Cisco Application Visibility and Control Solution Guide for IOS XE Release 3.9S

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Preface

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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 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.

Note The AVC solution is currently in limited availability (LA) to control customer adoption, gain more visibility about technical issues, and improve general usability for Cisco Prime Infrastructure throughout the LA period. To ensure the smoothest possible implementation, please contact the AVC support team at the following address as you plan your deployment: ask-avc-external@external.cisco.com

Warranty

For warranty, service, and support information, see the “Cisco One-Year Limited Hardware Warranty Terms” section in *Readme First for the Cisco Aggregation Services Routers*, which was shipped with your router.

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.
Appendix A	AVC Supported Platforms and Interfaces	Platforms that support Cisco AVC, and interfaces that AVC supports.
Appendix B	New Exported Fields	New Flexible NetFlow (FNF) fields and the CLI used to retrieve the value of the fields.
Appendix C	DPI/L7 Extracted Fields	Deep packet inspection (DPI)/L7 extracted fields and the CLI used to retrieve the value of the fields.
Appendix D	Fields that Require Punt to the Route Processor	Media monitoring/metadata metrics that require punt to the record processor.
Appendix E	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.

Table 2 Command Conventions

Convention	Description
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 E, "References," or visit:

http://www.cisco.com/go/avc

Searching for Cisco Documents

To search an HTML document using a web browser, use the **Ctrl+F** (Windows) or **Cmd+F** (Apple) sequences. In most browsers the option to search whole words only, invoke case sensitivity, or search forward and backward are also available.

To search a PDF document in Adobe Reader, use the basic Find toolbar **(Ctrl+F)** or the Full Reader Search window **(Shift+Ctrl+F)**. Use the Find toolbar to find words or phrases within one specific document. Use the Full Reader Search window to search multiple PDF files simultaneously as well as change case sensitivity, and other options. Adobe Reader comes with online help with more information regarding searching PDF documents.

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

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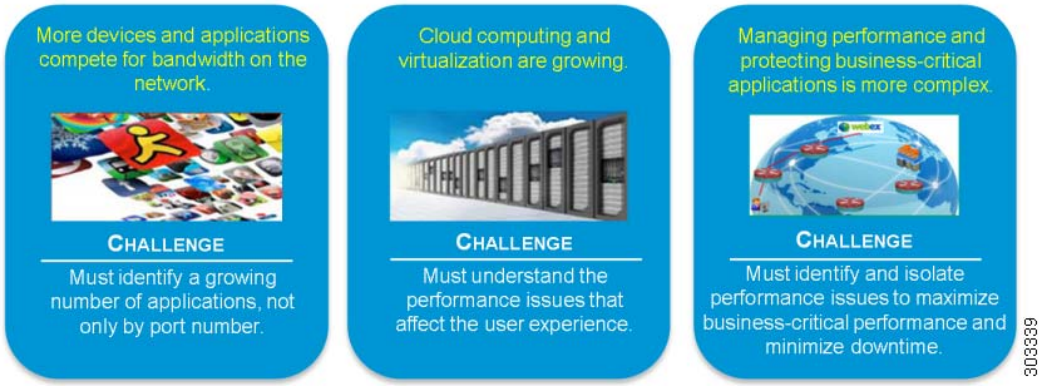
Introduction

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.

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?
  - What is the mix of application traffic?
  - What are the key network performance metrics?

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

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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 XE components, as well as communicating with external tools, to integrate the following functions into a powerful solution.

- **Application Recognition**

  Operating on 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. However, if more complex processing is required on the router, such as if the user requests that the router keep a history of exported records, the records may be exported from the route processor at a lower speed.

- **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.

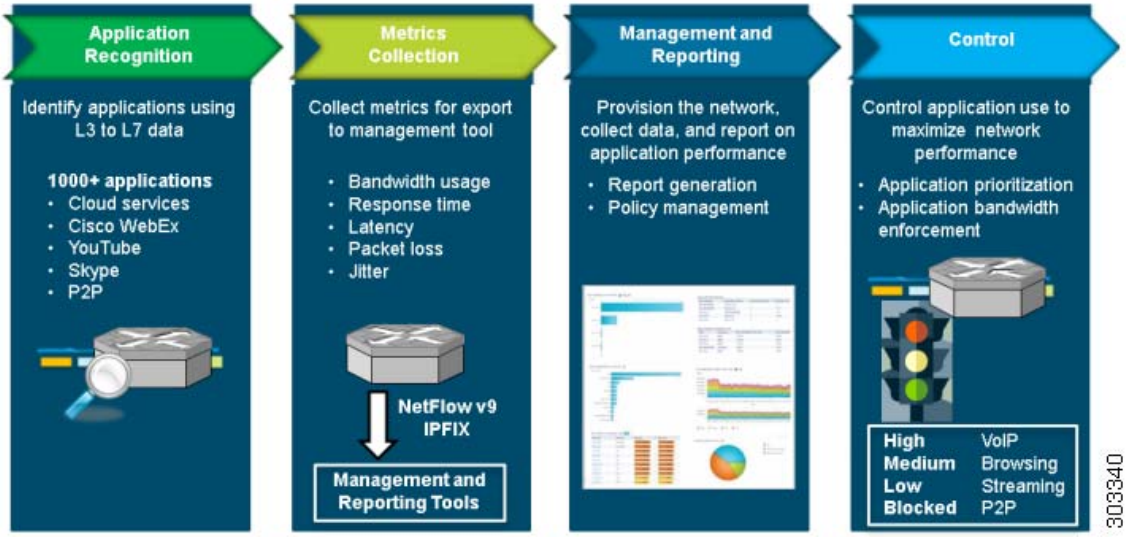
  Using the Cisco Prime Infrastructure management console, an administrator can configure each router in the network remotely by a GUI.

- **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 ASR 1000 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

The Cisco AVC solution for IOS XE 3.9 includes enhancements to existing components, as well as new features.

Existing/Enhanced Features

- **Application Recognition**—Network Based Application Recognition 2 (NBAR2) provides application recognition.
- **Traffic Filtering**—A policy-map defined in Cisco Common Classification Policy Language (C3PL) filters the traffic to be reported. The traffic filters operate exclusively of other types of policy-maps employed in the system.
- **Media Monitoring**—Media performance metrics are provided by the Medianet technology.

- **Accounting**:
  - Accounting of all metrics performed by Flexible NetFlow (FNF) and the IPFIX exporter.
  - Multiple parallel monitors with overlapping data for the same traffic permitted.
  - Flexible record keys provide different aggregation schemes for different traffic types.
- **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, Medianet, and so on.
- **Infrastructure Enhancements**—A common infrastructure, Metric Mediation Agent (MMA) enables adding stateful and derived parameters with dynamic registration. The infrastructure provides aggregation of connections, history, and alarms from the route processor at a lower speed than the data path export.
- **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. Beginning with IOS XE release 3.8, AVC 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.

New AVC Features in IOS XE 3.9

The following are new features in IOS XE 3.9:

- **Enhanced Connection/Transaction Metrics**—Beginning with this release, 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 4-15
- **QoS Metrics**—AVC 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, page 4-9
- **Support on Cisco Cloud Services Router**—AVC is supported on the new Cisco Cloud Services Router (CSV)-1000V. For more information, see:
  Licensing and Feature Activation, page 3-1

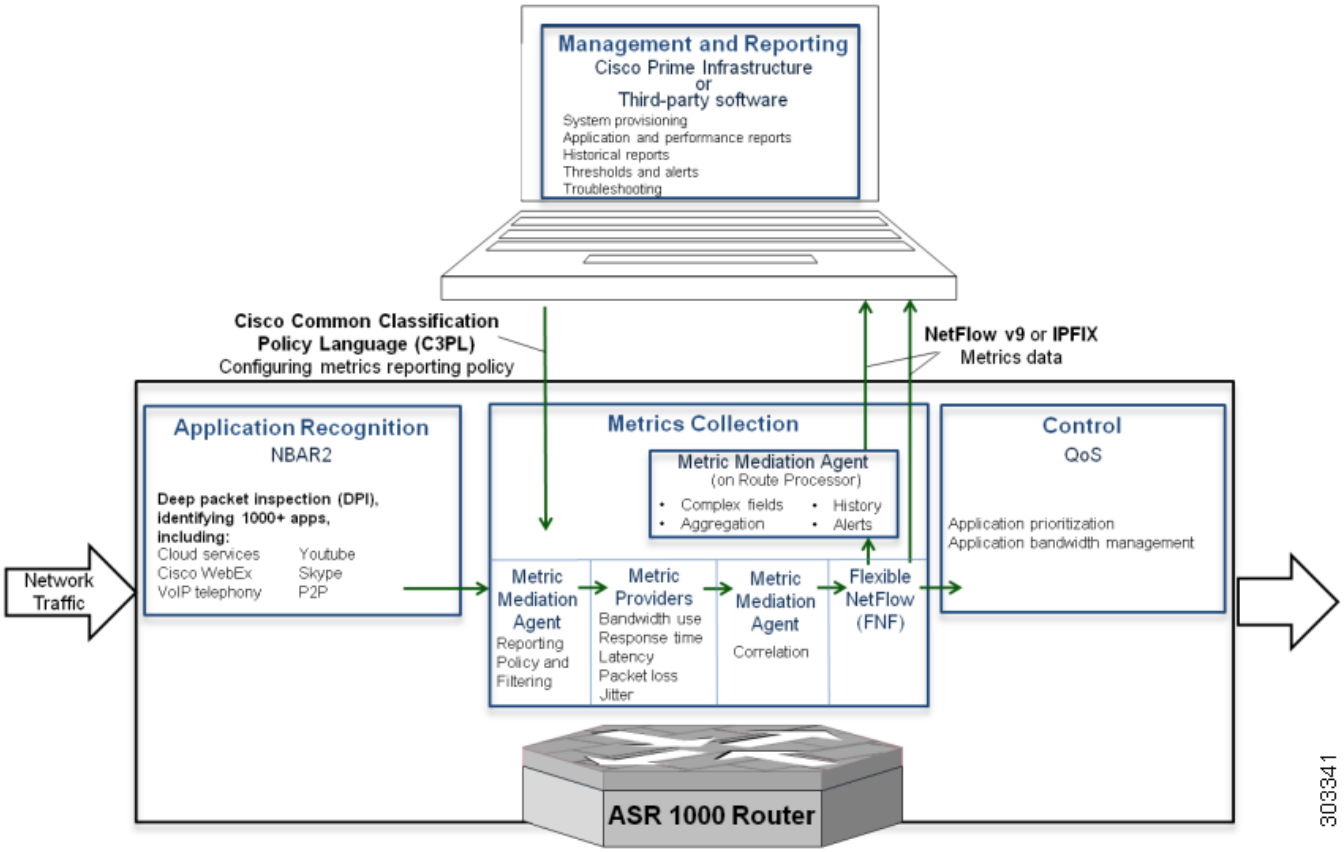
AVC Architecture

The following Cisco AVC components are described in this section:

- NBAR2, page 2-5
- Metric Mediation Agent, page 2-5
- Metric Providers, page 2-5
- Flexible NetFlow, page 2-6
- QoS, page 2-6
- Embedded Packet Capture, page 2-6
- Common Flow Table, page 2-6
- Cisco Management and Reporting System: Cisco Prime Infrastructure, page 2-6

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

Figure 2-2 AVC Architecture for 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.

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, visit: 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, visit: http://www.cisco.com/go/nbar

Metric Mediation Agent

The Metric Mediation Agent (MMA) is an infrastructure element added to the AVC solution in the IOS XE 3.8 release. 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 2-5) 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 2-5).

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, visit: http://www.cisco.com/go/fnf

QoS

Cisco Quality of Service (QoS) provides prioritization, shaping, or 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, visit: http://www.cisco.com/go/qos

Embedded Packet Capture

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, visit: 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.

Cisco Management and Reporting System: 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, visit: http://www.cisco.com/go/primeinfrastructure

Interoperability of AVC with other Services

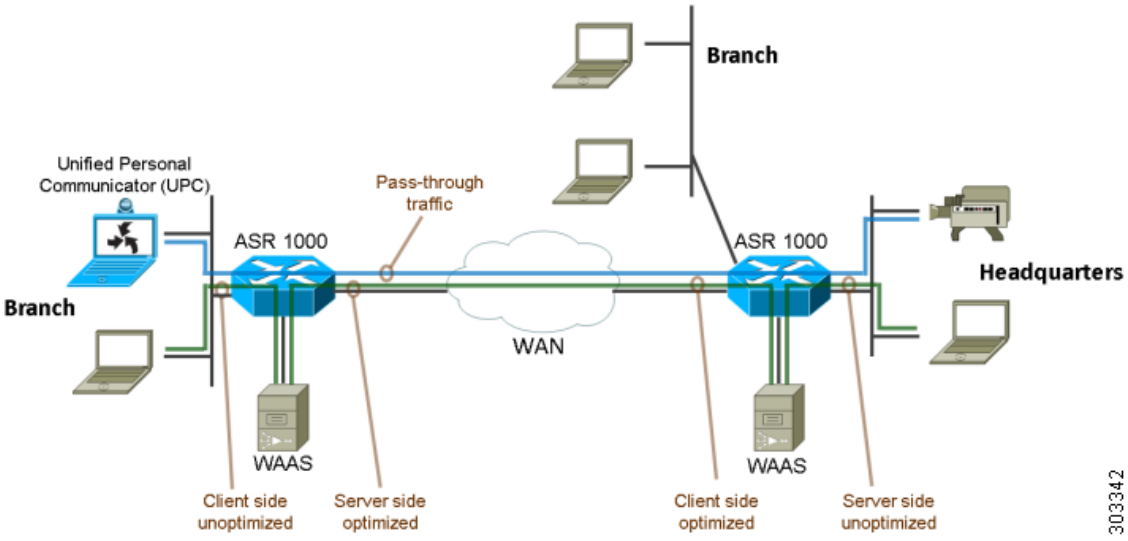
Cisco AVC is interoperable with many router features and services. This section provides additional information about AVC integration with AppNav WAAS, NAT, and VRF.

- Interoperability with AppNav WAAS, page 2-7
- Interoperability with NAT and VRF, page 2-9

Interoperability with AppNav WAAS

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

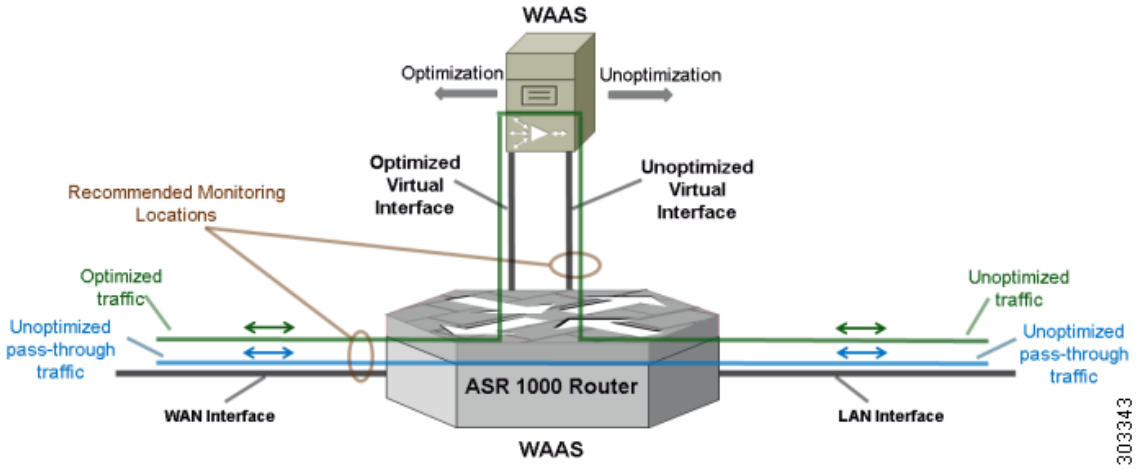


Attachment to a WAAS-Enabled Interface

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 2-1 describes the segment definitions.

Table 2-1 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 Appendix B, "New Exported Fields" 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 2-2 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 2-2 AppNav Exported Interfaces

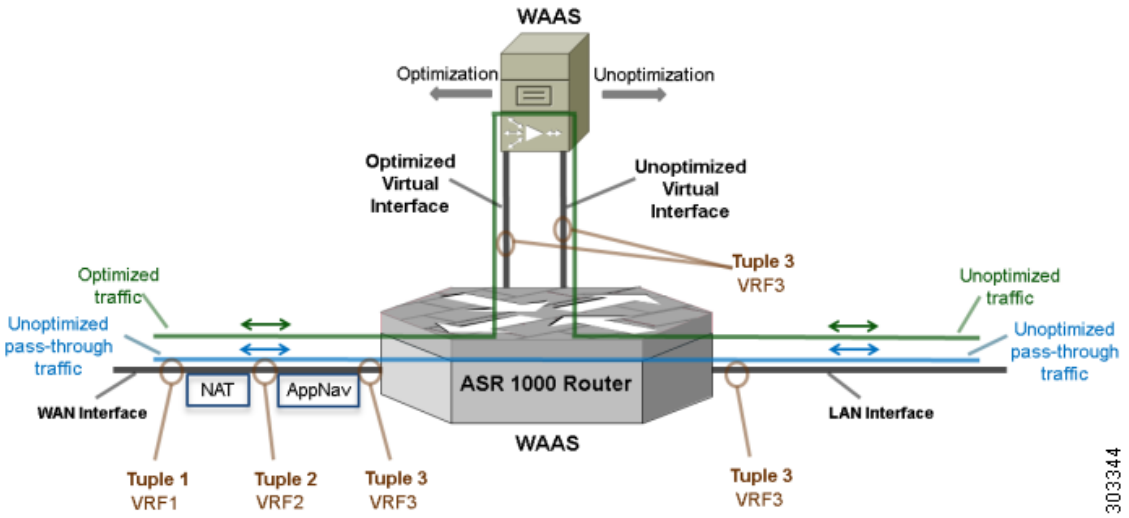
Interface	Direction	Input interface value	Output interface value
WAN	Ingress	WAN	LAN
WAN	Egress	LAN	WAN
Optimized VI	Egress	WAN	Optimized VI
Optimized VI	Ingress	Optimized VI	LAN
UnOptimized VI	Ingress	UnOptimized VI	LAN
UnOptimized VI	Egress	LAN	UnOptimized VI
LAN	Egress	WAN	LAN
LAN	Ingress	LAN	WAN

Interoperability with NAT and VRF

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



Major External Interfaces

New Exported Fields

Appendix B, "New Exported Fields" describes Flexible NetFlow (FNF) fields new to the IOS XE 3.8 and IOS XE 3.9 releases.

DPI/L7 Extracted Fields

Appendix C, "DPI/L7 Extracted Fields" describes the deep packet inspection (DPI)/L7 extracted fields.

Fields that Require Records Punt to the Route Processor

Appendix D, "Fields that Require Punt to the Route Processor" describes the media monitoring/metadata metrics that require punt to the route processor (RP).

AVC Licensing and Feature Activation

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

Licensing and Feature Activation

Activating full Cisco AVC functionality on supported platforms may require additional feature licensing and activation. See AVC Supported Platforms, page A-1 for information about supported platforms.

Feature activation is accomplished differently for different platforms. See the following sections for details:

AVC Functionality

The AES or AIS license adds advanced AVC functionality, as summarized in Table 3-1.

Table 3-1 AVC feature licensing

Feature	Without Additional Licensing	With AES or AIS Licensing
NBAR[1] Protocol Pack	Standard	Advanced
NBAR custom protocols	Not available	Available
NBAR customization of application protocol attributes	Not available	Available
NBAR HTTP field extraction	Not available	Available
NBAR IPv6 tunneling	Not available	Available
WAAS[2]	Not available	Available

1. NBAR = Cisco Network Based Application Recognition
2. WAAS = Cisco Wide Area Application Services

Required IOS XE Image and License

Table 3-2 describes the IOS XE image and the license required to activate full AVC functionality for supported models.

Table 3-2 Image/License required for AVC functionality

Platform	IOS XE image required for AVC functionality	License	Temporary licence activation supported
Cisco ASR 1001 Cisco ASR 1002-X	Universal	AES[1] or AIS[2]	Yes
Cisco ASR 1000 Series routers other than ASR 1001 and ASR 1002-X **Note**: These platforms are also provided with the IPBASE image, which does not include AVC functionality.	AES or AIS	AES or AIS **Note**: This license is typically bundled with the AIS or AES image.	No
Cisco CSR-1000V Cloud Services Router	AES	AES **Note**: The AES license is typically bundled with the AES image provided with the platform.	No

1. AES = Advanced Enterprise Services
2. AIS = Advanced IP Services

AVC Licensing for Cisco ASR 1000 Series Routers

See Table 3-2 for information about the IOS XE image and the license required to activate full AVC functionality.

For additional 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*

Temporary Activation/Deactivation of the AES or AIS License

Cisco ASR 1001 and Cisco ASR 1002-X routers support temporary activation of AES or AIS features before obtaining a license, using the `license boot level` CLI command. Activating either of these feature sets provides full AVC functionality.

Note Cisco ASR 1000 series models other than Cisco ASR 1001 and Cisco ASR 1002-X do not support temporary license activation.

Activation

To temporarily activate AES or AIS features, load the AES or AIS image and reboot the router. Execute the following from the console (using `adventerprise` for the AES image or `advipservices` for the AIS image):

```
conf t
     license boot level [adventerprise | advipservices]
end
reboot
```

Deactivation

To deactivate the AES/AIS license features, load the IPbase image and reboot the router. Execute the following from the console:

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

AVC Licensing for Cisco CSR 1000V

Cisco CSR 1000V Cloud Services Routers are provided with an Advanced Enterprise Services (AES) IOS XE image and license, providing full AVC functionality.

AVC Configuration

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

Unified Policy CLI

Beginning with Cisco IOS XE 3.8, monitoring configuration is done using performance-monitor unified monitor and policy.

```
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

- Support for:
  - 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).

Attach policy to the interface using following command:

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

Metric Producer Parameters

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

Note Cisco IOS XE 3.8 and 3.9 support only MediaNet-specific parameters.

```
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. 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, it is preferable when possible to send the monitor records directly to the Management and Reporting system and apply the network alerts in the Management and Reporting system.

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

NetFlow/IPFIX Flow Monitor

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

```
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 | synchronized} <value> | 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.)

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 as of release IOS XE 3.8, 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 ASR 1000 platform.

A detailed description of NetFlow fields appears in the *Cisco IOS Flexible NetFlow Command Reference*. Appendix B, "New Exported Fields" describes new NetFlow exported fields.

Note In this release, the record size is limited to 30 fields (key and non-key fields or match and collect fields).

L3/L4 Fields

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

```
[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 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.

  – 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 Appendix C, “DPI/L7 Extracted Fields”.

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:

```
collect           connection client counter bytes   [long]
collect           connection client counter packets [long]
collect           connection server counter bytes   [long]
collect           connection server counter packets [long]
collect           counter packets [long]
collect           counter bytes   [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
```

Counter Metrics Added in the Cisco IOS XE 3.9.2 Release

In the Cisco IOS XE 3.9.2 maintenance release, the following counter fields were added:

- Client Bytes—Total L3 bytes sent by the initiator of a connection. Counted for TCP and UDP connections.

  ```
  collect           connection client counter bytes network long
  ```

- Server Bytes—Total L3 bytes sent by the responder of a connection. Counted for TCP and UDP connections.

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

For addition information about these fields, see *Cisco Application Visibility and Control Field Definition Guide for Third-Party Customers*.

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 in AVC for IOS XE 3.9:

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

Figure 4-1 provides an overview of network response time metrics.

Figure 4-1 Network response times

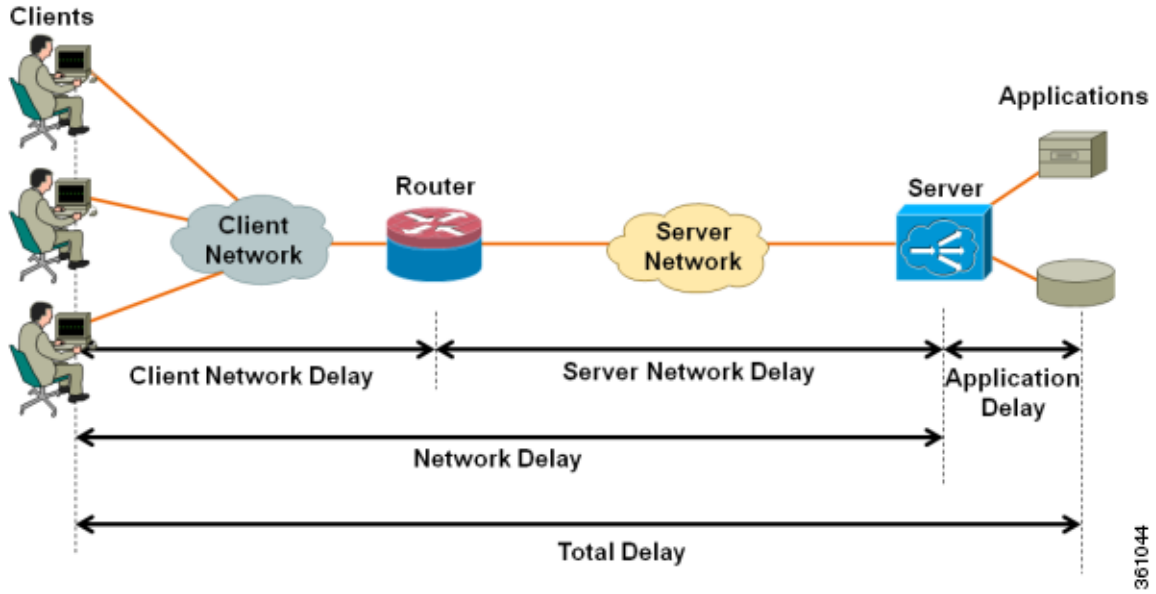
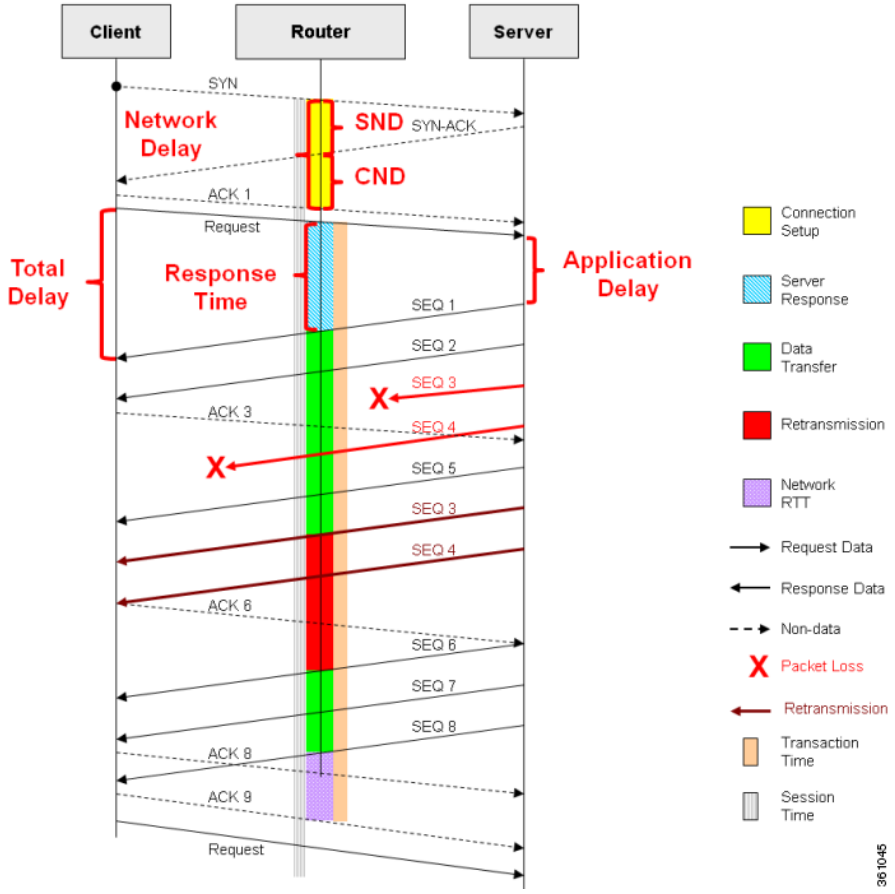


Figure 4-2 provides details of network response time metrics.

Figure 4-2 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 Appendix D, "Fields that Require Punt to the Route Processor".

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

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 or debug 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]
```

NBAR Attribute Customization

Use the following commands to customize the NBAR attributes:

```
[no] ip nbar attribute-map <profile 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> <profile 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.

NBAR Customize 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

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

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

Background

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, visit: 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 4-1 shows an example of the information provided in an FNF record for three flows governed by this configuration.

Table 4-1 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 4-1, 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 4-11.

```
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 4-11.

```
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

Beginning with Cisco AVC for IOS XE Release 3.9, 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 3.9 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 following for the Multi-transaction feature:

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 “collect application http url” 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 Native FNF Mode

Use the following to configure exporter, record, and monitor.

The “match connection” statement shown in **bold** below must be one of the following:

- `match connection id`
- `match connection transaction-id`

```
flow exporter <exporter_name>
    destination <exporter_address>
    transport <exporter_port>

flow record <record_name>
    match connection <id or transaction-id>
    collect <specify_metric>
    collect application name
    collect application http url

flow monitor <monitor_name>
    record  <record_name>
    exporter <exporter_name>
    cache timeout event transaction-end

interface <interface>
    ip flow monitor <monitor_name> input
```

Example

In the following example:

- Exporter: mul_trans_exporter
- Record: mul_trans_record_1
- Specifies the **transaction-id** metric for the FNF record, as shown in **bold**. Alternatively, you can specify the **connection id** metric.
- The `collect` statements specify the following metrics: `counter packets, application name, application http url`
- Monitor: mul_trans_monitor_1
- Interface: GigabitEthernet0/0/2

```
flow exporter mul_trans_exporter
    destination 64.128.128.128
    transport udp 2055

flow record mul_trans_record_1
    match connection transaction-id
    collect counter packets
    collect application name
    collect application http url

flow monitor er_mul_trans_monitor_1
    record  mul_trans_record_1
    exporter mul_trans_exporter
    cache timeout event transaction-end

interface GigabitEthernet0/0/2
    ip flow monitor mul_trans_monitor_1 input
```

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 Native FNF Mode, page 4-16 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

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
    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:

- Native or Performance Monitor Mode, page 4-18
- Native FNF Mode, page 4-18
- Performance Monitor Mode, page 4-19

Note For information about the **show** commands in the sections below, see the FNF command reference guide: http://www.cisco.com/en/US/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
```

Configuration Examples

This section contains configuration examples for the Cisco AVC solution. These examples provide a general view of a variety of configuration scenarios. Configuration is flexible and supports different types of record configurations.

Conversation Based Records—Omitting the Source Port

The monitor configured in the following example 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.

```
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 4-19).

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

Application Traffic Statistics

The monitor configured in the following example collects application traffic statistics:

```
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>
```

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

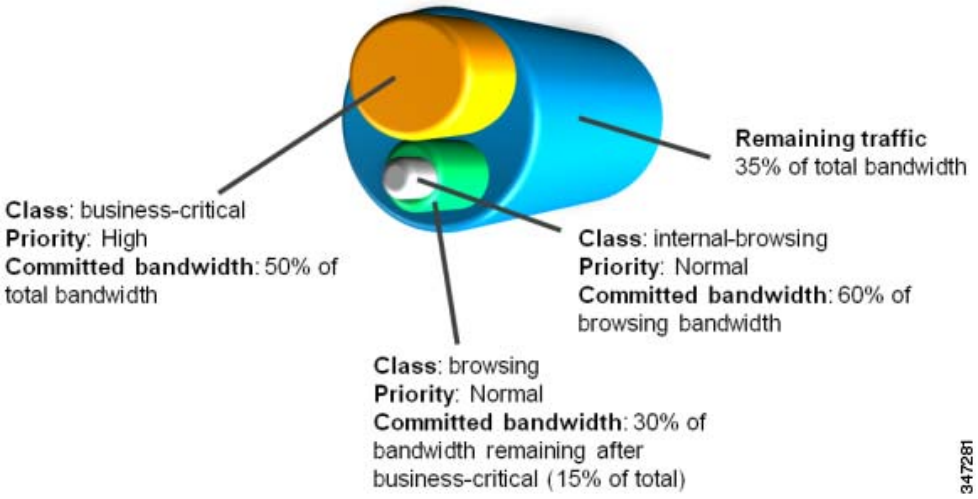
The following QoS configuration example illustrates how to allocate available bandwidth on the eth0/0 interface to different types of traffic. The allocations are as follows:

- 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 4-3 illustrates the priority and bandwidth allocation for each class. "Remaining traffic" refers to all traffic not specifically defined by the class mapping.

Figure 4-3 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
```

Troubleshooting

Revised: August 14, 2013, OL-29170-03

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]
```

- 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.
- 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
```

FNF Memory Warning

The following type of error message typically occurs if the total memory consumed by all monitors exceeds 25% of the total available memory:

```
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. 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.

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 Supported Platforms and Interfaces

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This chapter addresses the following topics:

AVC Supported Platforms

Cisco AVC is supported on the following platforms:

- Cisco ASR1000 Series Aggregation Services Routers
- Cisco CSR 1000V Cloud Services Routers

AVC Supported Interfaces

Table A-1 describes the interfaces that Cisco AVC supports in the current release.

Table A-1 AVC supported interfaces

Interface	Visibility	QoS	Notes
Ether/Port Channel	Yes	No	
Gig	Yes	Yes	
GRE mGRE[1]	Yes	Yes	Tunnels are supported only on terminating devices. QoS only supports output direction. mGRE is not supported with IPv6.
IPSEC[2] DMVPN[3]	Yes	Yes	Tunnels are supported only on terminating devices. QoS only supports output direction. Pure IPv6 is not supported with these tunnels.
IPv6	Yes	Yes	
MLFR[4]	Yes	Yes	

Interface	Visibility	QoS	Notes
MLPPP[5]	Yes	Yes	
Pass Through Tunneled IPv6	No	Yes	
POS[6]/ATM[7]	Yes	Yes	
PPP[8]	No	Yes	Tunnels are supported only on terminating devices.
Sub Interface	Yes	Yes	
VASI[9]	Yes	Yes	
VRF[10] VLAN[11]	Yes	Yes	

1. GRE = Generic Routing Encapsulation, mGRE = Multipoint Generic Routing Encapsulation
2. IPSEC = IP Security
3. DMVPN = Dynamic Multipoint Virtual Private Network
4. MLFR = Multilink Frame Relay
5. MLPPP = Multilink PPP (also referred to as MP, MPPP, and MLP)
6. POS = Packet over SONET (SONET = Synchronous Optical Network)
7. ATM = Asynchronous Transfer Mode
8. PPP = Point-to-Point Protocol
9. VASI = VRF-Aware Service Infrastructure
10. VRF = Virtual Routing and Forwarding
11. VLAN = Virtual LAN

APPENDIX B

New Exported Fields

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Table B-1 describes the Flexible NetFlow (FNF) fields and the CLI used to retrieve the value of the fields, added for Cisco AVC for IOS XE 3.8 and 3.9.

In addition to the these new fields, an AVC record can include FNF fields defined prior to IOS XE 3.8. For information about FNF fields, see: *Cisco IOS Flexible NetFlow Command Reference*.

Table B-1 New FNF Exported Fields

Field ID	Name	Enterprise Specific	Data Type	Data Type Semantics	Description	Units	CLI
56	sourceMacAddress	No	macAddress	identifier	IEEE 802 source MAC address field. This field is collected only for a monitor attached in the ingress direction.	MAC	<collect | match> datalink mac source address input
57	postDestinationMac Address	No	macAddress	identifier	The definition of this information element is identical to the definition of information element “destinationMacAddress,” except that it reports a potentially modified value caused by a middlebox function after the packet has passed the observation point.	MAC	<collect | match> datalink mac destination address output
58	vlanId	No	unsigned16	identifier	IEEE 802.1Q VLAN identifier (VID) extracted from the tag control Information field that was attached to the IP packet. This field is collected only for a monitor attached in the ingress direction.	number	<collect | match> datalink source-vlan-id

Field ID	Name	Enterprise Specific	Data Type	Data Type Semantics	Description	Units	CLI
59	postVlanId	No	unsigned16	identifier	The definition of this information element is identical to the definition of information element “vlanId,” except that it reports a potentially modified value caused by a middlebox function after the packet has passed the observation point.	number	<collect | match> datalink destination-vlan-id
80	destinationMacAddress	No	macAddress	identifier	IEEE 802 destination MAC address field. This field is collected only for a monitor attached in the ingress direction.	MAC	<collect | match> datalink mac destination address input
81	postSourceMacAddress	No	macAddress	identifier	The definition of this information element is identical to the definition of information element “sourceMacAddress,” except that it reports a potentially modified value caused by a middlebox function after the packet has passed the observation point.	MAC	<collect | match> datalink mac source address output
209	tcpOptions	No	unsigned64	flags	TCP options in packets of this flow. The information is encoded in a set of bit fields. For each TCP option, there is a bit in this set. The bit is set to 1 if any observed packet of this flow contains the corresponding TCP option. Otherwise, if no observed packet of this flow contained the respective TCP option, the value of the corresponding bit is 0.	bitmap	collect transport tcp option map
231	initiatorOctets	No	unsigned64	identifier	Total number of layer 4 payload bytes in a flow from the initiator. The initiator is the device that triggered the session creation, and remains the same for the life of the session.	octets	collect counter initiator bytes long
232	serverOctets	No	unsigned64	identifier	Total number of layer 4 payload bytes in a flow from the server. The server is the device that replies to the client, and remains the same for the life of the session.	octets	collect connection server counter bytes long

Field ID	Name	Enterprise Specific	Data Type	Data Type Semantics	Description	Units	CLI
235	egressVRFID	No	unsigned32	identifier	Unique identifier of the VRF name where the packets of this flow are being sent. This identifier is unique per metering process.	number	<collect | match> routing vrf output
280	connectionTransactionId	No	unsigned64	identifier	Identifies a transaction within a connection. A transaction is a meaningful exchange of application data between two network devices or a client and server. A transactionId is assigned the first time a flow is reported, so that later reports for the same flow will have the same transactionId. A different transactionId is used for each transaction within a TCP or UDP connection. The identifiers need not be sequential.	number	match connection transaction-id
298	clientPackets	No	unsigned64	identifier	Total number of layer 4 packets in a flow from the client. The client is the device that triggered the session creation, and remains the same for the life of the session.	packets	collect connection client counter packets long
299	serverPackets	No	unsigned64	identifier	Total number of layer 4 packets in a flow from the server. The server is the device that replies to the client, and remains the same for the life of the session.	packets	collect connection server counter packets long
37083	tcpWindowSizeMin	Yes	unsigned32	identifier	Minimum TCP window size.	octets	collect transport tcp window-size minimum
37084	tcpWindowSizeMax	Yes	unsigned32	identifier	Maximum TCP window size.	octets	collect transport tcp window-size maximum
37086	tcpMaximumSegmentSize	Yes	unsigned16	identifier	TCP maximum segment size.	octets	collect transport tcp maximum-segment-size
37092	tcpWindowSizeSum	Yes	unsigned64	identifier	Sum of TCP window size values. Divide by packet counter to get average.	octets	collect transport tcp window-size sum
42036	retransPackets	Yes	unsigned32	delta-Counter	Number of packets retransmitted by the client	packets	collect connection client counter packets retransmitted

Field ID	Name	Enterprise Specific	Data Type	Data Type Semantics	Description	Units	CLI
42040	transactionCountDelta	Yes	unsigned32	delta-Counter	Total number of completed transactions observed for this flow.		collect connection transaction counter complete
42041	sumTransactionTime	Yes	unsigned32	Duration	Transaction time is the time between the client request and the corresponding last response packet from the server, as observed at the observation point. The value is the sum of all transaction times observed for this flow. For the average, this field must be divided by transactionCountDelta (42040).	milliseconds	collect connection transaction duration sum
42042	maxTransactionTime	Yes	unsigned32	Duration	Maximum transaction time observed for this flow.	milliseconds	collect connection transaction duration max
42043	minTransactionTime	Yes	unsigned32	Duration	Minimum transaction time observed for this flow.	milliseconds	collect connection transaction duration min
42060	numRespsCountDelta	Yes	unsigned32	delta-Counter	Total number of responses sent by the server.	responses	collect connection server counter responses
42061	numResps1CountDelta	Yes	unsigned32	delta-Counter	Histogram Bucket 1 for response time. The bucket boundary should be specified in an option template or predefined in the reporting entity.	responses	collect connection delay response to-server histogram
42062	numResps2CountDelta	Yes	unsigned32	delta-Counter	Histogram Bucket 2 for response time. The bucket boundary should be specified in an option template or predefined in the reporting entity.	responses	collect connection delay response to-server histogram
42063	numResps3CountDelta	Yes	unsigned32	delta-Counter	Histogram Bucket 3 for response time. The bucket boundary should be specified in an option template or predefined in the reporting entity.	responses	collect connection delay response to-server histogram
42064	numResps4CountDelta	Yes	unsigned32	delta-Counter	Histogram Bucket 4 for response time. The bucket boundary should be specified in an option template or predefined in the reporting entity.	responses	collect connection delay response to-server histogram

Field ID	Name	Enterprise Specific	Data Type	Data Type Semantics	Description	Units	CLI
42065	numResps5CountDelta	Yes	unsigned32	delta-Counter	Histogram Bucket 5 for response time. The bucket boundary should be specified in an option template or predefined in the reporting entity.	responses	collect connection delay response to-server histogram
42066	numResps6CountDelta	Yes	unsigned32	delta-Counter	Histogram Bucket 6 for response time. The bucket boundary should be specified in an option template or predefined in the reporting entity.	responses	collect connection delay response to-server histogram
42067	numResps7CountDelta	Yes	unsigned32	delta-Counter	Histogram Bucket 7 for response time. The bucket boundary should be specified in an option template or predefined in the reporting entity.	responses	collect connection delay response to-server histogram
42068	numLateRespsCountDelta	Yes	unsigned32	delta-Counter	Total number of late responses sent by the server. A late response is a response whose time is greater than the last bucket. This informational element can be treated as the last bucket that has no end limit.	responses	collect connection delay response to-server histogram
42071	sumRespTime	Yes	unsigned32	Delay	Response time is the time between the client request and the corresponding first response packet from the server, as observed at the observation point. The value of this information element is the sum of all response times observed for the responses of this flow. For the average, this field must be divided by numRespsCountDelta (42060).	milliseconds	collect connection delay response to-server sum
42072	maxRespTime	Yes	unsigned32	Delay	Maximum response time observed for this flow.	milliseconds	collect connection delay response to-server max
42073	minRespTime	Yes	unsigned32	Delay	Minimum response time observed for this flow.	milliseconds	collect connection delay response to-server min
42074	sumServerRespTime	Yes	unsigned32	Delay	Yes	milliseconds	collect connection delay application sum

Field ID	Name	Enterprise Specific	Data Type	Data Type Semantics	Description	Units	CLI
42075	maxServerRespTime	Yes	unsigned32	Delay	Maximum application delay observed for the responses of this flow.	milliseconds	collect connection delay application max
42076	minServerRespTime	Yes	unsigned32	Delay	Minimum application delay observed for the responses of this flow.	milliseconds	collect connection delay application min
42077	sumTotalRespTime	Yes	unsigned32	Delay	Total delay is the time between the client request and the first response packet from the server, as seen by the client. This is the sum of all total delays observed for the responses of this flow. For the average, this field must be divided by numRespsCountDelta (42060)	milliseconds	collect connection delay response client-to-server sum
42078	maxTotalRespTime	Yes	unsigned32	Delay	Maximum total delay observed for the responses of this flow.	milliseconds	collect connection delay response client-to-server max
42079	minTotalRespTime	Yes	unsigned32	Delay	Minimum total delay observed for the responses of this flow.	milliseconds	collect connection delay response client-to-server min
42081	sumNwkTime	Yes	unsigned32	Delay	Network delay is the round-trip time between the client and the server, as measured by the observation point, calculated once per session. The value of this information element is the sum of all network delays observed for the sessions of this flow. For the average, this field must be divided by connectionCountNew (278).	milliseconds	collect connection delay network client-to-server sum
42082	maxNwkTime	Yes	unsigned32	Delay	Yes	milliseconds	collect connection delay network client-to-server max
42083	minNwkTime	Yes	unsigned32	Delay	Yes	milliseconds	collect connection delay network client-to-server min

Field ID	Name	Enterprise Specific	Data Type	Data Type Semantics	Description	Units	CLI
42084	sumClientNwkTime	Yes	unsigned32	Delay	Client network delay is the round-trip time between the observation point and the client, calculated once per session. The value of this information element is the sum of all client network delays observed for the sessions of this flow. For the average, this field must be divided by connectionCountNew (278).	milliseconds	collect connection delay network to-client sum
42085	maxClientNwkTime	Yes	unsigned32	Delay	Maximum client network delay observed for the sessions of this flow.	milliseconds	collect connection delay network to-client max
42086	minClientNwkTime	Yes	unsigned32	Delay	Minimum client network delay observed for the sessions of this flow.	milliseconds	collect connection delay network to-client min
42087	sumServerNwkTime	Yes	unsigned32	Delay	Server network delay is the round-trip time between the observation point and the server, calculated once per session. The value of this information element is the sum of all server network delays observed for the sessions of this flow. For the average, this field must be divided by connectionCountNew (278)	milliseconds	collect connection delay network to-server sum
42088	maxServerNwkTime	Yes	unsigned32	Delay	Maximum server network delay observed for the sessions of this flow.	milliseconds	collect connection delay network to-server max
42089	minServerNwkTime	Yes	unsigned32	Delay	Minimum server network delay observed for the sessions of this flow.	milliseconds	collect connection delay network to-server min
45004	clientIPv4Address	Yes	ipv4Address	identifier	The IPv4 client address in the IP packet header. This may be the source or destination IP address, depending on the first packet of the connection. The client is the device that triggered the session creation, and remains the same for the life of the session.	address	<collect | match> client ipv4 address

Field ID	Name	Enterprise Specific	Data Type	Data Type Semantics	Description	Units	CLI
45005	serverIPv4Address	Yes	ipv4Address	identifier	The IPv4 server address in the IP packet header. The server is the device that replies to the client, and remains the same for the life of the session.	address	<collect | match> server ipv4 address
45006	clientIPv6Address	Yes	ipv6Address	identifier	The IPv6 client address in the IP packet header. The client is the device that triggered the session creation, and remains the same for the life of the session.	address	<collect | match> client ipv6 address
45007	serverIPv6Address	Yes	ipv6address	identifier	IPv6 server address in the IP packer header. The server is the device that replies to the client, and remains the same for the life of the session.	address	<collect | match> server ipv6 address
45008	clientTransportPort	Yes	unsigned16	identifier	Client transport port identifier. This may be the source or destination transport port. The client is the device that triggered the session creation, and remains the same for the life of the session.	number	<collect | match> client transport port
45009	serverTransportPort	Yes	unsigned16	identifier	Server transport port identifier. This may be the source or destination transport port. The server is the device that replies to the client, and remains the same for the life of the session.	number	<collect | match> server transport port
41000	classHierarchy	Yes	Var-Len	identifier	Identifies the policy-map hierarchy for different policy-map types. The field contains the policy-id, followed by a list of classes representing the policy hierarchy: {Pi | Ck … Cl}. A dedicated option template contains the policy and class id mapping to name and type.	number	<collect | match> policy performance-monitor classification hierarchy

Field ID	Name	Enterprise Specific	Data Type	Data Type Semantics	Description	Units	CLI
42020	servicesWaasSegment	Yes	unsigned8	identifier	WAAS optimization "segment" can have one of the following values:	number	<collect | match> services waas segment
					Unknown	0	
					Client Unoptimized	1	
					Server Optimized	2	
					Client Optimized	4	
					Server Unoptimized	8	
					Pass-Through	16	
42021	servicesWaasPassThroughReason	Yes	unsigned8	identifier	WAAS optimization pass-through reason can have one of the following values:	number	collect services waas pass-through-reason
					PT_NO_PEER	1	
					PT_RJCT_CAP	2	
					PT_RJCT_RSRCS	3	
					PT_RJCT_NO_LICENSE	4	
					PT_APP_CONFIG	5	
					PT_GLB_CONFIG	6	
					PT_ASYMMETRIC	7	
					PT_IN_PROGRESS	8	
					PT_INTERMEDIATE	9	

Field ID	Name	Enterprise Specific	Data Type	Data Type Semantics	Description	Units	CLI
					PT_OVERLOAD	10	
					PT_INT_ERROR	11	
					PT_APP_OVERRIDE	12	
					PT_SVR_BLACKLIST	13	
					PT_AD_VER_MISMTCH	14	
					PT_AD_AO_INCOMPAT	15	
					PT_AD_AOIM_PROGRESS	16	
					PT_DIRM_VER_MISMTCH	17	
					PT_PEER_OVERRIDE	18	
					PT_AD_OPT_PARSE_FAIL	19	
					PT_AD_PT_SERIAL_MODE	20	
					PT_SN_INTERCEPTION_ACL	21	
					PT_IP_FRAG_UNSUPP_PER	22	
					PT_CLUSTER_MEMBER_INDX	23	
					PT_FLOW_QUERY_FAIL_INDX	24	
					PT_FLOWSW_INT_ACL_DENY_INX	25	
					PT_UNKNOWN_INDX	26	
					PT_FLOWSW_PLCY_INDX	27	
					PT_SNG_OVERLOAD_INDX	28	
					PT_CLUSTER_DEGRADE_INDX	29	
					PT_FLOW_LEARN_FAIL_INDX	30	
					PT_OVERALL_INDX	31	
					PT_ZBFW	32	
					PT_RTSP_ALG	33	
42128	policyQosQueueID	No	unsigned32	identifier	QoS Policy queue ID	number	match policy qos queue id
42129	policyQosQueueDrop	No	unsigned64	counter	QoS Policy drops per queue	number	collect policy qos queue drops
45010	connectionId	Yes	unsigned32	identifier	Identifies a connection. A connection identifier is created when a new TCP or UDP flow is created between server and client. A single connection can hold several transactions.	number	match connection id

APPENDIX C

DPI/L7 Extracted Fields

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Table C-1 describes deep packet inspection (DPI)/L7 extracted fields and the CLI used to retrieve the value of the fields.

Table C-1 AVC DPI/L7 Extracted Fields

Field Name	Release	Type	Application ID EngID	Application ID Sel ID	Sub Application ID	Description	Data Source	CLI
httpUrl	3.7	String	3	80	13313	URL extracted from the HTTP transaction. The URL is required per transaction.	NBAR	collect application http url
httpHostName	3.7	String	3	80	13314	Host Name extracted from the HTTP transaction. The URL is required per transaction.	NBAR	collect application http host
httpUserAgent	3.7	String	3	80	13315	User agent field extracted from the HTTP transaction.	NBAR	collect application http user-agent
httpReferer	3.7	String	3	80	13316	REFERER extracted from the HTTP transaction.	NBAR	collect application http referer
rtspHostName	3.7	String	3	554	13313	RTSP host name extracted from the RTSP transaction.	NBAR	collect application rtsp host-name
smtpServer	3.7	String	3	25	13313	Server name extracted from an SMTP transaction.	NBAR	collect application smtp server
smtpSender	3.7	String	3	25	13314	Sender name extracted from an SMTP transaction.	NBAR	collect application smtp sender
pop3Server	3.7	String	3	110	13313	Server name extracted from a POP3 transaction.	NBAR	collect application pop3 server
nntpGroupName	3.7	String	3	119	13313	Group name extracted from an NNTP transaction.	NBAR	collect application nntp group-name
sipSrcDomain	3.7	String	3	5060	13314	Source domain extracted from a SIP transaction.	NBAR	collect application sip source
sipDstDomain	3.7	String	3	5060	13313	Destination domain extracted from a SIP transaction.	NBAR	collect application sip destination

Notes

- Beginning with IOS XE release 3.7, the fields are exported using the field subApplicationValue (ID=45003). The field is encoded as {**applicationID** (4B), **subApplicationID** (2B), Value (Variable Len)} merged together. If the field is not observed, the size of the field is 6 and includes only **applicationTag** and **subApplicationTag**.
- The **sub-application-table** option template maps the extracted field ID to name and description, as follows:
  - Extracted field ID: **subApplicationTag** (ID=97)
  - Name: **subApplicationName** (ID=109)
  - Description: **subApplicationDesc** (ID=110)
- All HTTP-based applications, such as YouTube, SharePoint, and so on, use the same sub-application ID, defined by the **subApplicationID**, as defined by the HTTP application.

APPENDIX D

Fields that Require Punt to the Route Processor

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Table D-1 describes the media monitoring/metadata metrics that require punt to the route processor (RP).

Table D-1 Media Monitoring/Metadata Metric Fields

Metric	NetFlow ID
Media Monitoring related fields	
collect counter flows	3
collect application media bytes rate	37006
collect application media packets rate	37009
collect application media packets rate variation	37010
collect application media event	37011
collect monitor event	37012
collect timestamp interval	37013
collect transport packets lost rate	37021
collect transport rtp jitter mean	37023
collect application media packets rate variation min	37038
collect application media packets rate variation max	37039
collect transport rtp flow count	37040
collect transport packets lost rate min	37047
collect transport packets lost rate max	37048
timestamp absolute monitoring-interval start	65500
timestamp absolute monitoring-interval end	65501
Metadata related fields	
collect application version	105
collect application version name	106
collect application vendor	107
collect metadata global-session-id	37054

Metric	NetFlow ID
Media Monitoring related fields	
collect metadata multi-party-session-id	37055
collect metadata clock-rate	37056

APPENDIX E

References

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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).
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.
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.
Configuration	
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.

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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

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