PCEP Extensions for MPLS-TE LSP Automatic Bandwidth Adjustment with Stateful PCE

draft-dhody-pce-stateful-pce-auto-bandwidth-06

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Summary of Updates

Last presented in Dallas was the -04 version

Changes since then…

Rakesh and Luyuan joined as co-authors

Clarity regarding the two deployment models

- Added a table summarizing the requirements and differences

Added a scaling consideration section

- Added a mechanism to report bandwidth samples together, reducing the number of PCRpt messages
- Described the use threshold to further curb them

Added new controls for overflow, underflow, etc.

Encoding Changes

- Created a separate BANDWIDTH-USAGE-ATTRIBUTE TLV
- Added sub-TLVs for the AUTO-BANDWIDTH-ATTRIBUTE and BANDWIDTH-USAGE-ATTRIBUTE
- Changes to Bandwidth-Usage object

Two Deployment Models

1) PCC to decide adjusted bandwidth

- PCC monitors and calculates the new adjusted bandwidth.
- PCC reports the calculated bandwidth to be adjusted to the PCE.
- For PCE-initiated LSP, the PCC is requested during the LSP initiation to monitor and calculate the new adjusted bandwidth

2) PCE to decide adjusted bandwidth

- PCE calculates the new adjusted bandwidth for the LSP.
- PCE needs to learn the real-time bandwidth usage.
- For PCE-initiated LSP, the PCC is requested during initiation to monitor and report the real-time bandwidth usage.

Requirements for PCEP Extensions

	PCC Initiated LSP	PCE Initiated LSP
Model (1) PCC decides adjusted bandwidth	PCC monitors the bandwidth usage and reports the calculated bandwidth to be adjusted to the PCE.	At the time of initiation, PCE request PCC to monitor the bandwidth usage and reports the calculated bandwidth to be adjusted to the PCE.
	No new extensions are needed.	**Extension is needed for PCE to pass on the adjustment parameters at the time of Initiation.**
	Optionally AUTO-BANDWIDTH-ATTRIBUTE TLV can be used to identify the LSP with Auto-Bandwidth Feature enabled.	*AUTO-BANDWIDTH-ATTRIBUTE TLV (and sub-TLVs e.g. Adjustment-Interval, Minimum-Bandwidth)*
Model (2) PCC reports real-time bandwidth usage and PCE decides adjusted bandwidth	PCC monitors the bandwidth usage and reports the real-time bandwidth usage to the PCE. It is PCE that decides the calculated bandwidth to be adjusted and updates the LSP accordingly.	At the time of initiation, PCE request PCC to monitor the bandwidth usage and reports the real-time bandwidth usage to the PCE. It is PCE that decides the calculated bandwidth to be adjusted and updates the LSP accordingly.
	Extension is needed for PCC to pass on the adjustment parameters at the time of delegation to PCE.	**Extension is needed for PCE to pass on the real-time bandwidth usage reporting parameters at the time of Initiation.**
	AUTO-BANDWIDTH-ATTRIBUTE TLV (and sub-TLVs e.g. Adjustment-Threshold, Real-time-bandwidth-usage-Report-Interval)	*Real-time bandwidth usage Reporting (e.g. Real-time-bandwidth usage-Report-Interval, Real-time-bandwidth-usage-Report-Threshold)*
	Extension to report the real-time bandwidth usage to PCE are also needed (Bandwidth-Usage object-type)	

Key Takeaway…

Identify and inform the PCEP peer,

- the LSP that are enabled with Auto-Bandwidth feature
  - *Not all LSP are enabled with this feature*
- the model of operation i.e. if it is PCC or PCE that decides the bandwidth to be adjusted
  - *PCEP extension for reporting real-time bandwidth usage is one of the ways*

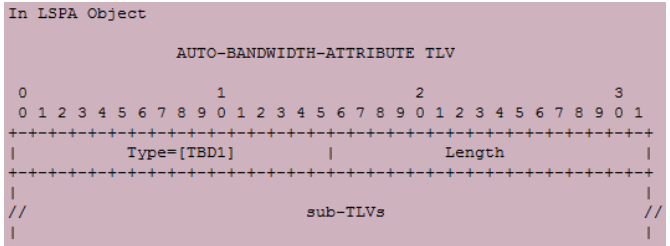
For LSP with Auto-Bandwidth feature enabled,

- adjustment parameters to control the feature
  - *Min/max bandwidth range*
  - *Adjustment Threshold*
  - *Report Threshold*
  - *Overflow and Underflow Thresholds*

PCEP Extensions - 1

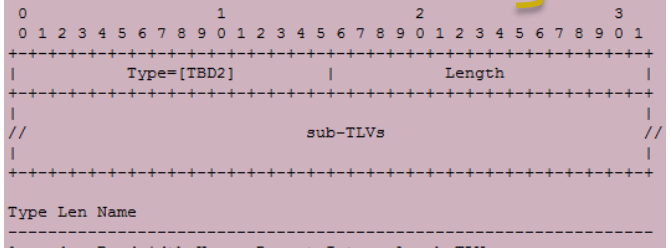
In LSPA Object

AUTO-BANDWIDTH-ATTRIBUTE TLV



Type	Len	Name
1	4	Sample-Interval sub-TLV
2	4	Adjustment-Interval sub-TLV
3	4	Adjustment-Threshold sub-TLV
4	4	Adjustment-Threshold-Percentage sub-TLV
5	4	Minimum-Bandwidth sub-TLV
6	4	Maximum-Bandwidth sub-TLV
7	8	Overflow-Threshold sub-TLV
8	4	Overflow-Threshold-Percentage sub-TLV
9	8	Underflow-Threshold sub-TLV
10	4	Underflow-Threshold-Percentage sub-TLV

BANDWIDTH-USAGE-ATTRIBUTE TLV



Type	Len	Name
1	4	Bandwidth-Usage-Report-Interval sub-TLV
2	4	Bandwidth-Usage-Report-Threshold sub-TLV
3	4	Bandwidth-Usage-Report-Threshold-Percentage sub-TLV
4	4	Bandwidth-Usage-Report-Flow-Threshold sub-TLV
5	4	Bandwidth-Usage-Report-Flow-Threshold-Percentage sub-TLV

Sample Interval	Sample Interval, the time interval in which the bandwidth usage rate is collected as a sample.
Adjustment Interval	Adjustment Interval, the time interval in which the bandwidth adjustment should be made.
Adjustment Threshold (to avoid frequent adjustments)	Bandwidth is adjusted only if the difference between the calculated bandwidth to be adjusted and current bandwidth allocated >= threshold. Both Percentage and absolute value.
Minimum and Maximum Bandwidth	The minimum and maximum bandwidth that should be reserved for the LSP.
Overflow and Underflow Threshold	Bandwidth is adjusted immediately overriding the adjustment interval to accommodate for sudden change of bandwidth usage.
Real-time-bandwidth-usage Report Interval	Multiple bandwidth samples are collected every report-interval, and reported together to the PCE.
Report-Threshold	To suppress the sending of the collected samples during the report-interval. The collected samples are reported if at least one sample crosses the Report-Threshold.
Report-Flow-Threshold	For sudden changes in the real-time bandwidth usage, report flow threshold is employed by pre-maturely expiry of the report-interval to report the unreported bandwidth samples collected so far.

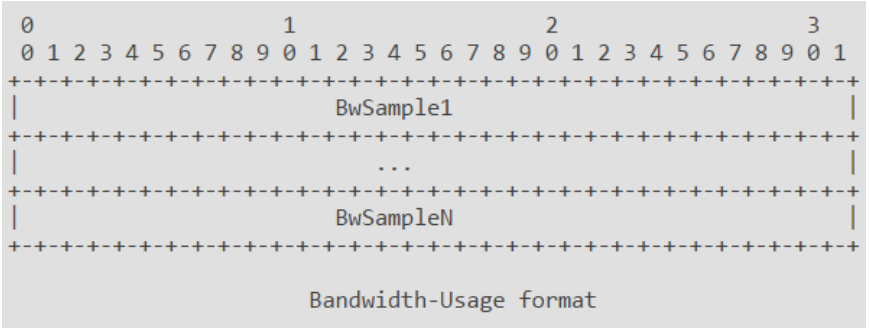
PCEP Extensions - 2

Auto-Bandwidth Adjusted Bandwidth

- The calculated bandwidth to be adjusted
- Via existing "Requested Bandwidth: BANDWIDTH Object-Type is 1."

Bandwidth-Usage Report

- A new BANDWIDTH object type is defined to report the actual bandwidth usage of a TE LSP.
- PCC reports the TE LSP bandwidth usage and the PCE decides the auto-bandwidth adjusted bandwidth.



Bandwidth-Usage format

BwSample(i) - The actual bandwidth usage, (the BwSample collected at the end of each sample-interval). The number of samples dependent on the Report interval as well as the report-flow-threshold.

Can be used independent of the auto-bw feature..

PCEP Scaling Consideration

Frequency of PCC reports with real-time bandwidth usage information to the stateful PCE for a large number of LSPs

Combine multiple bandwidth samples using larger report-interval and report them together to the PCE, thus reducing the number of PCRpt messages.

Further Report-Threshold can be use to skip reporting the bandwidth samples for small changes in the bandwidth.

Frequent Bandwidth change and signaling

Use longer adjustment-interval value, thus reducing the number of bandwidth change request and signaling

Further adjustment threshold can be use to skip making adjustments from small changes in the bandwidth

* Implementation Dependent - The processing cost of monitoring a large number of LSPs at the PCC and handling bandwidth change requests at PCE.

Next Steps

Useful functionality to have?

- **We think so :)**

Updated based on the comments received so far

- **Suggestions are welcome…**

Requesting WG adoption

Requesting early code-points for our implementation

Questions & Comments?

Thanks!