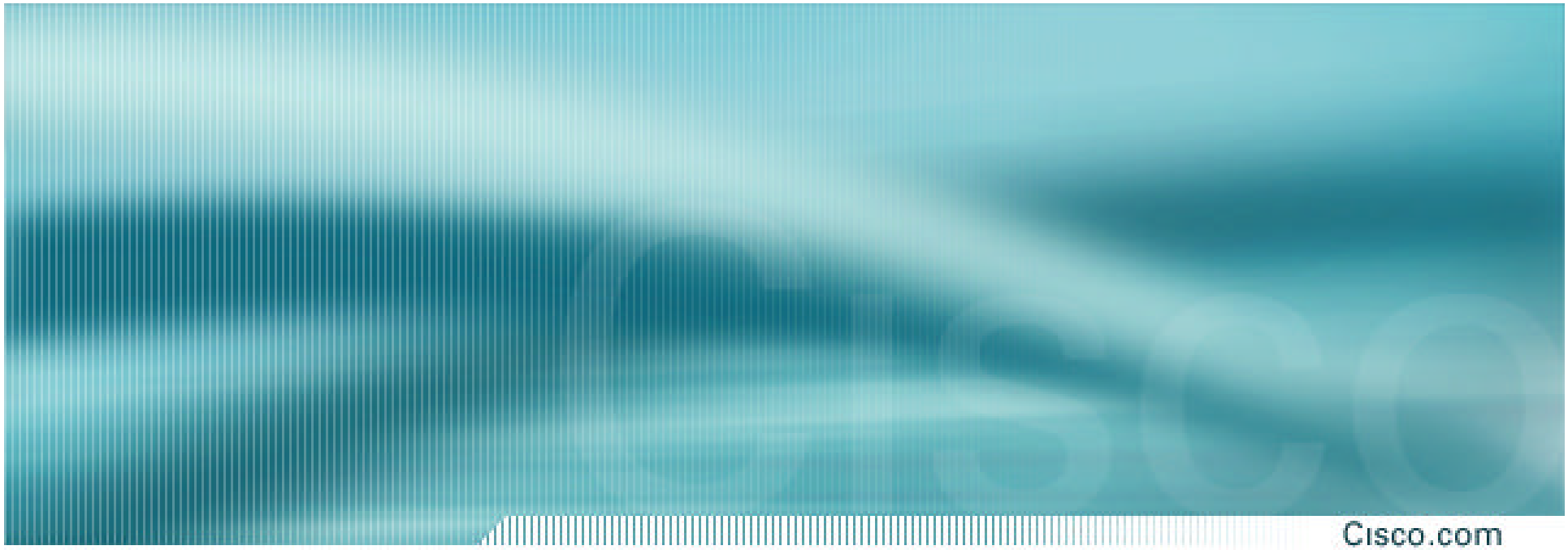

Metro Ethernet Standards

Lim Wong

APAC Consulting Team

limwong@cisco.com

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Metro Ethernet Standard Bodies

- **Metro Ethernet Forum**

  Service Definitions & Internetworking

- **IEEE**

  Physical Layer, OAM, Provider Bridges…

- **IETF**

  MPLS, VPLS, Traffic Engineering…

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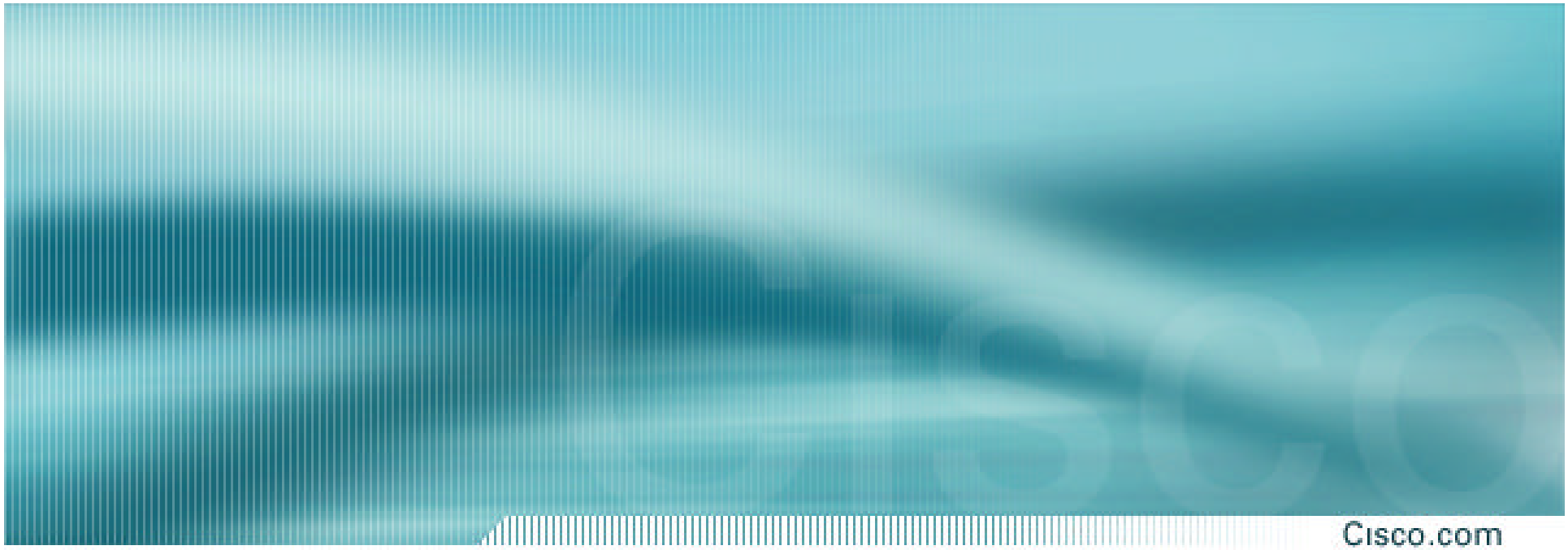

IEEE 802.3ah Updates

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IEEE 802.3ah projects

- **Copper**

  Line coding for EoVDSL

- **EPON**

  New protocol to extend MAC functionality for point to multipoint (or PON) topology

  Concerns about cost, security

- **OAM**

  For remote subscriber management, OAM in frames vs OAM in preamble. OAM for 10GBASE- links

- **Optics**

  Defining and standardizing specs for extended temp. operation –40 to +85 Celsius case temp.

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IEEE 802.3ah – Physical layer Specifications

Cisco.com

- **10PASS-TS**
  - **Symmetrical min 10 Mbps**
  - **Point-to-point topology**
  - **>= 750 m on voice grade copper cable**
  - **DMT line code chosen**
  - **Supports PSTN in baseband**
- **2BASE-TL**
  - **Symmetrical min 2Mbps**
  - **Point-to-point topology**
  - **>=2700 m on voice grade copper cable**
  - **Higher speed with bonding**

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IEEE 802.3ah – Physical Layer Specifications cont.

- **100BASE-LX10/BX10 & 1000BASE-LX10/BX10**
  - **Up to 10 km over SMF**
  - **Point-to-point topology**
- **1000BASE-PX10/20 (PON)**
  - **Point-to-Multipoint topology**
  - **Up to 10 or 20 km with 1:16 splits on SMF**

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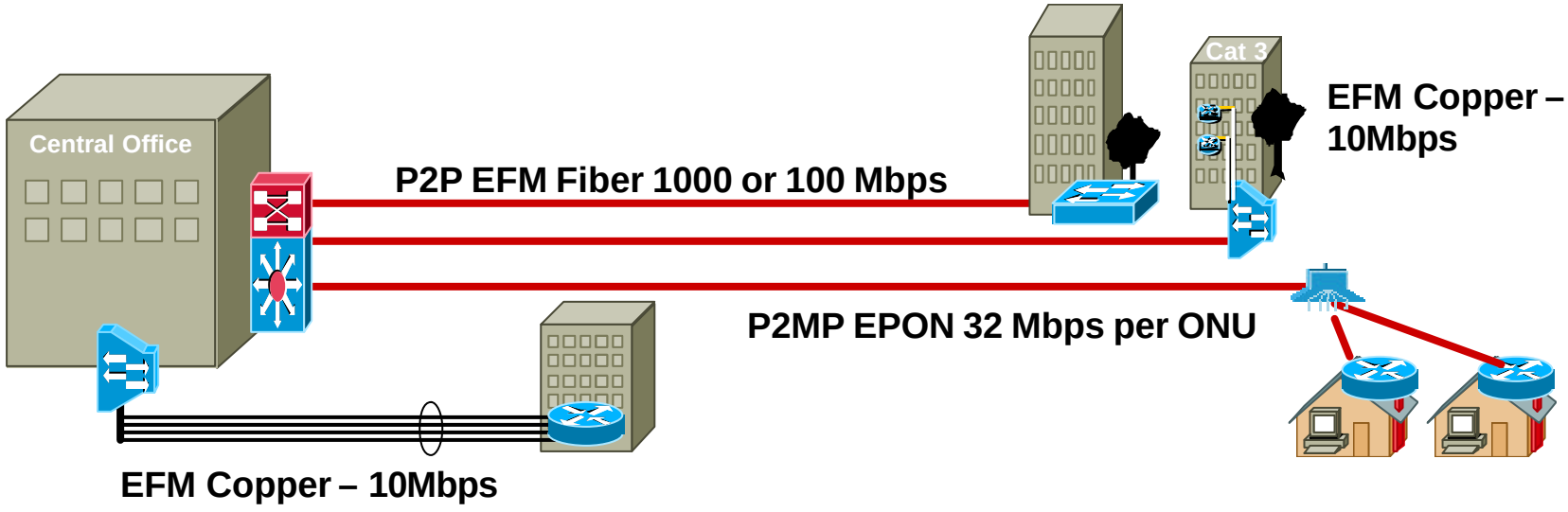
IEEE 802.3ah – Ethernet in the First Mile

- **Ethernet Standard for the First Mile Access Network**
  - **EFM Copper for the last 750 to 2700 meters**
  - **10 Megabit and 2 Megabit Ethernet over local loop copper**
  - **Hybrid deployment with EFM fiber supports a flexible variety of access network topologies (greenfield and legacy)**



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IEEE 802.3ah - OAM Objectives

- **OAM provides mechanisms to:**
  - **Monitor link operation and health**
  - **Improve fault isolation**
- **Method: OAM data conveyed in basic (*untagged*) 802.3 Slow Protocol frames**
  - **Sent between two ends of a single link**
  - **Slow Protocols will allow S/W implementation**
- **Fills major requirement to reduce EFM OpEx**

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IEEE 802.3ah - OAM Non-objectives

- **Does not provide capabilities for:**
  - **Station management**
  - **Protection switching**
  - **Provisioning**
    - ***No SET functions***
  - **Bandwidth allocation**
  - **Speed/duplex negotiation**
  - **End-to-end OAM communication**
    - ***802.3 scope restricted to single links***

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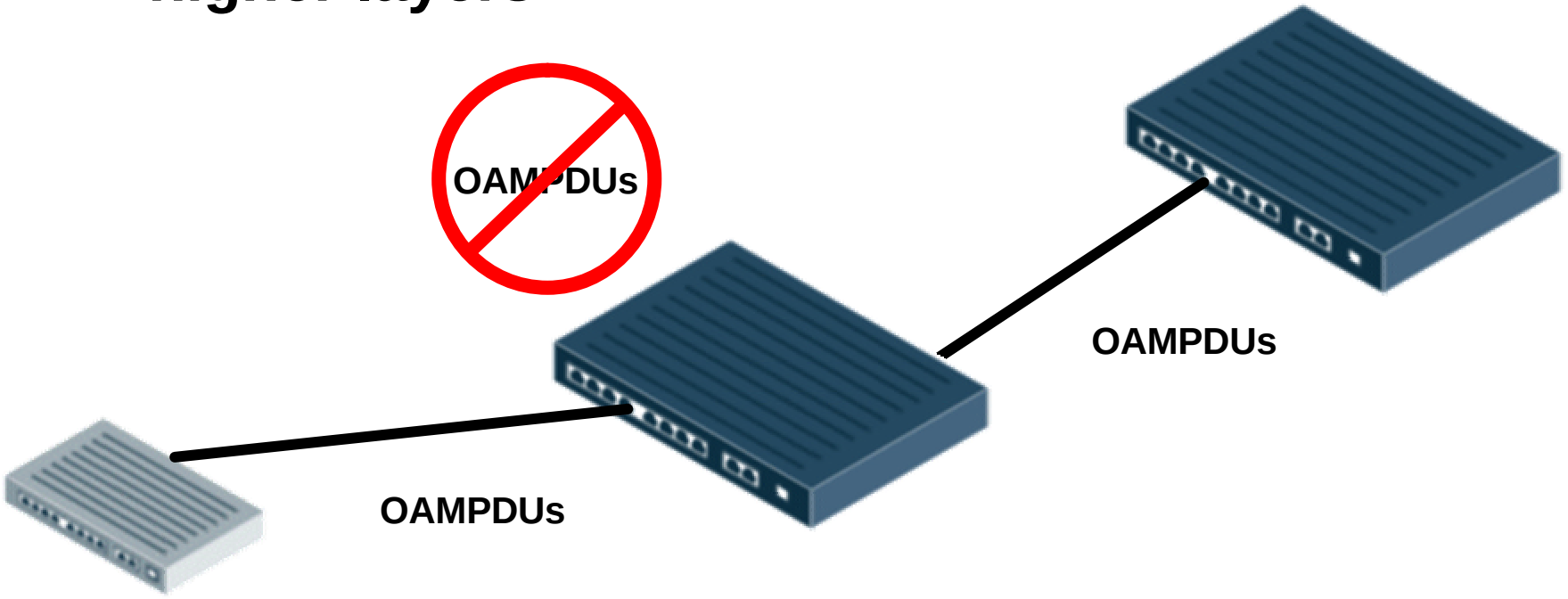
IEEE 802.3ah - OAM Forwarding

- **Can only traverse a single link**

  Not forwarded by bridges

- **Communication beyond a single link left to higher layers**



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OAM Critical Link Events

- **Link Fault**

  Signal remote device that receive path is broken

  Sent only once per second in Information OAMPDU

- **Dying Gasp**

  Signal remote device that unrecoverable local fault (e.g. power failure) has occurred

  May be sent immediately/continuously

- **Critical Event**

  An unspecified critical event has occurred

  May be sent immediately/continuously

New as of D2.1

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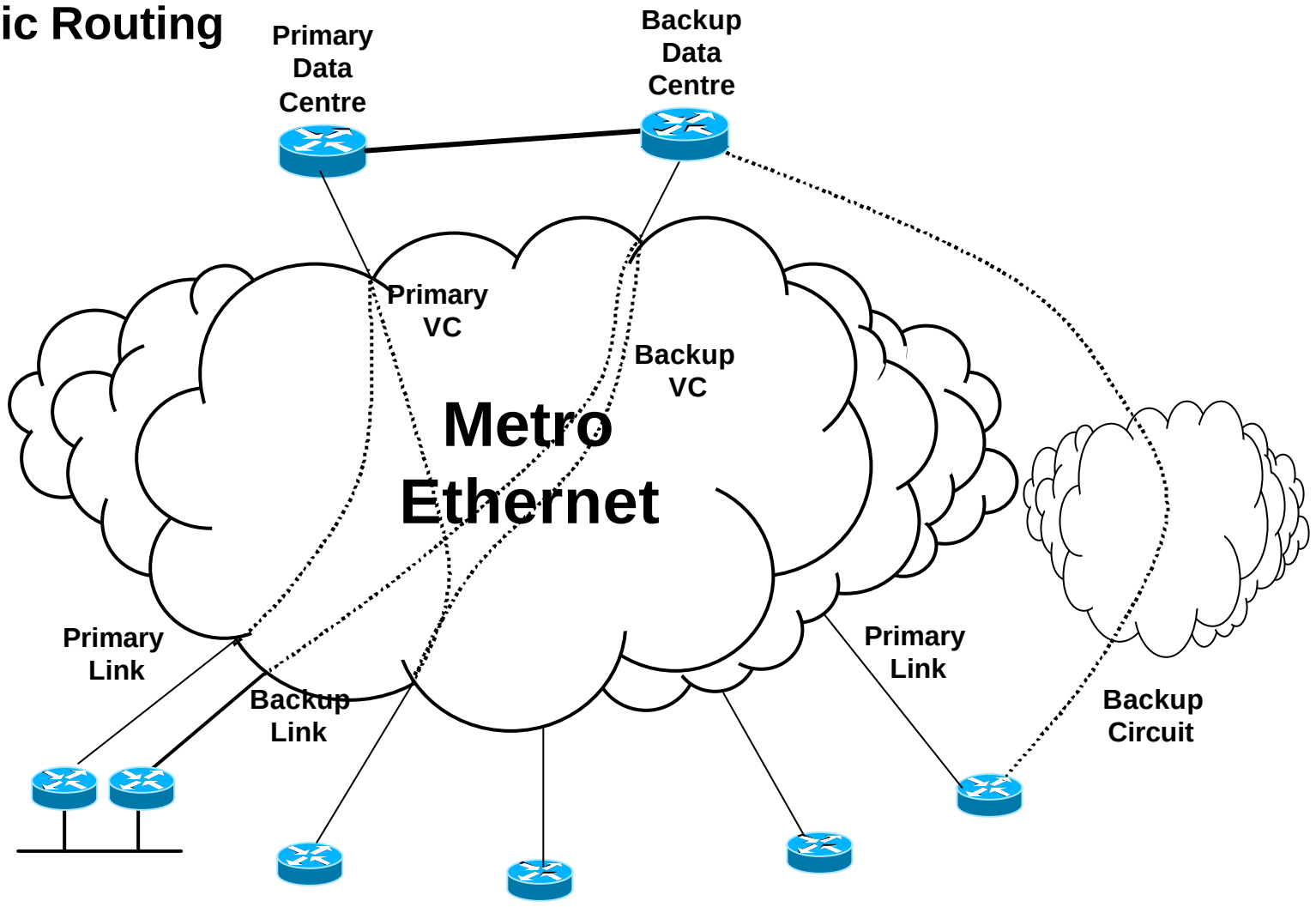
Hub & Spoke Architecture – With redundancy

- Dynamic Routing
- OAM



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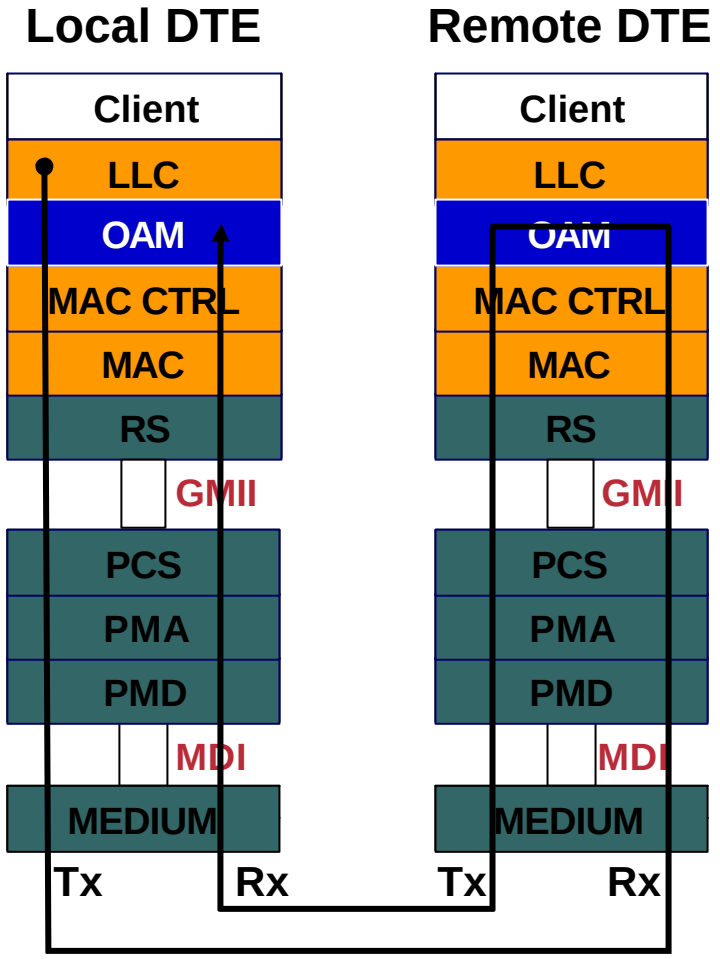
OAM Remote Loopback

- Local DTE sends arbitrary data frames
- Remote DTE returns data frames
-



Can be implemented in H/W or S/W

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Source: Kevin Daines, Editor EFM-OAM Sub Task Force

OAM Discovery

- Allows local DTE to detect OAM on remote DTE
- Once OAM support is detected, both ends of the link exchange state and configuration information
  - e.g. mode, PDU size, loopback support
- If both DTEs are satisfied with settings, OAM is enabled on link
- Loss of link and non-reception of PDUs for 5 seconds are causes of Discovery re-starting

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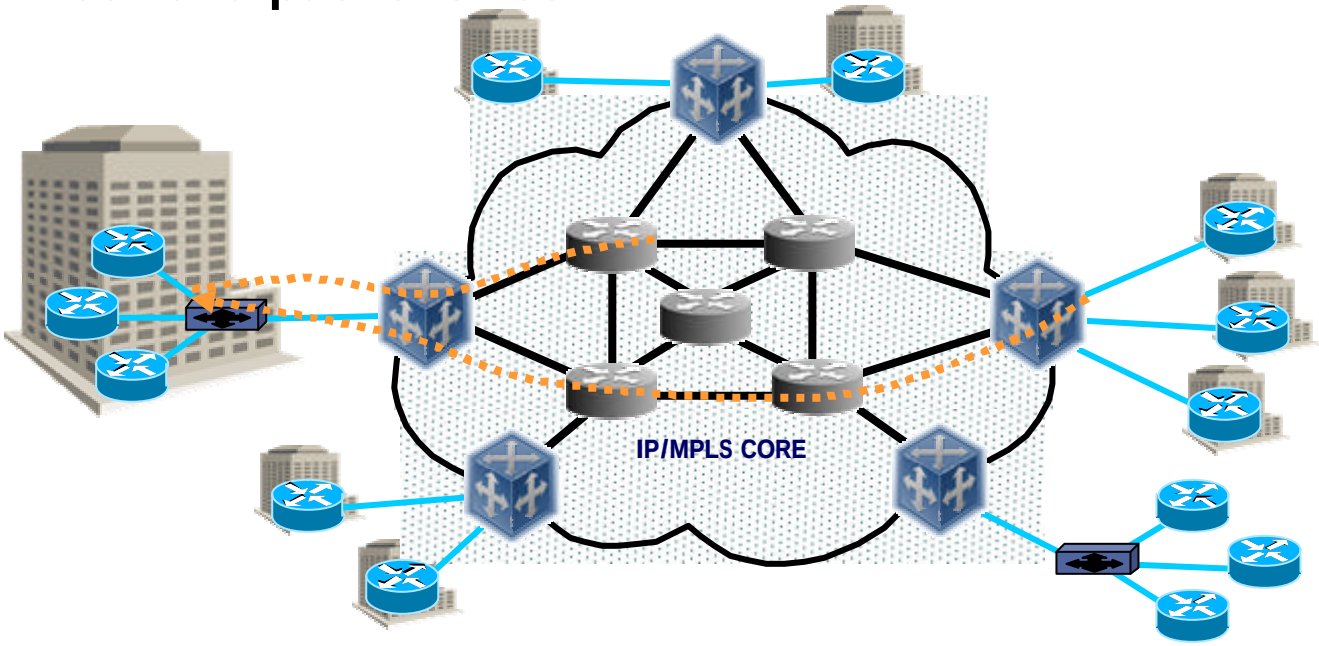
Ethernet Ping

- Verifies all aspects of an Ethernet service, end-to-end
- Verifies valid packet sizes
- Measures round-trip delay
- Uses 802.3ah OAM in band



Ethernet Ping Enables Rapid Traffic Verification and Problem Isolation

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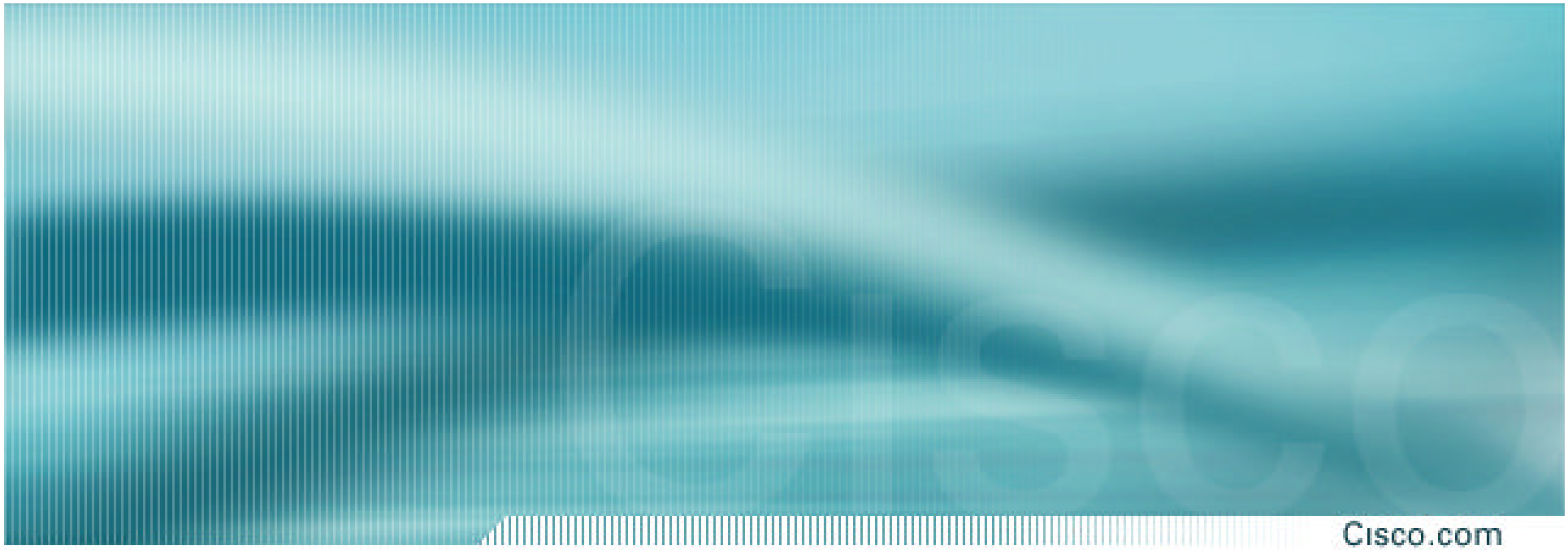

IEEE 802.1ad Updates

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Firm Directions

- **Double Tag Format**
- **New Well Known MAC Addresses**
- **Layer Control Protocol Handling**
- **“Complex” UNI**

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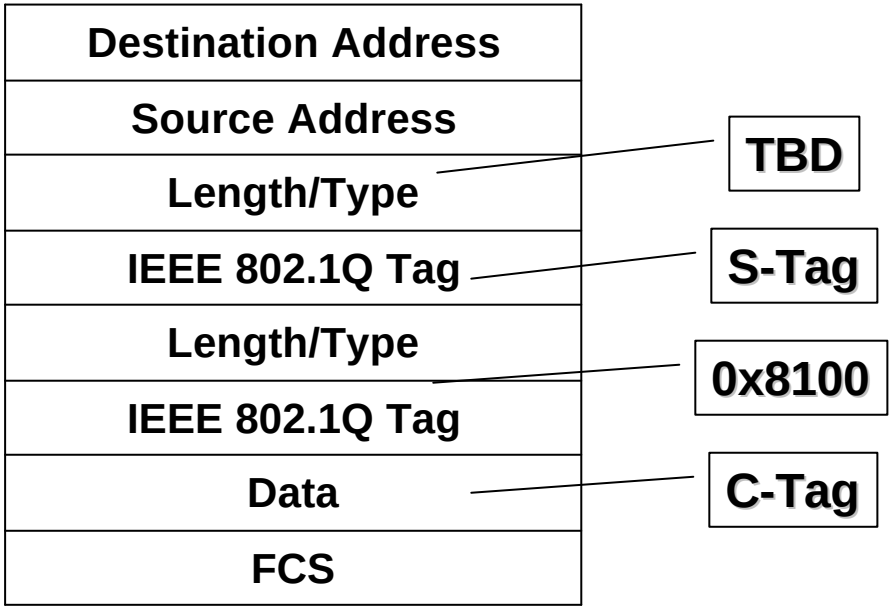
New Tag EtherType

MAC Frame



S-Tag stands for Service Tag (formerly P-Tag for Provider Tag)

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Provider Well Known MAC Addresses

- Originally thought was 33 new addresses
- Agree now that Provider Well Known Addresses will be in the existing BPDU block, 01:80:C2:00:00:xx
- Result is that Provider Layer 2 Control Protocols can not tunnel through a Subscriber's bridged network

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Well Known Address Notes

- **General Agreements**

  802.3X (Pause Frames) and Slow Protocols (EFM, Link Aggregation) will not be tunneled

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Model for Edge Bridge

- Model to explain allowed behavior
- Implementation must match model behavior not model structure
- Constrains some features relative to MEF
- Enables new features relative to MEF
- Details still to be worked out, e.g., dealing with .1p bits in C-Tag

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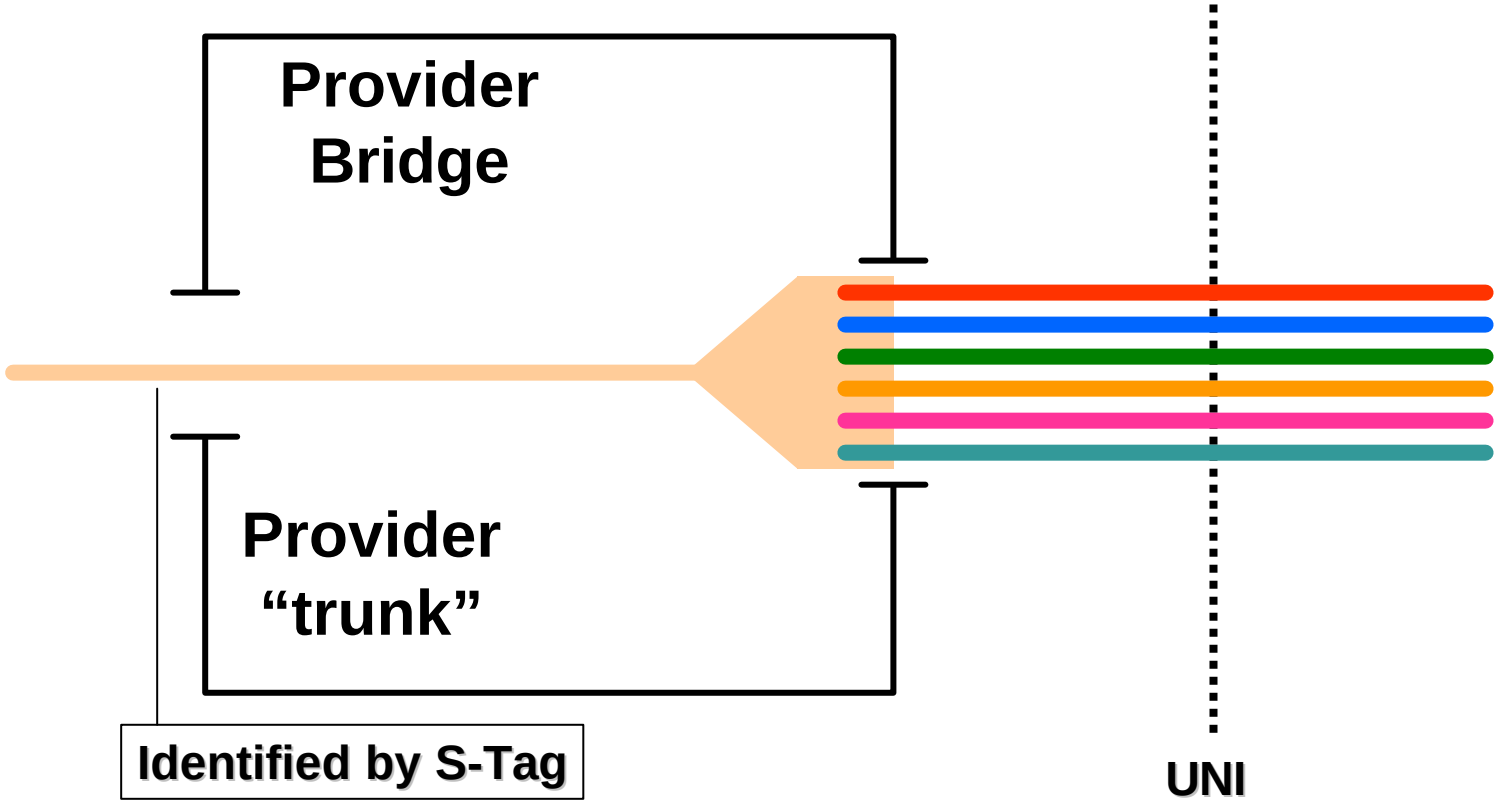
Model of Single Service UNI



- Classical QinQ
- Subscriber Layer 2 Control protocols can be tunneled as data

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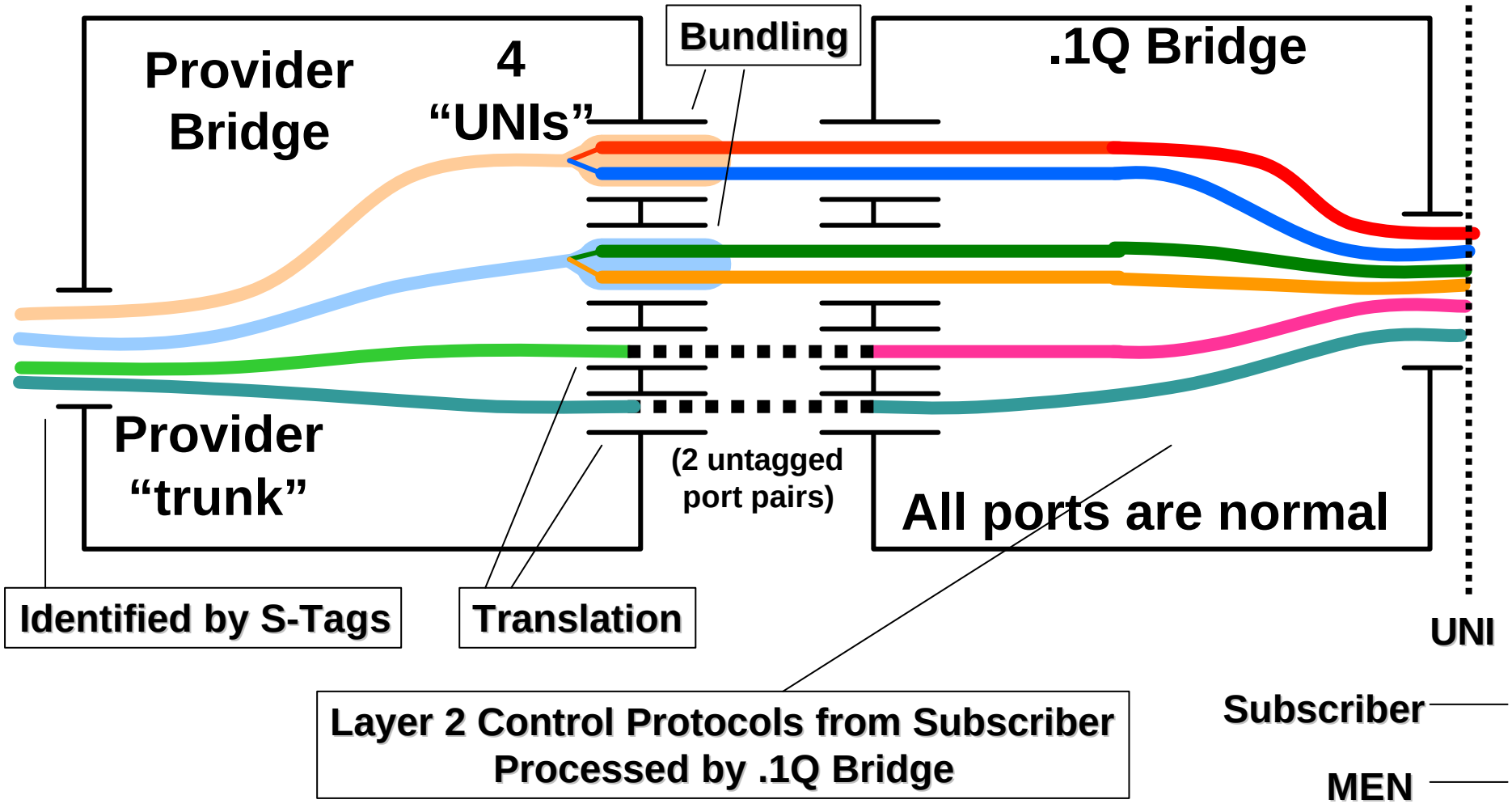
Model of Multiple Service UNI



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Notes on Multiple Service UNI

- **No Layer 2 Control Protocol tunneling**
- **MEN participates in Layer 2 Control Protocols, e.g., Subscriber's Spanning Tree Protocol**
  - **Robust way to prevent loops when CE is a bridge**
  - **Probably need to discard in .1Q Bridge to prevent participation**
- **Links between Provider Bridge and .1Q Bridge will be virtual in an implementation**

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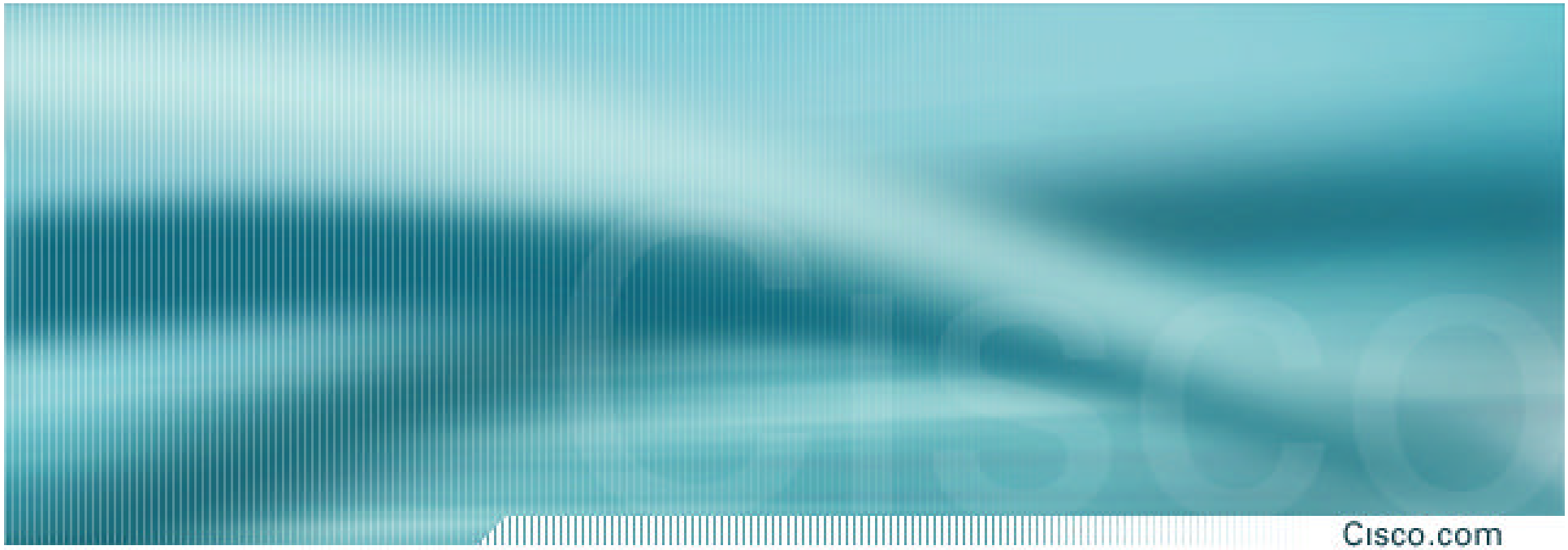

Metro Ethernet Services

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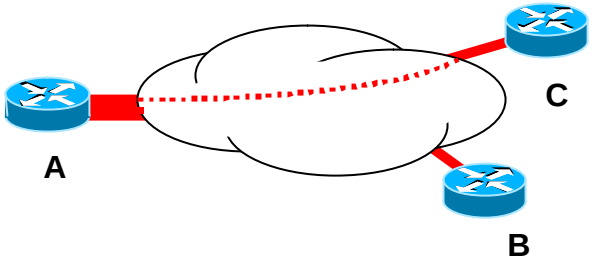
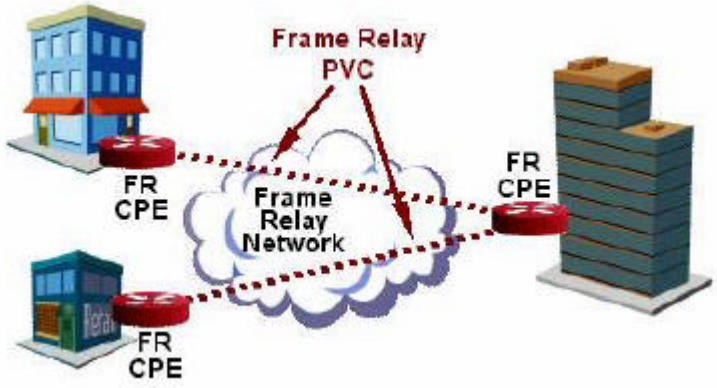
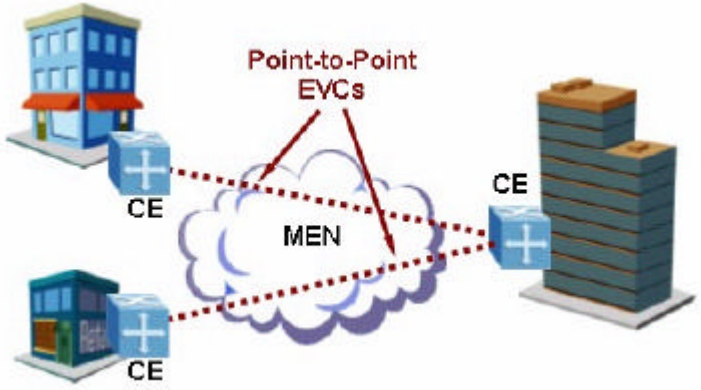
Ethernet Relay Service (ERS)

- Logical Port to Logical Port
- Analogous to Frame Relay Service
- Well Defined Service Model





Frame Relay Service



Ethernet Relay Service

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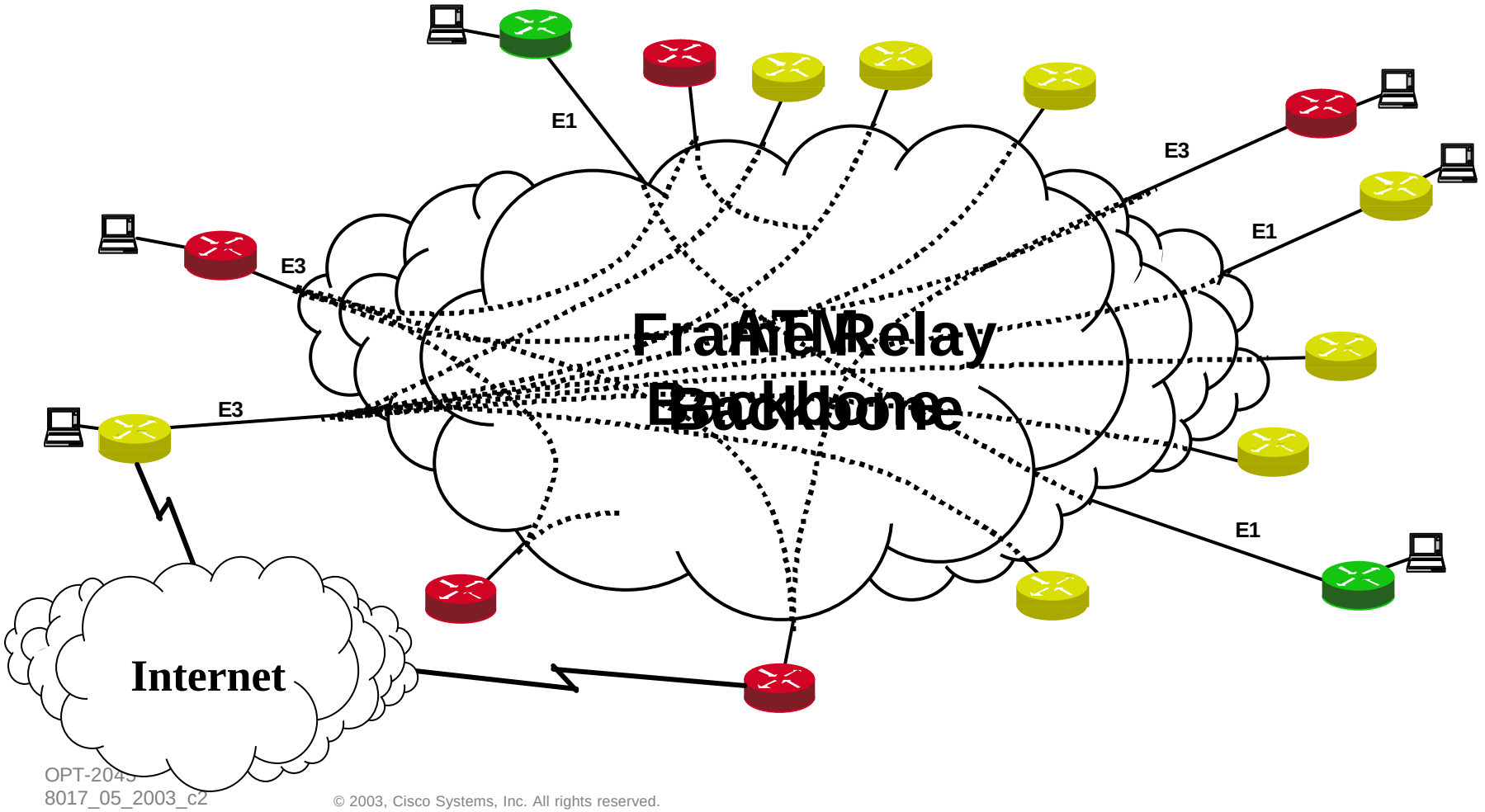
Typical Enterprise Network Architecture



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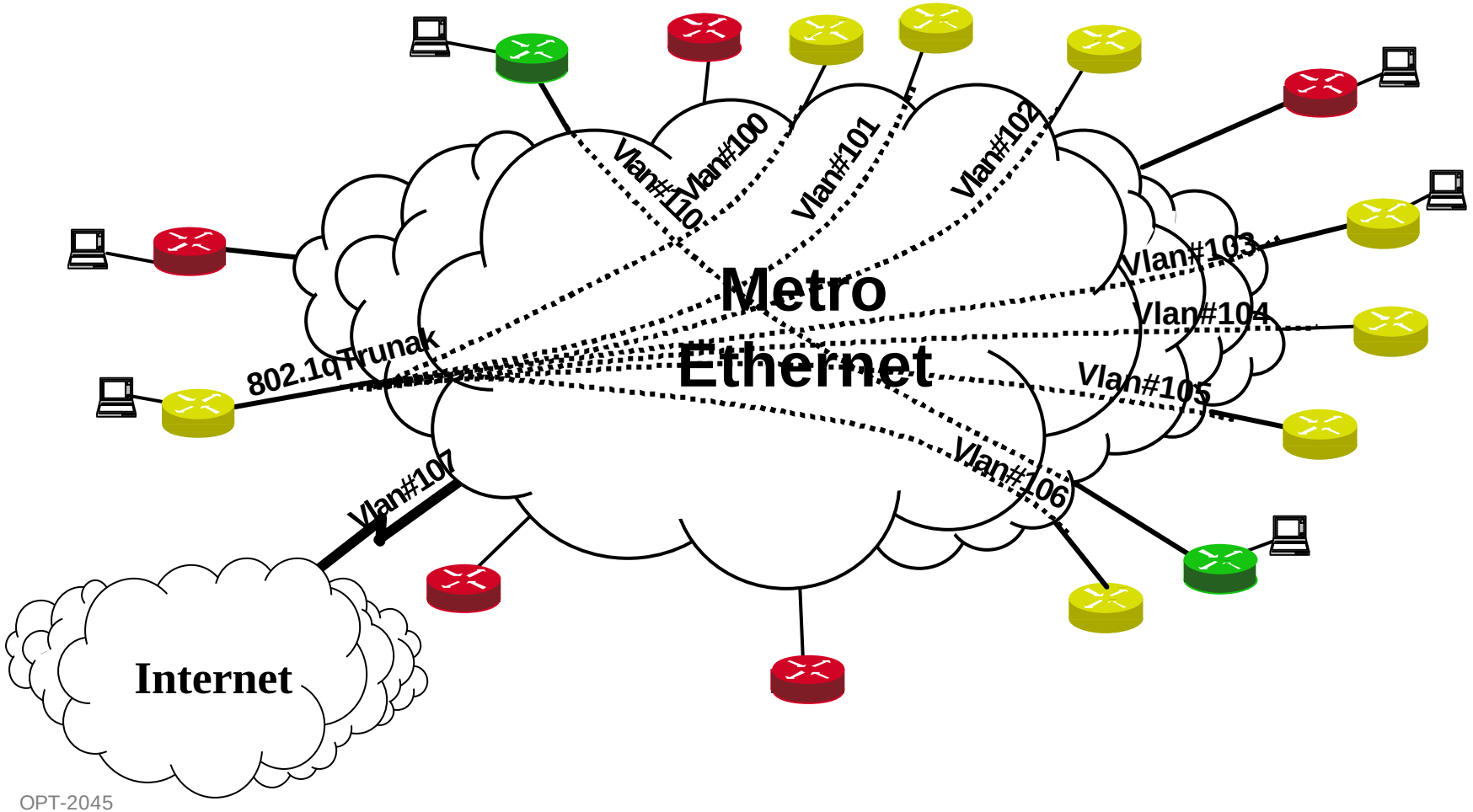
Ethernet Relay Service



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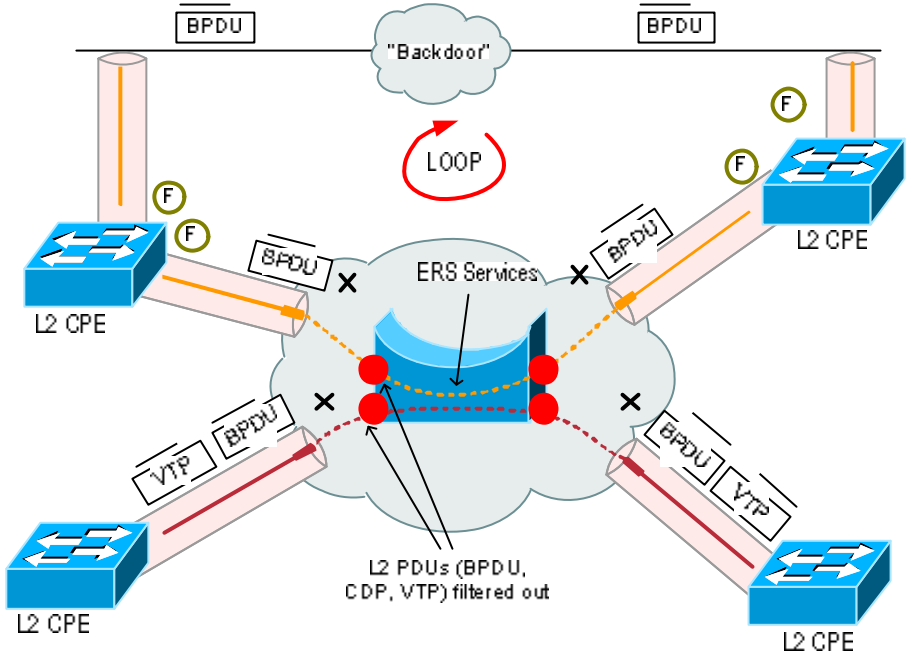
CPE Considerations - ERS and L2 Switches

- ERS is a VLAN service opaque to L2 PDUs
- L2 CPE must use VLAN IDs determined by SP
- STP loops cannot be detected in the presence of "Backdoors"
- A "Backdoor" could be a service from another SP
- In a loop-free scenario:

  STP domain partitioned, one root on each side

  VTP advertisements will not flow end-to-end



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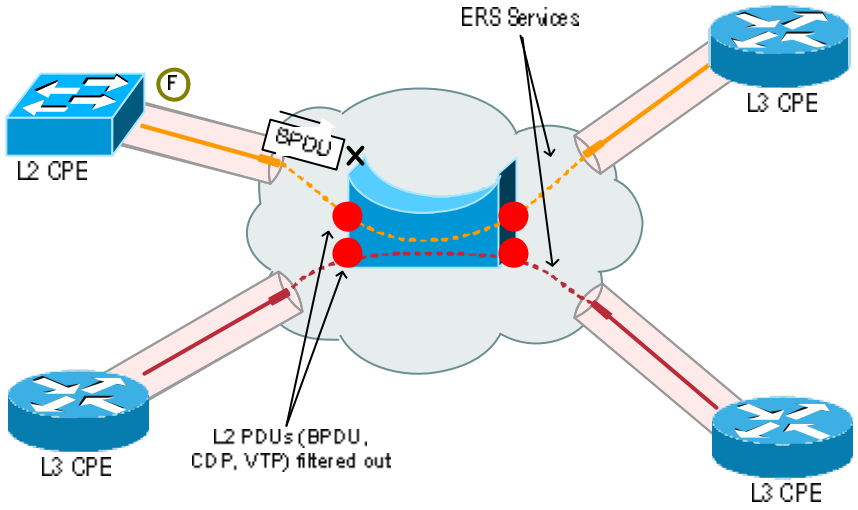
CPE Considerations – ERS Valid Combinations

- ERS is mainly intended for L3 CPEs or any other scenarios where L2 PDU transparency is not required
- SP should protect the UNI against un-expected L2 PDUs
- L2 CPE to L3 CPE is another valid combination



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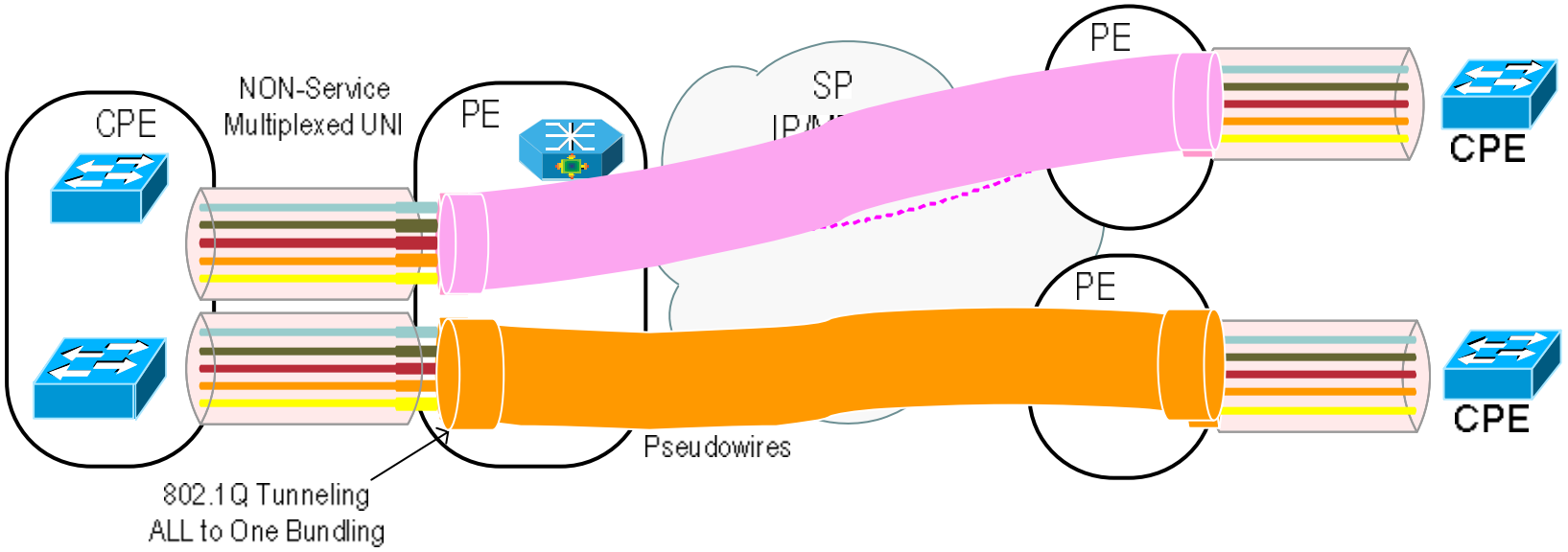
Ethernet Wire Service (EWS)



- **Defines a point-to-point, port-based service**
- **No service multiplexing – "all-to-one" Bundling**
- **Transparent to customer BPDUs**
- **Routers and switches can safely connect**

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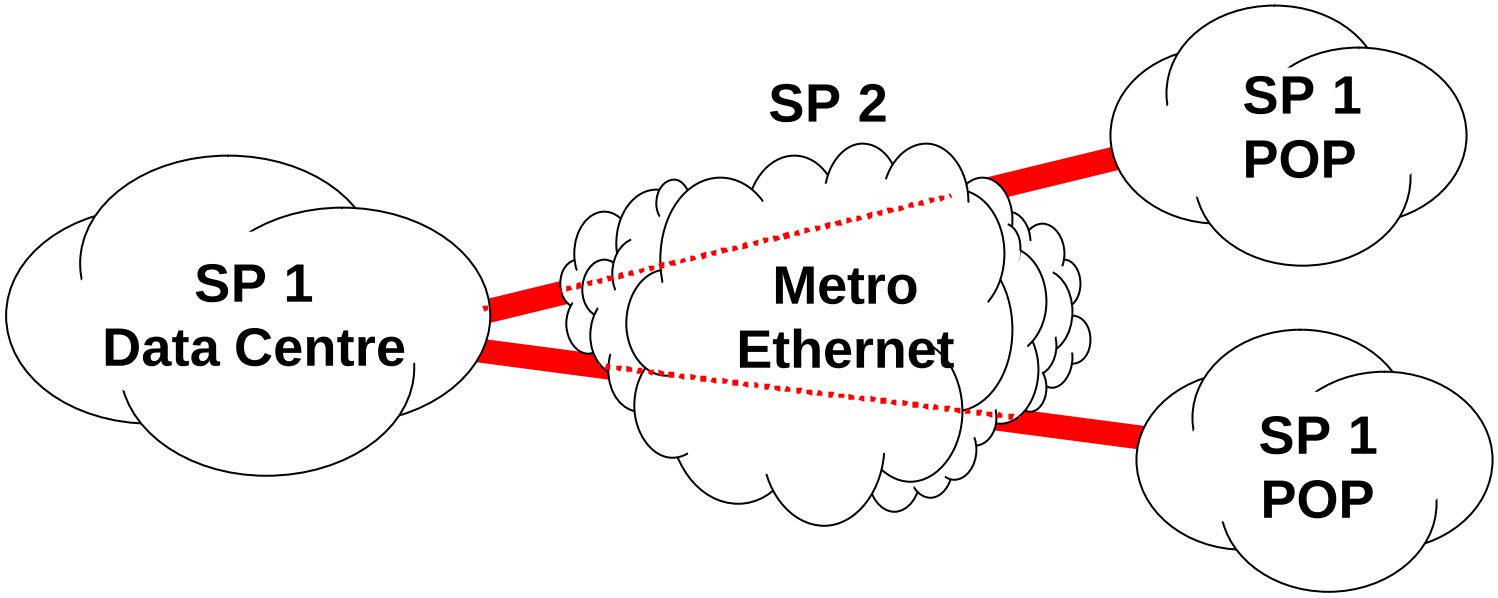
Ethernet Wire Service Example



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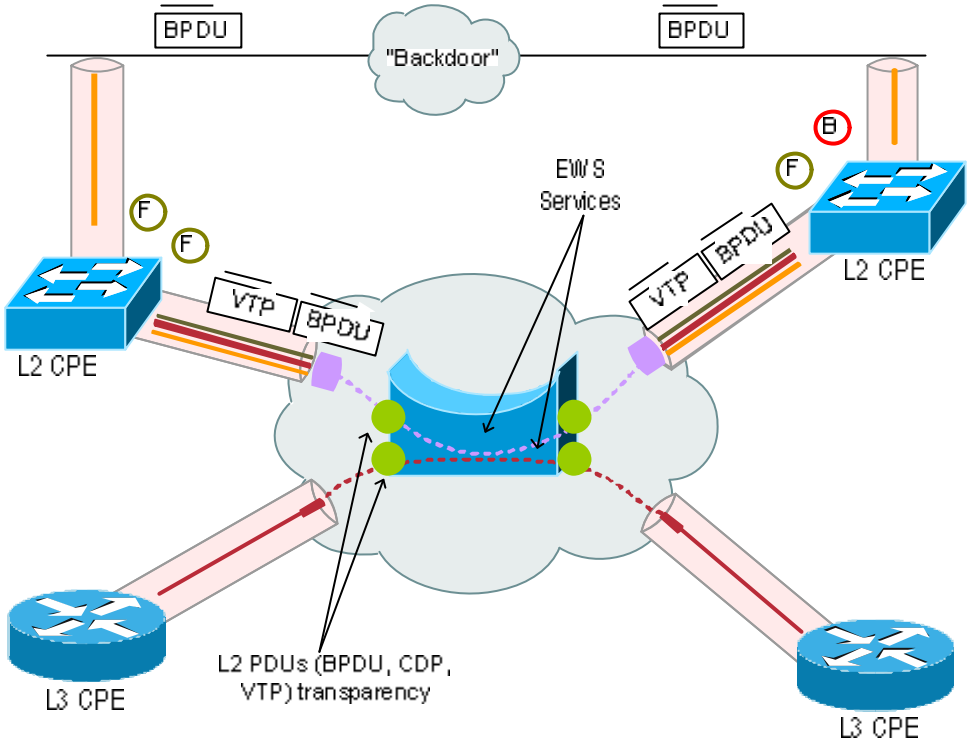
CPE Considerations— EWS Valid Combinations

- EWS is a port based service with L2 PDU transparency
- External loops can be detected by the end devices
- Both L2 and L3 CPEs can be connected to an EWS UNI



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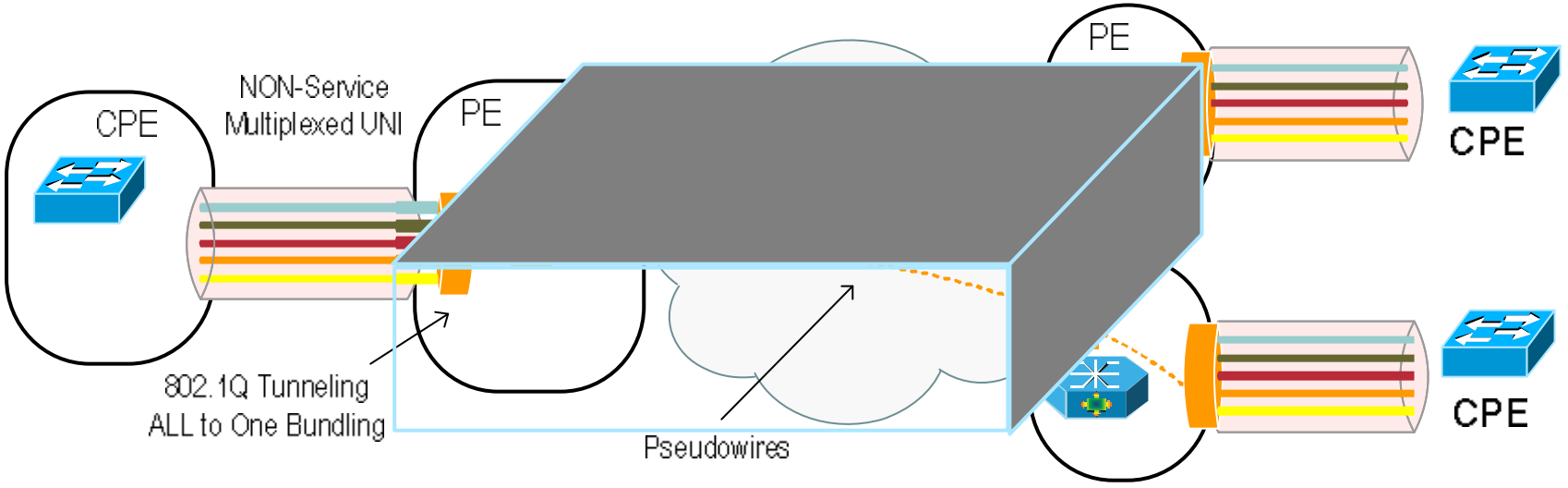
Ethernet Multipoint Service (EMS)



- **Multipoint service where all devices are direct peers**
- **No service multiplexing—all VLANs are presented to all sites (“all-to-one” bundling)**
- **Transparent to customer BPDUs**
- **Routers and switches can safely connect**
  - **Multicast Scaling Issues**

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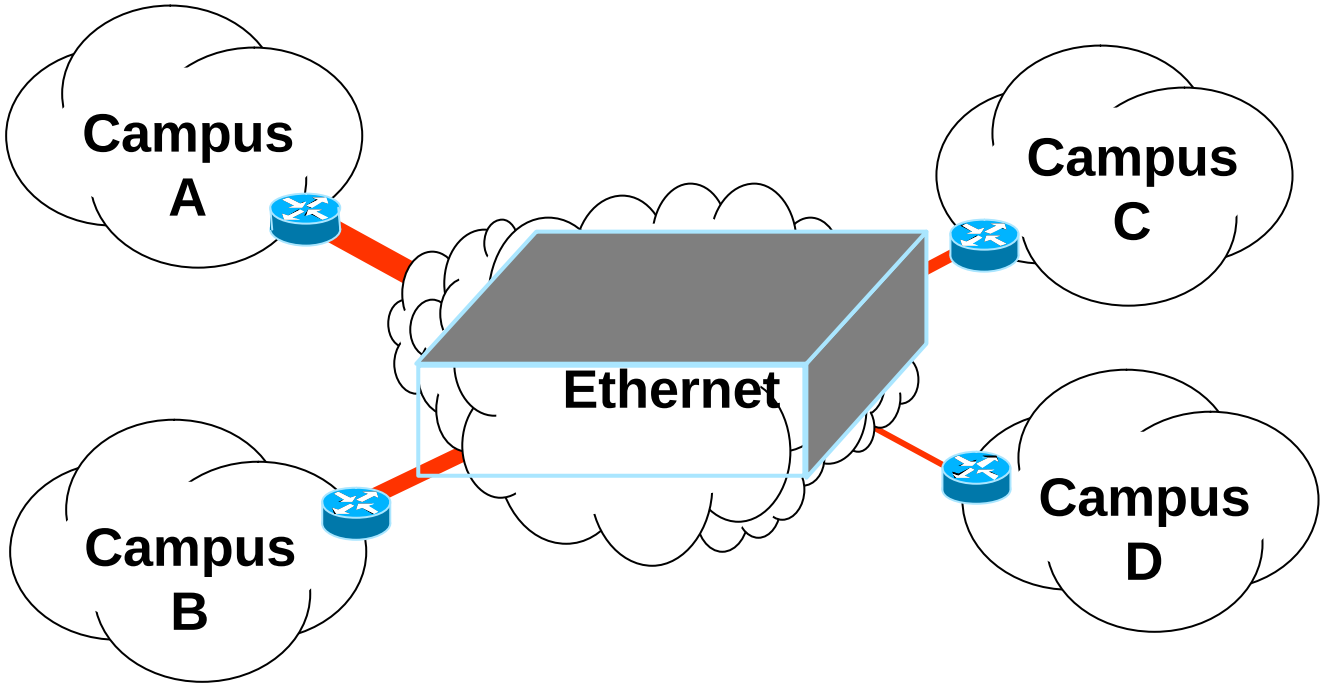
Ethernet Multipoint Service Example



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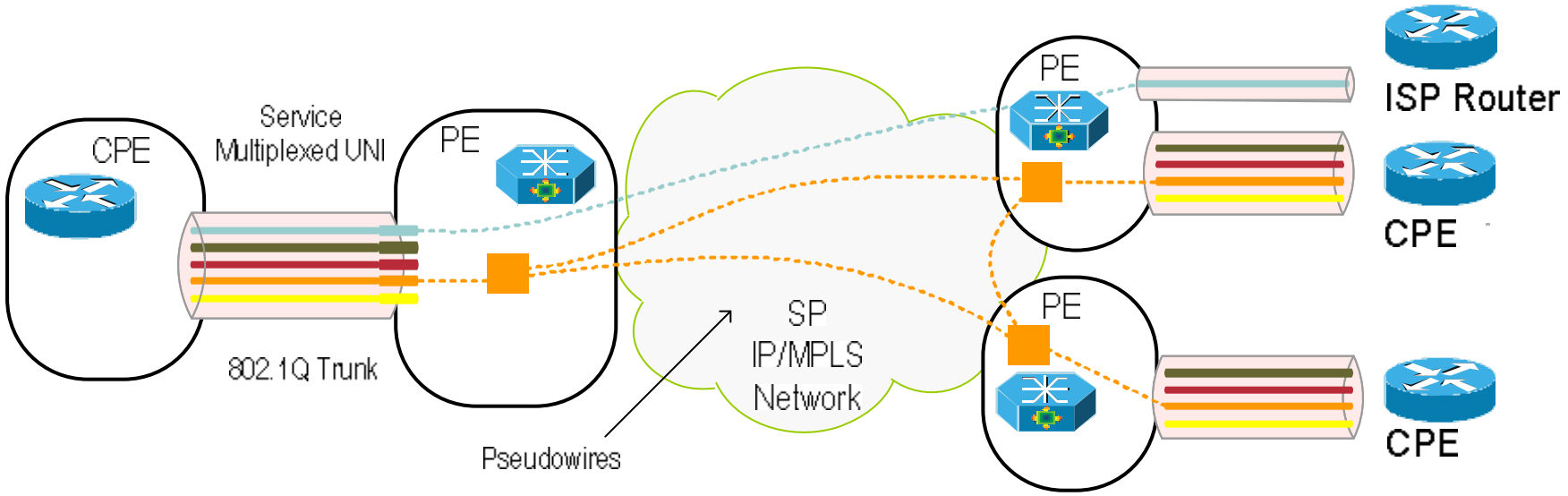
Ethernet Relay Multipoint Service (ERMS)



- **Both P2P and MP2MP Services can coexist on the same UNI**
- **Service multiplexed UNI (e.g. 802.1Q trunk)**
- **Opaque to customer PDUs (e.g. BPDUs)**
- **Routers can safely connect to an ERMS UNI**

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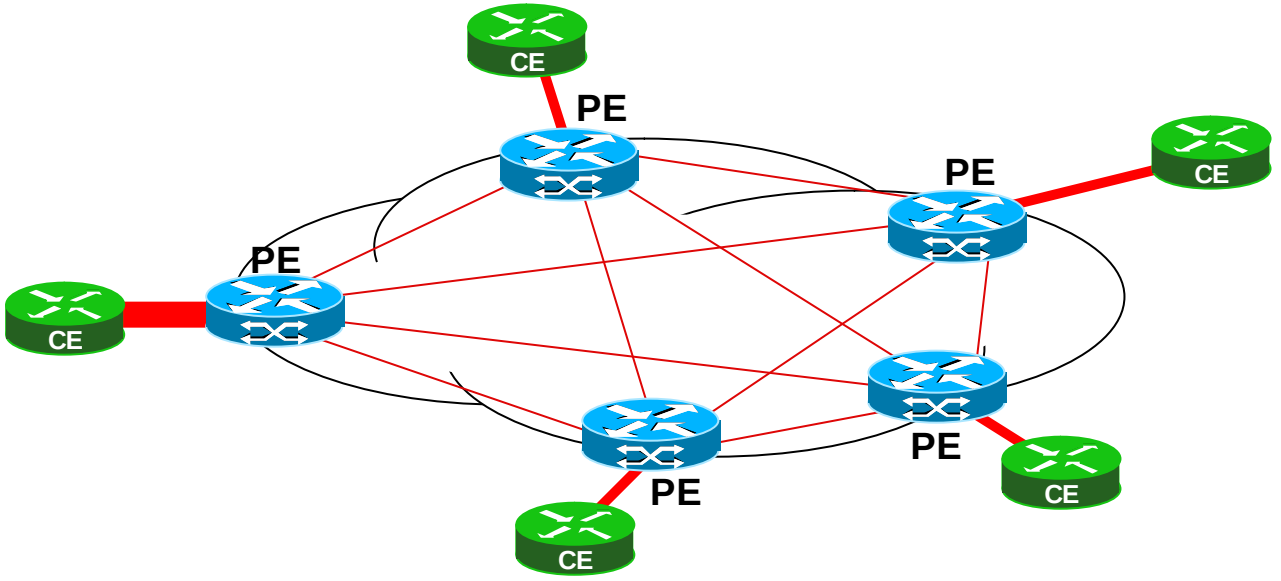
L3 VPN Service



- **L3 MPLS VPN Service**
  - **Scalable Any-to-Any connectivity**
  - **Internet & Intranet**
  - **Managed & Unmanaged Service**

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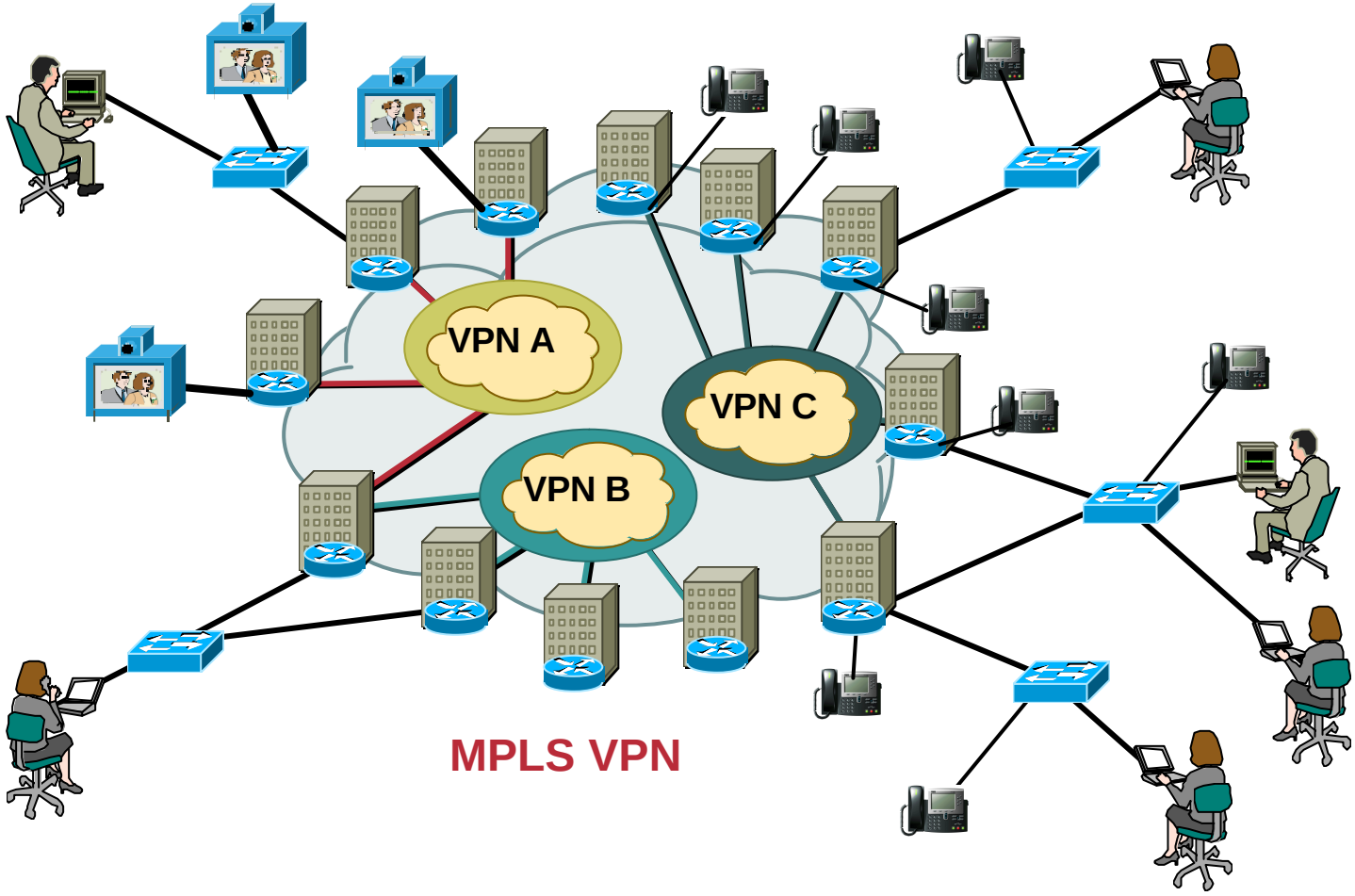
L3 VPN Applications



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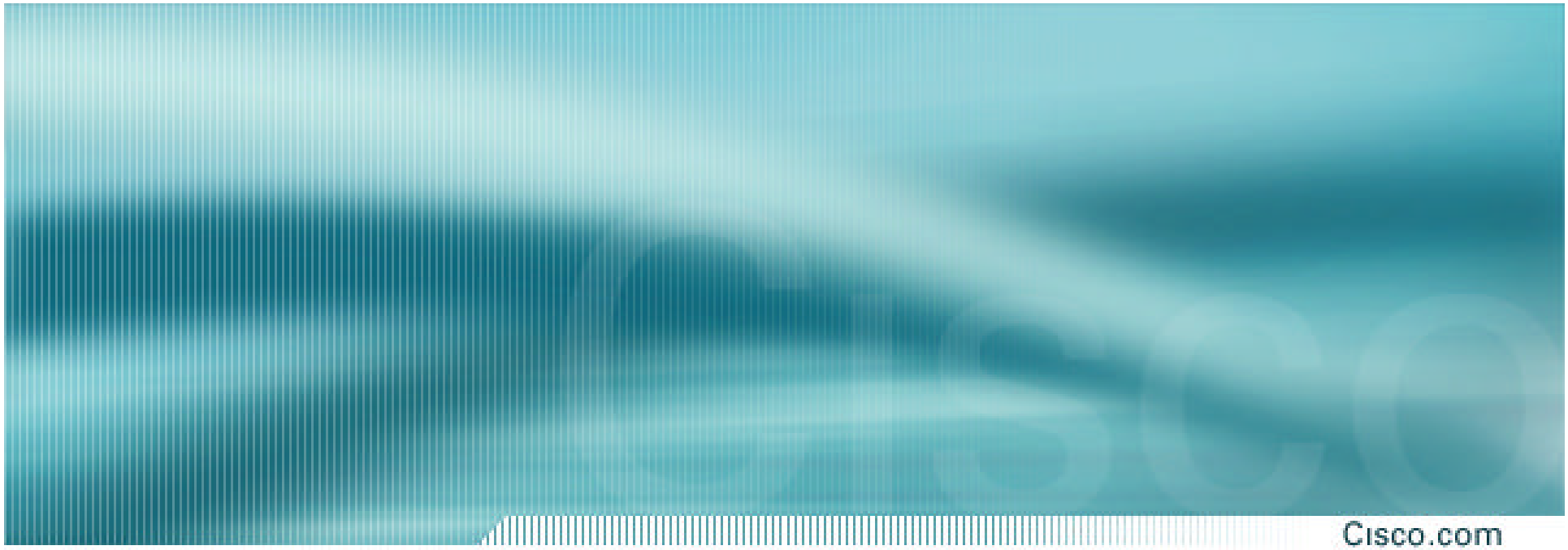

MPLS Services

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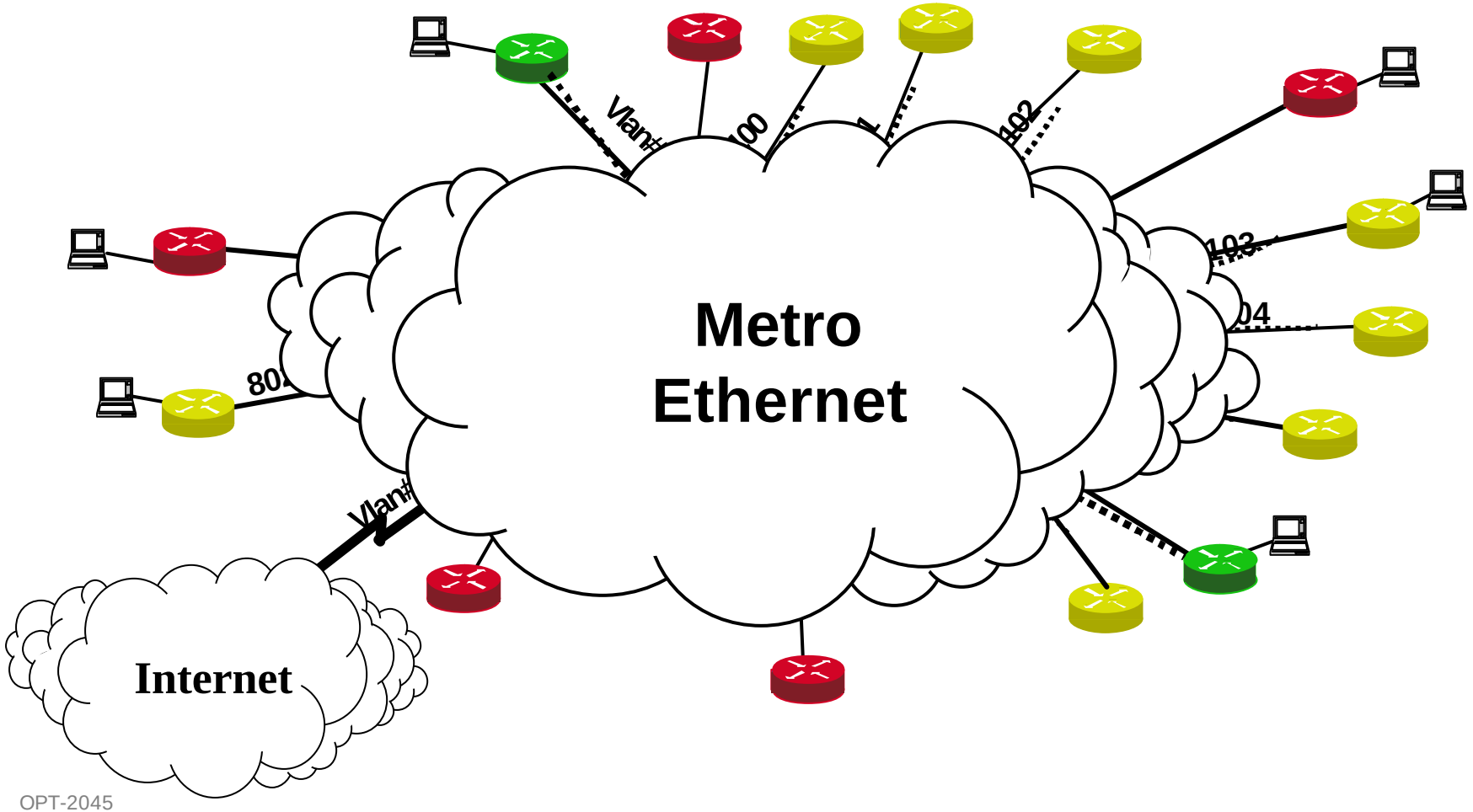
Metro Ethernet Architecture



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Switch based Metro Ethernet Network

- **Pros**
  - **Relatively inexpensive**
  - **Simple, easy to build**
- **Cons**
  - **4K VLAN ID limitation**
  - **Scaling issue – Spanning tree**

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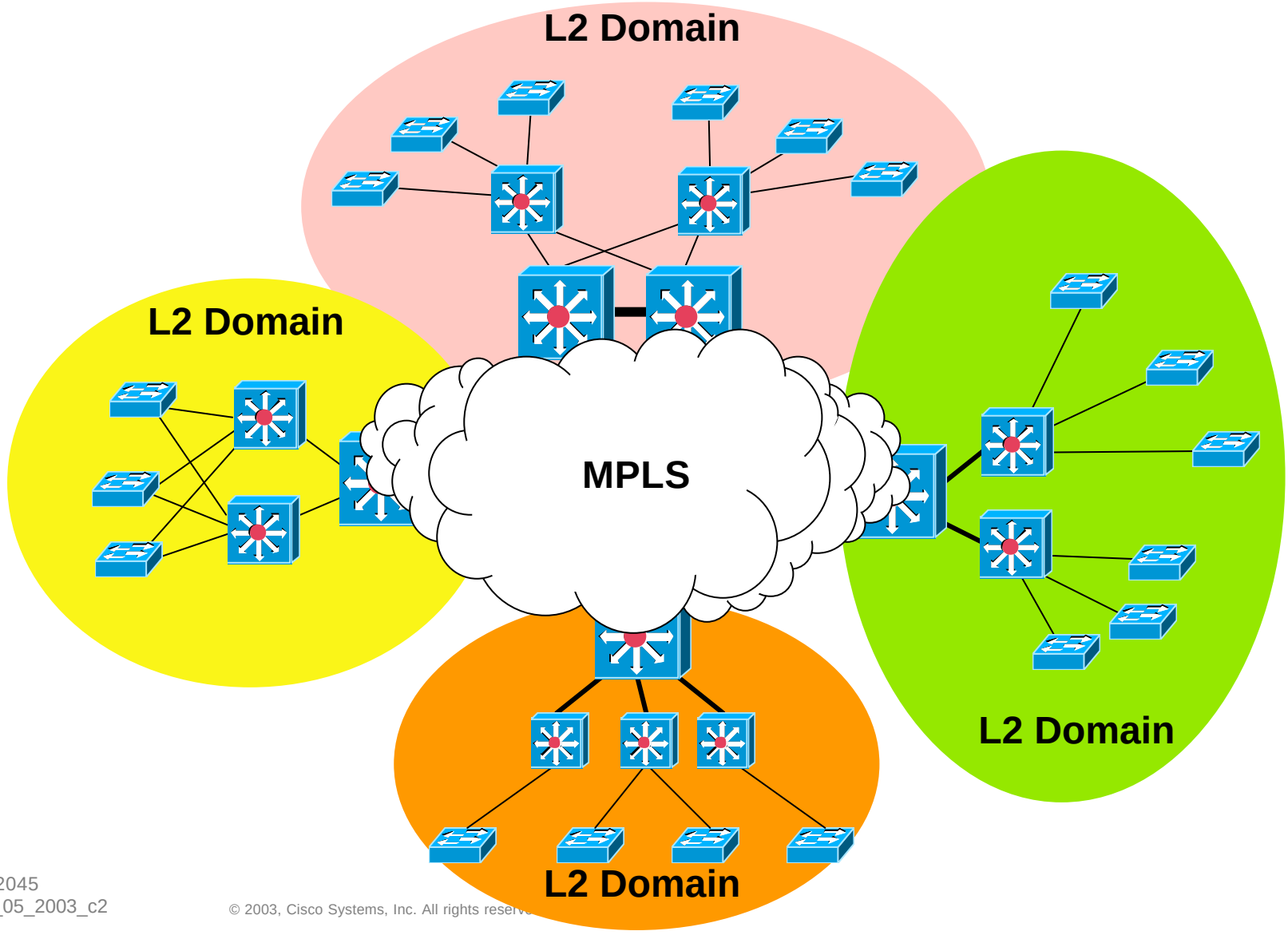
Scaling the Network – MPLS



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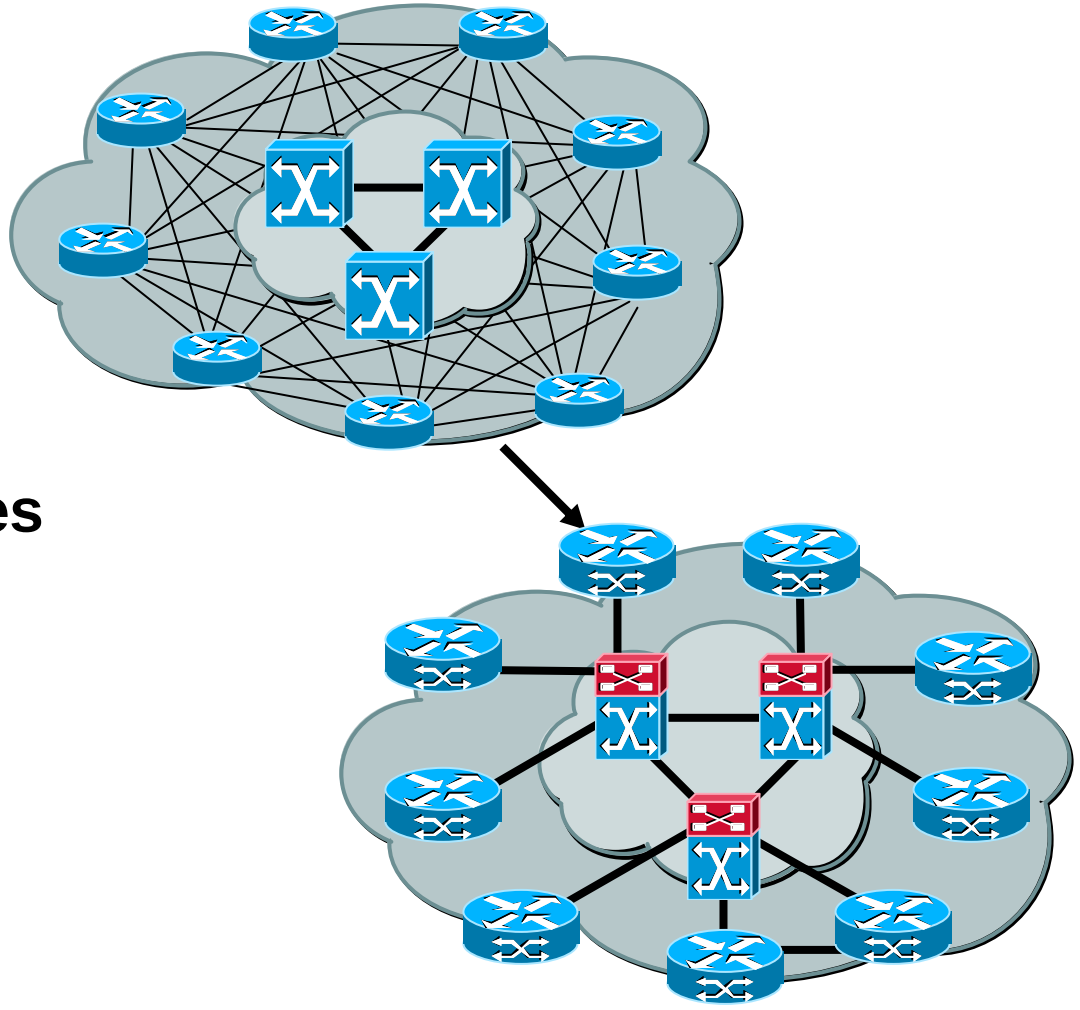
Basic MPLS

- Solve ISP peering problem
- Same as IP routing
- No VPN Services
- MPLS routers/switches
  - Label Distribution Protocol
  - IS-IS or OSPF



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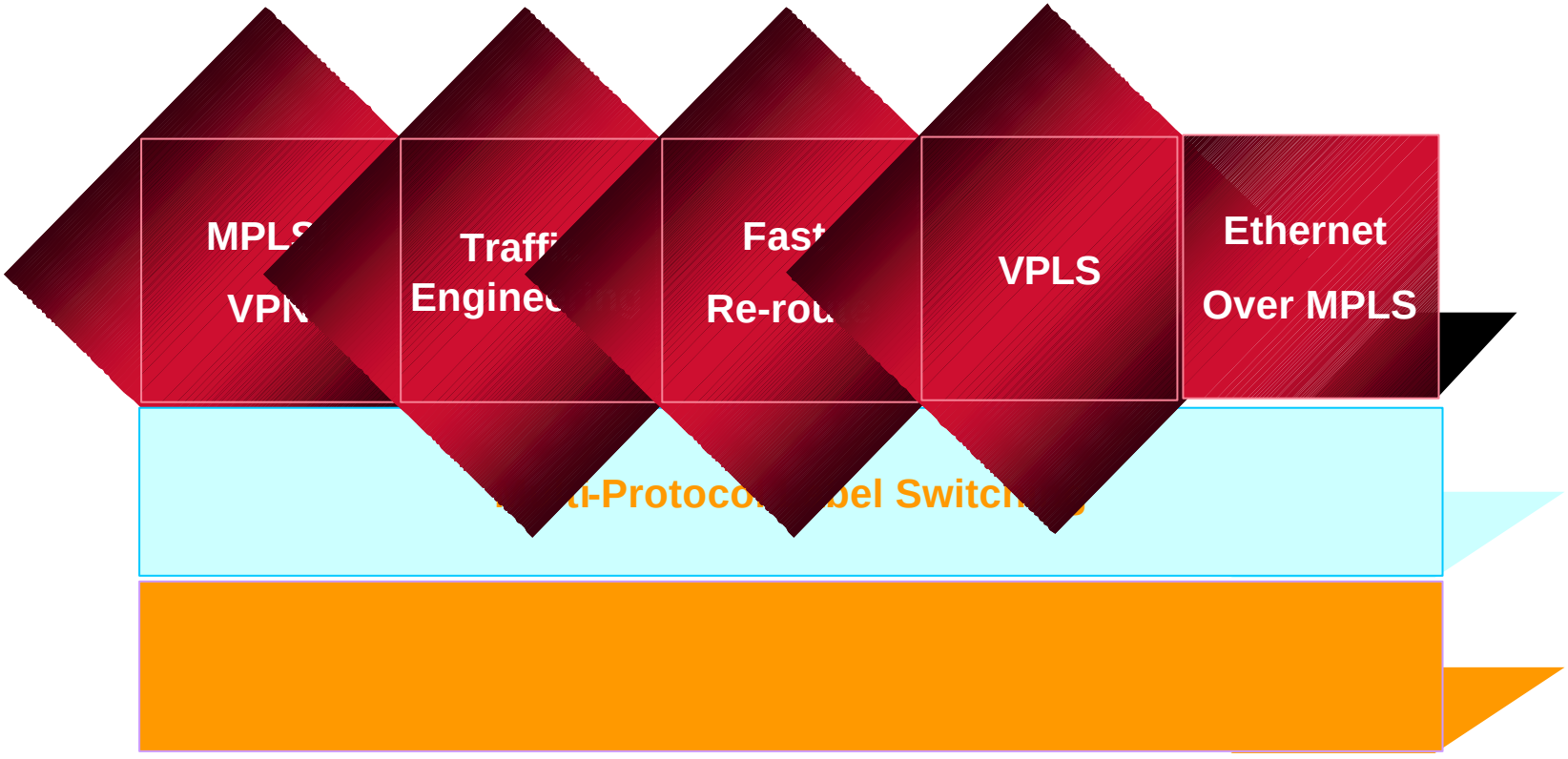
MPLS as a Foundation for Value Added Services



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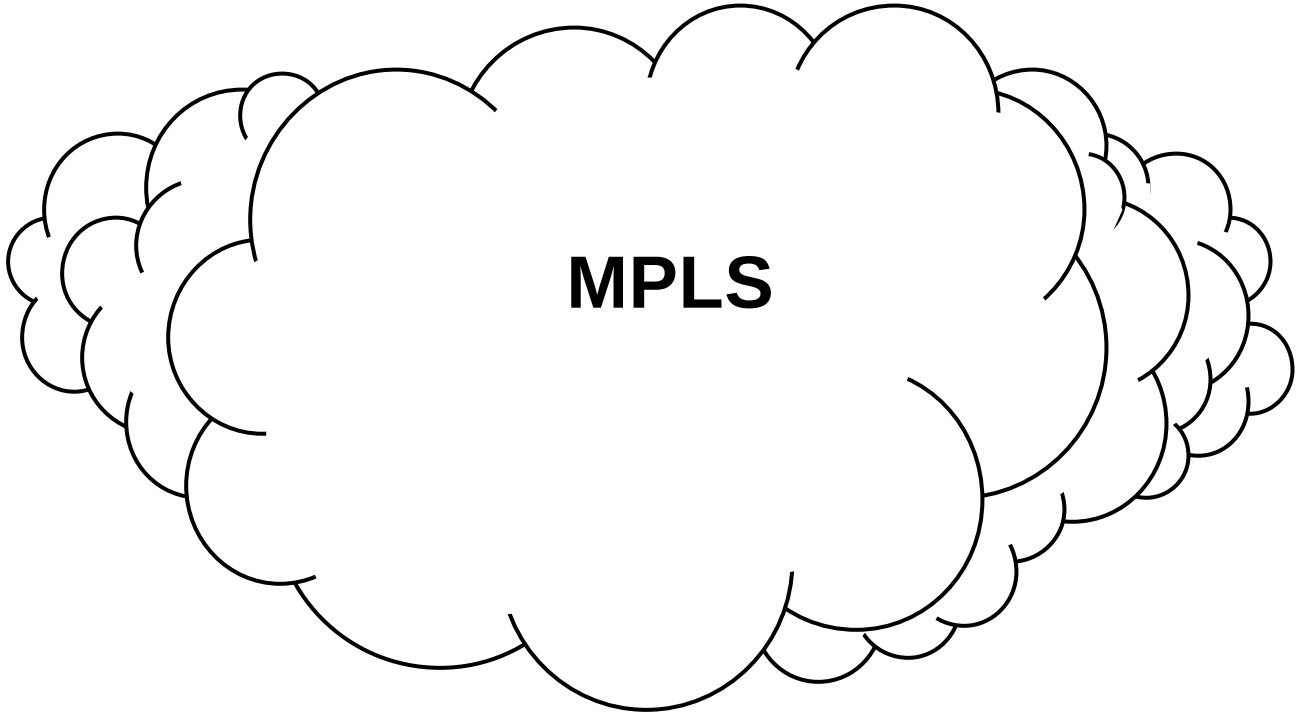
MPLS Components



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EoMPLS - Draft-martini

- The basic idea is to tunnel L2 packets through the MPLS cloud using an LSP tunnel
- A Layer 2 “circuit” is allocated a label and LDP is used to distribute the label-circuit mapping.

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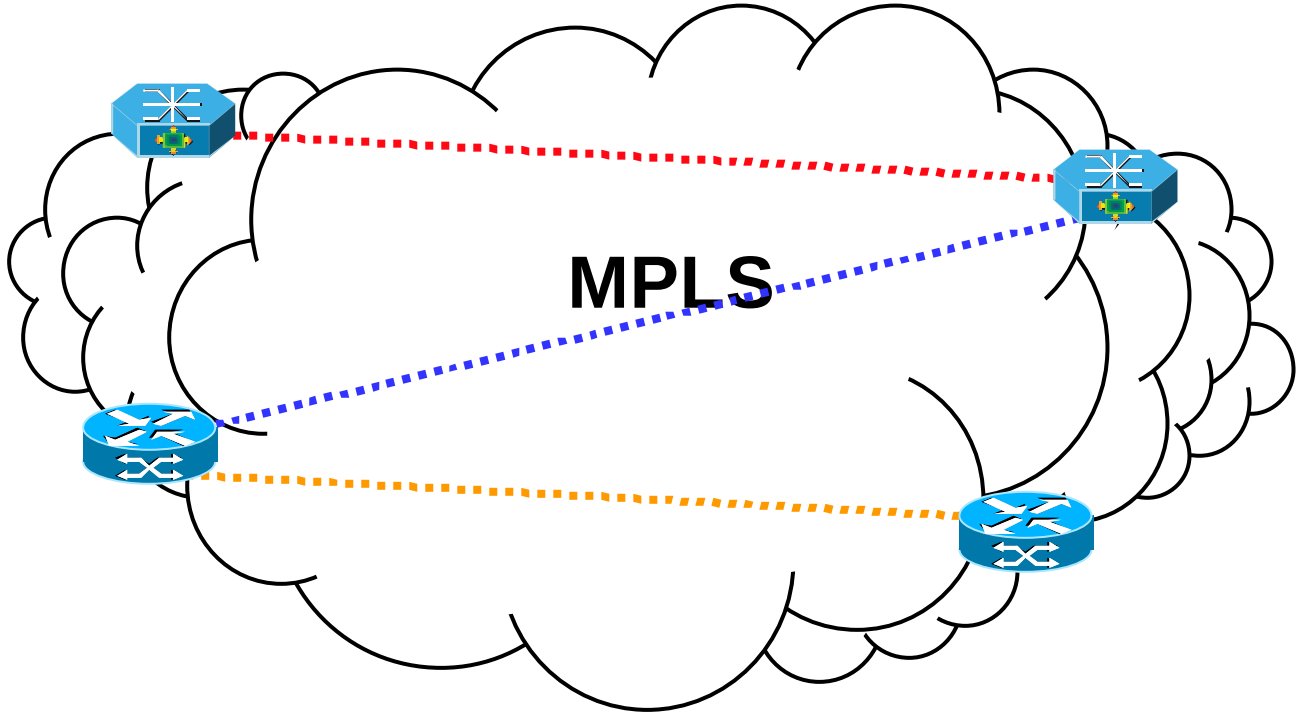
Ethernet Over MPLS (EoMPLS)



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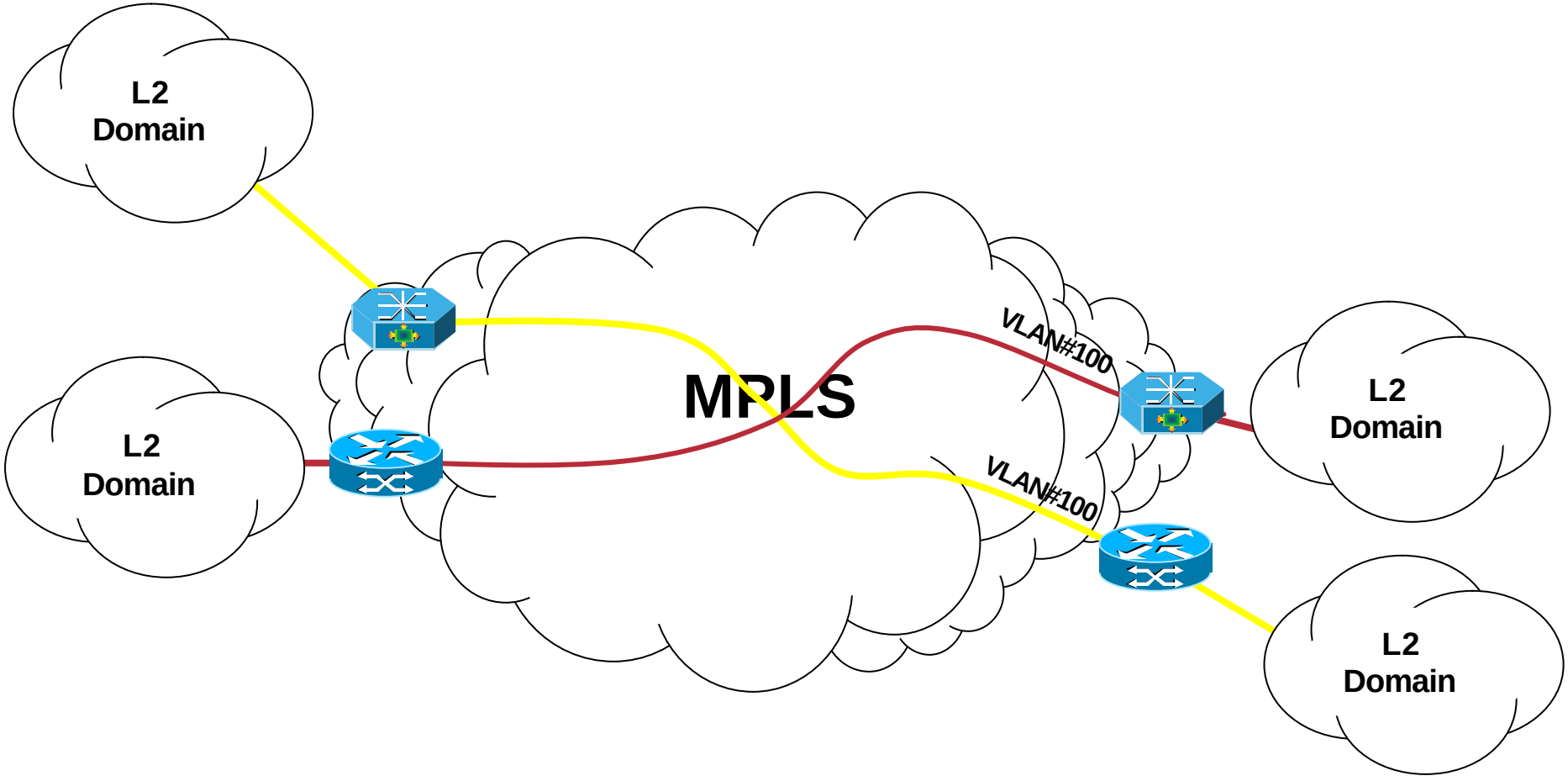
Ethernet Over MPLS (EoMPLS)



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What is VPLS?

- A Virtual Private LAN Services (VPLS) is a multipoint Layer 2 VPN that connects two or more customer devices using Ethernet bridging techniques
- VPLS is an ARCHITECTURE defined within IETF
- A VPLS emulates an Ethernet Switch with each EMS being analogous to a VLAN

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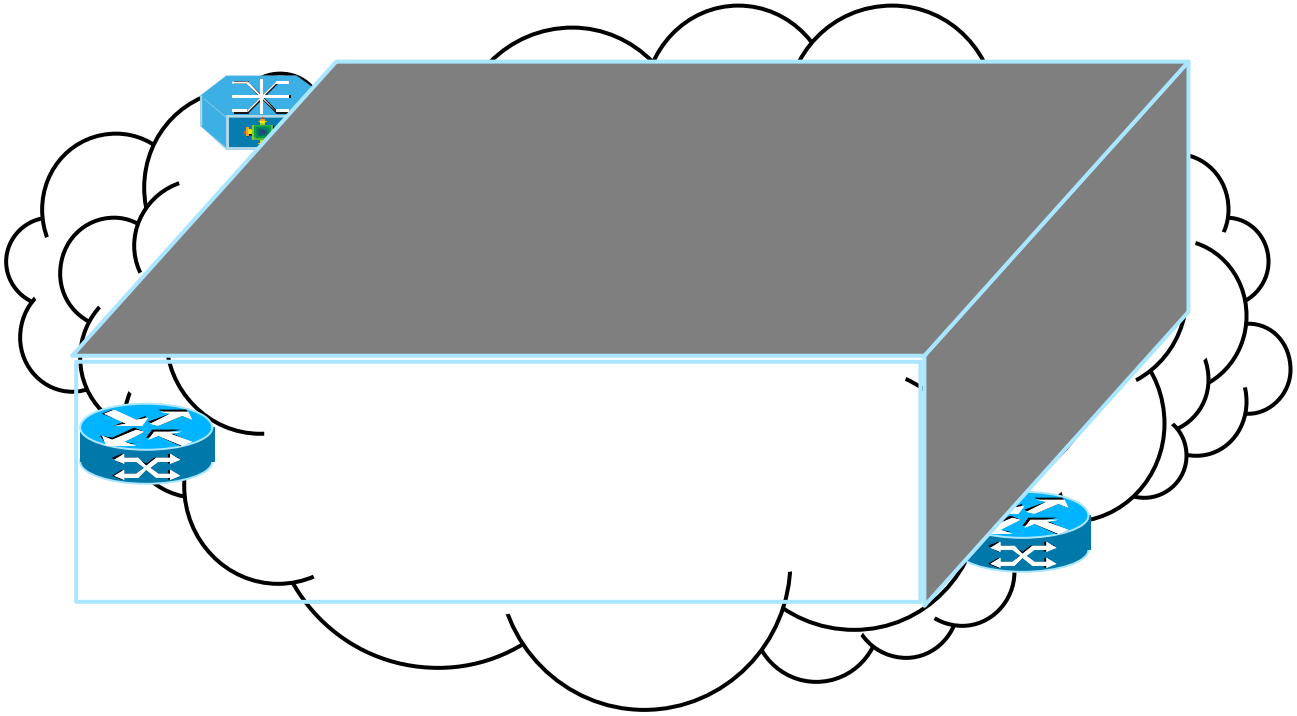
VPLS



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How VPLS works

- A VPLS essentially emulates an Ethernet switch from a users perspective
  - All connections are peers within the VPLS and have direct communications
- The architecture is actually that of a distributed switch
- A VPLS forwards frames based upon bridging techniques
  - Self learns Source MAC to Port Associations
  - Floods unknown destination addresses, broadcast and multicast packets
- A VPLS does not run Spanning tree

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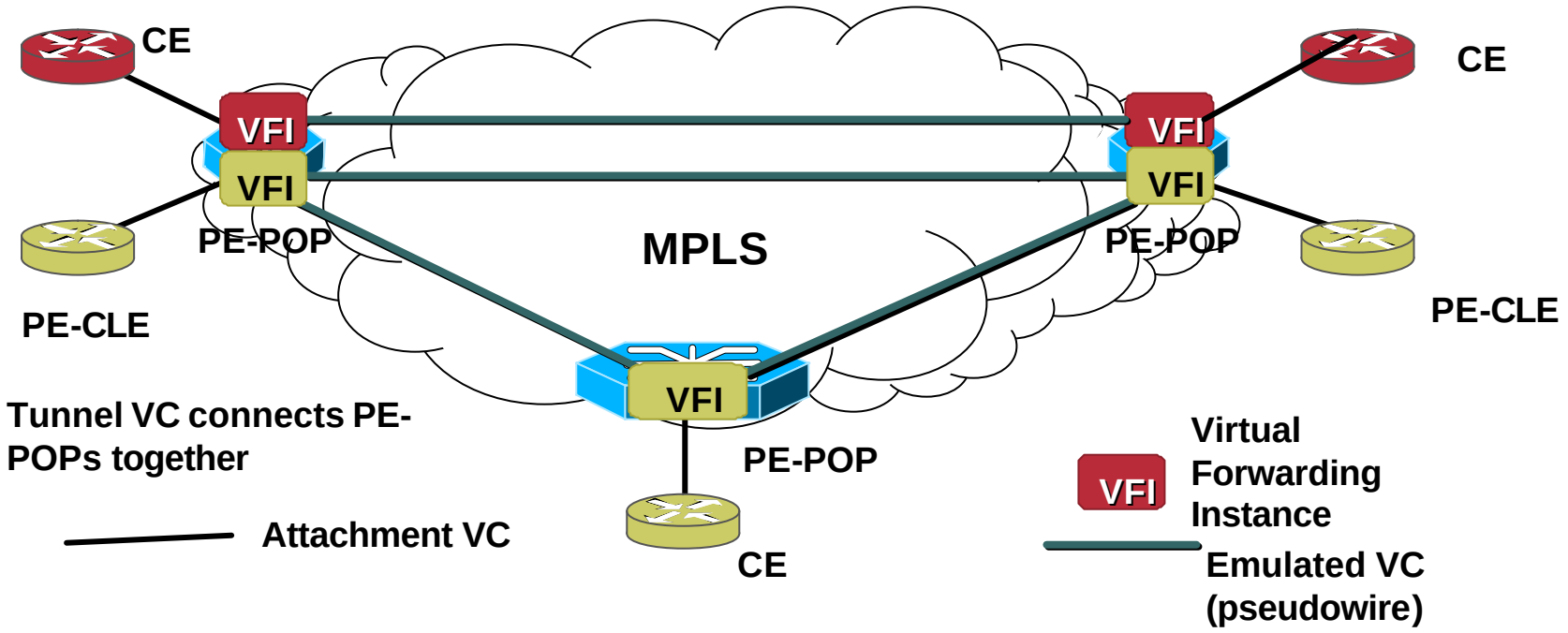
VPLS



- **VPLS runs on the PE-POP's and acts as an overlay on the MPLS Core providing Multipoint Capabilities**

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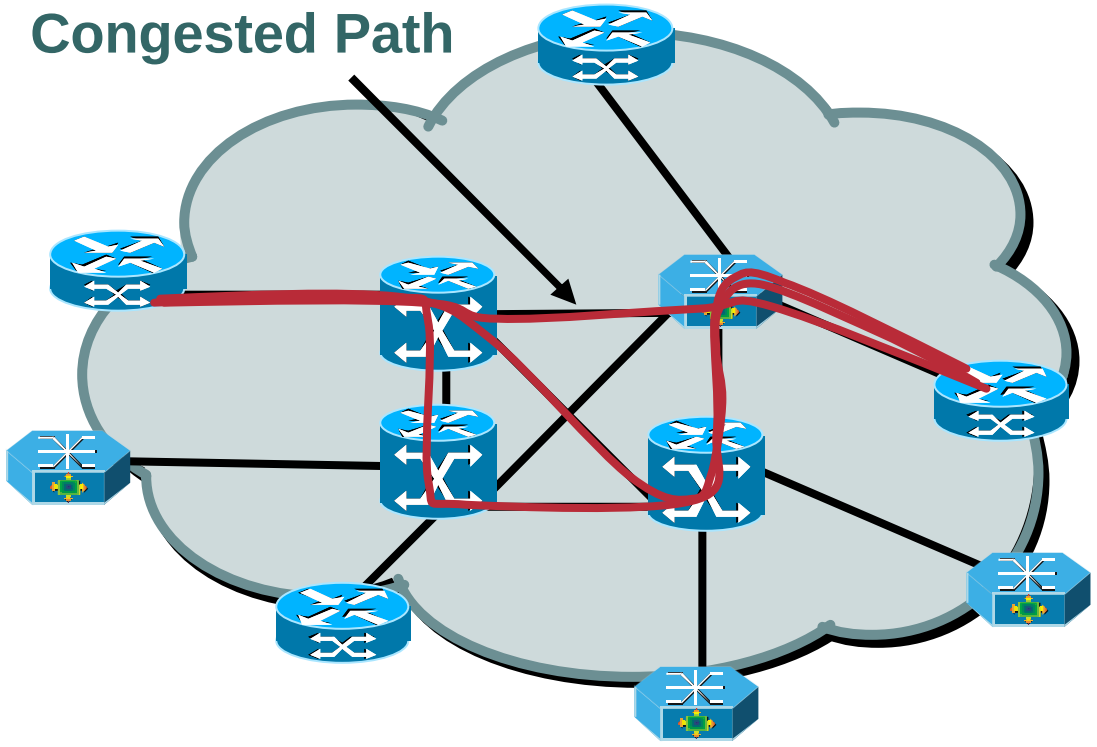
MPLS Traffic Engineering



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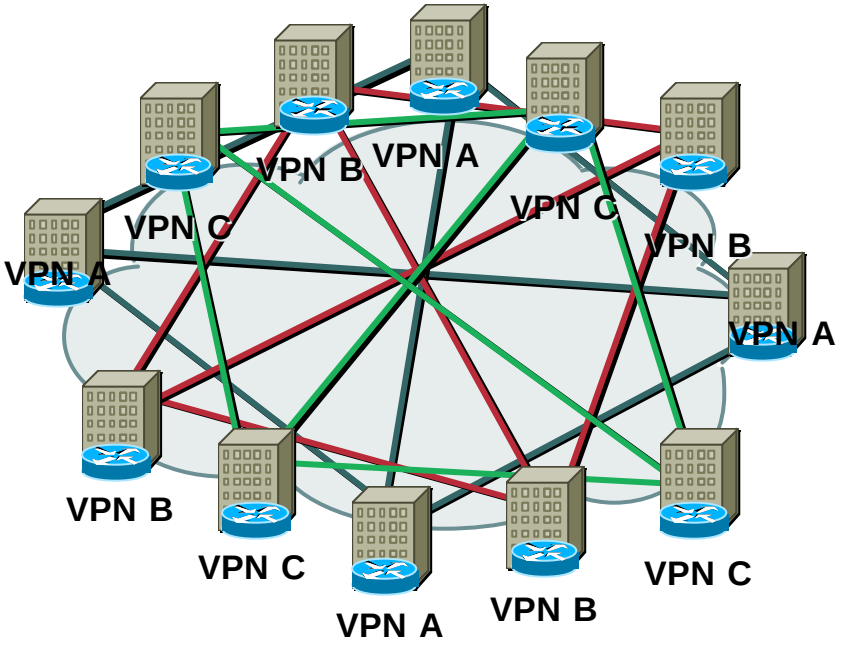
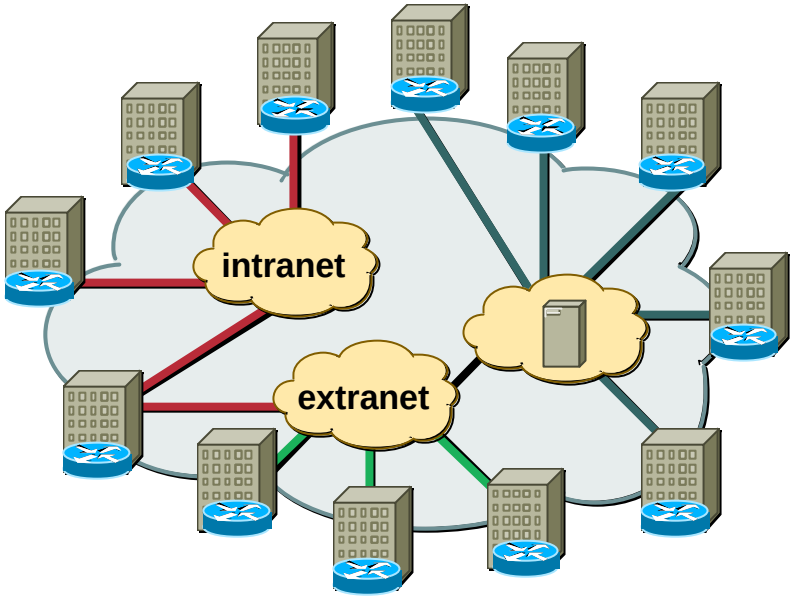
MPLS VPN



Overlay VPN

- Frame Relay/VC privacy
- VC-based
- Frame Relay/ATM aware
- groups endpoints



MPLS-Based VPNs

- Network privacy
- Network-based (subnets)
- IP and VPN-aware
- groups users and services

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MPLS-VPN Benefits

- Any-to-Any connectivity
- Interworks with legacy infrastructure
- Overlapping IP address space
- No VLAN ID coordination
- QoS

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