Cisco Video Quality Monitoring Configuration Guide

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Preface

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The Preface discusses the objectives, audience, conventions, and organization of the *Cisco Video Quality Monitoring Configuration Guide* and provides general information about Cisco IOS software documentation.

Objectives

This guide describes the tasks and commands necessary to configure the Cisco Video Quality Monitoring solution on the Cisco Integrated Service Router Generation 2 (Cisco ISR G2).

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.

Cisco IOS Software Documentation

In addition to the information provided in this publication, you might need to refer to the Cisco IOS documentation set. The Cisco IOS software documentation is divided into nine modules and two master indexes. Each module consists of two books: a configuration guide and a corresponding command reference. Chapters in a configuration guide describe protocols, configuration tasks, and Cisco IOS software functionality and contain comprehensive configuration examples. Chapters in a command reference provide complete command syntax information. Each configuration guide can be used in conjunction with its corresponding command reference.

Organization

The following table describes the contents of each chapter in this document.

Table 1 Organization

Chapter	Title	Description
Chapter 1	Video Quality Monitoring	A general overview of video quality monitoring, monitoring index, and discussion about how to configure video quality monitoring.

Command Syntax Conventions

The following table describes the syntax used with the commands in this document.

Table 2 Command Syntax Guide

Convention	Description
boldface	Commands and keywords.
italic	Command input that is supplied by you.
[ ]	Keywords or arguments that appear within square brackets are optional.
{ x | x | x }	A choice of keywords (represented by x) appears in braces separated by vertical bars. You must select one.
^ or Ctrl	Represent the key labeled *Control*. For example, when you read ^*D* or *Ctrl-D*, you should hold down the Control key while you press the D key.
`screen font`	Examples of information displayed on the screen.
boldface screen font	Examples of information that you must enter.
< >	Nonprinting characters, such as passwords, appear in angled brackets.
[ ]	Default responses to system prompts appear in square brackets.

Video Quality Monitoring

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Information About Video Quality Monitoring

The Video Quality Monitoring (VQM) module monitors the quality of the video calls delivered over a network. The VQM solution offered in the Cisco Integrated Services Routers Generation 2 (Cisco ISR G2) provide a complete set of video quality metrics for calls with H.264 codec.

The VQM module parses the Real-Time Transport Protocol (RTP) header and the first few bytes of the video packet payloads to retrieve critical information about the video stream. The first few bytes parsed by the VQM module includes Sequence Parameter Sets (SPS), Picture Parameter Sets (PPS), and slice headers (SH). In Cisco ISR G2, VQM measures the quality of the RTP video flows crossing the WAN link (Ingress or Egress). The VQM reports the video-quality related fields through Cisco Flexible NetFlow Version 9 (FNFv9) and IP Flow Information Export (IPFIX).

Video Quality Monitoring Index

The video quality monitoring index is calculated using the Cisco proprietary model called estimated Mean Opinion Score (eMOS). eMOS is a quantitative number assigned to the quality of the video stream based on internal measurements and calculations. The following aspects of a video is used to calculate the eMOS:

- Uncompressed Video Quality
- Compression Distortion
- Packet Loss and Delay Distortion

Table 1-1 lists the three parts of the Video Quality Model and integrated parameters.

Table 1-1 Three Parts of the Video Quality Model and Integrated Parameters

	Uncompressed Video Quality	Compression Distortion	Packet Loss and Delay Distortion
Video Content	—	Y	Y
Resolution	Y	—	—
Frame Rate and Fluctuation	Y	Y	—

	Uncompressed Video Quality	Compression Distortion	Packet Loss and Delay Distortion
Video Encoder Implementation	—	Y	—
Bits Per Pixel	—	Y	—
GOP Structure	—	Y	Y
Packet Loss Pattern	—	—	Y
Packet Loss Concealment	—	—	Y
Packet Delay	—	—	Y
Packet Jitter	—	—	Y

The eMOS value calculated using the above model is measured on a continuous scale of 0 to 100, as shown in Figure 1-1.

Figure 1-1 Scale to Measure eMOS

Key Metrics Collected Using VQM

The VQM module produces a list of metrics along with the eMOS score. These metrics are the result of eMOS calculation, and they provide a complete view of all the characteristics of a video stream. The VQM module monitors the quality of a video stream in real time, but reporting of eMOS and other metrics can be based on a configured period. The configured period should be between 1 and 10 seconds. The recommended period is 5 seconds.

The VQM module produces the following major categories of metrics:

- Basic Video Attributes, page 1-3
- Video Compression, page 1-3
- Packet Loss, page 1-6
- Video Entropy, page 1-6
- Delay and Jitter, page 1-7
- Metrics Produced by Other Products, page 1-7

Basic Video Attributes

Basic Video Attributes consist of the following metrics:

- Most Recent Resolution Width
- Most Recent Resolution Height
- Frame Rate
- Video Payload Average Bit Rate
- Video Payload Bit Rate Fluctuation

These metrics can be used to monitor the actual resolution and frame rate of a video stream and raise flags when it is not consistent with the values configured or signaled. Also, they are used to monitor the average video bit rate and fluctuation for the purpose of cross-stream bandwidth allocation. You can adjust the buffer and queue length based on the bit rate fluctuation calculated using these metrics.

Table 1-2 lists the metric details.

Table 1-2 Basic Video Attributes Metric Details

Name of Metric	Description	Unit	Range
Most Recent Resolution Width	The most recently observed width of the video frame.	pixels	1-8000
Most Recent Resolution Height	The most recently observed height of the video frame.	pixels	1-8000
Frame Rate	Actual frame rate observed in the period.	frames per second (fps)	0-120
Video Payload Average Bit Rate	Average bit rate of the actual video payload (excluding Network, Layer 1-5, PHY+IP+UDP+RTP headers) observed in the period.	kbps	0-20000
Video Payload Bit Rate Fluctuation	Standard deviation in the bit rate of the actual video payload (excluding Network, Layer 1-5, PHY+IP+UDP+RTP headers) observed in the period.	kbps	0-20000

Video Compression

Video Compression consists of the following metrics:

- Number I Frames
- Number I Packets
- I Packet Sizes
- Number Short Term Reference (STR) Frames
- Number STR Packets
- STR Packet Sizes
- Number Long Term Reference (LTR) Frames

- Number LTR Packets
- LTR Packet Sizes
- Number Super-P Frames
- Number Super-P Packets
- Super-P Packet Sizes
- Number Non Referenced (NR) Frames
- Number NR Packets
- NR Packet Sizes
- Quantization Level of I Slices
- Quantization Level of STR Slices
- Quantization Level of LTR Slices
- Quantization Level of Super-P Slices
- Quantization Level of NR Slices
- eMOS Compression Bitstream
- eMOS Compression Network

The Video Compression metrics are used for the following purposes:

- Monitor the video traffic for each frame type. You can set flags for many or few frames for each type. This helps maintain fairness across different streams with different frame type distributions.
- Help troubleshoot video quality by providing visibility into the video endpoints' performance and codec implementation.
- Monitor the compression level of video to isolate the compression defect from the overall quality outage. When the compression level is too high, you can use this metric to troubleshoot which type of video frames are causing the problem.

Table 1-3 lists the Video Compression metric details.

Table 1-3 Video Compression Metric Details

Name of Metric	Description	Unit	Range
Number I Frames	Total number of I frames observed in the period.	—	0-0xFFFFFFFF
Number I Packets	Total number of I packets observed in the period.	—	0-0xFFFFFFFF
I Packet Sizes	Total number of I packets payload (excluding Network, Layer 1-5, PHY+IP+UDP+RTP headers) sizes observed in the period.	Kilobytes (KB)	0-0xFFFFFFFF
Number Short Term Reference (STR) Frames	Total number of STR frames observed in the period.	—	0-0xFFFFFFFF
Number STR Packets	Total number of STR packets observed in the period.	—	0-0xFFFFFFFF
STR Packet Sizes	Total number of STR packets payload sizes observed in the period.	Kilobytes (KB)	0-0xFFFFFFFF

Name of Metric	Description	Unit	Range
Number Long Term Reference (LTR) Frames	Total number of LTR frames observed in the period.	—	0-0xFFFFFFFF
Number LTR Packets	Total number of LTR packets observed in the period.	—	0-0xFFFFFFFF
LTR Packet Sizes	Total number of LTR packet payload sizes observed in the period.	Kilobytes (KB)	0-0xFFFFFFFF
Number Super-P Frames	Total number of super-P frames (frames that reference exclusively the LTR frames for error resilience) observed in the period.	—	0-0xFFFFFFFF
Number Super-P Packets	Total number of super-P packets observed in the period.	—	0-0xFFFFFFFF
Super-P Packet Sizes	Total number of super-P packet payload sizes observed in the period.	Kilobytes (KB)	0-0xFFFFFFFF
Number Non Referenced (NR) Frames	Total number of NR frames (P frames that are not used as reference for coding other frames) observed in the period.	—	0-0xFFFFFFFF
Number NR Packets	Total number of I packets observed in the period.	—	0-0xFFFFFFFF
NR Packet Sizes	Total number of I packet payload sizes in kilobytes observed in the period.	Kilobytes (KB)	0-0xFFFFFFFF
Quantization Level of I Slices	Average quantization level of I slices from a range defined in the H.264 standard.	—	0-51
Quantization Level of STR Slices	Average quantization level of STR slices from a range defined in the H.264 standard.	—	0-51
Quantization Level of LTR Slices	Average quantization level of LTR slices from a range defined in the H.264 standard.	Kilobytes (KB)	0-51
Quantization level of Super-P Slices	Average quantization level of super-P slices from a range defined in the H.264 standard.	—	0-51
Quantization Level of NR Slices	Average quantization level of NR slices from a range defined in the H.264 standard.	—	0-51
eMOS Compression Bitstream	Estimated Mean Opinion Score of video in the observed period after compression (bitstream model).	—	0-100
eMOS Compression Network	Estimated Mean Opinion Score of video in the observed period after compression (network model).	—	0-100

Packet Loss

Packet Loss consists of the following metrics:

- Number I Packets Lost
- Number STR Packets Lost
- Number LTR Packets Lost
- Number Super-P Packets Lost
- Number NR Packet Lost
- Severely Damaged Frame Percentage
- eMOS Packet Loss Bitstream
- eMOS Packet Loss Network

You can use these metrics to monitor packet loss and the effect of packet loss at three levels: packets, frame, and overall quality.

Table 1-4 lists the metric details.

Table 1-4 Packet Loss Metric Details

Name of Metric	Description	Unit	Range
Number I Packets Lost	Total number of I packets lost in the period.	—	0-0xFFFFFFFF
Number STR Packets Lost	Total number of STR packets lost in the period.	—	0-0xFFFFFFFF
Number LTR Packets Lost	Total number of LTR packets lost in the period.	—	0-0xFFFFFFFF
Number Super-P Packets Lost	Total number of super-P packets lost in the period.	—	0-0xFFFFFFFF
Number NR Packet Lost	Total number of NR packets lost in the period.	—	0-0xFFFFFFFF
Severely Damaged Frame Percentage	Total percentage of MBs impacted by packet loss and loss propagation in the observed period.	%	0-100
eMOS Packet Loss Bitstream	Deterioration of the eMOS score of video in the observed period due to packet loss (bitstream model).	—	0-100
eMOS Packet Loss Network	Deterioration of the eMOS score of video in the observed period due to packet loss (network model).	—	0-100

Video Entropy

Video Entropy consists of the following metrics:

- Scene Complexity
- Level of Motion

These metrics help you optimize the bandwidth of different video streams.

Table 1-5 lists the metric details.

Table 1-5 Video Entropy Metric Details

Name of Metric	Description	Unit	Range
Scene Complexity	Scene complexity from 0 to 100 as computed by the VQM algorithm. 0— Not complex. 100— Maximally complex.	—	0-100
Level of Motion	Level of motion from 0 to 100 as computed by the VQM algorithm. 0— No motion. 100—Maximally high motion.	—	0-100

Delay and Jitter

Delay and Jitter consists of the following metrics:

- Frame Arriving Times Difference
- Frame Arriving Times Difference Variation

These metrics help you monitor the video frame delay and jitter relative to the frame display time indicated by RTP timestamps without RTCP reports.

Table 1-6 lists the metric details.

Table 1-6 Delay and Jitter Metric Details

Name of Metric	Description	Unit	Range
Frame Arriving Times Difference	The average difference of the actual packet arriving time and the expected packet arriving time calculated using the RTP timestamp.	milliseconds(ms)	-4000-4000
Frame Arriving Times Difference Variation	The standard deviation in the difference of the actual packet arriving time and the expected packet arriving time calculated using the RTP timestamp.	milliseconds(ms)	-4000-4000

Metrics Produced by Other Products

The metrics produced by the other products consists of the following:

- First Packet RTP Sequence Num
- Last Packet RTP Sequence Num

These metrics help you troubleshoot synchronization issues with other producers.

Table 1-7 lists the metric details.

Table 1-7 Metrics Produced by Other Products

Name of Metric	Description	Unit	Range
First Packet RTP Sequence Num	The RTP sequence number of the first packet inspected in the period.	—	0-0xFFFF
Last Packet RTP Sequence Num	The RTP sequence number of the last packet inspected in the period.	—	0-0xFFFF

Configuring Video Quality Monitoring

Configuring VQM involves configuring the performance monitor policies on the hub router and the branch router. The performance monitor policy should be enabled on the interface. Note that the video quality monitoring depends upon the Flow Meta Data (FMD) of the video stream.

Configuring the VQM involves the following steps:

Step 1 Turn on Video Monitoring.

Step 2 Create flow records for the match and collect fields.

Step 3 Create a flow exporter.

Step 4 Create a flow monitor with flow records and monitoring thresholds.

Step 5 Create an appropriate class map to match the video streams that are monitored.

Step 6 Create a monitoring policy map with the class map and flow monitor.

Step 7 Attach the monitoring policy map to the interfaces.

Turning On the Video Monitoring

The following example shows how to turn on Video Monitoring:

```
video monitoring
  maximum-sessions 100
  no shutdown
```

The default maximum session is 100. The default mode is shutdown.

Creating Flow Records for the Match and Collect Fields

The following perf-monitor example configures a monitor to create flow records for the match and collect fields:

```
flow record type performance-monitoring vqm-rec
  match ipv4 protocol
  match ipv4 source address
  match ipv4 destination address
  match transport source-port
  match transport destination-port
  match transport rtp ssrc
  collect application video resolution [ width | height ] last
  collect application video frame rate
  collect application video payload bitrate [ average | fluctuation ]
  collect application video frame [ I | STR | LTR | super-P | NR ] counter frames
```

```
  collect application video frame [ I | STR | LTR | super-P | NR ] counter packets [lost]
  collect application video frame [ I | STR | LTR | super-P | NR ] counter bytes
  collect application video frame [ I | STR | LTR | super-P | NR] slice-quantization-level
  collect application video eMOS compression [ network | bitstream ]
  collect application video eMOS packet-loss [ network | bitstream ]
  collect application video frame percentage damaged
  collect application video scene-complexity
  collect application video level-of-motion
  collect transport rtp sequence-number [ last ]
```

Creating a Flow Exporter

The following example shows how to create a flow exporter configuration:

```
flow exporter vqm-exporter
  description PAM or CPCM interface
  destination < ip address>
```

Creating a Flow Monitor with Flow Records and Monitoring Thresholds

The following example shows how to create a flow monitor and monitoring thresholds:

```
flow monitor type performance-monitoring vqm-mon
  record vqm-rec
  exporter vqm-exporter
  cache type synchronized
  cache entries 1000
  cache timeout synchronized 5
  history size 60 timeout 30
```

Creating a Class Map to Match the Monitored Video Stream

The following example shows how to create a class map to match a monitored video stream:

```
class-map match-all vqm-class
  match access-group 101
```

Creating Monitoring Policy Map with the Class Map and Flow Monitor

The following example shows how to create a policy map with the class map and the flow monitor you created earlier:

```
policy-map type performance-monitoring vqm-policy
  class vqm-class
    flow monitor vqm-mon
```

Attaching the Monitoring Policy Map to Interfaces

The following example shows how to attach a monitoring policy map to an interface:

```
Interface serial 0/0:0
   service-policy type performance-monitoring input vqm-policy
   service-policy type performance-monitoring output vqm-policy
```

Troubleshooting Video Quality Monitoring

Table 1-8 lists the debug and show commands that you can use to troubleshoot VQM.

Table 1-8 Show and debug Commands for Troubleshooting VQM

Commands	Description
show video quality monitoring	Displays the video quality monitoring status.
show video quality monitoring record	Displays all the active video quality monitoring sessions.
show video quality monitoring record <*num*>	Displays one particular session's record.
debug video monitoring error	Turns on VQM error debugging.
debug video monitoring event	Turns on VQM event debugging.
debug video monitoring datapath	Turns on monitoring datapath debugging.

The following example shows the output of the **show video quality monitoring record** command:

```
router# show video quality monitoring record

----- record begin -----
vqm session id: 14, vqm_cpu_saving_mode: FALSE    time: 23:46:44

From: 20.20.20.1,   To: 20.20.20.2
    SrcPort: 16422, DstPort: 16420, Protocol: udp
most_recent_resolution_width: 1280, most_recent_resolution_height: 720
frame_rate: 30
video_payload_average_bit_rate: 1153, video_payload_bit_rate_fluctuation: 105
I_frame_count: 0, I_packet_count: 0, I_packet_byte_count: 0
STR_frame_count: 24, STR_packet_count: 99, STR_packet_byte_count: 1219
LTR_frame_count: 43, LTR_packet_count: 195, LTR_packet_byte_count: 1128
SuperP_frame_count: 41, SuperP_packet_count: 188, SuperP_packet_byte_count: 1130
NR_frame_count: 33, NR_packet_count: 154, NR_packet_byte_count: 984
quantization_level: I-slice 0, STR-slice 23, LTR-slice 23, SuperP-slice 23, NR-slice 23
I-pkt-lost: 9, STR-pkt-lost: 9, LTR-pktlost: 2, SuperP-pkt-lost: 3, NR-pkt-lost: 20
severely_damaged_frame_percentage: 91
emos_compression_bitstream: 76, emos_packet_loss_bitstream: 75, emos_bit(14): 1
emos_compression_network: 89, emos_packet_loss_network: 7, emos_net(14): 82
scene_complexity: 42, level_of_motion: 1
first_packet_rtp_sequence_num: 7907, last_packet_rtp_sequence_num: 8669
-----record end-----
Total active record number: 1
```