

# PCEP Extensions for Performance Measurements for SR-TE and MPLS-TE LSPs with Stateful PCE

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Rakesh Gandhi ([rgandhi@cisco.com](mailto:rgandhi@cisco.com)) - Presenter

Bin Wen ([Bin\\_Wen@cable.comcast.com](mailto:Bin_Wen@cable.comcast.com))

Colby Barth ([jonathan.barth@hpe.com](mailto:jonathan.barth@hpe.com))

Dhruv Dhody ([dhruv.ietf@gmail.com](mailto:dhruv.ietf@gmail.com))

# Agenda

- Requirements
- Scope
- Overview
- Capability, Attributes and Reporting
  - Delay
  - Loss
  - Bandwidth Utilization
  - Liveness Detection
- PCRpt Message RBNF
- Notification Message
- Next Steps

# Requirements

1. Stateful PCE using SR-TE (SR-MPLS and SRv6 data plane) LSPs and MPLS-TE LSPs to provide guaranteed SLAs
  - PCE originally computed path using the link delay/loss metrics
2. Monitor end-to-end delay/loss performance and detect liveness of an LSP
  - ✓ PCC **proactive** action before installing the LSP in data plane
  - ✓ PCC **reactive** action when upper-bound is violated
  - ✓ Stateful PCE path computation that **avoid the degraded path**
3. Stateful PCE monitors real-time bandwidth utilization an of LSP to detect and avoid congestion
  - a. Implement auto-bandwidth at Stateful PCE

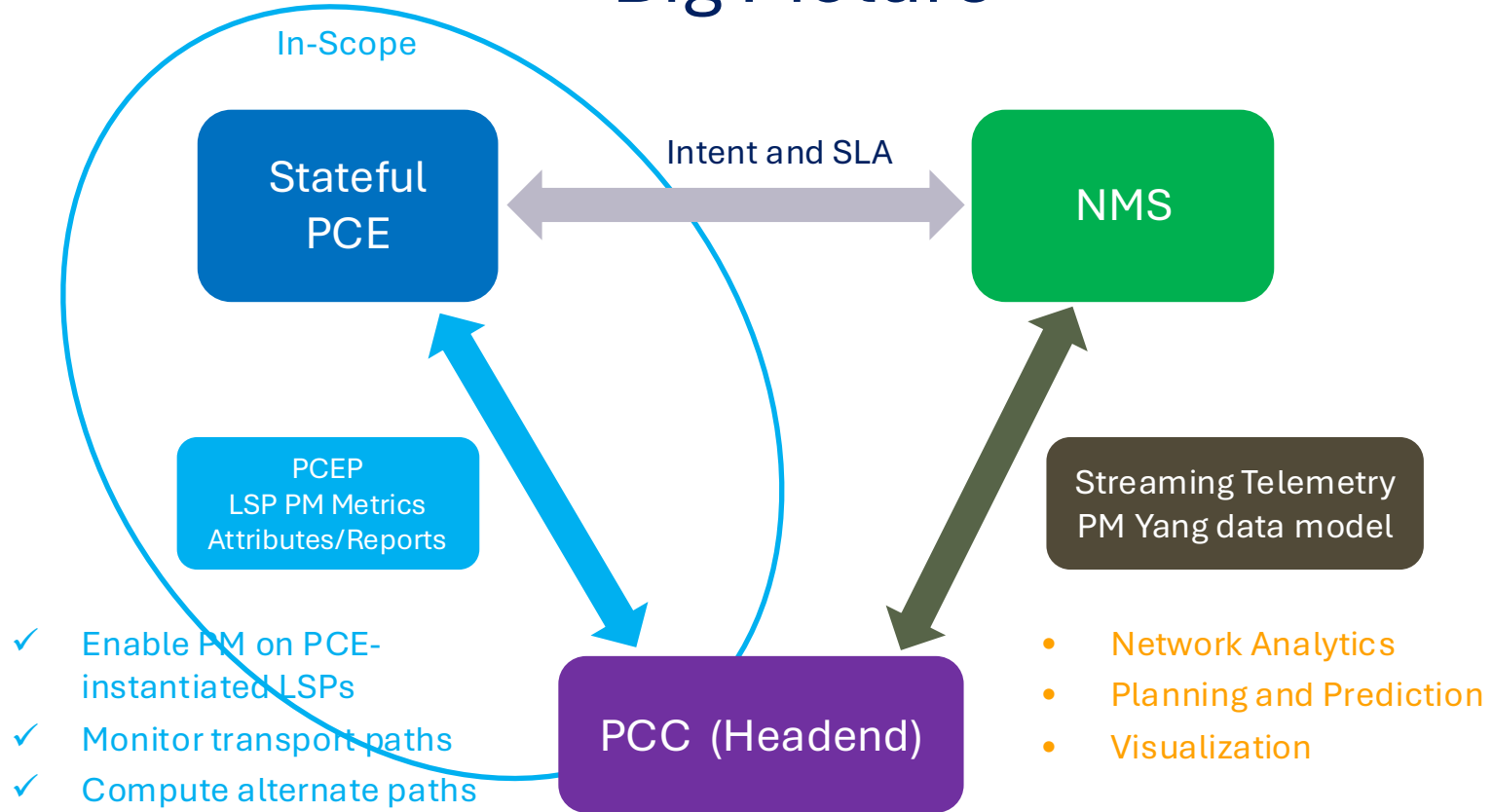
# Scope

- Requesting and reporting of LSP delay metrics, loss metrics, bandwidth utilization and liveness detection with Stateful PCE
  - ✓ PCE-Initiated LSPs
  - ✓ PCC-Initiated LSPs
  - ✓ SR-TE LSPs (SR-MPLS and SRv6 data planes) and MPLS-TE

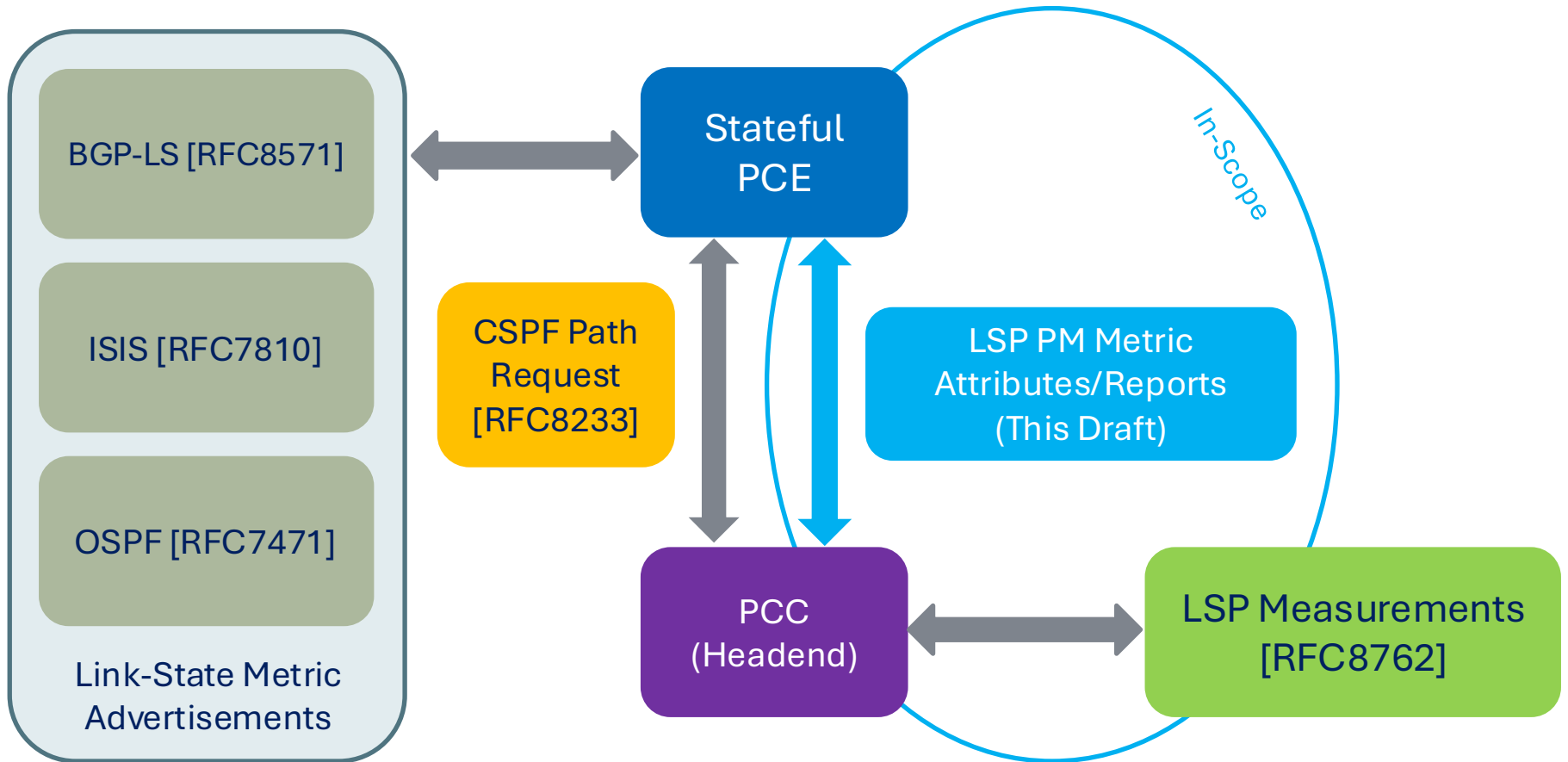
## Out-of-scope

- Usage of the performance metrics by the Stateful PCE
- Protocol to measure delay, loss, bandwidth utilization, and detect liveness of an LSP on a PCC
- Streaming telemetry to NMS

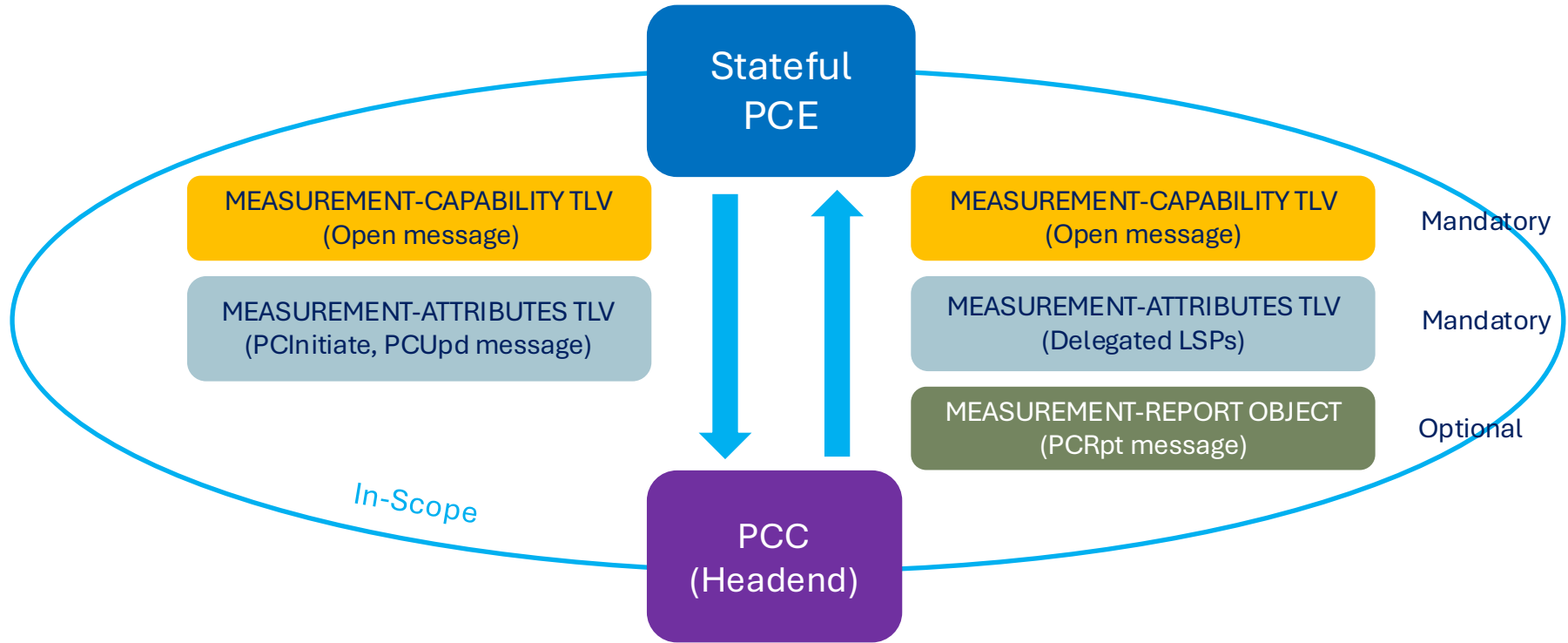
# Big Picture



# Performance Measurement Protocols



# PCEP Extensions for PM for LSPs

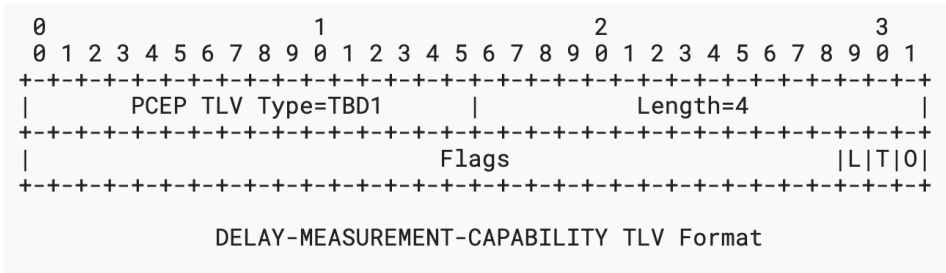


OPEN Object

LSPA Object

New Object Class

# Measurement Capability TLVs



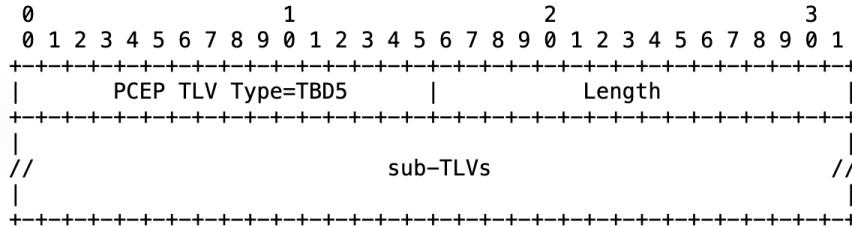
TLV Type	Carried in OPEN Object
TBD1	DELAY-MEASUREMENT-CAPABILITY
TBD2	LOSS-MEASUREMENT-CAPABILITY
TBD3	BW-UTILIZATION-MEASUREMENT-CAPABILITY
TBD4	LIVENESS-DETECTION-CAPABILITY

Flag in TLV	Meaning in DELAY-MEASUREMENT
O	One-way Delay Measurement - 1 bit
T	Two-way Delay Measurement - 1 bit
L	Loopback Delay Measurement - 1 bit

Flag in TLV	Meaning in LOSS-MEASUREMENT
O	One-way Loss Measurement - 1 bit
T	Two-way Loss Measurement - 1 bit
L	Loopback Loss Measurement - 1 bit
I	Inferred Loss Measurement - 1 bit
D	Direct Loss Measurement - 1 bit

- ✓ TLV presence indicates that PCE/PCC is Delay/Loss/BW-Utilization/Liveness-Detection capable
- ✓ Useful when the network has devices with and without PM capabilities

# Measurement Attributes TLVs



MA TLV Type	Carried in LSPA Object
TBD5	DELAY-MEASUREMENT-ATTRIBUTES
TBD6	LOSS-MEASUREMENT-ATTRIBUTES
TBD7	BW-UTILIZATION-MEASUREMENT-ATTRIBUTES
TBD8	LIVENESS-DETECTION-ATTRIBUTES

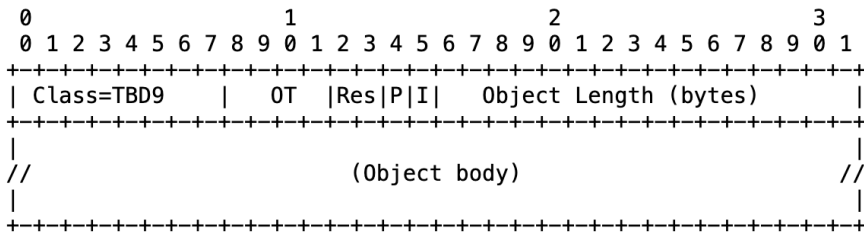
## Sub-TLV Types for Measurement Attributes TLV in LSPA Object

1	<b>Measurement-Enable Flags (Bit-position) (mandatory sub-TLV)</b>	Enable Delay measurement mode, loss measurement mode, bandwidth utilization and liveness detection.
2	<b>Transmit-Interval</b>	Transmit interval in milli-seconds (default 1 second).
3	<b>Measurement-Protocol</b>	Measurement protocol type: (1) STAMP [RFC8762], or (2) TWAMP [RFC5357], or (3) MPLS-PM [RFC6374]. Measurement mode: (1) one-way, or (2) two-way, or (3) loopback mode.
4	<b>Measurement-Interval</b>	Measurement interval in seconds (default 300 seconds).
5	<b>Report-Threshold</b>	Measurements reported immediately if report-threshold is crossed when comparing current metric (min/max/avg/variance) value with the reported value. Disabled by default.
6	<b>Report-Threshold-percentage, minimum-threshold</b>	Measurements reported immediately if report-threshold-percentage is crossed when comparing current metric (min/max/avg/variance) value with the reported value. Disabled by default.
7	<b>Report-Interval</b>	Measurements reported at the end of report-interval (periodically) configured in seconds (default 3600 seconds), Value 0 is used to disable periodic reporting. No threshold is checked for periodic reporting.
8	<b>Report-Upper-bound Lower-bound</b>	Measurements reported immediately if the upper-bound is crossed (in the up direction) or the lower-bound is crossed (in the down direction) when comparing current value with the reported value and set the anomaly flag in the reported value accordingly. Disabled by default.

# Measurement Attributes Sub-TLVs

Sub-TLV Type	Delay (TLV Type: TBD5)	Loss (TLV Type: TBD6)	BW (TLV Type: TBD7)	Liveness (TLV Type: TBD8)
1 <b>Measurement-Enable Flags (Bit-position) (mandatory sub-TLV)</b>	31 One-Way Delay Measurement Enabled 30 Two-Way Delay Measurement Enabled 29 Loopback Delay Measurement Enabled	28 One-Way Loss Measurement Enabled 27 Two-Way Loss Measurement Enabled 26 Loopback Loss Measurement Enabled 25 Inferred Loss Measurement Enabled 24 Direct Loss Measurement Enabled	23 Bandwidth Utilization Reporting Enabled	22 Liveness Detection Enabled
2 <b>Transmit-Interval</b>	Applicable	Applicable	Not applicable	Applicable
3 <b>Measurement-Protocol</b>	Applicable	Applicable	Not applicable	Applicable
4 <b>Measurement-Interval</b>	Applicable	Applicable	Applicable	Applicable (Detection Interval)
5 <b>Report-Threshold</b>	Applicable	Applicable	Applicable	Not applicable
6 <b>Report-Threshold-percentage, minimum-threshold</b>	Applicable	Applicable	Applicable	Not applicable
7 <b>Report-Interval</b>	Applicable	Applicable	Applicable	Not applicable
8 <b>Report-Upper-bound Lower-bound</b>	Applicable	Applicable	Applicable	Not applicable

# Delay Measurement Report Class-Type



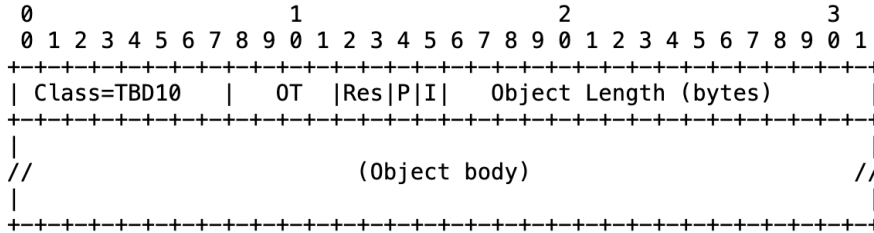
DELAY-MEASUREMENT Object Format

- Metric types and units aligned with RFC7471
- Metric reporting is disabled when report interval is 0 and report thresholds not set

## Object-Types in Delay Measurement Report Class-Type

1	Delay Measurement Status	Indicates the Status of Delay Measurement as: (1) Active, (2) Failed, (3) Errored
2	One-Way Delay Metric value	End-to-end one-way average delay for the LSP in one (forward) direction, encoded as 24-bit integer
3	One-Way Delay Metric Min/Max values	Minimum and maximum values of the one-way delay, encoded as 24-bit integer
4	One-Way Delay Variation Metric value	Delay variation value for the LSP in one (forward) direction, encoded as 24-bit integer
5	Two-Way Delay Metric value	End-to-end two-way average delay for the LSP in both (forward and reverse) directions, encoded as 24-bit integer
6	Two-Way Delay Metric Min/Max values	Minimum and maximum values of the two-way delay, encoded as 24-bit integer
7	Two-Way Delay Variation Metric Value	Delay variation value for the LSP in both (forward and reverse) directions, encoded as 24-bit integer
8	Loopback Delay Metric value	End-to-end loopback average delay for the LSP in both (forward and reverse) directions, encoded as 24-bit integer
9	Loopback Delay Metric Min/Max values	Minimum and maximum values of the loopback delay, encoded as 24-bit integer
10	Loopback Delay Variation Metric Value	Delay variation value for the LSP in both (forward and reverse) directions, encoded as 24-bit integer

# Loss Measurement Report Class-Type



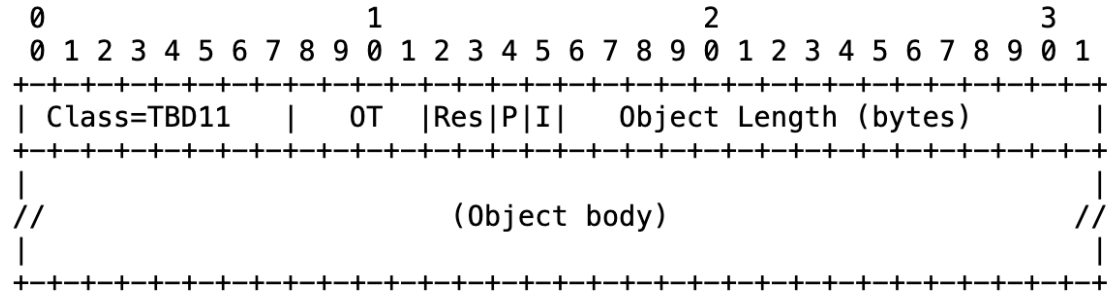
LOSS-MEASUREMENT Object Format

- Metric types and units aligned with RFC7471
- Metric reporting is disabled when report interval is 0 and report thresholds not set

## Object-Types in Loss Measurement Report Class-Type

1	Loss Measurement Status	Indicates the Status of Loss Measurement as: (1) Active, (2) Failed, (3) Errored
2	Tx Packets-Lost	24-bit field identifying the packet loss as a percentage of the total packets sent in Tx direction
3	Rx Packets-Lost	24-bit field identifying the packet loss as a percentage of the total packets received in Rx direction
4	Total Packets-Sent-Received	Two 32-bit fields identify the total packets sent and received

# Liveness Detection Report Class-Type



LIVENESS-DETECTION Object Format

## Object-Types in Liveness Detection Report Class-Type

1	Liveness State	Indicates the State of Liveness Detection as: (1) Up, (2) Down, (3) Errored
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# PCEP PCRpt Message

- Routing Backus-Naur Form (RBNF) format of <actual\_attribute-list> in PCRpt message modified as:

```
<actual_attribute-list> ::= [<BANDWIDTH>  
                             [<DELAY-MEASUREMENT>  
                             [<LOSS-MEASUREMENT>  
                             [<LIVENESS-DETECTION>  
                             [<metric-list>
```

- For the LSPs with multiple ERO/RRO objects [I-D.ietf-pce-multipath]:

```
<path> ::= <intended-path>  
          [<actual_attribute-list><actual-path>  
          <intended-attribute-list>
```

```
<intended-path> ::= <ERO> |  
                  <PATH-ATTRIB><ERO> [<intended-path-multipath>
```

```
<intended-path-multipath> ::= <PATH-ATTRIB><ERO>  
                             [<intended-path-multipath>
```

```
<actual-path> ::= <RRO> |  
                 <PATH-ATTRIB><RRO> [<actual-path-multipath>
```

# PCEP Notification Message

If Stateful PCE gets overwhelmed when deploying high LSP scale, it can notify PCC to temporarily suspend the PM reporting.

- PCNtf Message Notification Type = TBD13 (PM Overwhelm State)
  - Notification Value = 1 (Entering PM overwhelm state)
  - Notification Value = 2 (Clearing PM overwhelm state)

# Next Steps

- Welcome your comments and suggestions
- Useful functionality to have?
  - Request for WG adoption

**Thank you!**