Outline

› Scope
› Problem(s) to solve
› Requirements
› Possible operation modes
› Proactive approaches
› Reactive approaches
› Approaches vs. requirements
› Way forward
Scope

› Provide ability to deviate from the shortest path
  – Resource reservation is not in the scope for now
  – It is referred to as Traffic Engineering
    › Note that full scale TE involves resource reservation too
  – It is also referred to as Traffic Steering

› Goal
  – Provide a knob for Traffic Engineering

› The level of path control may vary
  – From: Only specifying which link or node (hotspot) to be avoided
  – To: Specifying the entire forwarding path
Problem(s) to Solve

› Only A-E and E-F links are used between A and F
  – Other links could be also used to avoid congestion

› Best-effort traffic could be steered away from shortest path
  – Premium traffic forwarded on shortest path
  – Best-effort traffic is steered to non-shortest path
Requirements

› Preserve the 802.1Q-2011 service model
  – Symmetric congruence of unicast and multicast
› Minimal modifications to the existing technology base
› Impact on existing traffic minimized
  – Completely hitless if possible
› Minimal impact on the overall scaling and convergence times for the solution
Possible Operation Modes

› **Proactive (Design and Assign)**
  - Determine the forwarding paths in advance depending on the offered traffic
  - Impact of adding a new flow/service is a priori determined → appropriate forwarding path is chosen

› **Reactive (Observe and React)**
  - (temporarily) modify the alignment of flow/service to forwarding path
  - Move traffic away from congestion
Proactive Approaches

› Manipulating the shortest path
  - IS-IS Traffic Engineering (RFC 5305)
    › Administratively assigned to have a differently weighted topology to traffic engineering SPF calculations
  - IS-IS Multi-Topology (RFC 5120)
    › Multiple metric sets
    › Shortest path within a metric set
  - Load dependent ECT tie-breaking

› Specifying the forwarding path
  - PBB-TE coexisting independent to SPB (Ships in the Night (SiN))
    › Something else besides ISIS-SPB is needed, e.g. GMPLS (RFC 6060)
  - ESPs set by SPB (Hybrid SPB and PBB-TE)
    › Protection switching not applied for ESPs if not needed
    › ESPs are “exceptions” for SPB, which may affect convergence time
Reactive Approaches

› I-SID migration from a B-VID/ECT to another
  – Migrate I-SIDs to a less congested B-VID/ECT

› Dynamic metric or link load manipulation
  – Metric manipulation
    › Adjust the cost of a link to steer traffic away from it
    › Iterative, load dependent metric manipulation → Load Aware Computation
  – ECT link load manipulation
    › Adjust the link load in the load dependent ECT tie-breaking to steer traffic away from the link

› Selective Topology Override
  – Ability to selectively enhance the mesh density by the provision of “virtual links” that are leaked into IS-IS and treated as real links
## Approaches vs. Requirements

<table>
<thead>
<tr>
<th>Mode</th>
<th>Solution</th>
<th>Supports .1Q service model</th>
<th>Changes existing technology base?</th>
<th>Disruption of traffic</th>
<th>Impact on Scaling</th>
<th>Degree of specification required</th>
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<tbody>
<tr>
<td>Proactive</td>
<td>A priori SP manipulation</td>
<td>Yes</td>
<td>No</td>
<td>Hitless</td>
<td>None</td>
<td>None</td>
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<tr>
<td></td>
<td>SPB – PBB-TE SiN</td>
<td>Yes</td>
<td>No</td>
<td>Hitless</td>
<td>Significant</td>
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<tr>
<td></td>
<td>SPB – PBB-TE hybrid</td>
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<td>?? (TBD)</td>
<td>Hitless</td>
<td>Significant</td>
<td>Lots</td>
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<td>Reactive</td>
<td>I-SID migration</td>
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<td>No</td>
<td>Hitless</td>
<td>None</td>
<td>None</td>
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<tr>
<td></td>
<td>Metric Manipulation</td>
<td>Yes</td>
<td>No</td>
<td>Large disruption</td>
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<td>None</td>
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<tr>
<td></td>
<td>Load Aware Computation</td>
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<td>No</td>
<td>Large disruption</td>
<td>Computationally intensive</td>
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<tr>
<td></td>
<td>Selective Topology Override</td>
<td>Yes</td>
<td>Yes</td>
<td>Small disruption?</td>
<td>Low</td>
<td>Some</td>
</tr>
</tbody>
</table>
Way Forward

› Investigate further the solution space

› Analyze the open items related to the possible solutions

› Select the preferred approach