

Configure Performance Measurement

Table 1: Feature History

Feature Name	Release Information	Description
Segment Routing Performance Measurement Delay Measurement Using RFC 5357 (TWAMP Light)	Cisco IOS XE Bengaluru 17.4	This feature enables hardware timestamping. The Performance Measurement (PM) for link delay uses the light version of Two-Way Active Measurement Protocol (TWAMP) over IP and UDP defined in Appendix I of RFC 5357. TWAMP provides an alternative for interoperability when RFC 6374 is not used.
Segment Routing Absolute One-Way Link Loss Measurement for GRE-IPSec Tunnel	Cisco IOS XE Dublin 17.10.1a	This feature provides a mechanism for link loss measurement for point-to-point GRE-IPSec tunnel, in order to identify paths that meet specified loss criteria.

Network performance metrics such as packet loss, delay, delay variation, and bandwidth utilization are a critical measure for traffic engineering (TE) in service provider networks. These metrics provide network operators with information about characteristics of their networks for performance evaluation and helps to ensure compliance with service level agreements. The service-level agreements (SLAs) of service providers depend on the ability to measure and monitor these network performance metrics. Network operators can use the performance measurement (PM) feature to monitor the network metrics for links as well as end-to-end TE label switched paths (LSPs).

The following table explains the functionalities supported by the performance measurement feature for measuring delay for links or SR policies.

Table 2: Performance Measurement Functionalities

Functionality	Details
Probe and burst scheduling	Schedule probes and configure metric advertisement parameters for delay measurement.

Functionality	Details
Metric advertisements	Advertise measured metrics periodically using configured thresholds. Also supports accelerated advertisements using configured thresholds.
Measurement history and counters	Maintain packet delay and loss measurement history and also session counters and packet advertisement counters.

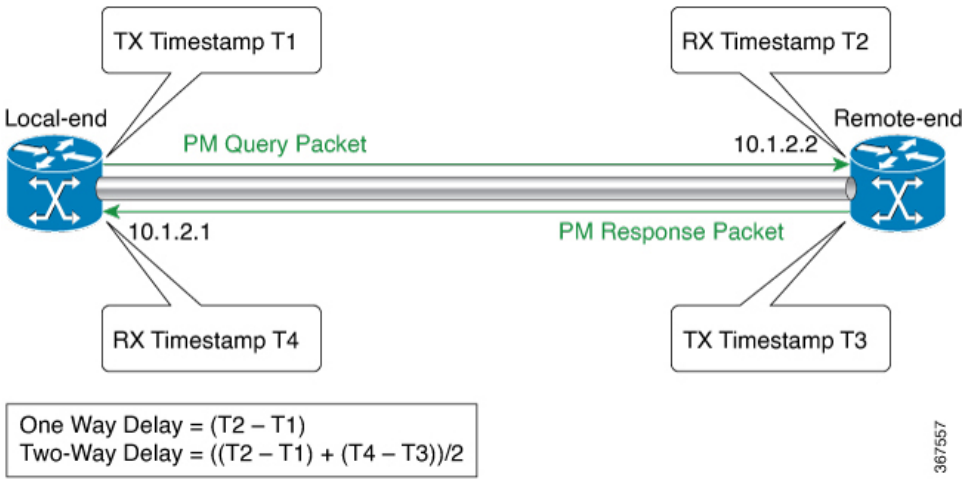
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Link Delay Measurement

The PM for link delay uses the light version of Two-Way Active Measurement Protocol (TWAMP) over IP and UDP defined in Appendix I of RFC 5357. Hence, only TWAMP test sessions are implemented and not the TWAMP control protocol. TWAMP provides an alternative for interoperability when RFC 6374 is not used. TWAMP packets are carried over IP and UDP. Thus, the dependency on MPLS dataplane is eliminated.

The following figure explains the PM query and response for link delay.

Figure 1: Performance Measurement for Link Delay



The PM query and response for link delay can be described in the following steps:

1. The local-end router sends PM query packets periodically to the remote side once the egress line card on the router applies timestamps on packets.
2. Ingress line card on the remote-end router applies time-stamps on packets as soon as they are received.
3. The remote-end router sends the PM packets containing time-stamps back to the local-end router. The remote-end router time-stamps the packet just before sending it for two-way measurement.

Restrictions and Usage Guidelines for PM for Link Delay

The following restrictions and guidelines apply for the PM for link delay feature for different links.

- For broadcast links, only point-to-point (P2P) links are supported. P2P configuration on IGP is required for flooding the value.
- As ASR 1000 platforms do not support PTP 1588v2 clock, it can not use the (T2-T1) to calculate the One-way delay value. Therefore, Two-way Delay value is divided by 2 to calculate the One-way delay value.
  - Two-Way Delay = (T2 – T1) + (T4 – T3)
  - One-Way Delay = ((T2 – T1) + (T4 – T3))/2

PM Link Delay: Default Values for Different Parameters

The default values for the different parameters in the PM for link delay is given as follows:

- probe: The default mode for probe is two-way delay measurement.
- interval: The default probe interval is 30 seconds. The range is from 30 to 3600 seconds.
- burst count: The default value is 10 and range is from 1 to 30.
- burst interval: The default value is 3000 milliseconds and the range is from 30 to 15000 milliseconds.
- periodic advertisement: Periodic advertisement is enabled by default.
- periodic-advertisement interval: The default value is 120 seconds and the interval range is from 30 to 3600 seconds.
- periodic-advertisement threshold: The default value of periodic advertisement threshold is 10 percent.
- periodic-advertisement minimum: The default value is 1000 microseconds (usec) and the range is from 0 to 100000 microseconds.
- accelerated advertisement: Accelerated advertisement is disabled by default.
- accelerated-advertisement threshold: The default value is 20 percent and the range is from 0 to 100 percent.
- accelerated-advertisement minimum: The default value is 1000 microseconds and the range is from 1 to 100000 microseconds.

Configuration Example: PM for Link Delay

This example shows how to configure performance-measurement functionalities for link delay as a global default profile.

```
R1(config)#performance-measurement
R1(config-perf-meas)# delay-profile interfaces

R1(config-pm-dm-intf)#advertisement
R1(config-pm-dm-intf-adv)# accelerated // Default: Disabled
```

```
R1(config-pm-dm-intf-adv-acc)#threshold 40 //Default 20%
R1(config-pm-dm-intf-adv-acc)#minimum-change 1000 //Default 1000uSec
R1(config-pm-dm-intf-adv)#periodic
R1(config-pm-dm-intf-adv-per)#interval 100 //Default 120seconds
R1(config-pm-dm-intf-adv-per)#threshold 40 //Default 10%
R1(config-pm-dm-intf-adv-per)#minimum-change 1000 //Default 1000 uSec
R1(config-pm-dm-intf)#probe

R1(config-pm-dm-intf-probe)#computation-interval 40 // Def: 30s
R1(config-pm-dm-intf-probe)#burst-interval 40 // Def: 3000 mSec
R1(config-perf-meas)#delay-profile sr-policy
R1(config-pm-dm-srpol)#advertisement
R1(config-pm-dm-sr-adv)#accelerated // Default: Disabled
R1(config-pm-dm-sr-adv-acc)#threshold 40 //Default 40%
R1(config-pm-dm-sr-adv-acc)#minimum-change 4000 // Def: 500 uSec
R1(config-pm-dm-sr-adv)#periodic

R1(config-pm-dm-srpol-adv-per)#interval 100 // Def: 120 sec
R1(config-pm-dm-srpol-adv-per)#threshold 40 // Def: 10%
R1(config-pm-dm-srpol-adv-per)#minimum-change 2000 // Def: 500 uSec
R1(config-pm-dm-srpol)#probe
R1(config-pm-dm-srpol-probe)#computation-interval 40 // Def: 30s
R1(config-pm-dm-srpol-probe)#burst-interval 40 // Def: 3000 mSec
R1(config-pm-dm-srpol-probe)#exit

R1(config-pm-dm-srpol)#exit

R1(config-pm-dm-srpol-adv-per)#exit
R1 R1(config-pm-dm-intf-probe)#exit
R1(config-pm-dm-intf-adv)#exit

R1(config-pm-dm-intf)#exit

R1(config-perf-meas)#exit
```

This example shows how to enable PM for link delay over an interface.

```
R1(config)#performance-measurement
R1(config-perf-meas)#interface GigabitEthernet 0/0/1
R1(config-pm-intf)#delay-measurement
R1(config-pm-intf-dm)#exit
R1(config-pm-intf-dm)#next-hop ipv4 10.50.62.1
R1(config-pm-intf)#exit
```

Verification: PM Link Delay Configuration

This example shows how to use the **show performance-measurement summary** [**detail**] command to verify the PM for link-delay configuration.

```
R1#show performance-measurement summary detail
Total interfaces                              : 3
Maximum PPS                                   : 100 pkts/sec

Interface Delay-Measurement:
  Total sessions                              : 3
  Profile configuration:
    Measurement Type                          : Two-Way
    Computation interval                      : 30 seconds
    Burst interval                            : 3000 mSec
    Burst count                               : 10 packets
```

```
    Protocol                                  : TWAMP-Lite Unauth
    HW Timestamp Supported                    : No
    Periodic advertisement                    : Enabled
      Interval                                : 30 (effective: 30) sec
      Threshold                               : 100%
      Minimum-Change                          : 100000 uSec
    Accelerated advertisement                 : Enabled
      Threshold                               : 100%
      Minimum-Change                          : 100000 uSec
    Threshold crossing check                  : Minimum-delay
  Counters:
    Packets:
      Total sent                              : 293020
      Total received                          : 293016
    Errors:
        TX:
          Total interface down                : 0
          Total no MPLS caps                  : 0
          Total no IP address                 : 0
          Total other                         : 19
        RX:
          Total negative delay                : 144
          Total delay threshold exceeded      : 0
          Total missing TX timestamp          : 0
          Total missing RX timestamp          : 0
          Total probe full                    : 0
          Total probe not started             : 0
          Total control code error            : 0
          Total control code notif            : 0
    Probes:
      Total started                           : 29306
      Total completed                         : 29155
      Total incomplete                        : 148
      Total advertisements                    : 3

Global Delay Counters:
  Total packets sent                          : 293020
  Total query packets received                : 293016
  Total invalid session id                    : 0
  Total no session                            : 0

HW Support for MPLS-GAL [RFC6374] timestamp   : No
HW Support for TWAMP [RF5357] timestamp       : No
HW Support for 64 bit timestamp               : No
HW Support for IPv4 UDP Cheksum               : No
```

This example shows how to use the **show performance-measurement interfaces** [*interface-name*] [**detail**] command to verify the PM for link-delay configuration.

```
R1#show performance-measurement interfaces detail
Interface Name: GigabitEthernet0/2/3 (ifh: 0xA)
  Delay-Measurement           : Enabled
  Local IPV4 Address          : 10.50.62.2
  Local IPV6 Address          : ::
  State                       : Up

  Delay Measurement session:
    Session ID                : 1

    Last advertisement:
      Advertised at: 09:21:08  12 2019 (439879 seconds ago)
      Advertised reason: Advertise delay config
      Advertised delays (uSec): avg: 2000, min: 2000, max: 2000, variance: 0
```

```
    Next advertisement:
      Check scheduled at the end of the current probe (roughly every 30 seconds)
      No probes completed
      Rolling average (uSec): 3146

    Current Probe:
      Started at 11:32:17  17 2019 (10 seconds ago)
      Packets Sent: 4, received: 4
      Measured delays (uSec): avg: 1999, min: 1500, max: 2499, variance: 499
      Probe samples:
              Packet Rx Timestamp Measured Delay
                11:32:17  17 2019 1999999
                11:32:20  17 2019 1500000
                11:32:23  17 2019 2499999
                11:32:26  17 2019 1999999
      Next probe scheduled at 11:32:46  17 2019 (in 19 seconds)
      Next burst packet will be sent in 1 seconds
R1#
```

You can also use the following commands for verifying the PM for link delay on the local-end router.

Command	Description
show performance-measurement history interfaces [name*interface-name*] probe	Displays the PM link-delay probe history for interfaces.
show performance-measurement history interfaces [name*interface-name*] aggr	Displays the PM link-delay aggregated history for interfaces.
show performance-measurement counters interface [name*interface-name*] [detail]	Displays the PM link-delay session counters.
show performance-measurement responder interfaces [name*interface-name*]	Displays PM for link-delay for interfaces on the remote-end router.
show performance-measurement responder counters interface [name*interface-name*]	Displays the PM link-delay session counters on the remote-end router.

End-to-End Delay Measurement

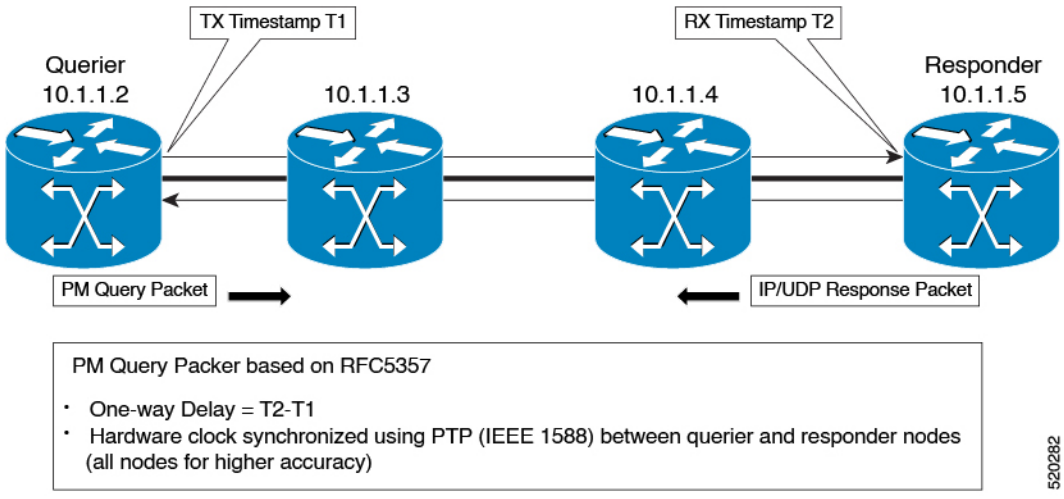
Table 3: Feature History

Feature Name	Release Information	Description
Segment Routing Performance Measurement End-to-End Delay Measurement	Cisco IOS XE Bengaluru 17.4	This feature allows to monitor the end-to-end delay experienced by the traffic sent over a Segment Routing policy. This feature ensures the delay does not exceed the specified threshold value and violate the SLAs. Use this feature to apply extended TE link delay metric (minimum delay value) to compute paths for Segment Routing policies as an optimization metric or as an accumulated delay bound.

Starting from Cisco IOS XE Release 17.4.1, end-to-end delay measurement feature is introduced for Segment Routing Performance Management. Use this feature to monitor the end-to-end delay experienced by the traffic sent over a Segment Routing policy. This feature ensures the delay does not exceed the specified threshold value and violate the SLAs. You can verify the end-to-end delay values before activating the candidate-path or the segment-list of the Segment Routing policy in the forwarding table. You can also use the end-to-end delay values to deactivate the active candidate-path or the segment-list of the Segment Routing Policy in the forwarding table. Use this feature to apply extended TE link delay metric (minimum delay value) to compute paths for Segment Routing policies as an optimization metric or as an accumulated delay bound.

The following figure explains the PM query and response for end-to-end delay measurement.

Figure 2: Performance Measurement for End-to-End Delay Measurement



The PM query and response for end-to-end delay measurement can be described in the following steps:

1. The querier router sends PM query packets periodically to the responder router once the egress line card on the router applies timestamps on packets.
2. Ingress line card on the responder router applies time-stamps on packets when they are received.
3. The end-to-end delay value of an SR Policy is different than the path computation result (the sum of TE link delay metrics) due to several factors like queuing delay within the routers.
4. The remote-end router sends the PM packets containing time-stamps back to the local-end router. The remote-end router time-stamps the packet just before sending it for two-way measurement.
5. The local-end router time-stamps the packet as soon as the packet is received for two-way measurement.

Configuration Example: PM for End-to-End Delay Management

These examples show how to configure on-demand segment routing policy for end-to-end delay management.

```
#show running-config | s on-demand color 800
on-demand color 800 ------------------------------------------------------> SR ODN Policy
authorize
performance-measurement ---------------------------------------------------> SR PM CLI
delay-measurement ---------------------------------------------------------> SR PM CLI
candidate-paths
preference 1
constraints
segments
dataplane mpls
!
!
dynamic
pcep
metric
type delay
!
!
!
#

#show segment-routing traffic-eng policy name *10.216.216.216|800

Name: *10.216.216.216|800 (Color: 800 End-point: 10.216.216.216)
Owners : BGP
Status:
Admin: up, Operational: up for 01:27:24 (since 11-29 04:41:36.053)
Candidate-paths:
Preference 1 (BGP):
Dynamic (pce 10.12.12.12) (active)
Weight: 0, Metric Type: DELAY
Metric Type: DELAY, Path Accumulated Metric: 330
16011 [Prefix-SID, 10.205.205.205]
1133 [Adjacency-SID, 10.50.72.1 - 10.50.72.2]
16009 [Prefix-SID, 10.216.216.216]
Attributes:
Binding SID: 1218
Allocation mode: dynamic
State: Programmed
IPv6 caps enabled
#
```

This example shows how to configure performance-measurement functionalities for end-to-end delay management as a global default profile.

```
R1(config)#performance-measurement
R1(config-perf-meas)#delay-profile sr-policy

R1(config-pm-dm-srpol)#probe
R1(config-pm-dm-srpol-probe)#computation-interval 40

R1(config-pm-dm-srpol-probe)#burst-interval 40

R1(config-pm-dm-srpol-probe)#protocol twamp-light
R1(config-pm-dm-srpol-probe-protocol)#exit

R1(config-pm-dm-srpol-probe)#exit
R1(config-pm-dm-srpol)#advertisement periodic

R1(config-pm-dm-srpol-adv-per)#interval 100
R1(config-pm-dm-srpol-adv-per)#threshold 20

R1(config-pm-dm-srpol-adv-per)#minimum-change 500

R1(config-pm-dm-srpol-adv-per)#exit

R1(config-pm-dm-sr-adv)#exit

R1(config-pm-dm-srpol)#advertisement accelerated

R1(config-pm-dm-sr-adv-acc)#threshold 40

R1(config-pm-dm-sr-adv-acc)#minimum-change 1000

R1(config-pm-dm-sr-adv-acc)#exit
R1(config-pm-dm-sr-adv)#exit

R1(config-pm-dm-srpol)#exit

R1(config-perf-meas)#exit
```

Verification: PM End-to-End Delay Management Configuration

This example shows how to use the **show performance-measurement summary** command to verify the PM for end-to-end delay management configuration.

```
R1#show performance-measurement summary
Total interfaces                              : 6
Total SR Policies                             : 1
Maximum PPS                                   : 1000 pkts/sec

SR Policy Delay-Measurement:
  Total sessions                              : 1
  Profile configuration:
    Measurement Type                          : Two-Way
    Computation interval                      : 30 seconds
    Burst interval                            : 3000 mSec
    Burst count                               : 10
    Protocol                                  : TWAMP-Lite Unauth
    HW Timestamp Supported                    : Yes
    Periodic advertisement                    : Enabled
      Interval                                : 30 (effective: 30) sec
      Threshold                               : 15%
      Minimum-Change                          : 600 uSec
```

```
    Accelerated advertisement                : Enabled
      Threshold                              : 25%
      Minimum-Change                         : 900 uSec
    Threshold crossing check                 : Minimum-delay
  Counters:
    Packets:
      Total sent                             : 334
      Total received                         : 0
    Errors:
      Total sent errors                      : 0
      Total received errors                  : 0
    Probes:
      Total started                          : 33
      Total completed                        : 0
      Total incomplete                       : 33
      Total advertisements                   : 0

Global Delay Counters:
  Total packets sent                         : 1251
  Total query packets received               : 917
  Total invalid session id                   : 0
  Total no session                           : 0

HW Support for MPLS-GAL [RFC6374] timestamp  : No
HW Support for TWAMP [RF5357] timestamp      : Yes
HW Support for 64 bit timestamp              : Yes
HW Support for IPv4 UDP Cheksum              : No
R1#
```

One-Way Link Loss Measurement

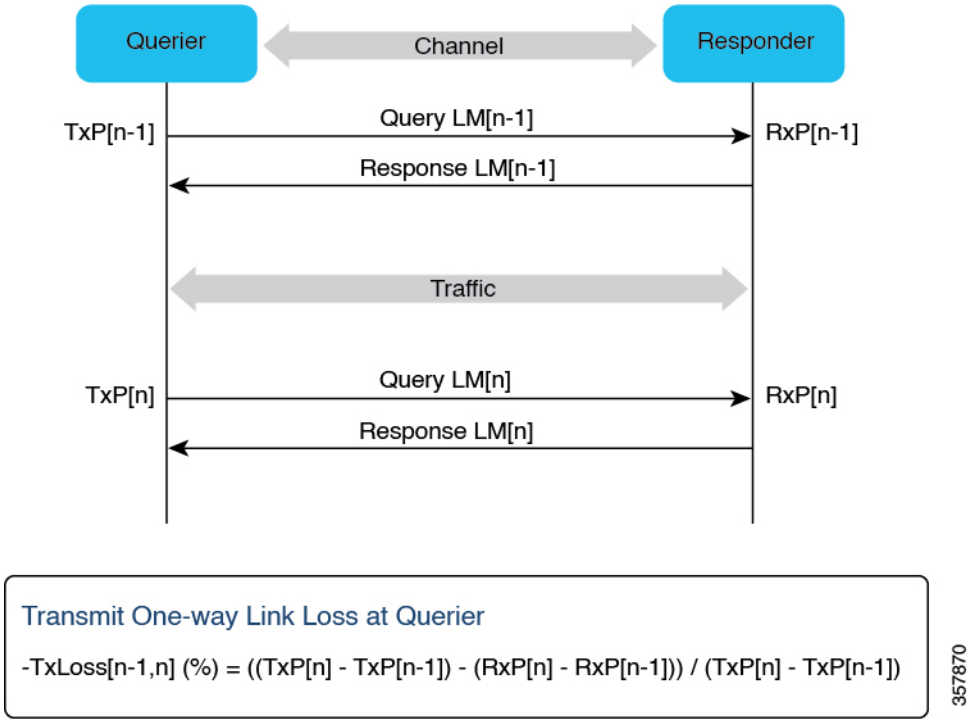
From Cisco IOS XE release 17.10.1a, a dual-color loss measurement mechanism is implemented to measure the link loss for point-to-point GRE-IPSec tunnels.

Information About One-Way Link Loss Measurement

Paths that are calculated across a network have to meet specified loss requirements to achieve specific SLAs. The One-Way Link Loss Measurement feature extends the existing network performance measurement capabilities to measure link loss and use it as a criterion to meet loss requirements of SLA.

To achieve this, an absolute one-way passive mechanism, which leverages the basic protocol of the *Simple Two-Way Direct Loss Measurement (SDLM)* over IP with User Datagram Protocol (UDP), is introduced.

Figure 3: Overview of One-Way Link Loss Measurement



Restrictions for One-Way Link Loss Measurement

- Only dual-color GRE one-way link loss measurement is supported.
- Dual-color loss measurement mechanism can only be used to measure point-to-point GRE-IPSec tunnel link loss.
- The Querier and Responder must use the same querier-dst-port UDP ports.
- The configured querier destination port (querier-dst-port) and querier source port (querier-src-port) must be different.
- The overlay destination IP address must be configured as next-hop for the measured GRE-IPSec tunnel.
- All measured interfaces must use the same GRE at both the Querier and the Responder ends.
- The maximum sessions supported are:
  - GRE-IPSec tunnel with BFD and IS-IS: 500
  - Performance measurement: 500
- Only IS-IS is supported as the Interior Gateway Protocol (IGP).

Supported Platforms for One-Way Link Loss Measurement

From Cisco IOS XE 17.10.1a, one-way link loss measurement is available on the following platforms:

- Cisco 1000 Series Aggregation Service Routers (ASR)

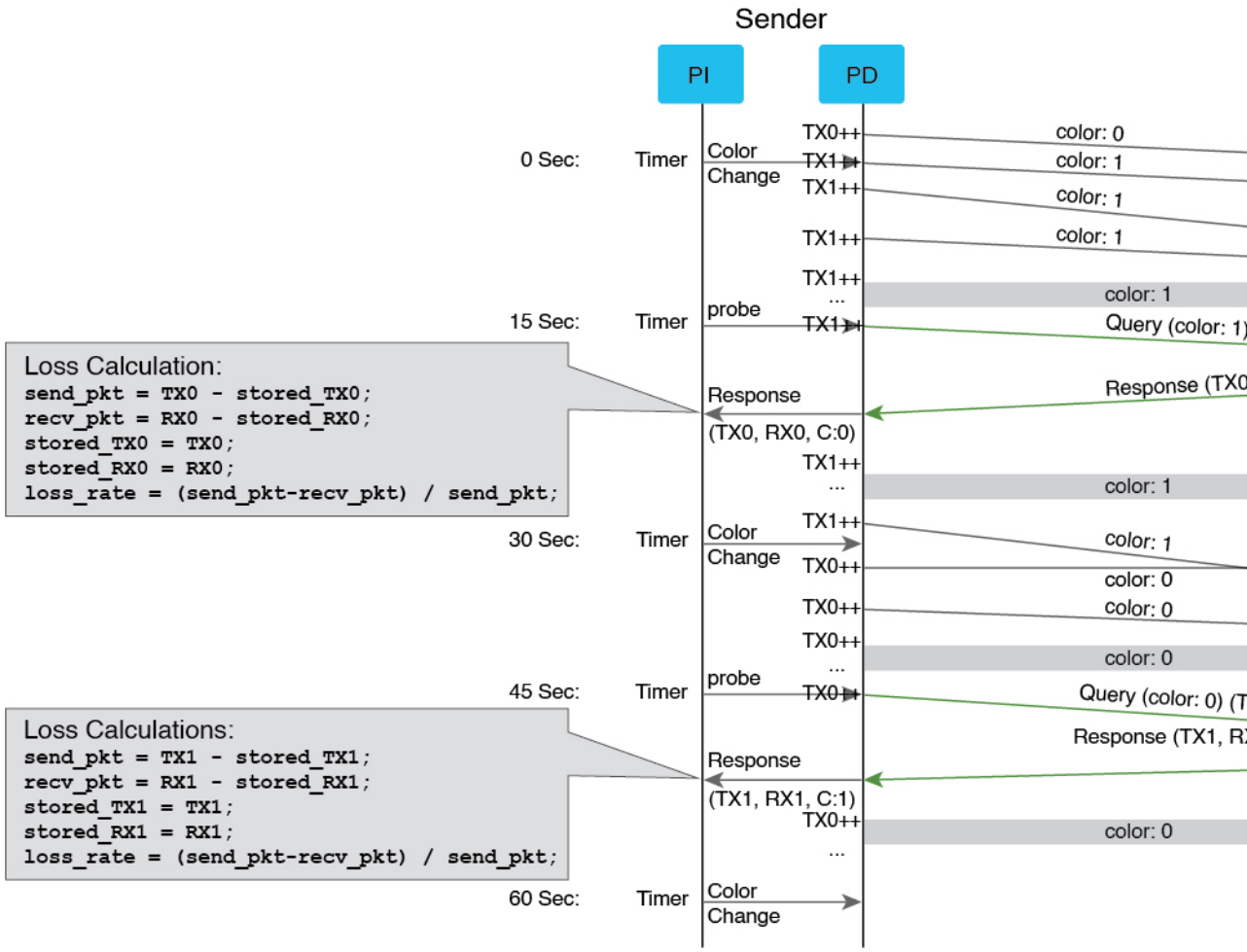
- Cisco Catalyst 8300 Series Edge Platforms
- Cisco Catalyst 8500 Series Edge Platforms
- Cisco Catalyst 8000V Edge Software

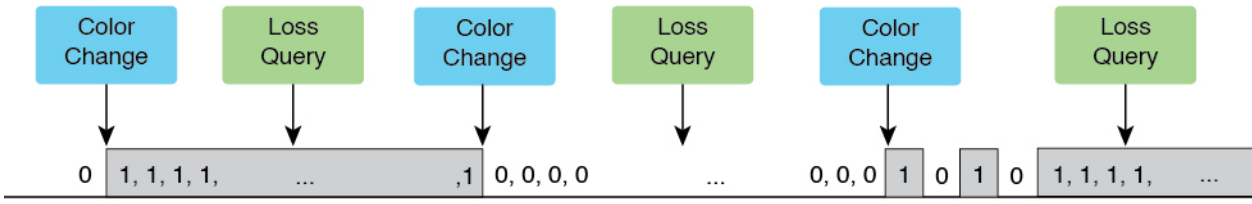
Dual-Color Loss Measurement for GRE-IPSec Tunnel

the dual-color loss-measurement mechanism is introduced to measure the GRE-IPSec tunnel link loss in real-time traffic. It uses one of the unused bits (9-12 in the **Flags** field) as the **Color** field of the GRE header (RFC 1701) for dual coloring. If not configured explicitly, the default value is 9.

A new keyword—**dual-color gre**—is introduced for the **color-type** command to implement the dual-color loss-measurement mechnism.

Figure 4: Dual-Color Loss Measurement Mechanism





The dual-color mechanism is implemented as follows:

- Traffic is tagged with Color value (0 or 1) in the Color field of the GRE header, and the Color value switches between 0 and 1 alternately at regular intervals.
- Colored traffic per color per interface is counted.
- The Unauthenticated SDLM format over IP with UDP protocol is used to encode the SDLM probe packet and SDLM reply probe packet. These packets carry the inactive TX or RX counters and calculate the loss at the querier side.

IGP IS-IS Advertisement for Link Loss Measurement

IGP advertises the extended traffic engineering link loss metric as a percentage, with or without the A-bit from Segment Routing performance measurement (SR-PM). No additional configuration is required in IS-IS to enable this advertisement.

- If the link loss value measured by SR-PM violates the configured *threshold* and *minimum-change* values, the SR-PM sends the value as a percentage to IS-IS, which advertises this value in the IS-IS domain.
- An **Anomalous (A) bit** is introduced to provide a new method to advertise the measured link loss value by checking the configured *lower-bound* and *upper-bound* values.
  - If the measured link loss value exceeds the *upper-bound* vaue and **A-bit** is not set, SR-PM sends the value as a percentage, with **A-bit** set, to IS-IS for advertisement.
  - If the measured link loss value falls below the *lower-bound* value and **A-bit** is set, SR-PM sends the value as a percentage, with **A-bit** unset, to IS-IS for advertisement.

IGP IS-IS Metric Penalty Option for Measured Link Loss

IS-IS implements the Metric Penalty mechanism by adding a new CLI under the ISIS interface to provide the option of increasing the IGP, TE, or both IGP and TE link metrics for the measured link when the A-bit is set, or decreasing it when the A-bit is unset:

isis metric fallback anomaly loss <*options*>

Configuration Example: One-Way Link Loss Measurement

Configuration at Querier

The following example shows the configuration at the querier side, with link loss measurement enabled for GRE-IPSec tunnel, and next-hop configured. The periodic interval for advertising the measured link loss value to IGP is set at 120 seconds, with the probe interval at 30 seconds. The lower and upper bounds for anomaly criteria are set at 0.5 and 1.0 for the default configuration, and at 1.0 and 2.0 for the sample configuration.

The default loss measurement probe color type is single color. In the following example, dual-color GRE is configured to enable the Loss Measurement functionality. IS-IS loss anomaly penalty can be set to either **Increment**, **Maximum**, or **Multiplier** options.

Default configuration:

```
loss-profile interfaces
  advertisement
   periodic
    interval 120
    threshold 10.000000
    minimum-change 0.100000
   anomaly-check
    lower-bound 0.500000 upper-bound 1.000000
   !
  probe
   tx-interval 30
   color-type
    dual-color gre
  !
```

Sample configuration:

```
performance-measurement
      protocol sdlm-light
        measurement loss
          unauthenticated
            querier-dst-port 6634
      dual-color gre-flags bit-position 9
      interface Tunnel55
        loss-measurement
          loss-profile name Profile1
      loss-profile name Profile1
        advertisement
          periodic
            interval 120
            threshold 10.0
            minimum-change 0.1
          anomaly-check
               lower-bound 1.0 upper-bound 2.0
        probe
          tx-interval 30
          color-type
            dual-color gre

interface Tunnel55
    ip address 10.0.0.10 10.255.255.0
    ip router isis 1
    mpls ip
    mpls traffic-eng tunnels
    tunnel source GigabitEthernet3
    tunnel destination 10.0.0.20
    tunnel protection ipsec profile gre_profile
    isis metric fallback anomaly loss maximum level-1
```

Configuration at Responder

The following example shows the configuration on the responder side:

```
performance-measurement
  protocol sdlm-light
   measurement loss
    unauthenticated
```

```
    querier-dst-port 6634
  dual-color gre-flags bit-position 9
```

Configuration Example: SR-MPLS Policy Configuration

The following example shows how to configure a static segment routing policy, and an on-demand segment routing policy:

```
segment-routing traffic-eng
 policy static-policy
  color 100 end-point 10.12.12.12
  candidate-paths
   preference 100
    constraints
     segments
      dataplane mpls
     !
    !
    dynamic
     metric
      type igp
     !
    !
   !
  !
 !
 on-demand color 100
  candidate-paths
   preference 100
    constraints
     segments
      dataplane mpls
     !
    !
    dynamic
     metric
      type igp
     !
    !
   !
  !
     !
```

Note You can configure either the static or the on-demand segment routing policy.

Verification: One-Way Link Loss Measurement

Use the **show performance-measurement summary** command on the querier side to provide information about the performance measurement parameters for link-loss measurement configuration:

```
show performance-measurement summary
Total interfaces                              : 1
Total SR Policies                             : 0
Total endpoints                               : 0
Maximum PPS                                   : 2000 pkts/sec
Dual-color gre bit-position                   : 9

Interface Delay-Measurement:
```

```
  Total sessions                            : 0
  Counters:
    Packets:
      Total sent                            : 0
      Total received                        : 0
    Errors:
      Total sent errors                     : 0
      Total received errors                 : 0
    Probes:
      Total started                         : 0
      Total completed                       : 0
      Total incomplete                      : 0
      Total advertisements                  : 0

SR Policy Delay-Measurement:
  Total sessions                            : 0
  Counters:
    Packets:
      Total sent                            : 0
      Total received                        : 0
    Errors:
      Total sent errors                     : 0
      Total received errors                 : 0
    Probes:
      Total started                         : 0
      Total completed                       : 0
      Total incomplete                      : 0
      Total advertisements                  : 0

Endpoint Delay-Measurement:
  Total sessions                            : 0
  Counters:
    Packets:
      Total sent                            : 0
      Total received                        : 0
    Errors:
      Total sent errors                     : 0
      Total received errors                 : 0
    Probes:
      Total started                         : 0
      Total completed                       : 0
      Total incomplete                      : 0
      Total advertisements                  : 0

Interface Loss-Measurement:
  Total sessions                            : 1
  Counters:
    Packets:
      Total sent                            : 22
      Total received                        : 10
    Errors:
      Total sent errors                     : 0
     Total received errors                  : 0
    Probes:
      Total started                         : 6
      Total completed                       : 2
      Total incomplete                      : 3
      Total advertisements                  : 6

Global Counters:
  Total packets sent                        : 22
  Total query packets received              : 10
  Total invalid session id                  : 0
  Total no session                          : 0
```

```
HW Support for MPLS-GAL [RFC6374] timestamp    : Yes
HW Support for IPv4 TWAMP [RF5357] timestamp   : Yes
HW Support for IPv6 TWAMP [RF5357] timestamp   : Yes
HW Support for 64 bit timestamp                : No
HW Support for IPv4 UDP Cheksum                : Yes
```

Use the **show performance-measurement sessions detail** command to provide detailed information about the performance measurement sessions for link-loss measurement configuration:

```
show performance-measurement sessions detail
Transport type              :Interface
Measurement type            :Loss Measurement
Interface name              :Tunnel100
Nexthop                     :100.0.0.2

Loss Measurement session:
  Session ID                :1
  Profile name              :loss1

  Last advertisement:
    Advertised at: 17:48:05 10-25 2022 (14 seconds ago)
    Advertised reason: First advertisement
    Advertised anomaly: INACTIVE
    Advertised loss(%) [Capped @ 50.331642%]: avg: 0.000000, min: 0.000000, max: 0.000000,
 variance: 0.000000

  Next advertisement:
    Check scheduled at the end of the current probe (roughly every 40 seconds)
    No probes completed
    Rolling average (%): 0.000000

  Current Probe:
    Started at 17:48:05 10-25 2022 (14 seconds ago)
    Packets Sent: 1, received: 1
    Measured loss(%) [Capped @ 50.331642%]: avg: 0.000000, min: 0.000000, max: 0.000000,
variance: 0.000000

Probe samples:
Rx Timestamp          Last TX     TX       Last RX     RX        Co Loss(0-100%)
17:48:10 10-25 2022   677         680       11         14        0  0.000000

Next probe scheduled at 17:48:45 10-25 2022 (in 26 seconds)
    Next burst packet will be sent in 1 seconds

  Liveness Detection:
    Session Creation Timestamp :10-25 17:32:00.699
    Session State: Up
    Last State Change Timestamp :10-25 17:47:40.761
    Missed count [consecutive] :0
    Received count [consecutive] :5
    Backoff                    :1
    Unique Path Name           :Path-1
    Loss in Last Interval      :0 % [TX: 1 RX: 1]
```

Use the **show performance-measurement profile loss interface** command on the querier side to view the performance measurement profile loss for interfaces:

```
show performance-measurement profile loss interface
Default Interface Loss Measurement:
  Profile configuration:
    Measurement Type                        : One-Way
    Tx interval                             : 10 sec
    Protocol                                : SDLM-Lite Unauth
    ToS DSCP value                          : 48
```

```
    Anomaly-check:
      lower-bound                           : 0.500000%
      upper-bound                           : 5.000000%
    Color-type:
      Dual-color:
        gre                                 : Enabled
    Periodic advertisement                  : Enabled
      Interval                              : 120 (effective: 120) sec
      Threshold                             : 15.000000%
      Minimum-Change                        : 0.200000
```

Use the **show performance-measurement interfaces name** <*name*> **detail** command on the querier side to view the performance measurement details, including link loss and delay, for a specific interface:

```
show performance-measurement interfaces name tunnel100 detail

sh performance-measurement interfaces name Tunnel100 det
Interface Name: Tunnel100 (ifh: 0x11)
  Delay-Measurement           : Disabled
  Loss-Measurement            : Enabled
  Local IPV4 Address          : 100.0.0.1
  Local IPV6 Address          : ::
  State                       : Up

  Loss Measurement session:
    Session ID                : 1
    Profile name              : Not configured

    Last advertisement:
      Advertised at: 10:23:40 10-25 2022 (32 seconds ago)
      Advertised reason: Periodic timer, avg loss threshold crossed
      Advertised anomaly: ACTIVE
     Advertised loss(%) [Capped @ 50.331642%]: avg: 9.458820, min: 9.997998, max: 10.002333,
 variance: 0.002499

    Next advertisement:
      Check scheduled at the end of the current probe (roughly every 40 seconds)
      No probes completed
      Rolling average (%): 9.458820

    Current Probe:
      Started at 10:23:40 10-25 2022 (32 seconds ago)
      Packets Sent: 3, received: 3
     Measured loss(%) [Capped @ 50.331642%]: avg: 6.667149, min: 0.000000, max: 10.002120,
 variance: 6.667149

      Probe samples:

Rx Timestamp          Last TX    TX       Last RX    RX        Col  Loss(0-100%)
10:24:05 10-25 2022   153911     153917   138520     138526    0    0.000000
10:23:55 10-25 2022   149505     177779   134556     160002    1    10.002120
10:23:45 10-25 2022   123899     153911   111509     138520    0    9.999333

      Next probe scheduled at 10:24:20 10-25 2022 (in 8 seconds)
      Next burst packet will be sent in 3 seconds

    Liveness Detection:
      Session Creation Timestamp: 10-25 10:09:56.898
      Session State: Up
      Last State Change Timestamp: 10-25 10:19:05.803
      Missed count   [consecutive]: 0
      Received count [consecutive]: 32
      Backoff                     : 1
      Unique Path Name            : Path-1
      Loss in Last Interval       : 0 % [TX: 3 RX: 3]
```

Use the **show performance-measurement history interfaces probe** command on the querier side to view the performance measurement probe history for the configured interface:

```
show performance-measurement history interfaces probe

Interface Name: Tunnel1 (ifh: 0x10)
 Loss-Measurement history (%):
    Session ID: 1
    Probe Start Timestamp     Pkt(TX/RX) Average   Min       Max
    23:28:56 08-04 2022       4/4        0.000000  0.000000  0.000000
    23:28:16 08-04 2022       4/4        0.000000  0.000000  0.000000
    23:27:36 08-04 2022       4/4        0.000000  0.000000  0.000000
    23:26:56 08-04 2022       4/4        0.000000  0.000000  0.000000
    23:26:16 08-04 2022       4/4        0.000000  0.000000  0.000000
    23:25:36 08-04 2022       4/4        0.000000  0.000000  0.000000
    23:24:56 08-04 2022       4/4        0.000000  0.000000  0.000000
    23:24:16 08-04 2022       4/4        0.000000  0.000000  0.000000
    23:23:36 08-04 2022       4/4        0.000000  0.000000  0.000000
    23:22:56 08-04 2022       4/4        0.000000  0.000000  0.000000
    23:22:16 08-04 2022       4/4        0.000000  0.000000  0.000000
    23:21:36 08-04 2022       4/4        0.000000  0.000000  0.000000
    23:20:56 08-04 2022       4/4        0.000000  0.000000  0.000000
    23:20:16 08-04 2022       4/4        0.000000  0.000000  0.000000
    23:19:36 08-04 2022       4/4        0.000000  0.000000  0.000000
    23:18:56 08-04 2022       4/4        0.000000  0.000000  0.000000
    23:18:16 08-04 2022       4/4        0.000000  0.000000  0.000000
    23:17:36 08-04 2022       4/4        0.000000  0.000000  0.000000
    23:16:56 08-04 2022       4/4        0.000000  0.000000  0.000000
    23:16:16 08-04 2022       4/4        0.000000  0.000000  0.000000
    23:15:36 08-04 2022       4/4        0.000000  0.000000  0.000000
    23:14:56 08-04 2022       4/4        0.000000  0.000000  0.000000
    23:14:16 08-04 2022       4/4        0.000000  0.000000  0.000000
    23:13:36 08-04 2022       4/4        0.000000  0.000000  0.000000
    23:12:56 08-04 2022       4/4        0.000000  0.000000  0.000000
    23:12:16 08-04 2022       4/4        0.000000  0.000000  0.000000
    23:11:36 08-04 2022       4/4        0.000000  0.000000  0.000000
    23:10:56 08-04 2022       4/4        0.000000  0.000000  0.000000
    23:10:16 08-04 2022       4/4        0.000000  0.000000  0.000000
    23:09:36 08-04 2022       4/4        0.000000  0.000000  0.000000
```

Use the **show isis teapp** command to view the IS-IS traffic engineering application information:

```
show isis teapp

Tag 200:
Tag 100:
Tag 1:
      ISIS TE Attr PM Information:
       Tu100: IDB num:14 Min:0 Max:0 Min-max-anomaly:0 Avg:0 Avg-anomaly:0 Var:0
 Is-Loss-set:1, Loss:533333 Loss-anomaly:1
       Tu200: IDB num:15 Min:0 Max:0 Min-max-anomaly:0 Avg:0 Avg-anomaly:0 Var:0
 Is-Loss-set:1, Loss:633333 Loss-anomaly:1
```

To view additional show commands, see Verification: PM Link Delay Configuration, on page 4.

Debugging and Troubleshooting One-Way Link Loss Measurement

- Use the show platform hardware qfp active interface if-name <*interface name*> | i PM command to check if INPUT_PM_DUAL_COLOR_LM (responder side) and OUTPUT_PM_DUAL_COLOR_LM (querier side) are enabled.

- Use the show platform hardware qfp active feature sr client grebit-pos command to check the GRE bit position.
- Use the show platform hardware qfp active feature sr client udp-ports command to check the source and destination UDP ports.
- Use the show platform hardware qfp active feature sr client dualcolor <*interface name*> command to check the current color.
- Use the following commands to clear performance measurement configuration and data:

```
clear performance-measurement
all                 clear all data
counters            clear pm querier counters
delay               clear pm querier delay
errors              clear internal errors
loss                clear pm querier loss
responder           clear responder data
```

- Use the following commands to debug performance measurement configuration:

```
debug performance-measurement
 all                 Performance Measurements all categories
 global              Global
 ha                  HA
 query               Query debugs
 responder           Responder debugs
```

Sample show Commands

```
R1#show performance-measurement interfaces detail
Interface Name: GigabitEthernet2 (ifh: 0x8)
Delay-Measurement : Enabled
Local IPV4 Address : 10.0.0.74
Local IPV6 Address : ::
State : Up
Delay Measurement session:
Session ID : 2
Last advertisement:
Advertised at: 06:45:50 02 2020 (214 seconds ago)
Advertised reason: First advertisement
Advertised delays (uSec): avg: 227, min: 198, max: 263, variance: 29
Next advertisement:
Check scheduled in 1 more probe (roughly every 160 seconds)
Aggregated delays (uSec): avg: 250, min: 208, max: 301, variance: 38
Rolling average (uSec): 254
Current Probe:
Started at 06:49:14 02 2020 (10 seconds ago)
Packets Sent: 3, received: 3
Measured delays (uSec): avg: 243, min: 230, max: 265, variance: 13
Probe samples:
Packet Rx Timestamp Measured Delay
06:49:22 02 2020 265500
06:49:18 02 2020 230000
06:49:14 02 2020 233500
Next probe scheduled at 06:49:54 02 2020 (in 30 seconds)
Next burst packet will be sent in 2 seconds
```

```
R1#show performance-measurement history interfaces name Gi2 probe
Interface Name: GigabitEthernet2 (ifh: 0x8)
  Delay-Measurement history (uSec):
```

```
        Probe Start Timestamp Pkt(TX/RX) Average   Min       Max
            06:48:34  02 2020 10/10      254       216       301
            06:47:54  02 2020 10/10      246       208       282
            06:47:14  02 2020 10/10      262       182       380
            06:46:34  02 2020 10/10      278       201       360
            06:45:54  02 2020 10/10      274       202       364
            06:45:14  02 2020 10/10      227       198       263

R1#show performance-measurement history interfaces name Gi2 aggr
Interface Name: GigabitEthernet2 (ifh: 0x8)
  Delay-Measurement history (uSec):
        Aggregation Timestamp Average   Min       Max       Action
            06:47:50  02 2020 259       182       380       NONE


R1#show performance-measurement counters interface name Gi2 detail
Interface Name: GigabitEthernet2 (ifh: 0x8)
  Delay-Measurement:
    Packets:
      Total sent                            : 67
      Total received                        : 67
    Errors:
        TX:
          Total interface down              : 0
          Total no MPLS caps                : 0
          Total no IP address               : 0
          Total other                       : 0
        RX:
          Total negative delay              : 0
          Total delay threshold exceeded    : 0
          Total missing TX timestamp        : 0
          Total missing RX timestamp        : 0
          Total probe full                  : 0
          Total probe not started           : 0
          Total control code error          : 0
          Total control code notif          : 0
    Probes:
      Total started                         : 6
      Total completed                       : 6
      Total incomplete                      : 0
      Total advertisements                  : 1


R1#show segment-routing traffic-eng policy all
Name: *10.2.2.2|100 (Color: 100 End-point: 10.2.2.2)
  Owners : BGP
  Status:
    Admin: up, Operational: up for 03:14:11 (since 12-02 03:36:05.290)
  Candidate-paths:
    Preference 100 (BGP):
      Dynamic (active)
        Metric Type: TE, Path Accumulated Metric: 30
          16002 [Prefix-SID, 10.2.2.2]
  Attributes:
    Binding SID: 40
      Allocation mode: dynamic
      State: Programmed
  IPv6 caps enabled


R1#show performance-measurement sr-policy name *10.2.2.2|100 detail
SR Policy name: *10.2.2.2|100
  Color                         : 100
  Endpoint                      : 10.2.2.2
  Source                        : 10.9.9.9
  Number of candidate-paths     : 1
```

```
  Candidate-Path:
    Preference                    : 100
    Protocol-origin               : BGP
    Discriminator                 : 0
    Active:                       : Yes
    Number of segment-lists       : 1
    Number of atomic paths        : 1
    Max Pkts per Burst            : 4000
    Max Pkts per Probe            : 40000
    AP Min Run per Probe          : 3
    Round-robin bursts            : 1
    Round-robin probes            : 1
    Last advertisement:
      Advertised at: 06:45:52  02 2020 (271 seconds ago)
      Advertised delays (uSec): avg: 860, min: 740, max: 946, variance: 120
    Next advertisement:
      Check scheduled in 1 more probe (roughly every 160 seconds)
      Aggregated delays (uSec): avg: 935, min: 795, max: 1146, variance: 140
    Last probe:
      Packets Sent: 10, received: 10
      Measured delays (uSec): avg: 910, min: 844, max: 1013, variance: 66
    Current Probe:
      Packets Sent: 8, received: 8
      Measured delays (uSec): avg: 949, min: 851, max: 1065, variance: 98

    Segment-List:
      Name                        : SegmentList0
      Number of atomic paths      : 1
      Last advertisement:
        Advertised at: 06:45:52  02 2020 (271 seconds ago)
        Advertised delays (uSec): avg: 860, min: 740, max: 946, variance: 120
      Next advertisement:
        Aggregated delays (uSec): avg: 935, min: 795, max: 1146, variance: 140
      Last probe:
        Packets Sent: 10, received: 10
        Measured delays (uSec): avg: 910, min: 844, max: 1013, variance: 66
      Current probe:
        Packets Sent: 8, received: 8
        Measured delays (uSec): avg: 949, min: 851, max: 1065, variance: 98

R1#show performance-measurement sr-policy name *10.2.2.2|100 private
SR Policy name: *10.2.2.2|100
  Color                           : 100
  Endpoint                        : 10.2.2.2
  Source                          : 10.9.9.9
  Number of candidate-paths       : 1

  Candidate-Path:
    Preference                    : 100
    Protocol-origin               : BGP
    Discriminator                 : 0
    Active:                       : Yes
    Number of segment-lists       : 1
    Number of atomic paths        : 1
    Max Pkts per Burst            : 4000
    Max Pkts per Probe            : 40000
    AP Min Run per Probe          : 3
    Round-robin bursts            : 1
    Round-robin probes            : 1
    Last advertisement:
      Advertised at: 06:45:52  02 2020 (284 seconds ago)
      Advertised delays (uSec): avg: 860, min: 740, max: 946, variance: 120
    Next advertisement:
```

```
      Check scheduled in 4 more probes (roughly every 160 seconds)
      Aggregated delays (uSec): avg: 935, min: 795, max: 1146, variance: 140
    Last probe:
      Packets Sent: 10, received: 10
      Measured delays (uSec): avg: 963, min: 851, max: 1083, variance: 112
    Current Probe:
      Packets Sent: 1, received: 1
      Measured delays (uSec): avg: 925, min: 925, max: 925, variance: 0
```

```
R1#show performance-measurement sr-policy name *10.2.2.2|100 verbose
SR Policy name: *10.2.2.2|100
  Color                          : 100
  Endpoint                       : 10.2.2.2
  Source                         : 10.9.9.9
  Number of candidate-paths      : 1

  Candidate-Path:
    Preference                   : 100
    Protocol-origin              : BGP
    Discriminator                : 0
    Active:                      : Yes
    Number of segment-lists      : 1
    Number of atomic paths       : 1
    Max Pkts per Burst           : 4000
    Max Pkts per Probe           : 40000
    AP Min Run per Probe         : 3
    Round-robin bursts           : 1
    Round-robin probes           : 1
    Last advertisement:
      Advertised at: 06:45:52  02 2020 (290 seconds ago)
      Advertised delays (uSec): avg: 860, min: 740, max: 946, variance: 120
    Next advertisement:
      Check scheduled in 4 more probes (roughly every 160 seconds)
      Aggregated delays (uSec): avg: 935, min: 795, max: 1146, variance: 140
    Last probe:
      Packets Sent: 10, received: 10
      Measured delays (uSec): avg: 963, min: 851, max: 1083, variance: 112
    Current Probe:
      Packets Sent: 3, received: 3
      Measured delays (uSec): avg: 911, min: 882, max: 925, variance: 29
```

```
PE3#show performance-measurement history sr-policy name *10.2.2.2|100  probe
SR Policy name: *10.2.2.2|100
  Candidate-Path:
    Preference               : 100
    Protocol-origin          : BGP
    Discriminator            : 0
    Active                   : Yes
        Probe Start Timestamp Pkt(TX/RX) Average   Min       Max
            06:49:54  02 2020 10/10      963       851       1083
            06:49:14  02 2020 10/10      910       844       1013
            06:48:34  02 2020 10/10      896       795       1019
            06:47:54  02 2020 10/10      1000      882       1146
            06:47:14  02 2020 10/10      990       909       1135
            06:46:34  02 2020 10/10      931       735       1080
            06:45:54  02 2020 10/10      911       768       1087
            06:45:14  02 2020 10/10      860       740       946
    Segment-list:
      Name                   : SegmentList0
          Probe Start Timestamp Pkt(TX/RX) Average   Min       Max
              06:49:54  02 2020 10/10      963       851       1083
              06:49:14  02 2020 10/10      910       844       1013
              06:48:34  02 2020 10/10      896       795       1019
              06:47:54  02 2020 10/10      1000      882       1146
              06:47:14  02 2020 10/10      990       909       1135
```

```
            06:46:34  02 2020 10/10      931       735       1080
            06:45:54  02 2020 10/10      911       768       1087
            06:45:14  02 2020 10/10      860       740       946
      Atomic path:
        Hops                  : 10.2.2.2
        Labels                : 16002
        Outgoing Interface    : GigabitEthernet2
        Next Hop              : 10.0.0.73
        Destination           : 10.2.2.2
        Session ID            : 1
            Probe Start Timestamp Pkt(TX/RX) Average   Min       Max
                06:49:54  02 2020 10/10      963       851       1083
                06:49:14  02 2020 10/10      910       844       1013
                06:48:34  02 2020 10/10      896       795       1019
                06:47:54  02 2020 10/10      1000      882       1146
                06:47:14  02 2020 10/10      990       909       1135
                06:46:34  02 2020 10/10      931       735       1080
                06:45:54  02 2020 10/10      911       768       1087
                06:45:14  02 2020 10/10      860       740       946

R1#show performance-measurement history sr-policy name *10.2.2.2|100  aggr
SR Policy name: *10.2.2.2|100
  Candidate-Path:
    Preference                : 100
    Protocol-origin           : BGP
    Discriminator             : 0
    Active                    : Yes
        Aggregation Timestamp Average   Min       Max       Action
            06:50:32  02 2020 942       795       1146      NONE
            06:47:52  02 2020 922       735       1135      NONE
    Segment-list:
      Name                    : SegmentList0
          Aggregation Timestamp Average   Min       Max       Action
              06:50:32  02 2020 942       795       1146      NONE
              06:47:52  02 2020 922       735       1135      NONE
      Atomic path:
        Hops                  : 10.2.2.2
        Labels                : 16002
        Outgoing Interface    : GigabitEthernet2
        Next Hop              : 10.0.0.73
        Destination           : 10.2.2.2
        Session ID            : 1
            Aggregation Timestamp Average   Min       Max       Action
                06:50:32  02 2020 942       795       1146      NONE
                06:47:52  02 2020 922       735       1135      NONE
```