802.1aq Shortest Path Bridging
Design implications

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Design Decisions for 802.1aq

• Best Choice IS-IS as the Link state protocol
• SPB (Shortest Path Bridging) (802.1Q compliant)
  – must use unidirectional VID as SA Proxy, don’t own the C-SMAC
  – Solution Attributes
    • Uses VID Trees, one per (edge) bridge, distributed in IS-IS
    • Defines a SPT (Shortest Path Tree) Region, def by “Base VID”
    • SVL learning of unicast forwarding required?
    • Uses VID RPFC – requires VID semantics to be modified to be unidirectional
  – Solution Requirements
    • May Interwork at edges with RSTP, MSTP or Ships in the night with RSTP, MSTP
    • The region may default to a single instance MSTP (associated with the “Base VID”) if the VID allocation fails or detects errors
Design Decisions for 802.1aq cont

• SPPBB (Shortest Path Provider Backbone Bridging)
  – May use VID Trees or a Single VID for an SPT Region
    • The region may default to a single instance MSTP if the VID allocation fails or detects errors.
  – Does not allow learning of B-MACs
    • Provider addresses will all be known allows for more efficient flooding (no B-MAC broadcast storms), RPFC, Reduction in forwarding space Shared Forwarding, Efficient Multicast and faster convergence Link State.
  – Uses VID RPFC or SA based RPFC (Single VID) :
    • VID based imposes scaling limits on B-MACs and ECMT
  – Works Ships in the Night with RSTP, MSTP in the B-MAC space.
    • Only Translation is supported at the edges
    • No need to interwork with RSTP or MSTP (learning constraint)
Shortest Path Bridging

Per VID Trees
RFPC/VID
PBB Only

Most Scalable
VID and FIB
PBB Only

Currently Three Variants Why?
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Design Issues for Per VID Trees

SPVID

• Uses VID space at a rate of 1 per Node
  – Equal cost paths would cost more VIDs per node per ECMT
• Implications for MMRP
  – MMRP state machine/tree at every node?
  – Multicast interest can be delivered and populated by IS-IS
• Unidirectional VIDs
  – need modifications of other protocols
• Implications on Unicast address forwarding
  – Need VID/Unicast destination B-MAC
• Require VID RPFC
  – Can the VID be ignored for forwarding
    • single Base VID yes, Multiple?
Design Issues for DA Based Trees (Single VID)

- Uses a single VID per instance per domain
- Implications for MMRP
  - MMRP state machine/tree?
  - Multicast interest can be delivered and populated by IS-IS
- Unicast address forwarding
  - Single VID destination B-MAC
- Require SA RPFC
Switching Context of Source Tree
Always a VID & DA Context

VID Trees
SPVID = Source Tree and VLAN In VID Tree Context

Single VID
Resolve DA to unique destination
Optimal Multicast B-DA based on Multicast Interest (I-SID)

(B-VID + B-DA) = Source Tree and Destination in Source VID Tree Context

VID + DA = Topology and Destination in VID Context

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IS-IS Functional Elements
Shortest Path Bridging

Node (Bridge)

Port

Link

Service Port

Per Node

Per Multicast Group

Instance

Instance Attributes

Base VID

Group Multicast MASK

Per Instance

Node Identifier

SPVID

Master Port

Link Cost

Link Attributes

Per Neighbor

Multicast Group Interest

Per Node

Per Instance

Multicast Group to Port Mapping (local)

Optional Implied from PBB

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IS-IS Functional Elements
Shortest Path Provider Backbone Bridging

Note When looking at the IS-IS information, the similarities for all three options are striking. There is hope they are not all that different.
Create Shortest Path tree from every switch. Also simultaneously Create a congruent PBB_TE point to point path.
SPPBB Congruency

1 MMAC/Multicast Group
1 UMAC/Switch

Create Shortest Path tree from every switch. Also simultaneously Create a congruent PBB_TE point to point path
SPPBBB Congruency

Congruency
A-J, J-A

1 MMAC/Multicast Group
1 UMAC/Switch

Create Shortest Path tree from every switch. Also simultaneously
Create a congruent PBB_TE point to point path
There are 4 paths between nodes (1 bidirectional Unicast) (2 directional multicast/I-SID) 3 forwarding entries relevant to any MGI destination
**SPVID FIB Zoom In**

In this case VID may be used to Multicast or specific Multicast DAs may be installed.

<table>
<thead>
<tr>
<th>Type</th>
<th>VID</th>
<th>DA</th>
<th>RPFC</th>
<th>Multicast Group ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unicast A to D</td>
<td>10</td>
<td>UDA-D</td>
<td>VID 10</td>
<td></td>
</tr>
<tr>
<td>Unicast D to A</td>
<td>20</td>
<td>UDA-A</td>
<td>VID 20</td>
<td></td>
</tr>
<tr>
<td>Multicast Shortest path Rooted at A</td>
<td>10</td>
<td>MDA-A</td>
<td>VID 10</td>
<td>Per VID / MGI</td>
</tr>
<tr>
<td>Multicast Short Path Tree Rooted at B</td>
<td>20</td>
<td>MDA-D</td>
<td>VID 20</td>
<td>Per VID / MGI</td>
</tr>
</tbody>
</table>
Unicast Shared Forwarding and the PBB-TE

One PBT Label, a single VID+DMAC can be used by multiple sources, providing Order (n) Labels per network.

Additionally, packets can be examined at destination to determine the source.

Single VID shared forwarding = one entry / (B-VID + DMAC) + any I-SID
SPVID = one entry / (B-VID tree + DMAC) + any I-SID
Control Plane Scope

Different Operating Spaces

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"B" Space  "I" Space  "S" Space  "C" Space

SPVID  16M  4096  4096  4096

Single VID

VLANs & Control Plane Options

4096 PB

Ethernet VLAN

Ethernet

Mac in Mac

PBB

PB

Q in Q
VLAN Usage and Topology

Topography Extent
(ability to utilize multiple paths)

Single VID

Mesh topologies

VLAN ID Usage

1

2

4096

RSTP

MSTP

SPVID
SPPBB SPVID and Single VID
Similarities

- VLAN Topology: Both sport shortest path trees
- VLAN Partitioning: Both use a logical B-VLAN
- Link state topology: Both use Link State
- Mesh Networking: Both support mesh
- Forwarding backwards compatibility: Both operate Ships in the night with other VLANs
- Control plane objects: Similar
- SPT computation: Similar
- Multicast Groups: Both support via IS-IS
SPPBB Differences SPVID vs Single VID

- VLAN Usage: Per VID Tree Vs Single VID / Topology
- Shared Forwarding: Multiple entries per B-DA Vs Single VID one
- RPFC: Per VID Vs Single VID per B-SMAC
- Scalability VIDs: 4000 VID trees VS Single VID # of MMACs
- Auto Config: Per Node VID Vs Single Base VID
Next Steps

- **Continue Refining Draft**
  - D0.4 Available but Rough
- **All Spanning Tree - Shortest path bridging implications removed only IS-IS**
- **PAR issues ?**
- **Comments**