AVC for IOS XE 3.8 provides statistics before and after the AppNav WAAS service controller (AppNav SC), as well as inspecting and reporting application information on optimized traffic.
Packet Capture	Cisco Embedded Packet Capture (EPC) technology performs packet capture.
Cisco Prime Infrastructure	The Cisco Prime Infrastructure management and reporting system is an integral part of the Cisco AVC solution and provides extensive management and reporting features, including provisioning the system, storing exported data, and generating reports.
IPv6 Support	The Cisco AVC solution supports both IPv4 and IPv6.

Legacy: AVC Licensing and Feature Activation

Overview of Legacy Licensing and Activation Information

This appendix provides legacy information about AVC licensing and feature activation for:

- Platforms using Cisco IOS XE releases earlier than IOS XE Gibraltar 16.10.1
- Cisco ISR Generation 2 (ISRG2) platforms using Cisco IOS

AVC Licensed Features (Legacy)

Note This information applies only to devices using Cisco IOS and Cisco IOS XE releases before IOS XE Gibraltar 16.10.1.

Cisco AVC software components are provided as part of each Cisco IOS and Cisco IOS XE release.

Activating full AVC functionality requires additional feature licensing and activation. License and activation details vary according to the platform. For information about supported platforms, see AVC Supported Platforms, page A-1. For platform-specific details about activating features, see AVC Feature Activation, page C-3.

Licensing AVC

For full AVC capabilities, including the ability to recognize 1000+ applications using NBAR2, the Application Experience, or AppX, license is the recommended way to procure AVC functionality. Application Experience licenses provide a cost-effective Intelligent WAN (IWAN) solution, combining AVC, WAN Optimization, and Performance Routing (PfR) capabilities.

Combined hardware-software offerings simplify the procurement of ISR G2, ISR 4000, ASR 1001, ASR 1001X, and ASR 1002-X routers with the Application Experience licenses. Software licenses may be used to add Application Experience capabilities to previously purchased routers.

Table C-1 and Table C-2 describe recommended OS images and feature licenses for a variety of platforms. For detailed, up-to-date information about images and licenses for a particular platform, refer to the documentation associated with the platform.

Application Experience Licensing

For complete details about Application Experience licensing, see:

Application Experience

Table C-1 Recommended OS Image and License—IOS Platforms

Platform	Required OS Image	Recommended AVC License[1]
Cisco ISR G2 (880 series)	Universal - Data For information, see: http://www.cisco.com/c/en/us/products/collateral/routers/887-integrated-services-router-isr/data_sheet_c78_459542.html	Application Experience (AppX) For information about purchasing and installing the AppX license, see: *Cisco Software Activation on Integrated Services Routers*
Cisco ISR G2 (890 series)	Universal For information, see: http://www.cisco.com/c/en/us/products/collateral/routers/800-series-routers/data_sheet_c78-519930.html	Application Experience (AppX) For information about purchasing and installing the AppX license, see: *Cisco Software Activation on Integrated Services Routers*
Cisco ISR G2 (1900, 2900, 3900 series)	Universal	Application Experience (AppX) For information about purchasing and installing the AppX license, see: *Cisco Software Activation on Integrated Services Routers*

1. For the ISR G2 family, the Data license also enables the Right to Use the AVC feature set.

Table C-2 Recommended OS Image and License—IOS XE Platforms Using IOS XE Earlier than 16.10.1

Platform	Required OS Image	Recommended AVC License
Cisco ASR 1000 routers	AIS, AES, or Universal (depending on router model)	AVC Feature License
Cisco CSR1000V	Premium	Premium OS image includes Right to Use AVC
Cisco ISR 4000 Series	Universal	Application Experience (AppX) For information about purchasing and installing the AppX license, see: *Cisco Software Activation on Integrated Services Routers*

Additional Information

For additional information about licensing and other Cisco AVC details pertaining to Cisco ASR 1000 Series routers, see:
Cisco Application Visibility and Control FAQ

AVC Feature Activation

The following sections describe the Cisco IOS/IOS XE image and license to use for full AVC feature activation, and the activation process for different platforms:

- AVC Feature Activation: Cisco ISR G2 Series (Legacy), page C-3
- AVC Feature Activation: Cisco ASR 1000 Series Routers, page C-4
- AVC Feature Activation: Cisco ISR 4000 Series, page C-5
- AVC Feature Activation: Cisco CSR 1000V, page C-6

AVC Feature Activation: Cisco ISR G2 Series (Legacy)

Image and License Required

OS Image and License	Temporary License Activation Supported
See Table C-1 Cisco IOS 15.2(4)M or later	Yes

Temporary Activation/Deactivation of the Application Experience License

Cisco ISR G2 platforms support temporary 90-day activation of Application Experience (AppX) features, for evaluation, before obtaining a full license, using the `license boot module` CLI command. Activating AppX features provides full AVC functionality.

Activation

To temporarily activate AppX features, load the AppX package and reboot the router. Execute the following from the console:

Step 1 **configure terminal**

Step 2 **license boot module** *module-name* **technology-package datak9**

Step 3 **end**

Step 4 **reboot**

To display the *module-name* for your router, use the following command:

```
module ?
```

To display the software packages and features supported by your router, enter the following command:

```
technology-package ?
```

For additional information about activating an evaluation license, see *Software Activation on Cisco Integrated Services Routers and Cisco Integrated Service Routers G2*: http://www.cisco.com/c/en/us/td/docs/routers/access/sw_activation/SA_on_ISR.html#wp1155619

Deactivation

To deactivate the AppX features, unload the AppX package and reboot the router. Execute the following from the console:

Step 1 **configure terminal**

Step 2 **no license boot module** *module-name* **technology-package datak9**

Step 3 **end**

Step 4 **reboot**

AVC Feature Activation: Cisco ASR 1000 Series Routers

Note This information applies only to devices using Cisco IOS XE releases before IOS XE Gibraltar 16.10.1.

Image and License Required

OS Image and License	Temporary License Activation Supported
See Table C-2	Yes

Licenses

For information about purchasing and installing the AES or AIS license for Cisco ASR 1000 series routers, see:

- *Software Activation Configuration Guide, Cisco IOS XE Release 3S*
- *Cisco ASR 1000 Series Aggregation Services Routers Ordering Guide*

AVC Feature Activation: Cisco ISR 4000 Series

Note This information applies only to devices using Cisco IOS XE releases before IOS XE Gibraltar 16.10.1.

Image and License Required

OS Image and License	Temporary License Activation Supported
See Table C-2	Yes

Temporary Activation/Deactivation of the Application Experience License

The Cisco ISR 4000 Series supports temporary 90-day activation of Application Experience (AppX) features, for evaluation, before obtaining a full license, using the `license boot level` CLI command. Activating AppX features provides full AVC functionality.

Activation

To temporarily activate AppX features, load the AppX package and reboot the router. Execute the following from the console:

```
conf t
     license boot level datak9
end
reboot
```

Deactivation

To deactivate the AppX features, unload the AppX package and reboot the router. Execute the following from the console:

```
conf t
     no license boot level datak9
end
reboot
```

AVC Feature Activation: Cisco CSR 1000V

Note This information applies only to devices using Cisco IOS XE releases before IOS XE Gibraltar 16.10.1.

Image and License Required

OS Image and License	Temporary License Activation Supported
See Table C-2	Yes

License

For information about purchasing and installing the Application Experience (AppX) license, see Cisco IOS and IOS XE Licenses, page C-7.

Temporary Activation/Deactivation of the Premium License

Cisco CSR 1000V Cloud Services Routers support temporary 90-day activation of Premium license features, for evaluation, before obtaining a full license, using the `license boot level` CLI command. Activating Premium features provides full AVC functionality.

Activation

To temporarily activate Premium features, execute the following from the console:

```
conf t
     license boot level premium
end
reboot
```

Deactivation

To deactivate the Premium features, reboot the router and execute one of the following from the console:

Option 1:

```
conf t
     license boot level standard
end
reboot
```

Option 2:

```
conf t
     license boot level advanced
end
reboot
```

For information about images and licenses for the Cisco CSR 1000V, see:
Cisco CSR 1000V Series Cloud Services Router Release Notes

Cisco IOS Images and Licensing

Note This information applies only to devices using Cisco IOS and Cisco IOS XE releases before IOS XE Gibraltar 16.10.1.

Cisco IOS and IOS XE Licenses

For information about Application Experience (AppX) licensing, see:

- *Application Experience*

  http://www.cisco.com/c/en/us/solutions/enterprise-networks/application-experience/index.html
- *Cisco Software Activation on Integrated Services Routers*

  http://www.cisco.com/c/en/us/products/cloud-systems-management/software-activation-on-integrated-services-routers-isr/index.html

Universal Image and Software Activation License

The feature activation section for each platform indicates whether it supports use of a universal IOS XE software image. The universal software image includes all IOS XE functionality. You can purchase new software capabilities at any time for a deployed router. With the purchase, you receive a Product Activation Key (PAK). To activate the purchased functionality, you enter the PAK into the Software Activation License (SAL), which is preinstalled on the device.

The software activation licensing system simplifies IOS XE software deployment. The IOS XE software image remains unchanged, regardless of which functionality has been activated, and only one archive image must be maintained per device.

References

The following table provides additional reference material.

Document	Description
AVC	
Application Visibility and Control (AVC)	Cisco Application Visibility and Control (AVC) home page (www.cisco.com/go/avc).
Cisco Application Visibility and Control Field Definition Guide for Third-Party Customers	Overview of the metrics and Flexible NetFlow (FNF) IDs exported by Cisco routers, both for Cisco IOS and for Cisco IOS XE.
Licensing	
Software Activation Configuration Guide, Cisco IOS XE Release 3S	Activating licensed features in Cisco IOS XE.
Cisco ASR 1000 Series Aggregation Services Routers Ordering Guide	License ordering guide for Cisco ASR 1000 Series routers.
Cisco CSR 1000V Series Cloud Services Router Release Notes	Image and license information for CSR 1000V
Cisco Software Activation on Integrated Services Routers	Activating licensed features for Cisco Integrated Services Routers (ISR)
Configuration	
Application Visibility and Control Configuration Guide, Cisco IOS Release 15M&T	AVC configuration information for Cisco IOS platforms.
Application Visibility and Control Configuration Guide, Cisco IOS XE Release 3S	AVC configuration information for Cisco IOS XE platforms.
Configuring AVC to Monitor MACE Metrics	Information about AVC configuration using MACE on Cisco ISR G2 routers, prior to the Cisco IOS release 15.4(1)T. AVC continues to support MACE configuration but users are encouraged to migrate to MMA.
Easy Performance Monitor	Configuring Easy Performance Monitor (ezPM) on Cisco IOS XE Release 3S.
Cisco IOS Flexible NetFlow Command Reference	Flexible NetFlow commands.
Getting Started with Configuring NetFlow and NetFlow Data Export	Configuring NetFlow and NetFlow Data Export.
Configuring NetFlow and NetFlow Data Export	Configuring NetFlow network traffic data export.

Document	Description
Related Components	
Applying QoS Features Using the MQC	Defining traffic policy using the Modular Quality of Service CLI (MQC).
Cisco IOS Quality of Service Solutions Configuration Guide	Configuring Cisco QoS.
Classifying Network Traffic Using NBAR in Cisco IOS XE Software	Configuring Cisco NBAR.
NBAR Protocol Pack Library	NBAR protocol library and NBAR2 protocol packs.
Cisco Performance Monitor and Mediatrace QuickStart Guide	Cisco Performance Monitor and Mediatrace.
Cisco Prime Infrastructure	Cisco Prime Infrastructure home page, with links to product documentation.
Cisco IOS Embedded Packet Capture	Cisco IOS Embedded Packet Capture (EPC) documentation.

A

AVC Application Visibility and Control

C

CFT Common Flow Table

CP Control Plane

CSR Cloud Services Router

D

DP Data plane

E

ESP Embedded Services Processor

F

FNF Flexible NetFlow

FW Firewall

I

IP Internet Protocol – Layer 3 Datagram Protocol. IP provides features for addressing, type-of-service specification, fragmentation and reassembly, and security. Defined in RFC 791 (IPv4) and RFC 2460 (IPv6).

IPC Inter Process Communication

IPFIX Internet Protocol Flow Information Export

L

L2	Datalink Layer (layer 2) of the ISO reference model
L3	Network Layer (layer 3) of the ISO reference model
L4	Transport Layer (layer 4) of the ISO reference model
L7	Application Layer (layer 7) of the ISO reference model

M

MACE	Measurement, Aggregation, and Correlation Engine
MMA	Metric Mediation Agent
MMON	Media Monitoring

N

NAT	Network Address Translation
NBAR/NBAR2	Network Based Application Recognition

P

PA	Performance Agent

R

RP	Route Processor
RSVP	Resource Reservation Protocol

S

SNMP	Simple Network Management Protocol
SSRC	Synchronization Source

T

TCP Transmission Control Protocol—L4 Reliable Transport Mechanism. Connection-oriented transport layer protocol that provides reliable full-duplex data transmission. TCP is part of the TCP/IP protocol stack.

TSS TCP Session State

U

UDP User Datagram Protocol—L4 Transport Mechanism. Connectionless transport layer protocol in the TCP/IP protocol stack. UDP is a simple protocol that exchanges datagrams without acknowledgments or guaranteed delivery, requiring that error processing and retransmission be handled by other protocols. UDP is defined in RFC 768.

V

VRF Virtual Routing and Forwarding

W

WAAS Wide Area Application Services

WAN Wide Area Network

WCM WAAS Central Manager

Z

ZBFW Zone Based Firewall