

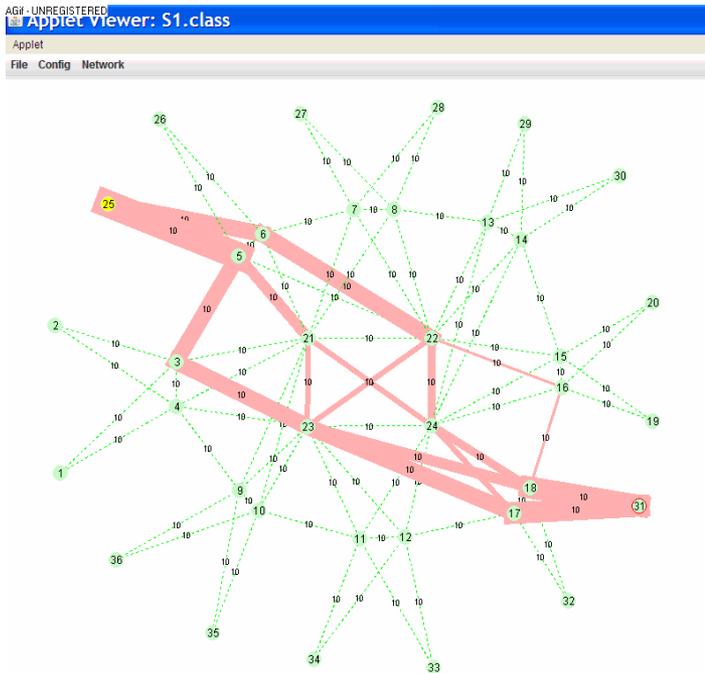
Shortest Path Bridging IEEE 802.1aq

Brought to you by:

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Shortest Path Bridging (SPB)

- Specified in the IEEE 802.1aq standard, is a computer networking technology intended to simplify the creation and configuration of networks, while enabling multipath routing.
- Link State Protocol
- Based on IS-IS



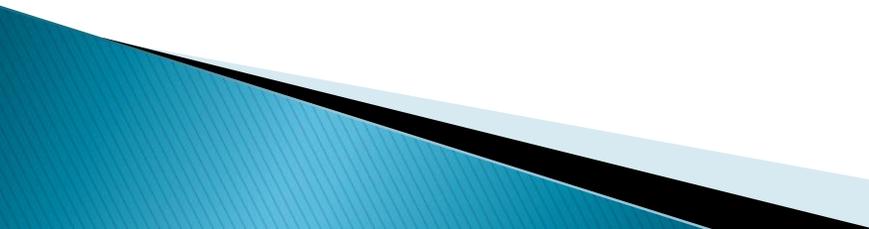
IEEE 802.1aq Standard (Purpose of standard)

-The standard is the replacement for the older spanning tree protocols such as IEEE 802.1D, IEEE 802.1w, and IEEE 802.1s. These blocked any redundant paths that could result in layer 2(Data Link Layer), whereas IEEE 802.1aq allows all paths to be active with multiple equal cost paths, and provides much larger layer 2 topologies.

Shortest path bridging (SPB)

- ▶ 802.1aq is an amendment to the "Virtual Bridge Local Area Networks" and adds Shortest Path Bridging (SPB).
- ▶ Shortest path bridging, which is undergoing IEEE's standardization process, is meant to replace the spanning tree protocol (STP). STP was created to prevent bridge loops by allowing only one path between network switches or ports. When a network segment goes down, an alternate path is chosen and this process can cause unacceptable delays in a data center network.

Benefits of standard

- ▶ The ability to use all available physical connectivity, because loop avoidance uses a Control Plane with a global view of network topology
 - ▶ Fast restoration of connectivity after failure, again because of Link State routing's global view of network topology
 - ▶ Under failure, the property that only directly affected traffic is impacted during restoration; all unaffected traffic just continues
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Radia Perlman



- Ideas are rejected by IEEE 802.1.
- accepted by the IETF and the TRILL WG is formed.
- Whoops, there is a problem. They start 802.1aq for spanning tree based shortest path bridging
- Whoops, spanning tree doesn't hack it. They copy a little of using IS-IS and nicknames from TRILL but don't actually do routing.

Transparent Interconnection of Lots of Links (TRILL)

- ▶ is an IETF Standard implemented by devices called Rbridges (routing bridges) or TRILL Switches.
 - ▶ TRILL uses two different mechanisms to forward packets, making it difficult to know the path of packets.
 - ▶ TRILL is susceptible to out-of-order packets when the MAC state transitions from unknown to known for Multicast, broadcast and Unknown packets.
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Section 4: Technology Compare and Contrast

Characteristic	SPB	TRILL
Standards Body Definition	IEEE (802.1aq)	IETF
Multi-Pathing Support	Yes	Yes
Eliminates Need for Spanning Tree and Blocked Links	Yes	Yes
Interoperability with Spanning Tree	Yes	Yes
Loop Prevention	RPFC	TTL-based (due to non-congruent trees) & RPFC
Uses IS-IS as the Layer 2 Routing Protocol	Yes	Yes
IS-IS Interoperability	Uses existing IS-IS with TLV extensions (interop with third-party IS-IS routing solutions)	New type of IS-IS instance with new PDU types
Dynamically Changes Network Paths for Traffic Flows	Yes	Yes
Cut-through Switching	Possible	Possible but difficult due to options field in header
Virtualization Support	Service Instance using I-SID (16Mio)	VLAN only (4k)
Low-Touch Configuration	Yes; need to configure VLAN to Service Instance Mapping	Yes
Election Processes	Pre-provisioned	Designated Forwarder, Root Bridge, IS-IS nicknames per Rbridge

<http://rtomaszewski.blogspot.com/2014/04/how-does-switch-fabric-network-work.html>

Characteristic	SPB	TRILL
Lookup and Forwarding	Traditional Ethernet switching in tandem nodes; IEEE 802.1ah in BCB and BEB. No MAC swapping ala router (IEEE 802.1ah capable hardware required)	New header with triple lookup required on every Rbridge node (new ASIC)
Encapsulation	Mac-in-Mac	TRILL Header
Unicast Traffic Path	Shortest Path based on IS-IS calculations	Shortest Path based on IS-IS calculations
Broadcast/Multicast Traffic Path	Between two end nodes same as Unicast and bi-directionally congruent – tree is source node based	Depends on Selected Root Bridge unicast and broadcast/multicast paths can be completely different (can cause out-of-sequence packets when switching from BR/MC path to Unicast path)
Egress Processing for Multicast	Not Required	Required due to MAC header change egress port
Customer MAC learning	Packet-based learning at edge of SPB network	Packet-based at edge access ports+ ESADI protocol
Out of Sequence Packets (possible)	No	Possible when a Dest MAC transitions from unknown MAC to known
Service Aggregation	Yes (multiple VLANs can be mapped into a Service Instance)	No
Traffic Management	Assigns traffic to shortest paths at the head end. Link based metrics for path calculations.	Assigns shortest path for Unicast with Layer 2 header swap at each Rbridge. Link based metrics for path calculations.
OA&M	IEEE 802.1ag, ITU Y.1731 performance and jitter management	N/A
Ease of Troubleshooting	Easier to see entire path through the network. Full set of IEEE/ITU based Ethernet OAM tools	Need to inspect traffic on a hop-by-hop basis to know the path. No OAM tools available.
New hardware required	Built on 802.1ah, 802.1ad, 802.1ag which is supported in many hardware platforms	TRILL requires new hardware and as of now there is no OA&M hardware support
Layer 3 and IP VPN Extensions	IP/SPB Draft	No integration
Scalability	10,000+ with multi-level IS-IS	10,000+ claimed
Convergence	Source Node based Tree Calculations (number of trees calculated is based on number of nodes)	Separate EASDI instance/VLAN – each port announces all VLANs via TRILL hello, up to 4,096 hellos can be sent per port. Dynamic Root Bridge Election, Dynamic Designated Forwarder Election
System ID	Node names use provisioned system IDs	Potential Nickname collisions when joining TRILL networks together

Operations and management

- ▶ 802.1aq builds on all existing Ethernet Operations, administration and management (OA&M). Since 802.1aq ensures that its unicast and multicast packets for a given virtual lan (VLAN) follow the same forward and reverse path and use completely standard 802 encapsulations.
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Overview

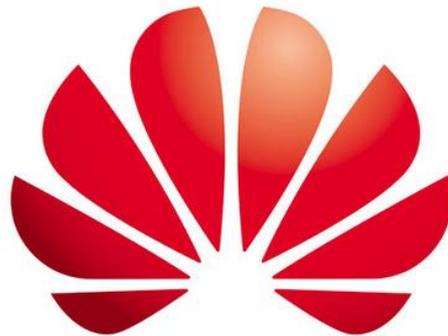
- ▶ In the modern data center, traditional technologies are limiting the speed, flexibility, scalability, and manageability of application deployments. There is emerging interest in the industry in overlay technologies, which may address some of these challenges.
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Thank You

Q & A

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