Extensions to the Path Computation Element protocol (PCEP) for residual path bandwidth support

draft-lazzeri-pce-residual-bw-01

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RFC5541 defines the objective function MBP (maximum residual bandwidth path)

- It enables to compute the path maximizing the minimum value of the residual bandwidth (that is the physical bandwidth left free on the links along the path)
- The path with the largest “bottleneck” is returned

However:

- The value of the bottleneck (which is the main objective of this proposal) cannot be returned as MBP is an OF and not a metric
- Only the physically available bandwidth is taken into account: it’s also needed (and possibly more important) to consider the available bandwidth per priority level
- It’s not possible to put constraints on the bottleneck of the path, that is finding a path which optimizes another metric and has a bandwidth bottleneck not narrower than a given value.
Proposal and rationale

- **Proposal for the introduction of additional metrics in PCEP**
  - **Path unreserved bandwidth at a given priority**: the minimum value of the unreserved bandwidth at that priority among all the links along the path
  - **Path residual bandwidth**: the minimum value of the free physical bandwidth among all the links along the path

- **Rationale for the introduction of these metrics**
  - When metrics are returned as a result of the path computation (using C bit as specified in RFC5440) they can be used to know how much traffic can still be routed through the path just computed
  - Optimizing a path against unreserved or residual bandwidth allows a better usage of the network resources, reducing network blockability
  - Putting constraints on the values of unreserved or residual bandwidth also helps preventing network bottlenecks
Changes between v01 and v00

- Focus moved away from Hierarchical Path computation in favor of definition of new metrics.
- Applicability to H-PCE and multi domain is no longer a requirement but moved to use case as example of applicability.
- 4.1 mode of operations: Description of usage within METRIC object in PCReq and PCRep
- 5. Procedures:
  - No change to procedures defined in RFC5440 and RFC5441
  - Use case: applicability to ACTN
Changes to the protocol

- Two new metric types are added to the METRIC object of RFC5440
  - Path unreserved bandwidth

  Given:
  - A network with a set of N links \{Li, (i=1...N)\}.
  - A path of a point to point LSP including a list of K links \{Lpi,(i=1...K)\}.
  - The maximum reservable bandwidth of each link Li, named Ri.

The path unreserved bandwidth at a given priority k is defined as the minimum value of the unreserved bandwidth at priority k among all the links along the P2P path, that is

\[ PU(p) = \min \{Ui(p), (i=1...K)\} \]

where:
  - \( Ui(p) = Ri - Bi(p) \) is the unreserved bandwidth at priority p of the link Li
  - \( Bi(p) \) is the bandwidth allocated to the LSPs at priority p on the link Li, that is the sum of the bandwidth of all the LSPs passing through the link Li with priority \( \geq p \)
Changes to the protocol

- Path residual bandwidth
  
  Given:
  
  - A network with a set of N links \{L_i, (i=1...N)\}.
  - A path of a point to point LSP including a list of K links \{L_{pi}, (i=1...K)\}.
  - The maximum reservable bandwidth of each link \(L_i\), named \(R_i\).
  - The allocated bandwidth of each link \(L_i\), that is the sum of the bandwidth of all the LSPs passing through the link \(L_i\), named \(A_i\)
  - The residual bandwidth of the link \(L_i\), \(r(L_i) = R_i - A_i\)

  The path residual bandwidth is defined as the minimum value of the residual bandwidth among all the links along the P2P path, that is

  \[PB = \min \{r(L_{pi}), (i=1...K)\}\]
Both path unreserved and path residual bandwidth have the same format:

```
0                   1                   2                   3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2
```

Path Unreserved/Residual Bandwidth

Two new metric types are added to the METRIC object of RFC5440.

The bandwidth is expressed in bytes/sec and encoded in 32 IEEE floating point format.

For non PSC requests the field could include (subject to further study) the count of available timeslots or lambdas (as included in the PCReq BANDWIDTH object), keeping the same format.

The priority to be used for path unreserved bandwidth is the one mentioned on the LSPA object (if any, otherwise 0).
Summary and next steps

- Simple extensions with no dependencies
- Can be used to know how much traffic can still be routed through the path just computed
- Help preventing network bottlenecks
- Interest in the WG?