



International Telecommunication Union

Highly Scalable Ethernets

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Agenda

- o Introduction to Metro Ethernet service network
- o Toward an IEEE Ethernet Metro
- o Conclusions



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IP and Carrier Ethernet are different things?

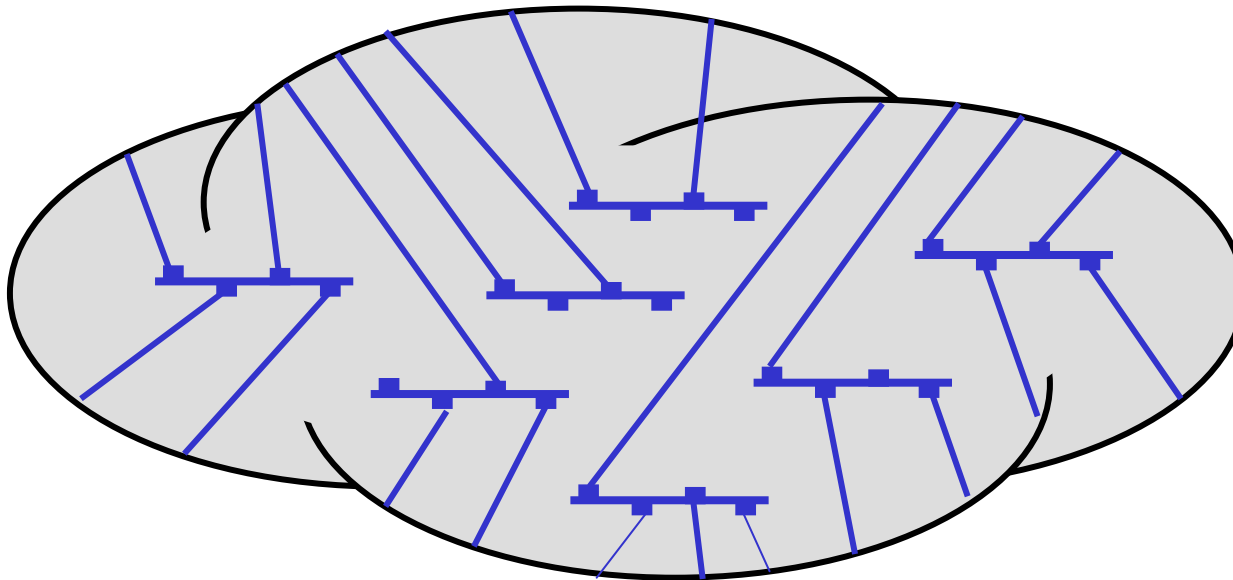
- o Ethernet is L2 and IP is L3, but:
 - Both do packet switching
 - Both can scale globally
 - Both use dynamic topology protocols
 - Both can provide protection, QoS, and traffic engineering
- o The fundamental difference is connectivity
 - IP can provide global any-to-any connectivity
 - Carrier Ethernet can provide global connectivity between provisioned sets of network interfaces
- o Carrier Ethernet is a global Virtual Private Ethernet multiplexing technology
- o IP is a global network technology
- o In the Enterprise and home IP runs over Ethernet networks
- o In the Metro IP will run over Carrier Ethernet Virtual Private Networks



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Carrier Ethernet Is a Network Providing Many Virtual Private Ethernets

- o Each Virtual Private Ethernet is provisioned by the carrier
- o Traffic does not mix from one Virtual Private Ethernet to another
- o Each Virtual Private Ethernet is a carrier service instance
- o Metro Ethernet Forum is modeling Ethernet service instances also called Ethernet Virtual Circuits (EVCs)



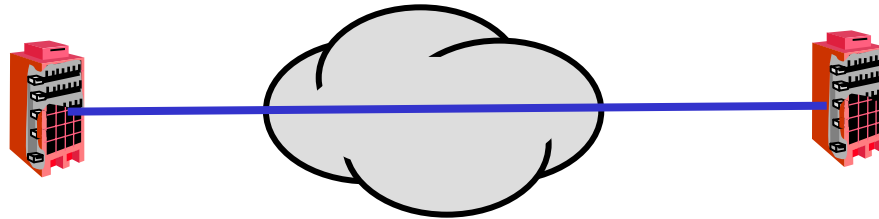
Carrier Ethernet Network (or MEF MEN)

Basic Ethernet Service Types

MEF Ethernet Virtual Connections (EVCs)

E-LINE

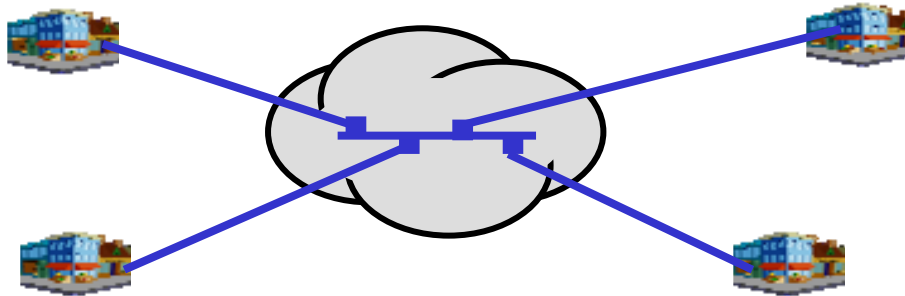
Router Mesh
MEF 10, 5



Pt-Pt, Like
Duplex Ethernet
Any-to-any

E-LAN

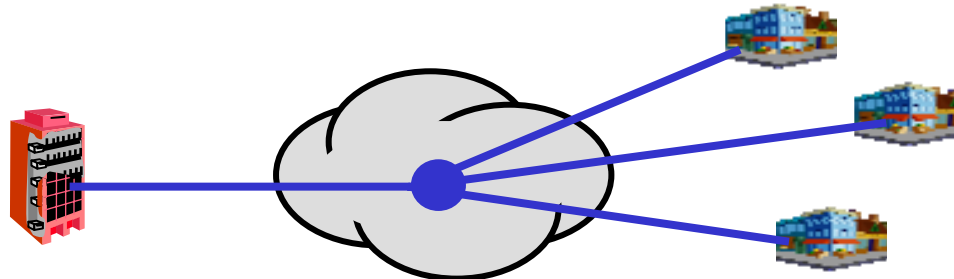
Multi-Site
MEF 10, 5



MPt, Like VLAN,
Any-to-any

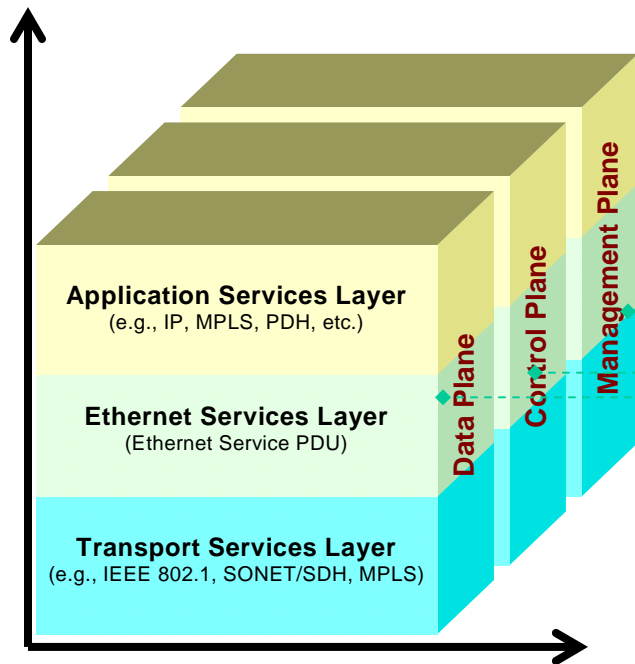
E-TREE

Hub & Spoke
MEF Phase 2
Work in progress



Pt-MPt, Like
EPON Ethernet,
Root-to-Leaf and
Leaf-to-Root

MEF Reference Model



- Management Plane is deemed to be quite important for carrier class Ethernet Service offering across Metro Ethernet Networks (MEN)
- Current focus is on both E<->W and N<->S OAM
- UNI Type 2 work is focusing on Management across the UNI
- EMS-NMS (MEF 7) have focused on N<->S OAM and have worked with TMF
- OAM Protocol, OAM Requirements and Framework have focused on E<->W OAM, and currently working with IEEE 802.1 and ITU-T Q5/13

- Provision for UNI Type 3 which is expected to focus on control aspects across the service interface i.e. UNI

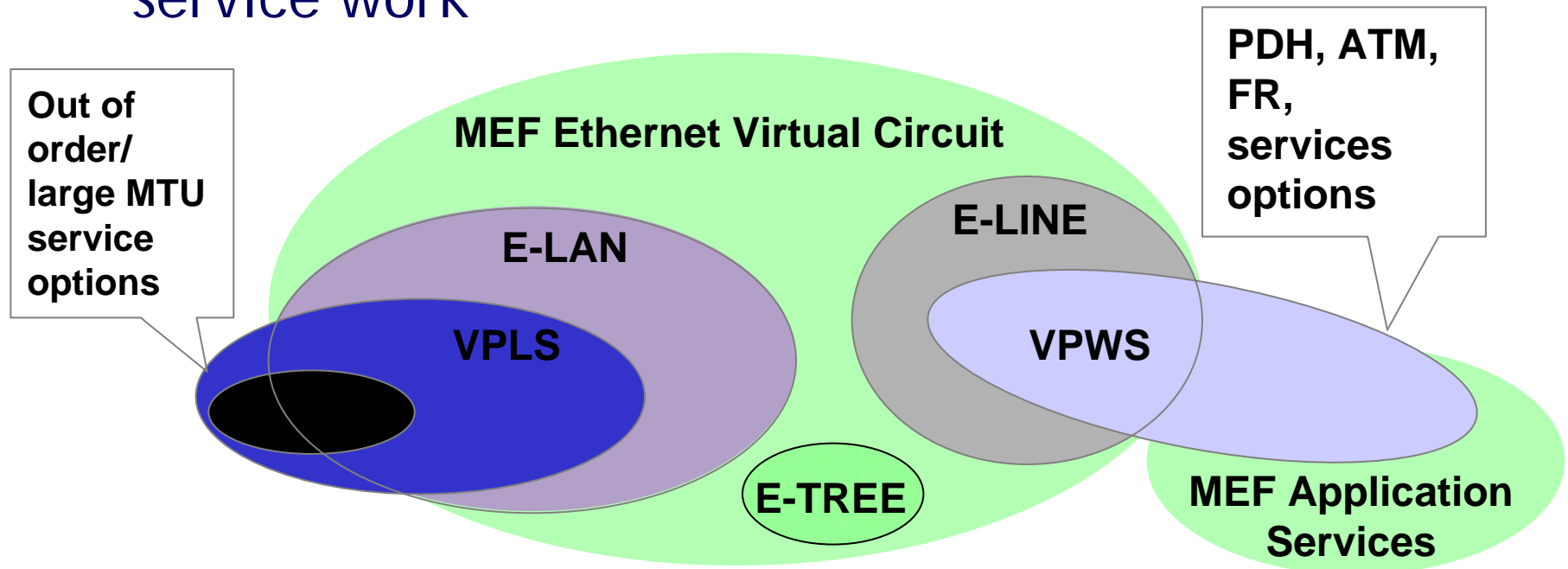
- Specific Data Plane activities relate to Ethernet Service Definitions, where Services are defined from a subscriber's point of view. MEF 10, MEF 6, MEF 3 are related to data plane attributes.
- Current work focused on phase II services
- UNI Type 1 IA is focusing on data plane interoperability across the UNI



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MEF Services May be Realized by IEEE Provider Bridge Networks, MPLS Networks, or SONET

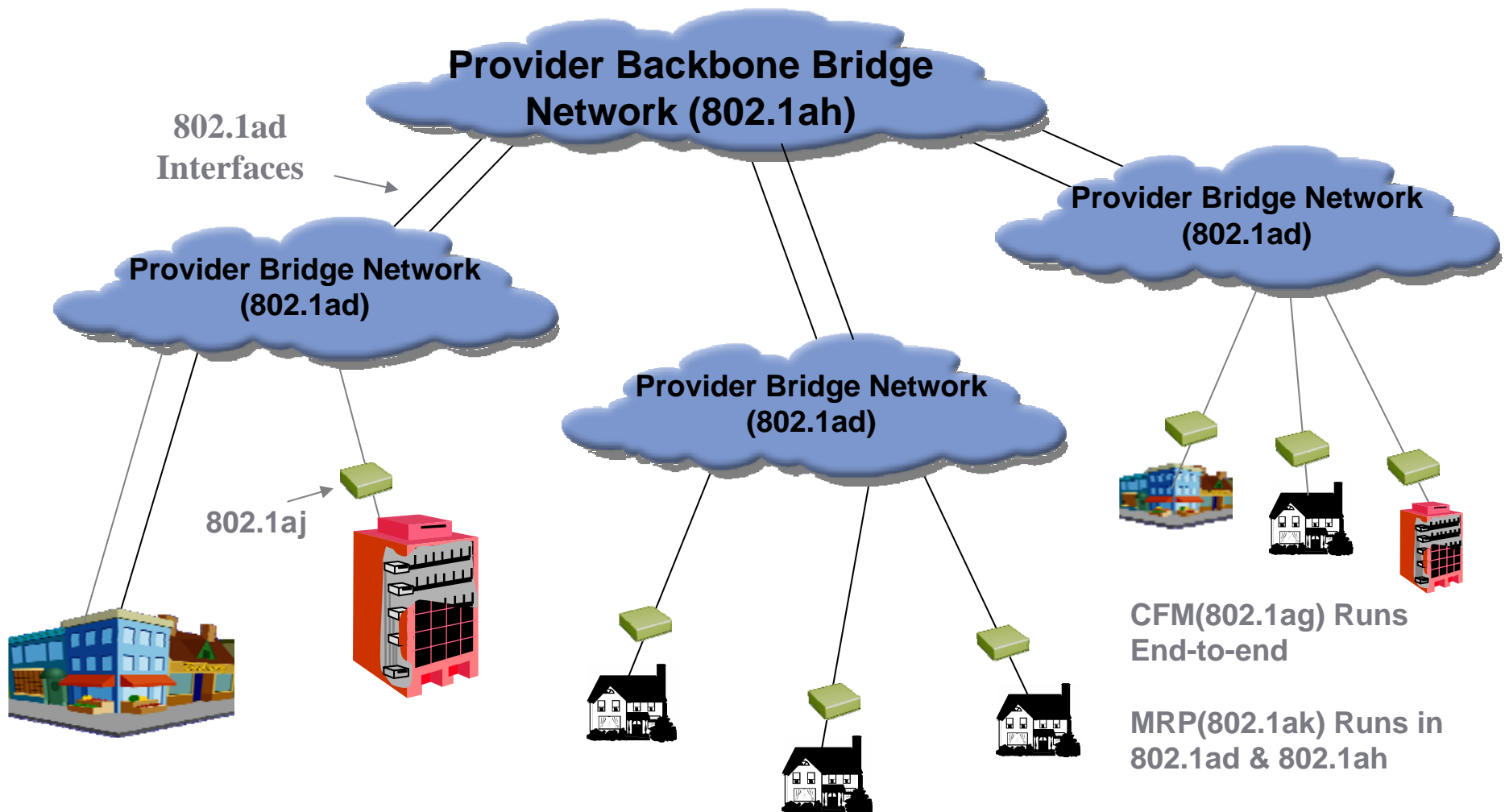
- All MEF services can be delivered by an IEEE Provider Bridge Network.
- PDH, ATM, FR services are carried as a application over the EVC
- E-TREE service type is part of ongoing MEF Phase 2 service work



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IEEE Provider Backbone Bridge Network (802.1ah)



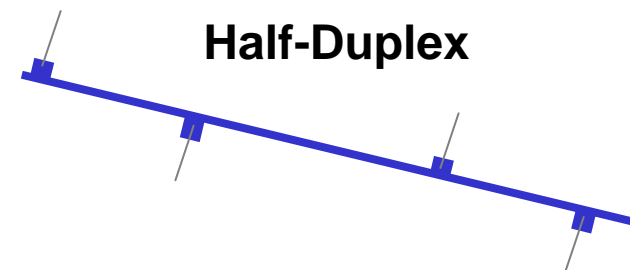
Eight Ethernet Innovations

- o Duplex Ethernet
- o Ethernet VLANs
- o Ethernet QoS
- o Multi-level Administrative Domains
- o Hierarchical Addressing
- o Ethernet VLAN Identifier Switching
- o Protection Switching
- o Point to point Ethernet Transport

Look Bob no CSMA/CD!

- o Duplex and switched Ethernet have removed transmission distance limits inherent in the original CSMA/CD Ethernet
- o IEEE 802.1 bridging is commonly thought of as part of Ethernet, however is a different standard

1973-80s half-duplex Cable-Tree using CSMA/CD

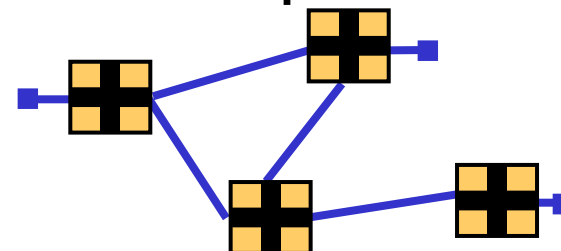


Early 90s move to duplex (point to point) no CSMA-CD



Along with duplex Ethernet bridging became an integral part of Ethernet technology

Switched Duplex Ethernet



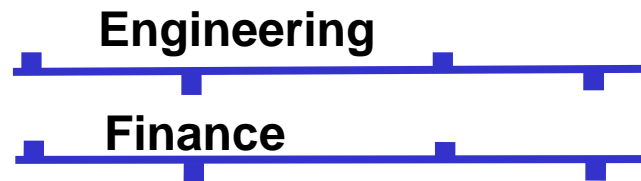


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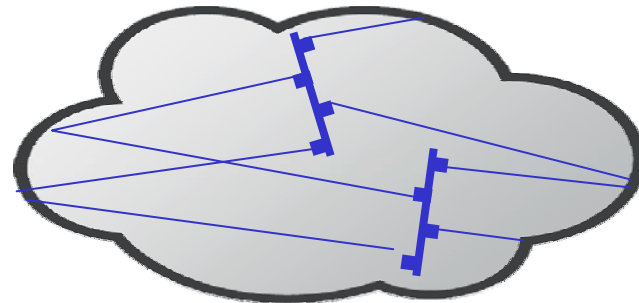
Separate Finance and Engineering

- o New standards IEEE P802.1ad and P802.1ah are defining Service VLAN (S-VLANs), extending tagging for S-VLANs (I-TAGs), and backbone tunnel VLANs (B-VLANs)

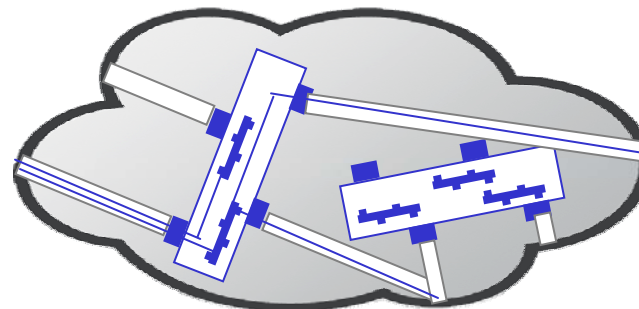
In the Mid 1980 multiple Ethernets were run to isolate parts of the business



In the 1990s along with duplex and switched Ethernet Virtual Bridged Ethernet(VLANs) was invented



Today virtual Bridged Ethernet is being expanded for Provider and Provider Backbone Bridging to allow nesting VLANs



Class based QoS for Ethernet

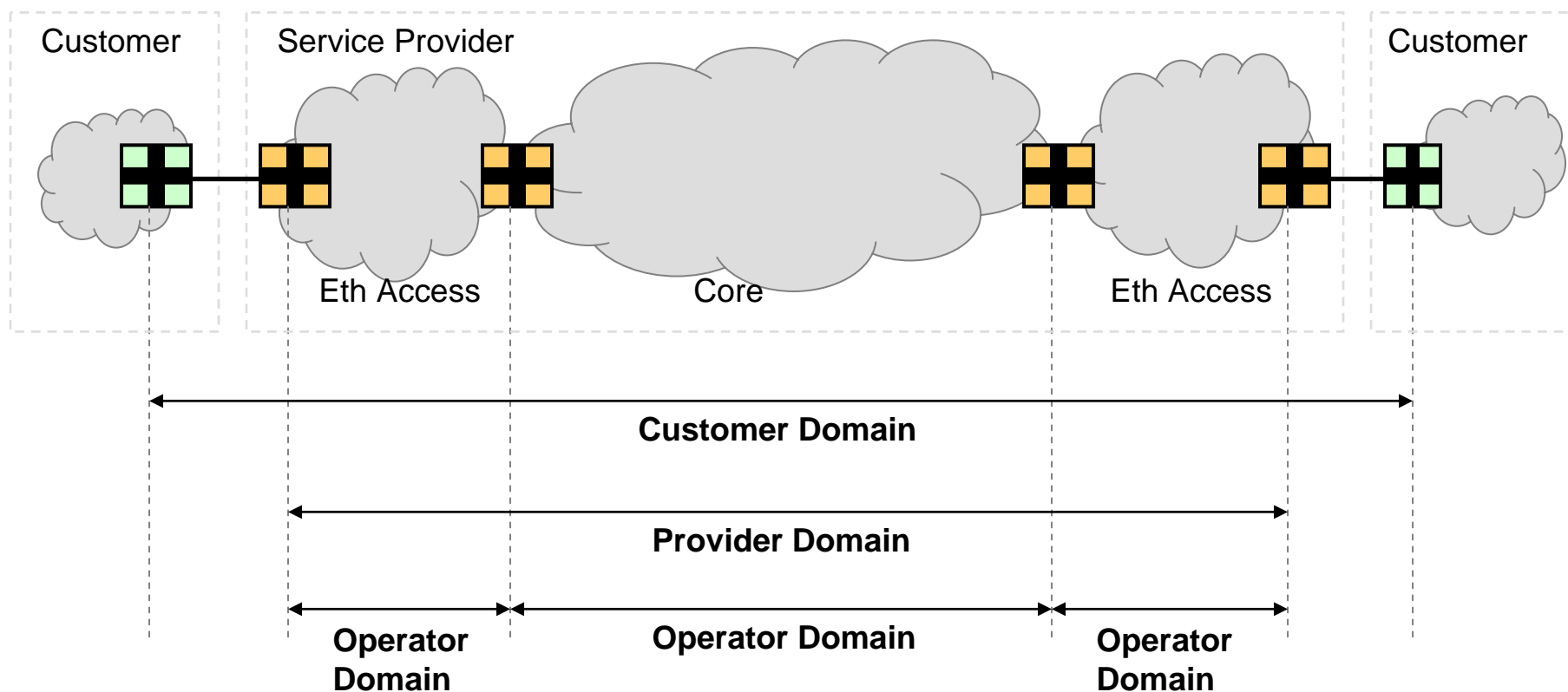
- o Ethernet of the 1980s was a best effort delivery network
- o However it became clear that not all information has the same priority. Ethernet therefore began moving to provide ways to manage information differently for different user classes.
- o This stated in the early 802.1p work, however is now continuing on many fronts.
- o The MEF 10 Phase 1 service specification has specified both traffic meters and performance metrics for Ethernet
- o The IEEE P802.1ad project is working on extensions to the original 802.1p code points to allow drop eligibility
- o MEF services phase 2 provides QoS models for multipoint as well as definitions for availability.
- o Standards work on bandwidth allocation is lagging



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Multiple Domain Management

- Ongoing work at IEEE (P802.1ag), MEF, and ITU SG13 (Y.1731)
- IEEE P802.1ag Service OAM flows at multiple levels.
- Ethernet Service OAM allows multiple autonomous networks.



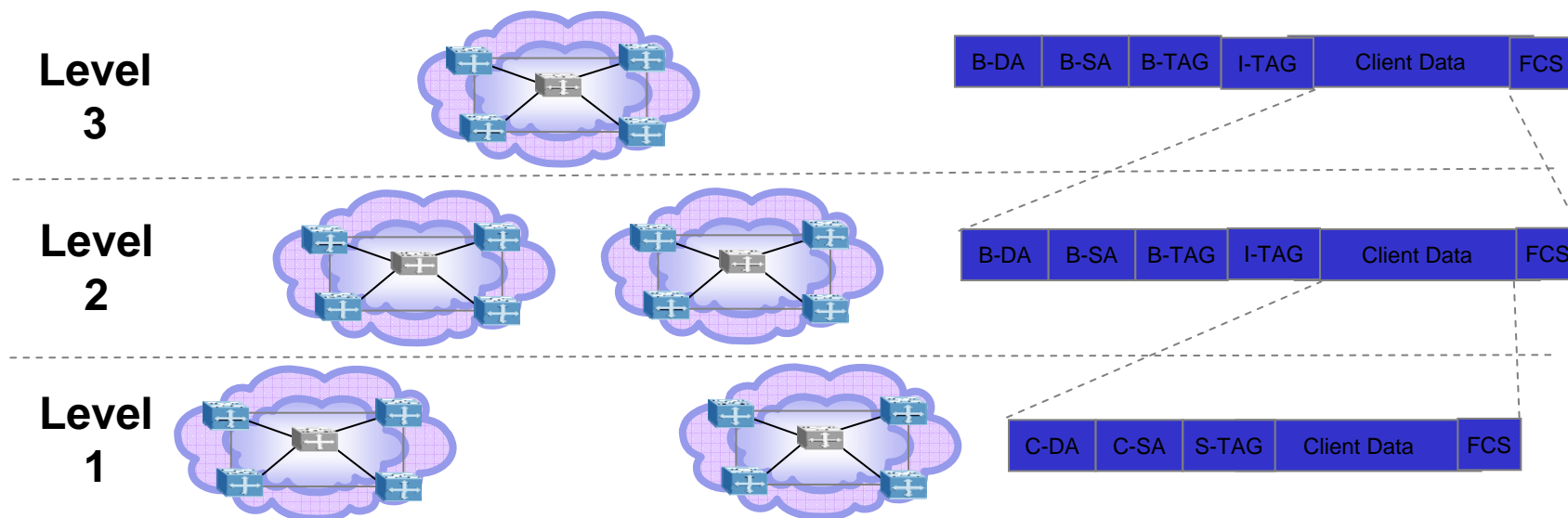


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What the Ethernet world is not flat?

- Each IEEE 802.1ah level encapsulates frames with a new MAC addresses and with a new service tag.
- Each IEEE 802.1ah nesting level summarizes the MAC addresses of the lower level with a Backbone MAC address
- The higher level 802.1ah bridges forward on summarized addresses allowing indefinite scaling without MAC lookup table explosion.

IEEE P802.1ah

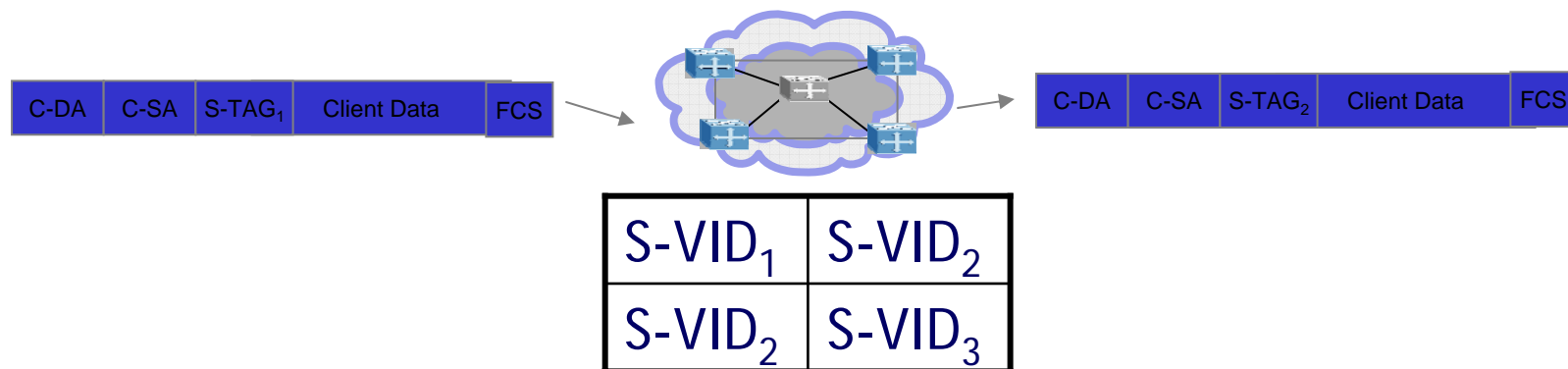




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VLAN ID Switching – Powerful but Dangerous

- o IEEE 802.1ad allows for VLAN ID switching
- o By switching the 802.1ad VLAN IDs and the 802.1ah Service IDs it is possible to have limitless VLAN scaling over a global Ethernet
- o Use of this technique complicates control since frames within the network must retain their context to be identified and traced.
- o Limiting swapping to administrative boundaries allow unlimited scaling without while keep control complexity to a minimum.



Ethernet Protection Switching

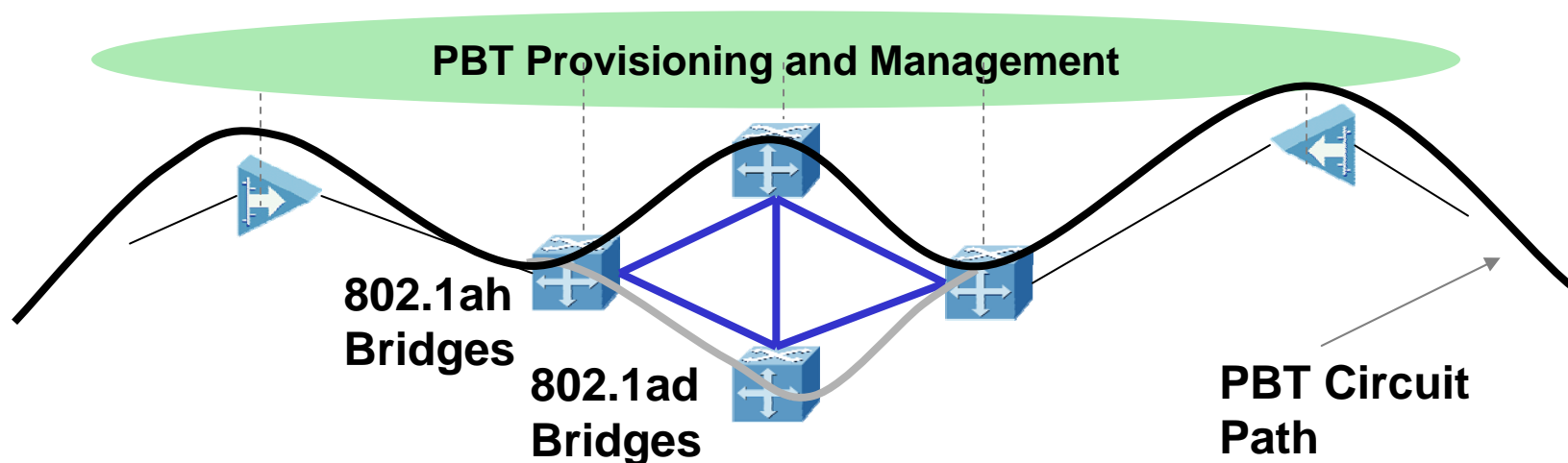
- Link recovery of 802.3 networks can be implemented today using IEEE 802.3 link aggregation protocols.
- Ethernet switch node recovery today is handled by Rapid Spanning Tree(RSTP) and Multiple Spanning Tree(MSTP).
- IEEE project 802.1aq will replace MSTP with a link state protocol for shortest path bridging allowing more extensive link and node recovery.
- Work currently ongoing at the ITU-T G.8031 is defining Ethernet protection switching.
- Future work will likely extend to Ethernet ring recovery.



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P2P Ethernet Transport

- Provider Backbone Transport is a variation on Provider Backbone Bridging which allows carriers to provision engineered and protected Pt-Pt service instance.
- PBT operates by adding configured routes to a nearly standard Provider Backbone Bridged Network. The PBT provisioning and management system allows a carrier to provision point-to-point trunks and services within the Ethernet network. Each trunk is identified by a 12 bit VLAN ID and a 46 bit destination address.



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Conclusions

- o New technologies in development for Ethernet by the IEEE and others including the ITU and MEF are breaking the barriers to scaling and mass deployment of Ethernet as an end-to-end carrier infrastructure.
- o The IEEE 802.1ah and associated standards provide the foundation for scaling provider Ethernets to almost limitless size.



Thank You