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

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

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94th IETF @ Yokohama
Summary of Updates

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

<table>
<thead>
<tr>
<th>PCC Initiated LSP</th>
<th>PCE Initiated LSP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Model (1) PCC decides adjusted bandwidth</strong></td>
<td><strong>Model (2) PCC reports real-time bandwidth usage and PCE decides adjusted bandwidth</strong></td>
</tr>
<tr>
<td>PCC monitors the bandwidth usage and reports the calculated bandwidth to be adjusted to the PCE.</td>
<td>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.</td>
</tr>
<tr>
<td>No new extensions are needed.</td>
<td>Extension is needed for PCC to pass on the adjustment parameters at the time of delegation to PCE.</td>
</tr>
<tr>
<td>Optionally AUTO-BANDWIDTH-ATTRIBUTE TLV can be used to identify the LSP with Auto-Bandwidth Feature enabled.</td>
<td>Extension is needed for PCE to pass on the real-time bandwidth usage reporting parameters at the time of initiation.</td>
</tr>
<tr>
<td>AUTO-BANDWIDTH-ATTRIBUTE TLV (and sub-TLVs e.g. Adjustment-Interval, Minimum-Bandwidth)</td>
<td>Real-time bandwidth usage Reporting (e.g. Real-time-bandwidth usage-Report-Interval, Real-time-bandwidth-usage-Report-Threshold)</td>
</tr>
<tr>
<td>Extension to report the real-time bandwidth usage to PCE are also needed (Bandwidth-Usage object-type)</td>
<td></td>
</tr>
</tbody>
</table>
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
## 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.

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### PCEP Extensions - 1

<table>
<thead>
<tr>
<th>In LSPA Object</th>
<th>AUTO-BANDWIDTH-ATTRIBUTE TLV</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 0 1</td>
<td>Type [16B]</td>
</tr>
<tr>
<td>1 2 3</td>
<td>sub-TLVs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type Len Name</th>
<th>1</th>
<th>Sample-Interval sub-TLV</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Adjustment-Interval sub-TLV</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Adjustment-Threshold-Percentage sub-TLV</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Maximum-Bandwidth sub-TLV</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Overflow-Threshold sub-TLV</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Underflow-Threshold sub-TLV</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Overflow-Threshold-Percentage sub-TLV</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Underflow-Threshold-Percentage sub-TLV</td>
<td></td>
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<tbody>
<tr>
<td>2</td>
<td>Bandwidth-Usage-Report-Threshold sub-TLV</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Bandwidth-Usage-Report-Threshold-Percentage sub-TLV</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Bandwidth-Usage-Report-Flow-Threshold sub-TLV</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Bandwidth-Usage-Report-Flow-Threshold-Percentage sub-TLV</td>
<td></td>
</tr>
</tbody>
</table>
**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.

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..

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**PCEP Scaling Consideration**

1. **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.

2. **Frequent Bandwidth change and signaling**
   - Use longer adjustment-interval value, thus reducing the number of bandwidth change request and signaling.

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

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Thanks!