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Evolution of Provider Backbone Bridging: PBB (IEEE 802.1ah) , PBB-TE (IEEE 802.1Qay), (PBT)

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Agenda

- Evolution of Ethernet
  - Networking
  - Services
- Provider Backbone Bridging & PBB -TE
- Control Plane Evolution
- OAM
- Applications
- Summary

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Review:
IP/MPLS Networking Evolution Lessons

- Encapsulation, Multiplexing and Hierarchy
  - For scalability, and Provider - Customer separation
- Service Richness versus Simplicity Tradeoff
  - Richer services are higher on the value chain but at a cost of OPEX
- Networking functions match the Service Layer
  - IP Service is best served by IP networking
  - Hop by Hop Paradigm, shortest path, unidirectional forwarding
- **MPLS**
  - Built as a helper to IP (Top down approach)
    - Classification & Encapsulation (IP address hiding)
    - Hierarchy (label stacking)
  - Used for Rich and Simples Services:
    - L3 VPNs, IP Resiliency, IP – TE, PWE2, L2VPNs X over MPLS…
  - Serves the IP Networking and Forwarding paradigm

Now lets look at Ethernet!

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Ethernet Networking & Bridging

- Layer 2 Frames
  - Ethernet Header and trailer (integrity check)
- Ubiquitous customer presentation (IEEE 802.3)
- Rapidly becoming ubiquitous link layer (IEEE 802.1)
  - Carries IP readily
  - Carries/is carried by pretty much everything
- Rapidly gaining much broader L2 capabilities
  - Multiple PHYs, 10M, 100M, 1G, 10G, 100G…..
  - Link Aggregation, OAM
- Header is self describing
  - Backwards compatible
  - Uniquely identifiable, all fields have Domain wide significance

Because of Ethernet's Simplicity it is THE choice for access

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Ethernet Bridging Evolution

- Networking functions match the Ethernet Service Layer
  - Forwarding **Unicast**, **Multicast**, **Bi-directional**, fate shared
  - Follow a service topology, Trees, Virtual LANS (VLAN)
  - Filter, [Replicate], Relay
- Encapsulation (fully backwards compatible Bottom up approach)
  - Provider Bridging (PB) IEEE 802.1ad
    - Q in Q (Customer and Service VLANs)
  - Provider Backbone Bridging (PBB) IEEE 802.1ah
    - Mac in Mac (Complete encapsulation)
  - PBB - Traffic Engineering (PBB-TE) IEEE 802.1Qay
- Evolution Maintains Ethernet Forwarding paradigm
  - Incremental leveraging of the basic forwarding engine….

Bridge Evolution is driven by the need for scaling provider services

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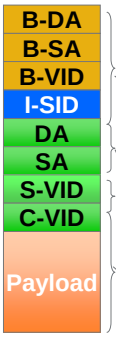
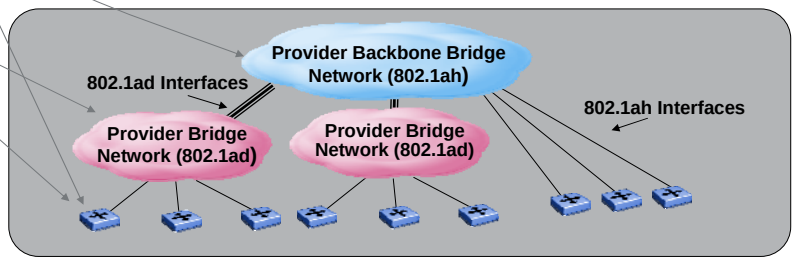
Provider Backbone Bridging (PBB)
IEEE 802.1ah

- IEEE 802.1ah is the Provider Backbone Bridge standard under development
- Also known as Mac In Mac (MiM) encapsulation
- Support ELAN, ELINE and ETREE connectivity models
- PBB solves several of today's Ethernet challenges….



802.1ah
Provider Backbone Bridges



PBB is built to scale the LAN

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PBB: Solving Current Ethernet Challenges

- Ethernet Service Scalability via I-SID tag
  - Up to 16 million service identifiers
- Decouples service identification (I-SID) from VLAN
  - But imposes no changes on Ethernet switching silicon
  - Separation of Ethernet as a service from Ethernet as infrastructure
- Customer Segregation
  - Clear demarcation between customer and provider domains
  - Customer address learning is limited to the Provider Edge Bridge
- Backwards compatibility built in

Interestingly PBB scales Customer traffic even without Control Plane Modifications

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Provider Backbone Bridging Traffic Engineering IEEE 802.1Qay (aka PBT)

- PBB-TE is Ethernet forwarding without the traditional control plane
- PBB-TE uses direct configuration of Ethernet forwarding tables
  - Vs. spanning trees, flooding and learning
  - Only part changed is population of tables for some VLANs
- Result is very scalable P2P & P2MP connectivity
  - Pinned and engineered routes
  - Protection switching for resilience
- Is suitable as a PSN for PW services in the metro
- Augments PBB with P2P TE capability “ships in the night”

PBB-TE/PBT takes nothing away from Ethernet

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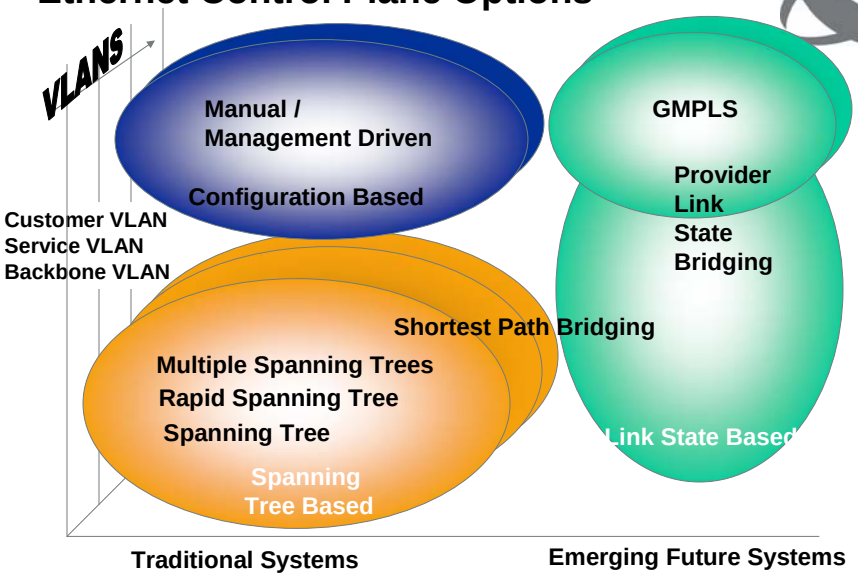
Ethernet Control Plane Options



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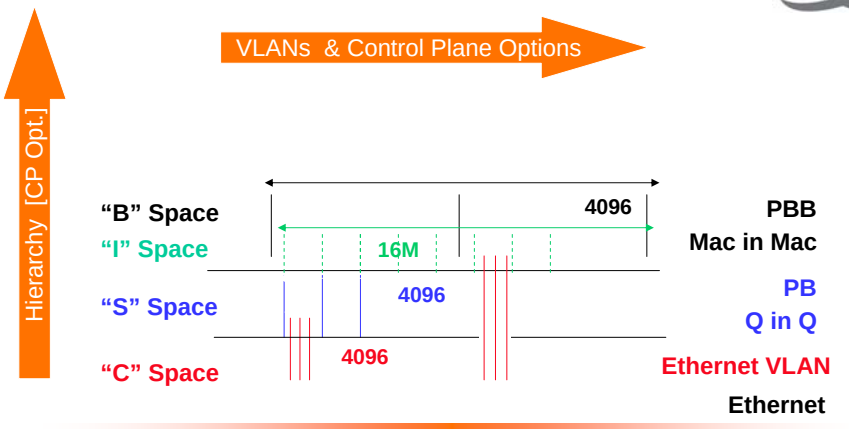
VLANs and Recursion



Recursion and VLAN partitioning is very powerful… Particularly true when you can assign different behaviors to different VLAN ranges. Graceful upgrade path with no flag days

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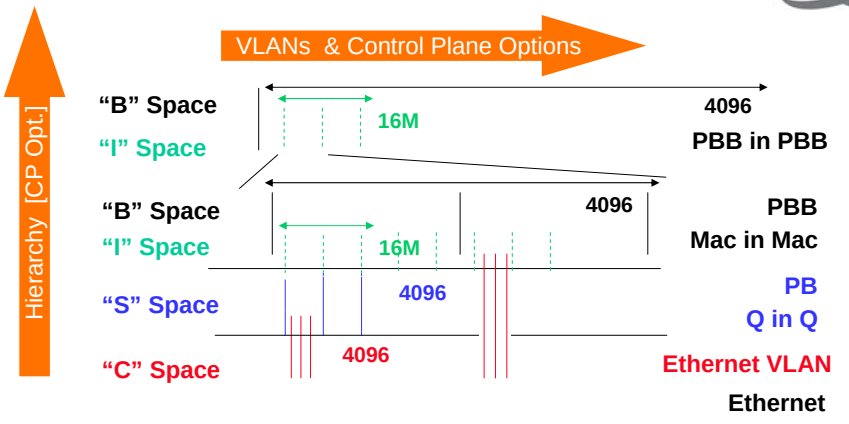
VLANs and Recursion



PBB is also fully recursive

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Provider Link State Bridging (PLSB)

- Shortest path forwarding via link state
- Carrier Grade Link State for fast reliable convergence
- Routing loop prevention without port blocking
- Reduced provisioning
  - Leverages the I-SID for service connectivity
- Support unicast and multicast traffic
  - …all in a MACinMAC context
- Well understood problems being considered by IEEE 802
  - Shortest path bridging IEEE 802.1aq

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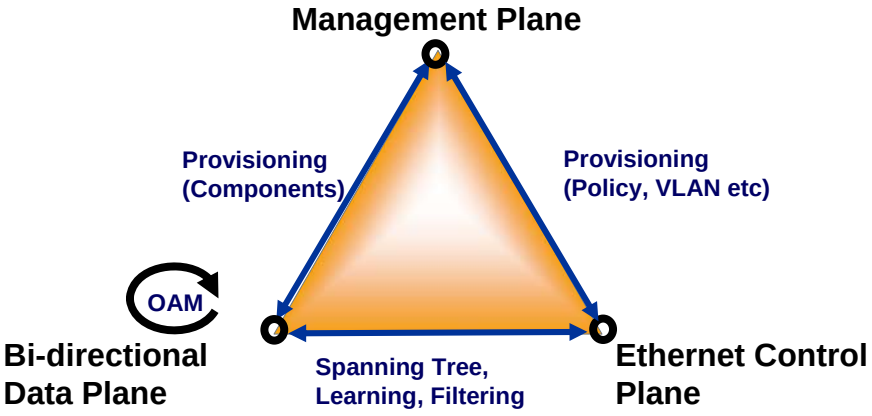
PBB/PBB-TE Control Plane Evolution
Conventional Ethernet Bridging



Strong Correlation between MP & DP or DP & CP

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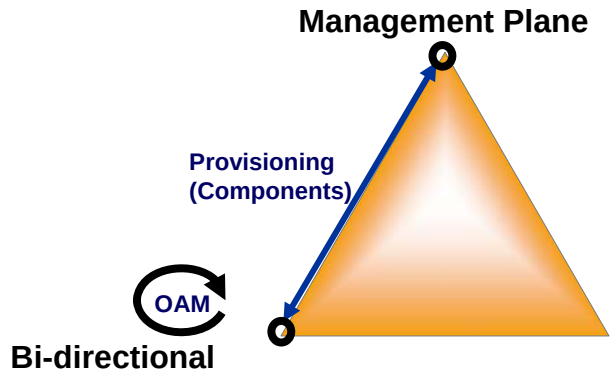
Decoupling Control Plane



Remove CP dependency

All elements of Ethernet for forwarding known VID DA/SA pairs work

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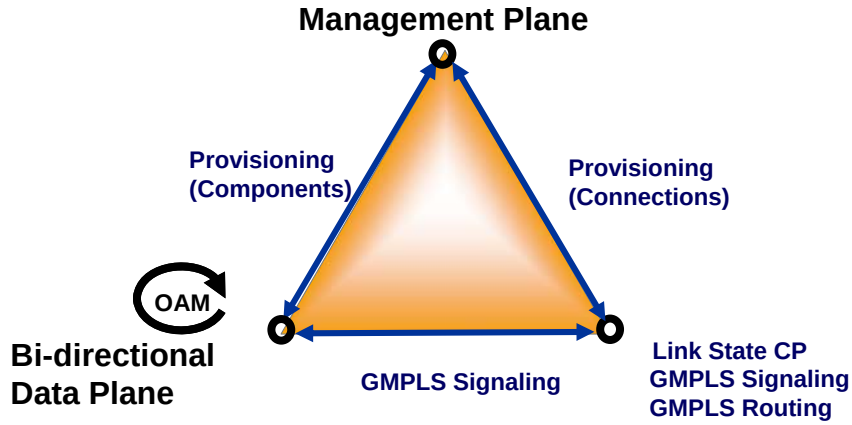
GMPLS control of PBB-TE



Add Link State and TE

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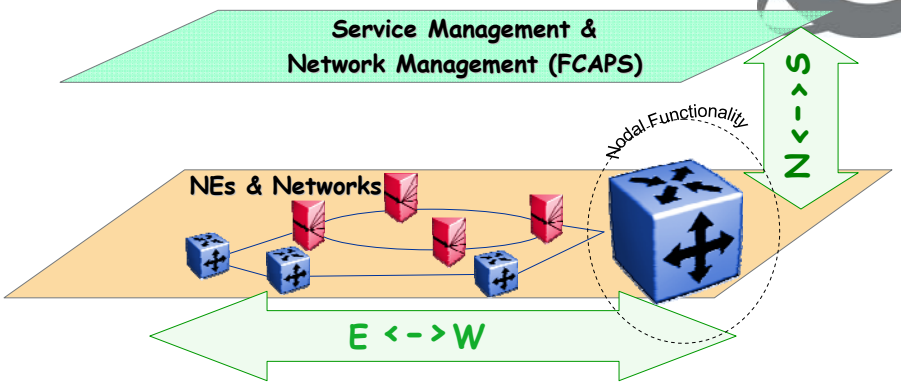
Ethernet OAM



- FCAPS = **F**ault, **C**onfiguration, **A**ccounting, **P**erformance, **S**ecurity
- OAM = **O**perations, **A**dministration & **M**aintenance
- Focus is on E <->W OAM to support Network/Service Management

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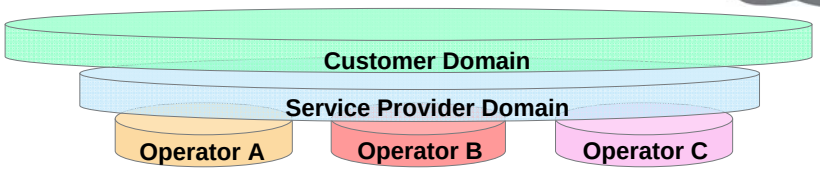
Where does Ethernet OAM apply?



- Multiple roles are involved:
  - Service Provider contracts with Operators for facilities
  - Customer contracts with Service Provider for services
- OAM is probably not needed when no faults occur and everyone is happy ☺
- However, each role is required to fulfill contract
  - Accountable for compliance
  - Must reduce Opex when things go wrong

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Ethernet OAM Principles (IEEE 802.1ag, ITU Y.1731)

OAM Target
- OAM frames should traverse the same path as data frames

OAM Accountability
- Each OAM domain is independently responsible for its monitoring

OAM Filtering
- OAM frames from one domain should not leak into other domain

OAM Controls
- Each domain should be able to control the level of access to other domains

OAM Functionality
- OAM should be functional enough to reduce Opex

OAM Modularity
- User can decide the level of OAM functionality deployed

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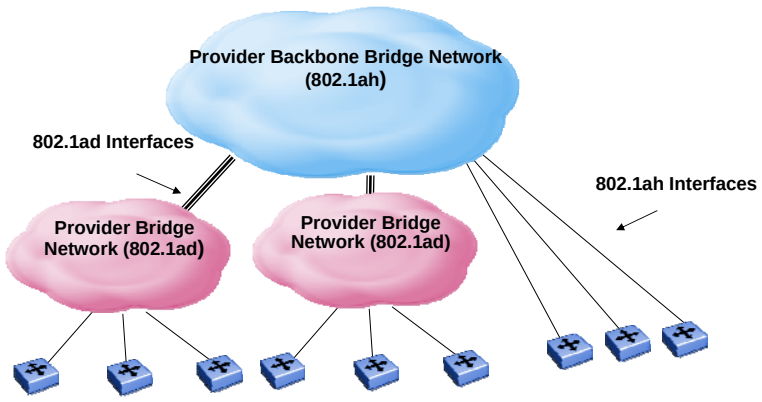
Application: Scaling Customer LANS



Look Familiar? An all Ethernet VPLS alternative

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Application: Scaling Customer LANS

- Provider
  - Customer demarcation and Provider Address space
  - BVLAN space for Topology management
- Native Ethernet learning
  - Customer addresses learned on the edge
- Native Ethernet Unicast Multicast
  - Efficient Multicast with choice of Control Plane
- Scalable Service Management
  - I-SIDs support P2P, P2MP, MP2MP
- OAM
  - Selectable OAM capability
  - Full FM/PM

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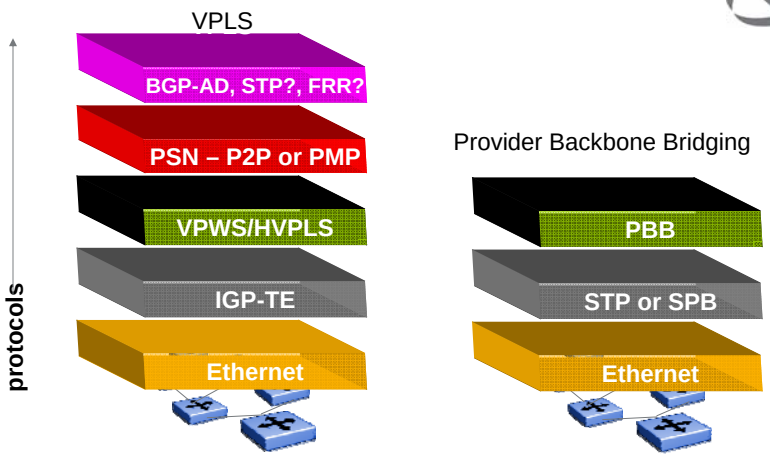
But What about Control Plane Complexity ?



LANs are a native construct to Ethernet vs. an overlay application of MPLS

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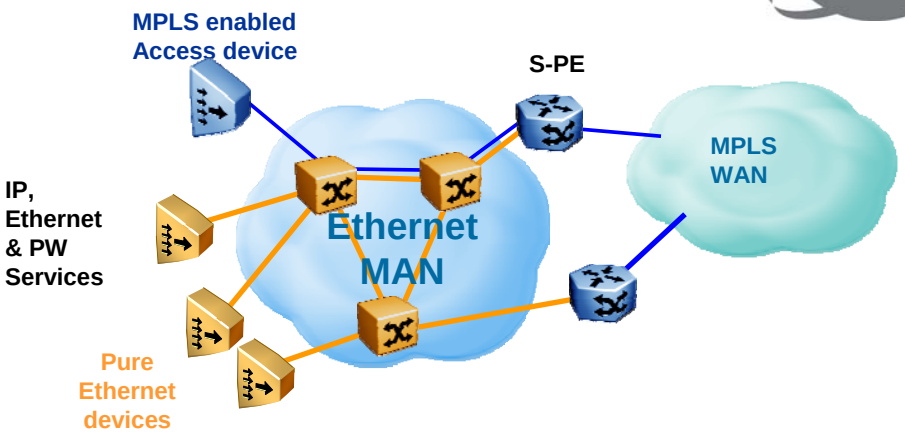
Application: Edge Aggregation for access



Old networking adage
"Switch where you can, route when you must"

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Review: Lessons of Packet Evolution applied to Ethernet PBB & PBB-TE

- Encapsulation, Multiplexing and Hierarchy
  - PBB/ PBB-TE Enable Encapsulation and multiplexing
  - Scales the technology, enables Hierarchy
  - Flexibility of Encapsulation trumps efficiency
- Service Richness versus Simplicity Tradeoff
  - The lower in the stack the simpler the service definition and Ethernet residing under IP/MPLS is a simpler interface
- Networking functions match the Service Layer
  - So called Peering versus Overlay argument
    - If the service is IP the network should be IP/MPLS aware
    - If the service is Ethernet the Network should be (V)LAN aware
    - If the service is Transport the Network should offer Transport capabilities

Ethernet is a better fit than MPLS in the last two areas

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Summary

- PBB is a natural Evolution of Ethernet VLANs
- PBB-TE [PBT] is simply Ethernet Data Plane Repurposed
- Ethernet control planes are simple today and will use known techniques to evolve PBB/PBB-TE.
- OAM for Ethernet was built to meet a strong set of requirements
- Standards ensure compatibly with Ethernet Bridging and graceful evolution
- This all adds up to a strong case for pure Ethernet based systems for access, provider based VLAN and emerging transport applications

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For Further Reading

Fedyk, Don, David Allan, et. al. “GMPLS control of Ethernet” IETF Draft March 2007 <http://www.ietf.org/internet-drafts/draft-fedyk-gmpls-ethernet-pbb-te-00.txt>.

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Allan, Bragg, McGuire, Reid. "Ethernet as Carrier Transport Infrastructure." IEEE Communications 44(2006): 134-139.

Allan, Bragg “Taking Control: The evolving role of control and data planes” Nortel Technical Journal, Issue 4 http://www2.nortel.com/go/technicaljournal_index.jsp?locale=en-US

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Thank you

Questions?

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Glossary

FM – Fault Management

I-SID – service identifier (802.1ah)

LAN – local Area network

MAC – media access control

OAM – operations, administration and maintenance

PBB – provider backbone bridging

PBB-TE – PBB traffic engineering

PBT – provider backbone transport also PBB-TE

PHYs – physical layer devices

PLSB – provider link state bridging

PM – Performance Measurement

PWE3- pseudo wires edge to edge emulation – IETF working group

SPB – shortest path bridging

TE – traffic engineering

VLAN – virtual local area network

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IEEE Agreed Terminology

IEEE 802.1ad Terminology

- C-TAG Customer VLAN TAG
- C-VLAN Customer VLAN
- C-VID Customer VLAN ID
- S-TAG Service VLAN TAG
- S-VLAN Service VLAN
- S-VID Service VLAN ID

IEEE 802.1ah Terminology

- I-TAG Extended Service TAG
- I-SID Extended Service ID
- C-MAC Customer MAC Address
- B-MAC Backbone MAC Address
- B-VLAN Backbone VLAN (tunnel)
- B-TAG Backbone TAG Field
- B-VID Backbone VLAN ID (tunnel)
- CBN Customer Bridge Network
- CB Customer Bridge
- PBN Provider Bridge Network
- PB Provider Bridge
- PBBN Provider Backbone Bridge Network
- BEB Provider Backbone Edge Bridge
- BB Provider Backbone Core Bridge

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