Metro Ethernet Convergence Toolkit

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BUSINESS MADE SIMPLE

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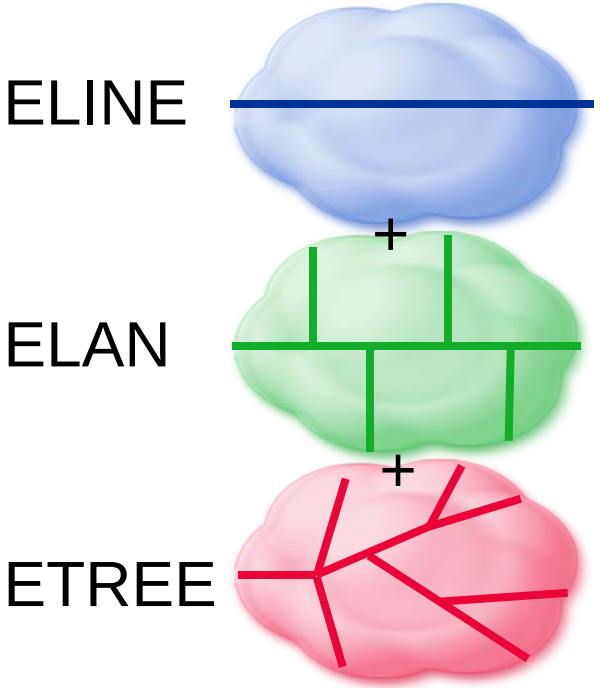
Metro Challenges & Provider Ethernet

- Appropriate and comprehensive connectivity models
- Support of Ethernet services
- Legacy Support
- Operational Needs
- Motherhood properties

MEF Connectivity Models



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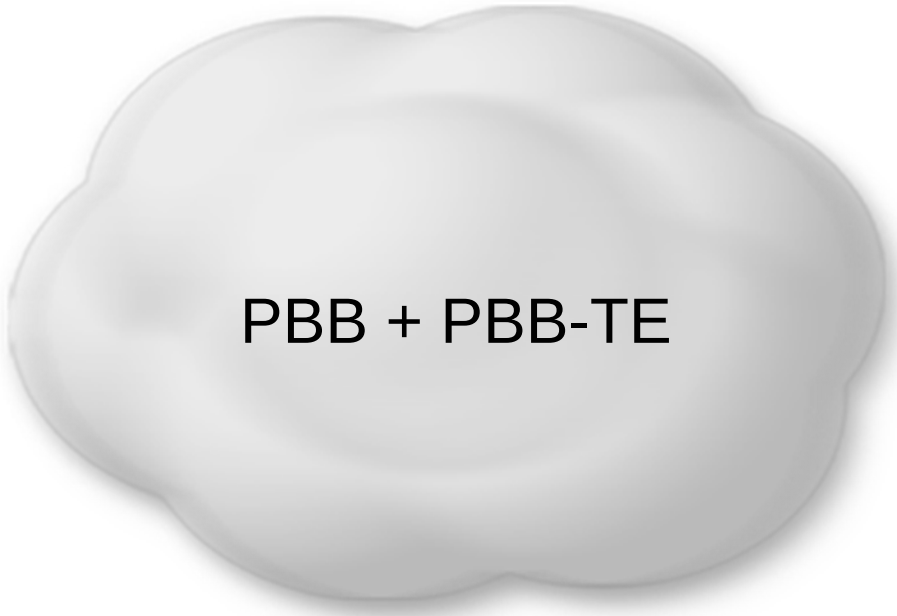


\+ Service Instance

The Simple Ethernet Interface allows an ideal service interface for connectivity

Today's Building blocks are the connection and the LAN segment

Support of Ethernet Services

- Ethernet is highest CAGR service
  - Expected to be so for some time
  - Deserves “special” attention, ***not an afterthought***
- Much of Ethernet is designed around symmetrical links and symmetrical paths
  - Spanning tree, OAM etc.
- When virtualizing Ethernet preserving these properties is desirable
  - What we call **“symmetrical congruence of unicast and multicast”**
- A number of “good things” ensue
  - No packet misordering in “learning” race conditions
  - Proper fate sharing of OAM with connectivity at all layers
  - Minimize probability of asymmetric failures impacting customer convergence
  - Recursion is “self-similar” with respect to a lot of properties
    - *Slice a UNI or an NNI and it looks the same*

Legacy Transformation

- Wrapping “best effort” cell or frame in “best effort” frame and shipping it is trivial
  - It is called a code point ***avec overhead***
- MEF already has the connectivity models
  - ELINE -> transport for P2P (CES, FR-ATM etc.)
  - ELAN/ETREE -> L2VPN & ***aggregation*** for L3VPN
- The challenges are services that require QoS
  - Well understood problem
- ***…and*** those that require precise time/frequency
  - Traceablity to precision time sources
- And it is not only legacy circuit emulation services that need this
  - Wireless base stations being an example

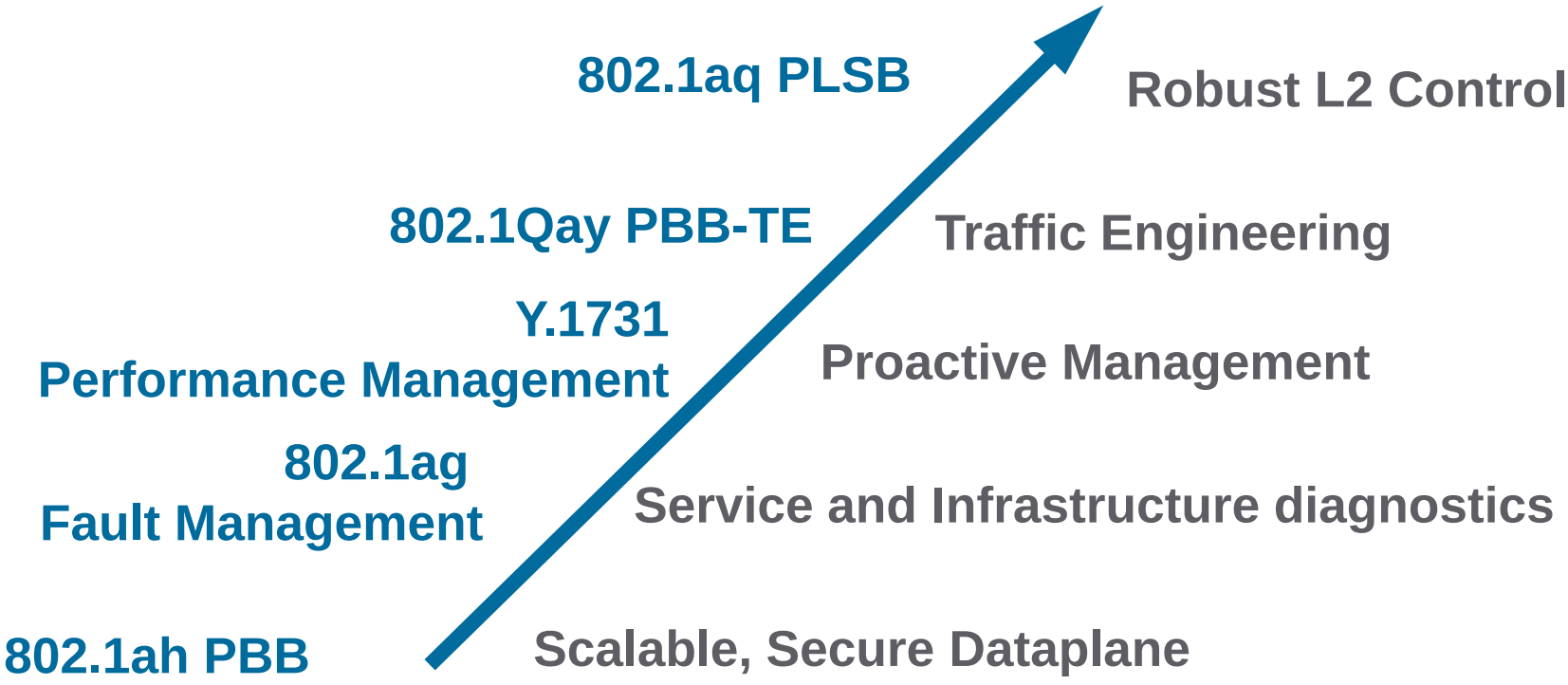
Operational Needs - Determinism

- Determinism, Determinism, Determinism
- When can I ***not*** add the “n+1”st customer?
- When is the network not performing as expected?
- How can I make best use of my network assets?
- Rationalize capacity planning
- Even with a distributed control plane, many providers want the OSS to model the behavior
  - Known placement of traffic matrix
  - Service level CAC

Motherhood:
Scalability, Efficiency, Measurability

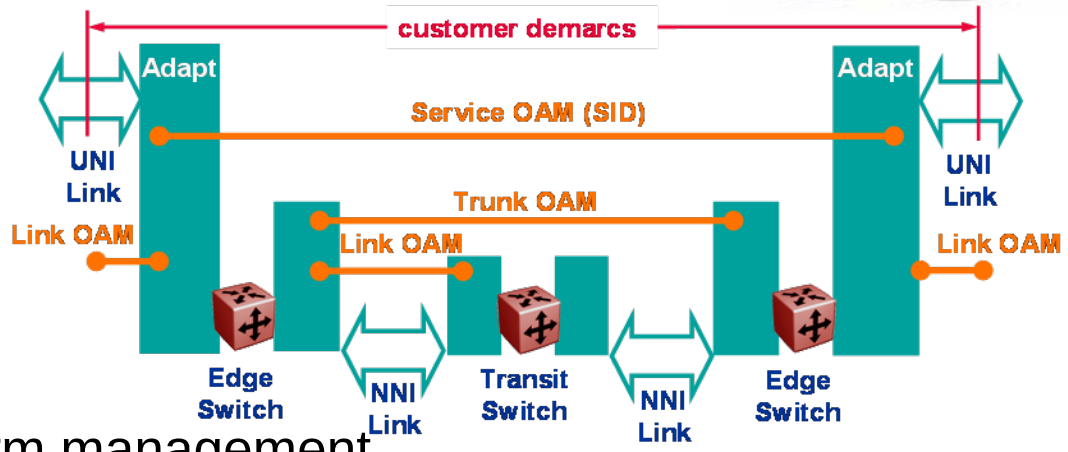
- Scalability
  - Ability to grow significantly beyond forseen requirements
  - Ability to grow without disrupting existing services
- Efficiency
  - Multicast - only one copy of one packet traverses any one link
  - Unicast – shortest path, constrained shortest path
- Measurability (a.k.a OAM)
  - double entry bookkeeping, or knowing more than your customer

Evolution of Provider Ethernet



Ethernet has steadily evolved to meet the needs of Service Providers

OAM – 802.1ag/Y.1731



> 802.1ag Fault Management
  - CCM heartbeat
  - ETH-LB loopback
  - ETH-LT link trace
> Y.1731 Performance and Alarm management
  - LM loss measurement
  - DM delay measurement
  - Throughput measurement
  - AIS/RDI Alarm inhibit/ reverse defect indications
> Layered architecture
  - Maintenance domains
  - MEP maintenance end point
  - MIP maintenance intermediate point

OAM – properties

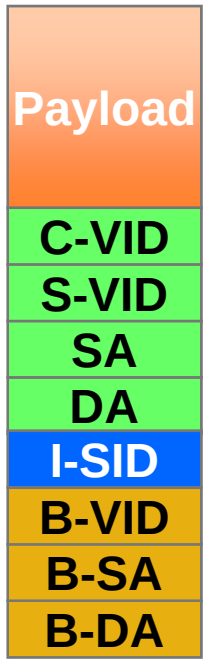
- Multipoint capability
  - Instrumentation of a mesh scales O(N) via use of multicast heartbeats
- Control plane independence
  - Maintenance associations are not tied to the application
- OAM frames and payload are both distinguishable and self describing
  - OAM PDUs identified via specific Ethertype
  - Where frames are **coming from**/ where **going to**, **required queuing discipline**, **payload format** etc. all explicitly encoded directly in the frame

DA-MAC	SA-MAC	VID	Priority	Ethertype	Payload

Key fields in an Ethernet frame

PBB – 802.1ah

- Also known as MACinMAC
- Isolates customer MAC addresses from provider space
- Key terms
  - BEB – backbone edge bridge (Ethernet “PE”)
  - BCB – Backbone core bridge (Ethernet “P”)
  - PBBN – Provider backbone bridged network (Ethernet PSN)
- Scopes multicast via use of “per service” multicast addressing
  - Community of interest instantiated as per I-SID multicast MAC address



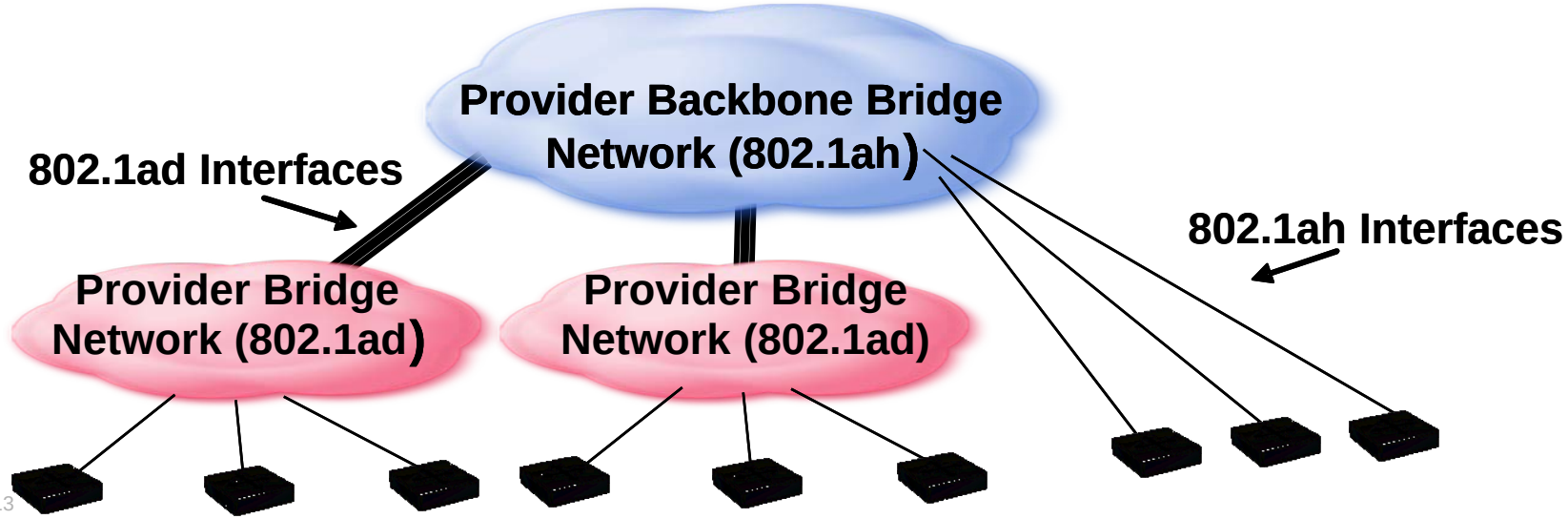
802.1ah
Provider Backbone Bridges

PBB - Properties

- Backwards compatibility with 802.1Q, Provider Bridges
- Full isolation of customer addressing from provider addressing
  - All identifiers in a PBBN are administered by the provider
  - Enhances security and stability of PBBN
  - Reduces MAC addresses in PBBN by orders of magnitude
- I-Component extends scalability to 16 million services
  - Analogous to BGP route target
  - Can nest S-tag for a further *3 orders of magnitude* scaling
- Resiliency “events” in the PBBN do not impact edge learning
- Uses xSTP control plane
  - RSTP/MSTP

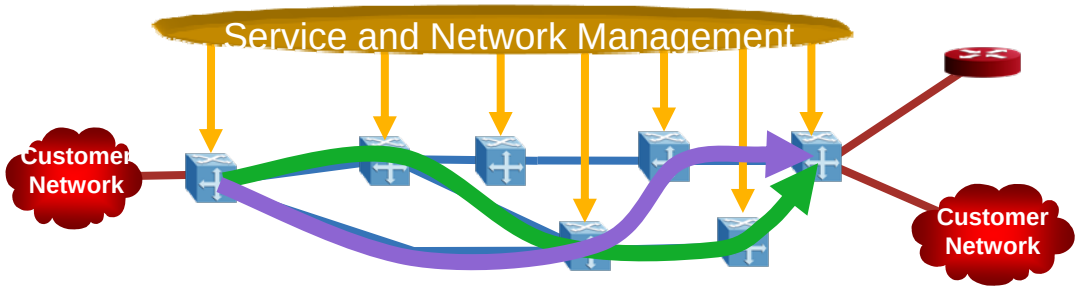
PBB - Applications

- PBB offers scalable ELINE/ELAN/ETREE connectivity
  - Combination of recursion and large service tag
- PBB adaptation offers highly scalable “front end” for PBB-TE and PLSB
- PBB is now commonly viewed as a desirable VPLS front end
  - draft-sajassi-l2vpn-vpls-pbb-interop-02.txt
  - draft-balus-l2vpn-vpls-802.1ah-01.txt



PBB-TE – 802.1Qay

- IEEE standards effort based on PBT proposals
- Replaces flooding and learning with explicit configuration of bridge forwarding
- Is simply a different mechanism for populating bridge forwarding tables
  - Utilizes existing addressing
  - Utilizes existing OAM procedures
- Replaces spanning tree with protection switching and restoration strategies for resilience



PBB-TE/PBT properties

- Full mesh Ethernet connectivity
- Full suite of OAM functionality
  - 802.1ag Fault Management, Y.1731 performance management
- Path protection with packet level preemption
- P2P connectivity today
  - p2mp also possible and “in scope” for 802.1Qay
- Network growth and addition of services does not perturb existing services
- Deterministic from the POV of clock and frequency distribution at L2
- Inherits scalability of 802.1ah
  - Theoretical limits not exhausted till many generations of moore’s law have passed
- “Management driven” evolving to GMPLS control plane
  - draft-ietf-ccamp-gmpls-ethernet-arch-01.txt
  - draft-ietf-ccamp-ethernet-pbb-te-00.txt

PBB-TE Applications

- ELINE transport
  - Can carry all manner of P2P traffic
- Wireless backhaul
- CES replacement
- Sub-wavelength grooming
  - Full packet flexibility Vs. VCAT/LCAS

PLSB – 802.1aq

- PLSB is the PBB variation of “shortest path bridging”
- PLSB adds a reverse path forwarding check (RFPC) and a routing system to the PBB-TE profile of behavior
  - RPFC adds loop mitigation to facilitate use of distributed control plane
- Single control protocol for ELINE/ELAN/ETREE – ***IS-IS***
- IS-IS floods topology, MAC and I-SID information
  - Global values, no link local personalization required….
  - Collapses all requisite functionality onto a single control plane
    - Auto-discovery, service and infrastructure
  - Eliminates signalling from the control plane equation
  - Eliminates flooding, learning and registration from the dataplane equation
- With a distributed routing system we can produce a “better spanning tree” for MACinMAC

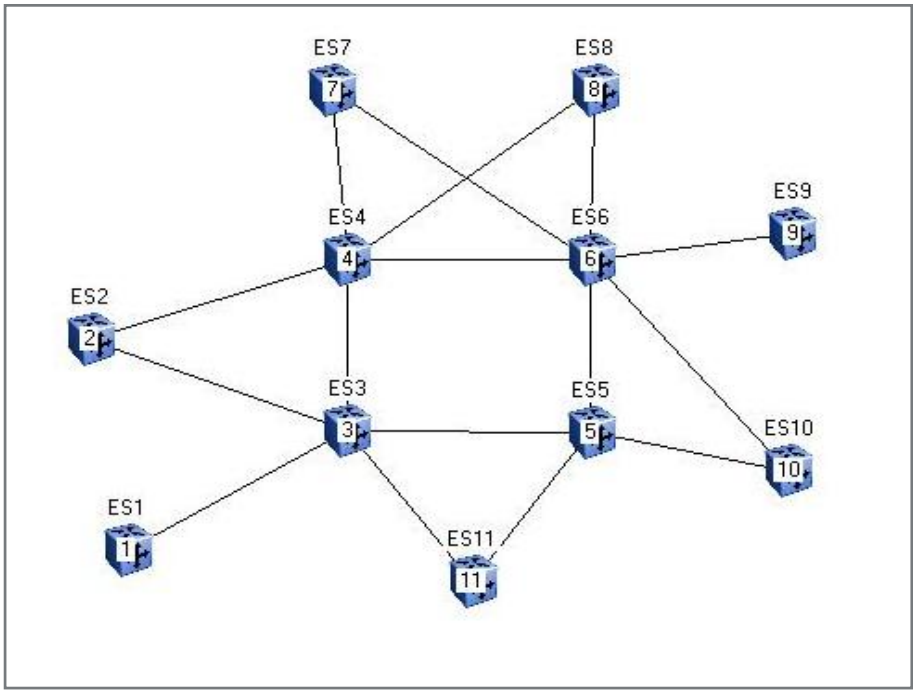
PBB+PBT+RPFC+IS-IS = PLSB

PLSB Properties

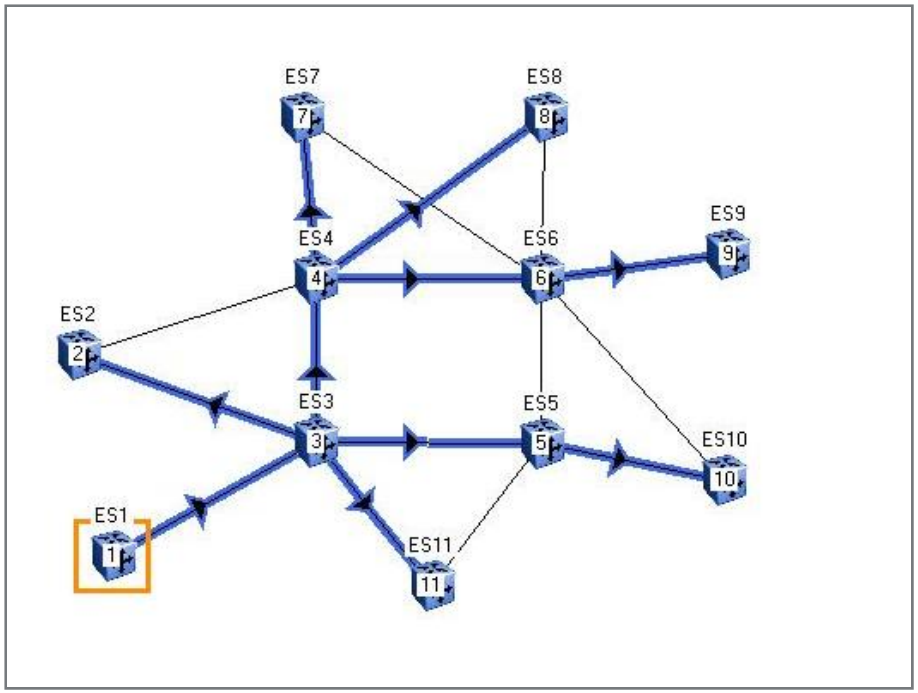
- Full mesh Ethernet connectivity
  - Can utilize parallel links & dual homing without looping
  - Like PBB-TE we can fully mesh the network once per B-VID
- Highly efficient multicast
  - No more than one copy of a packet appears on any link
- Full “symmetrical congruence” of unicast and multicast
- Single touch provisioning for adds/moves/changes of ELAN and ETREE services
- Confines customer state to the edge of the network
- Convergence of unicast and multicast driven directly by the routing system
- Builds shortest path unicast/multicast mesh connectivity
  - On a “per-service (I-SID)” basis
- PBB-TE, PLSB and existing Ethernet control protocols can operate side-by-side in the same network infrastructure
- Very predictable behavior for per-service CAC and capacity planning

PLSB visually

- PLSB discovers the network automatically setting up a shortest path distribution tree without blocking any links
- Each node computes its Shortest Path tree to all other nodes in the network
- Shortest path tree is “blueprint” for per service multicast trees
  - They will be perfect subsets of the SPF tree



Network Topology

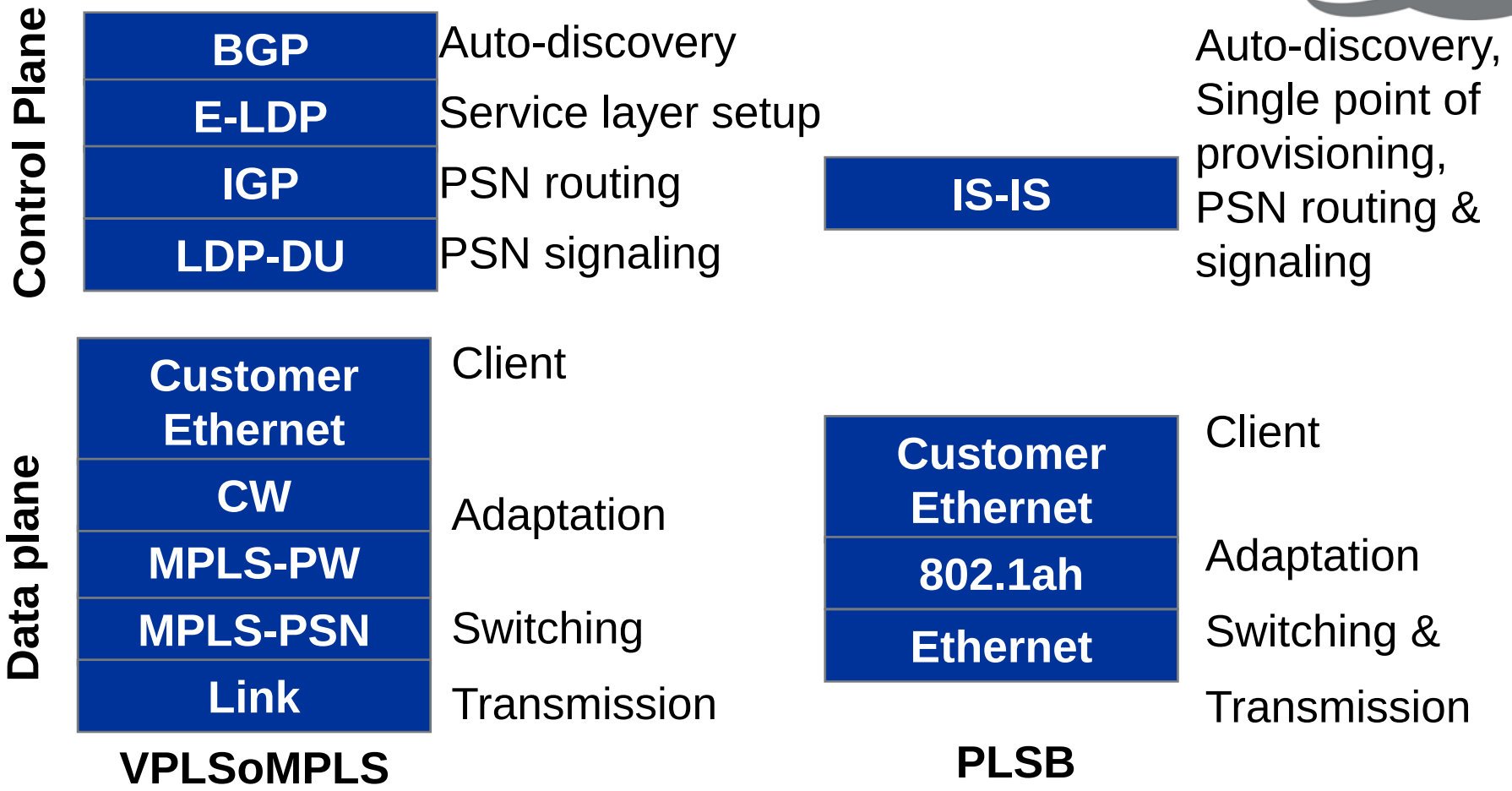


Shortest Path tree from ES1

PLSB Applications

- Ability to virtualize large numbers of multipoint services
- ELAN
  - L2VPN
  - Offers virtual aggregation for L3VPN
  - Potential application is PE interconnect
- ETREE
  - Residential backhaul DSL or other access technologies
    - DSLAM/GPON OLT/BRAS
    - WiMax
    - IPTV

Does PLSB make Ethernet Complicated?



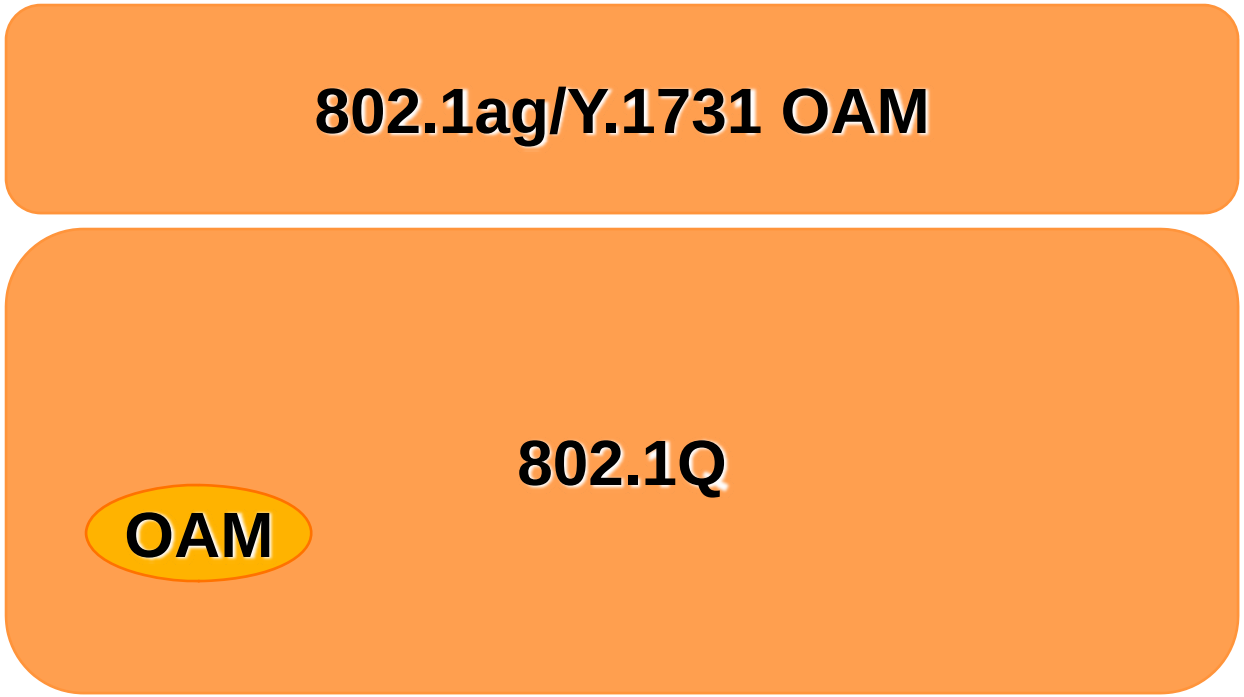
Not really, Ethernet is simpler in implementation and scope

A Few Missing Pieces

- Synchronization
  - Distribution of Precision Frequency via Ethernet phy (L1)
    - Very similar to how SONET/SDH does it today
    - Most concepts directly translatable
      - Traceability to precision source, qualification, hold over etc.
  - Distribution of Prevision Frequency via L2 Packet
    - Examples being IEEE 1588v2
    - Symmetrical congruence of Ethernet facilitates fast convergence
  - G.8261 covers this ground
- Multi-service adaptations
  - Lots of techniques exist, PWoPBT being an exemplar

Summary – The Provider Ethernet toolkit

- Putting the pieces together



These are primarily amendments to 802.1Q

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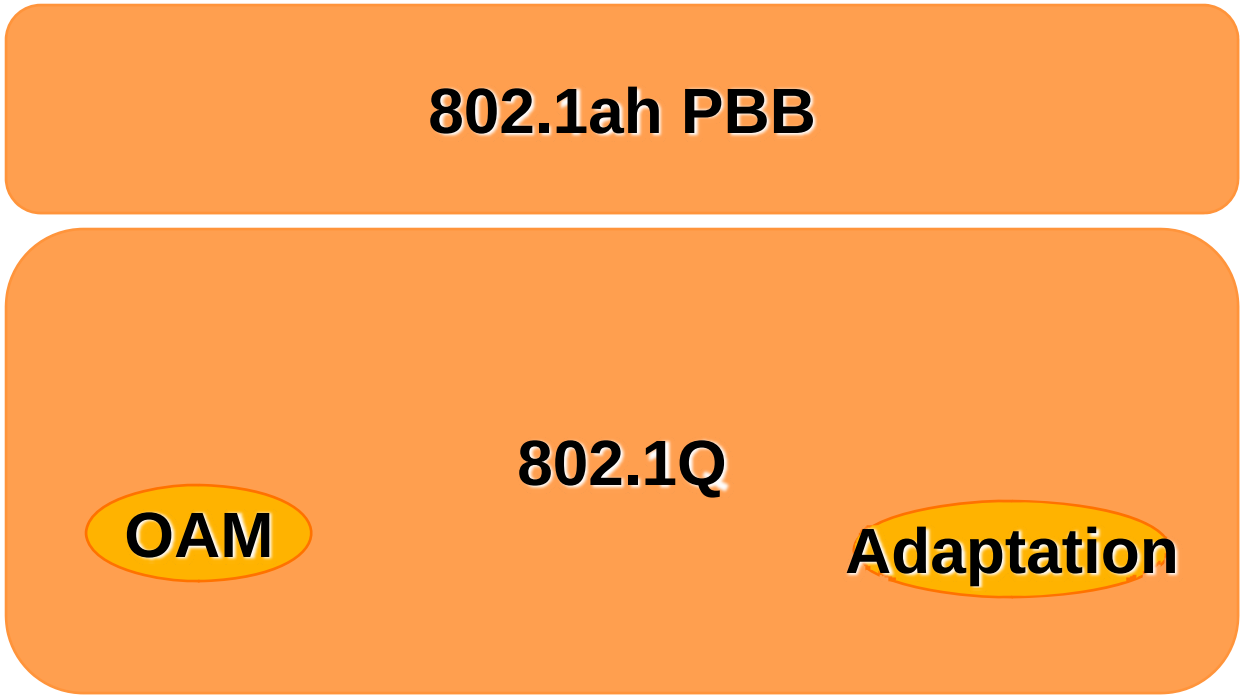

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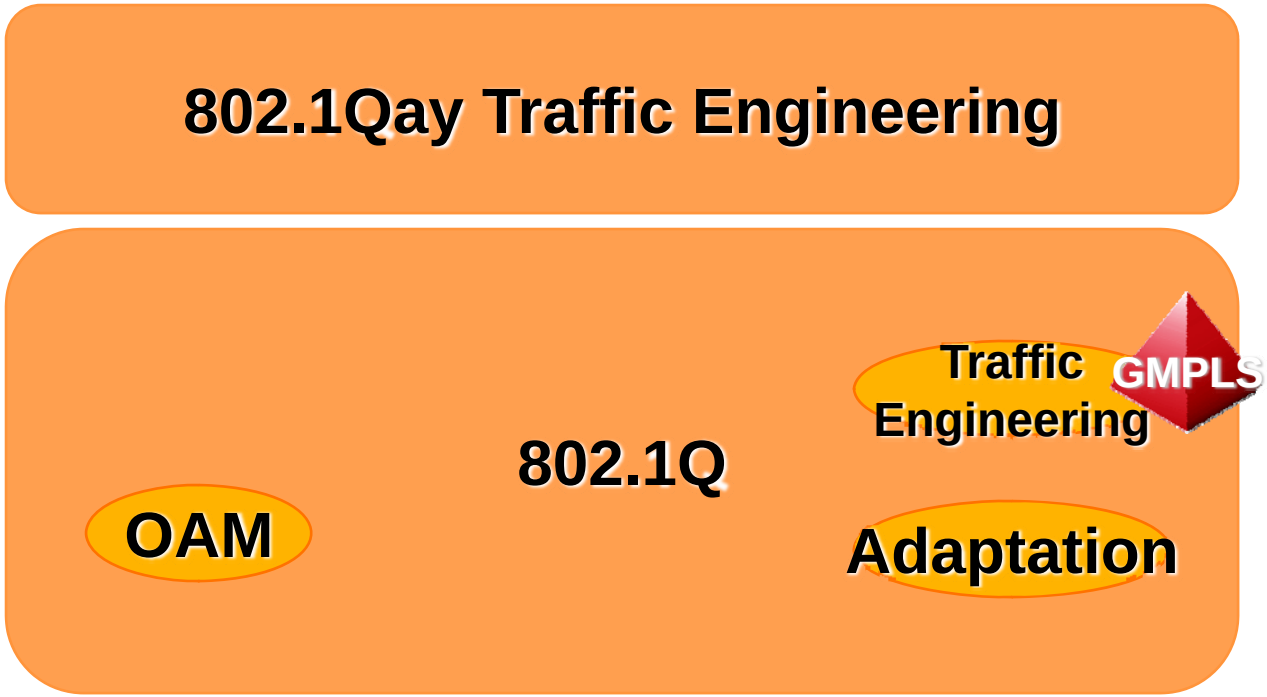

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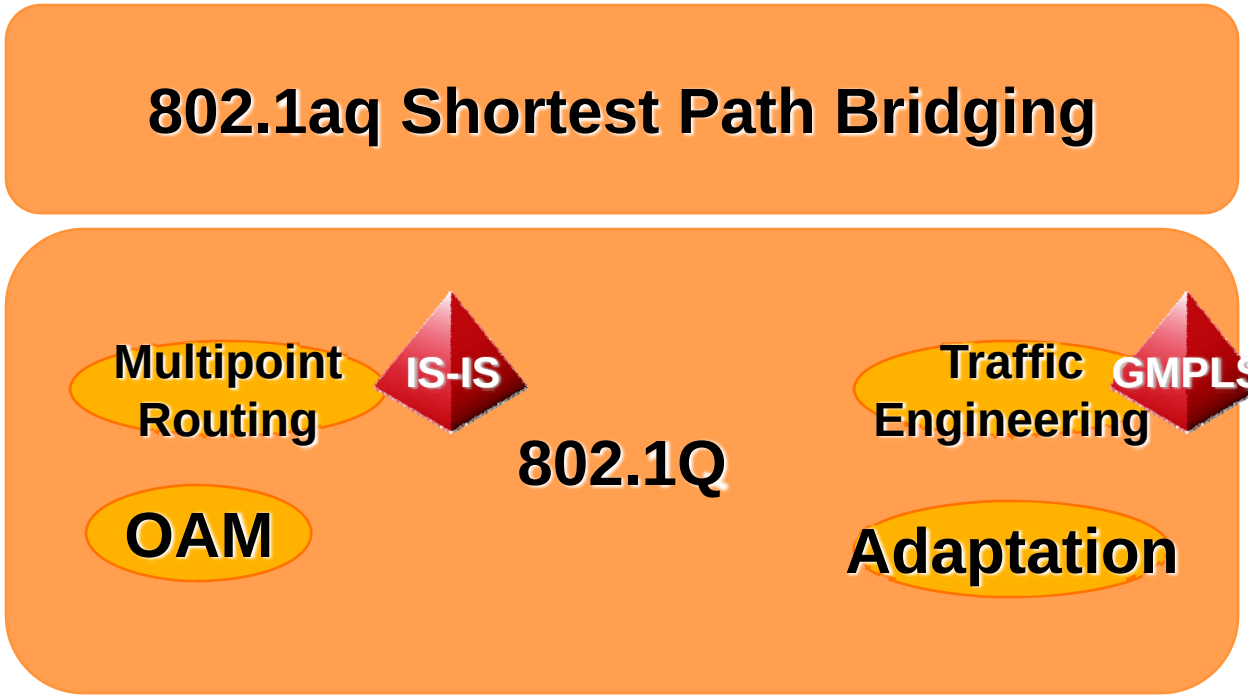

Each piece enhances ability to address key requirement while preserving Ethernet attributes

802.1ag/Y.1731
Measurability

802.1ah
Scalability of identifiers

802.1Qay
TE+Determinism

802.1aq
Scalability of multipoint services

These are primarily amendments to 802.1Q

Conclusions

- MEF service set offers a good basic guideline for the required connectivity models
- Ethernet provides it’s own guidelines for how to build those connectivity models
  - Symmetrical congruence etc.
  - Do Ethernet “well” and the rest comes naturally
- Provider Ethernet has evolved to offer a comprehensive toolkit for the MEF service set that ‘does Ethernet well’!
  - ELINE/ELAN/ETREE
  - Scalable, instrumented and efficient