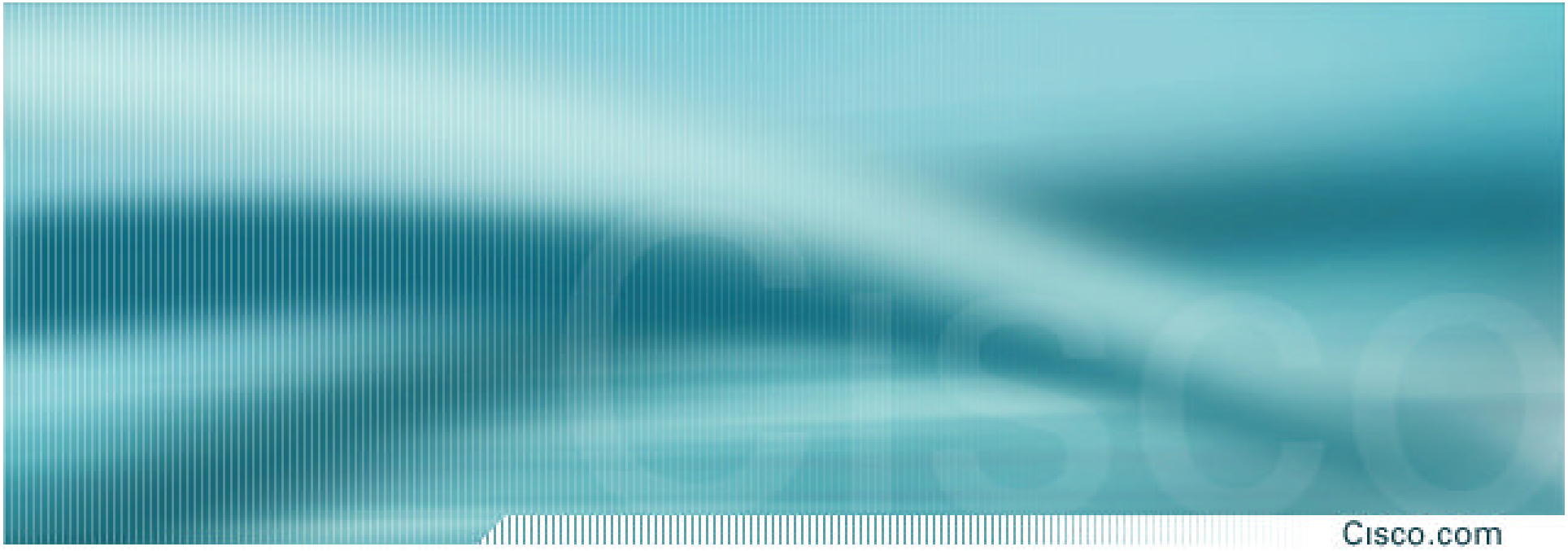

Deploying Metro Ethernet Solutions

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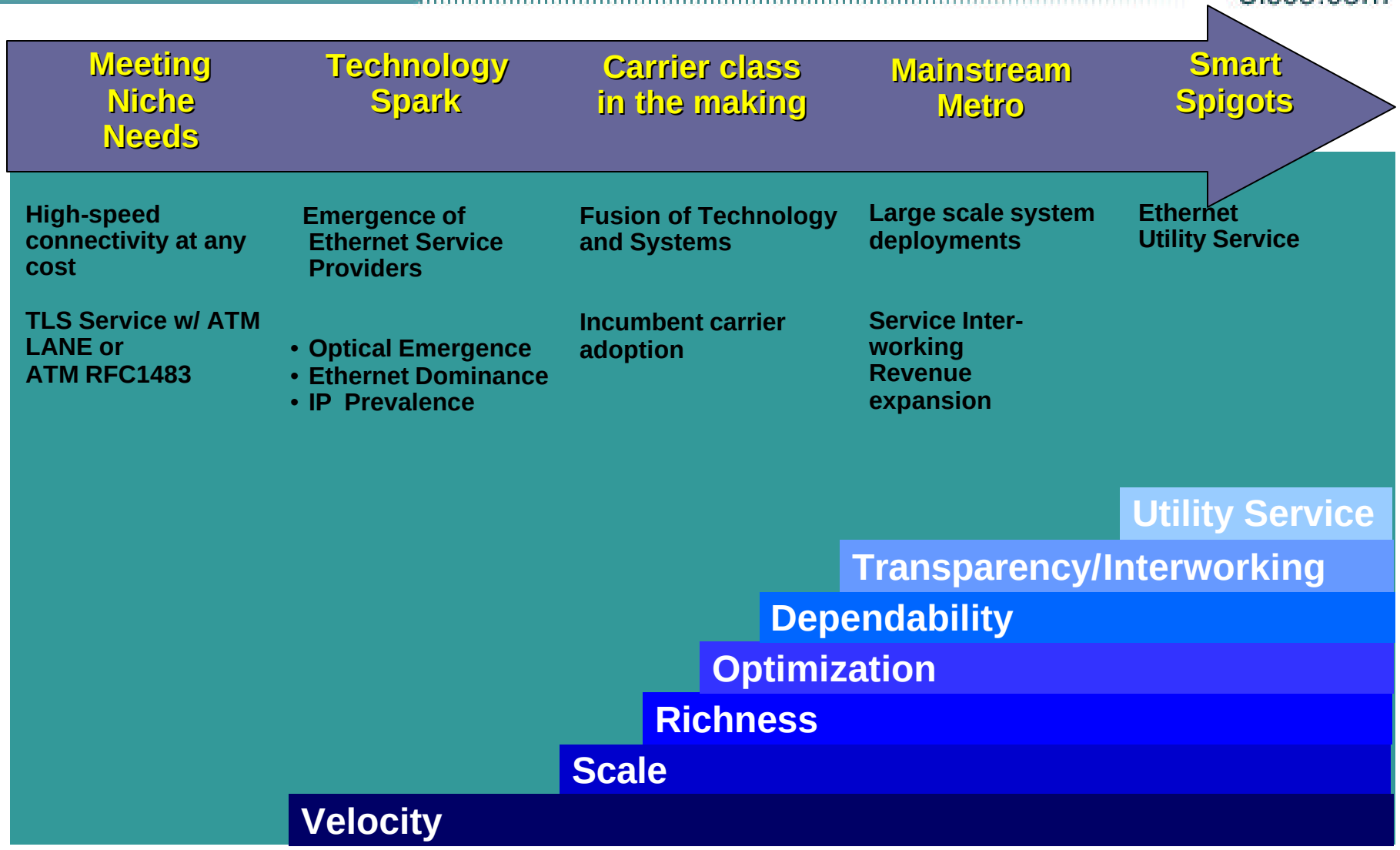
Deploying Metro Ethernet Solutions

Agenda

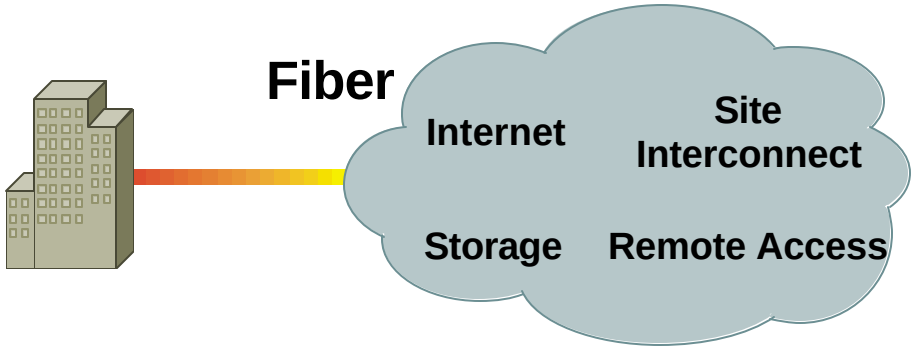
- Metro Services Evolution
- Designing with Fiber
- Designing with 10 Gigabit Ethernet
- Ethernet TLS
- Design Principles
- Metro Ethernet Design Recommendations
- Cisco Metro Solutions

Metro Services Evolution



Fiber Build-Out Changes Metro

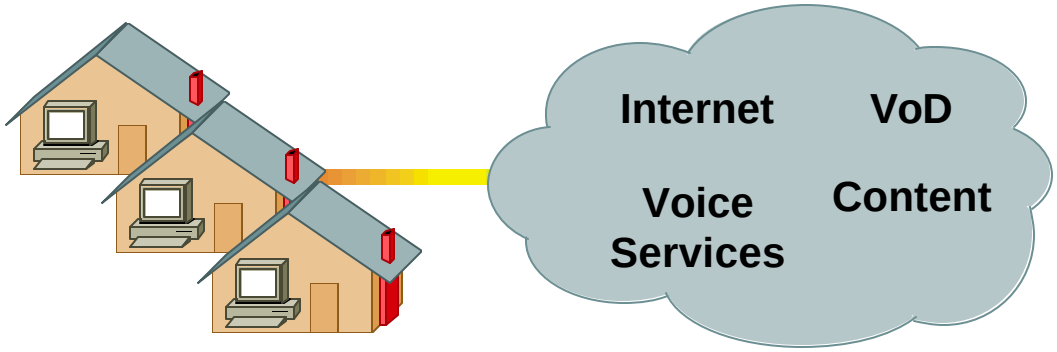
- Fiber reaching 20% of enterprises and growing
- Enterprise looking for interface consolidation of services
- Speed/cost/provisioning advantages



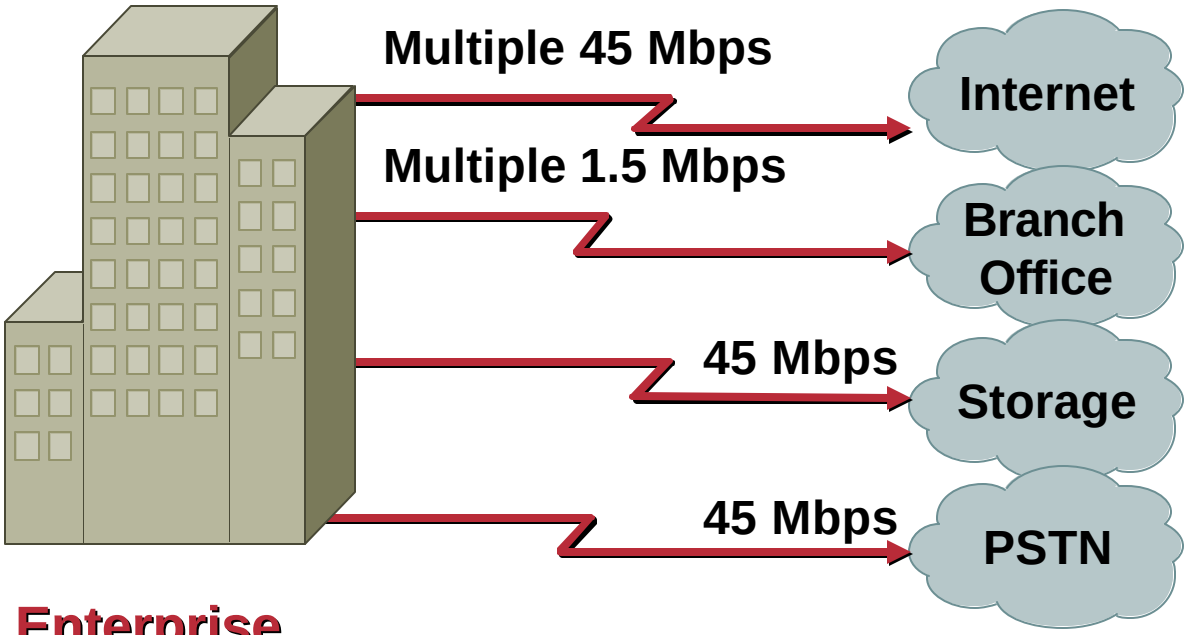
ETTB

ETTS

- Large scale network architecture
- Business model required
- Opportunity for value-added services (content, voice, etc..)



Metro Bandwidth and Service Issues



Enterprise

Large Price Mismatch Between T1s and T3 Service

10x Bandwidth Mismatch Between LAN and MAN

Converged Network for Cost Savings

Service Provider

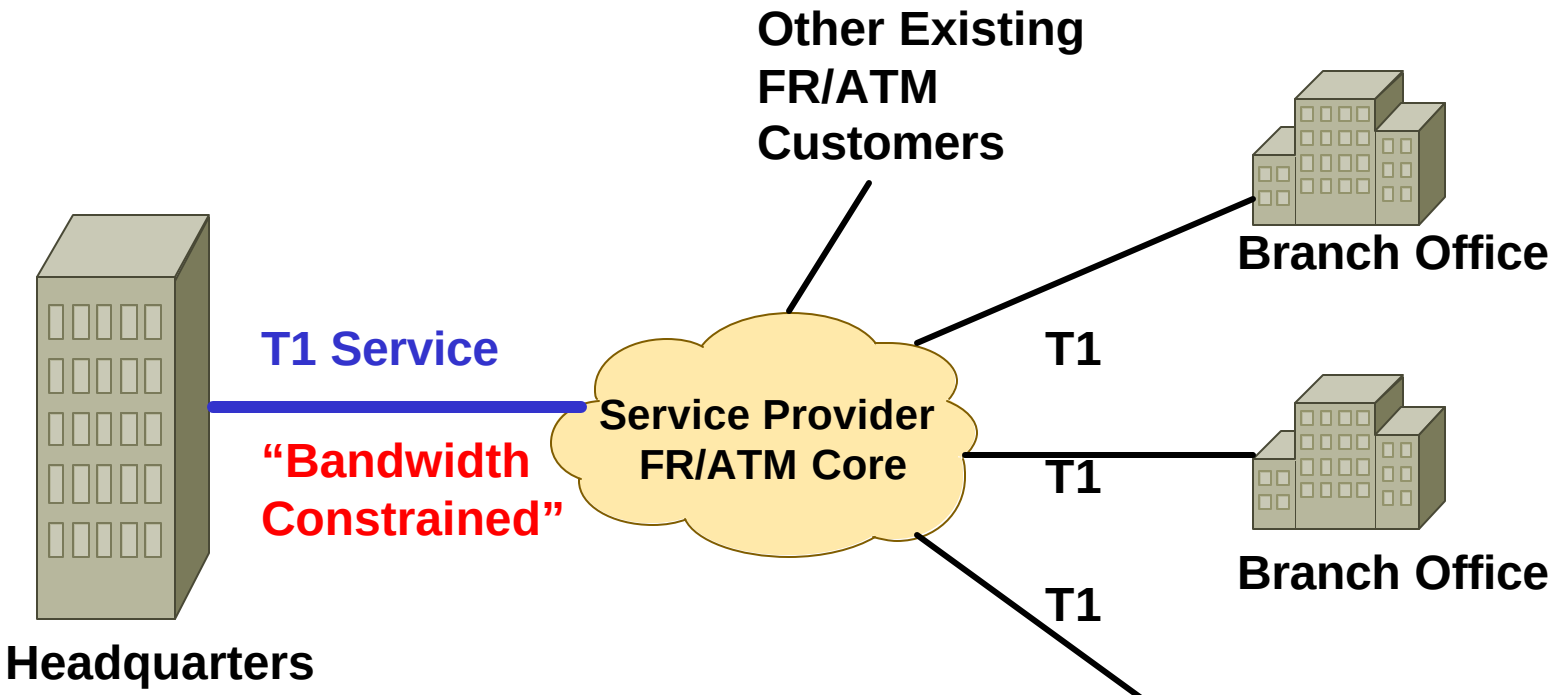
Transporting Data Over a Voice Network

Long Service Provisioning Times

Challenges In Managing Data Networks

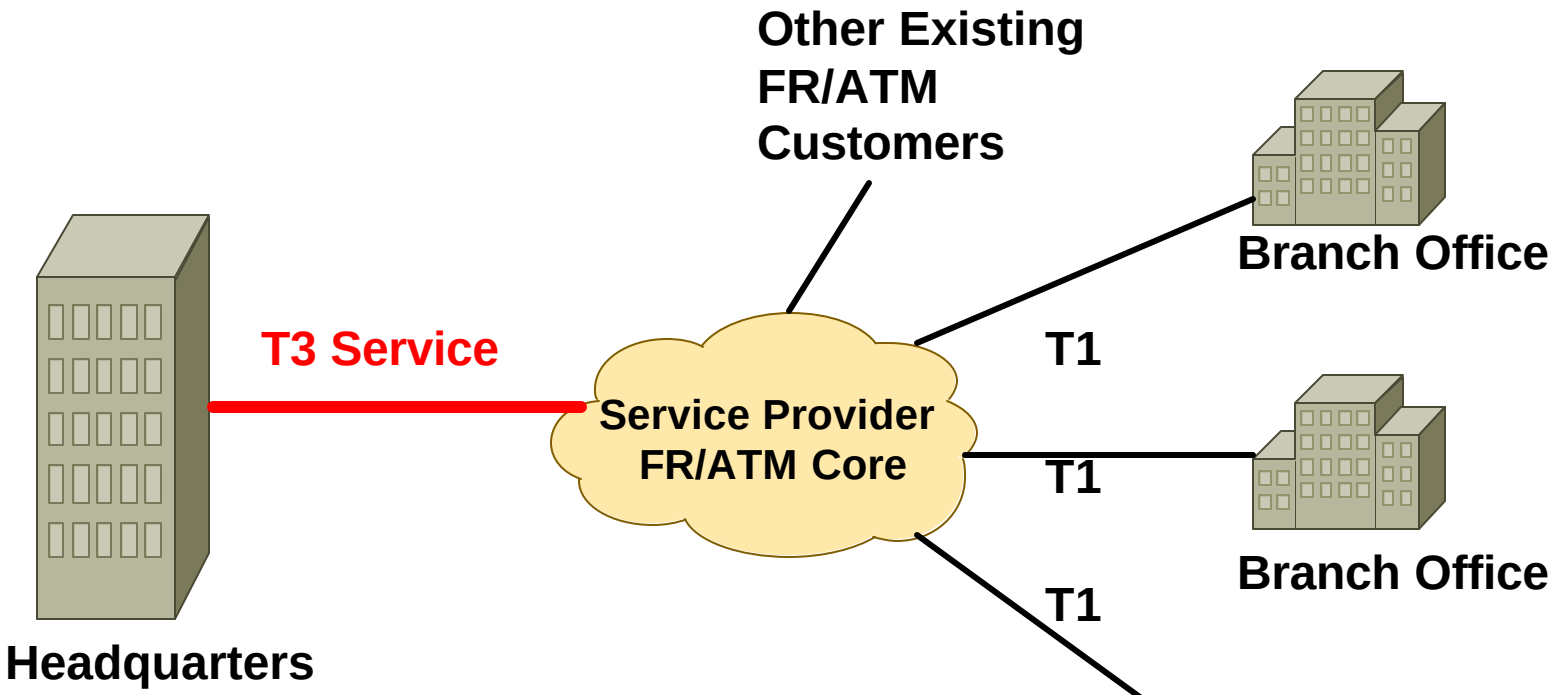
Cannot ProvisionAcross the Data and Transport Network

FR/ATM Services today



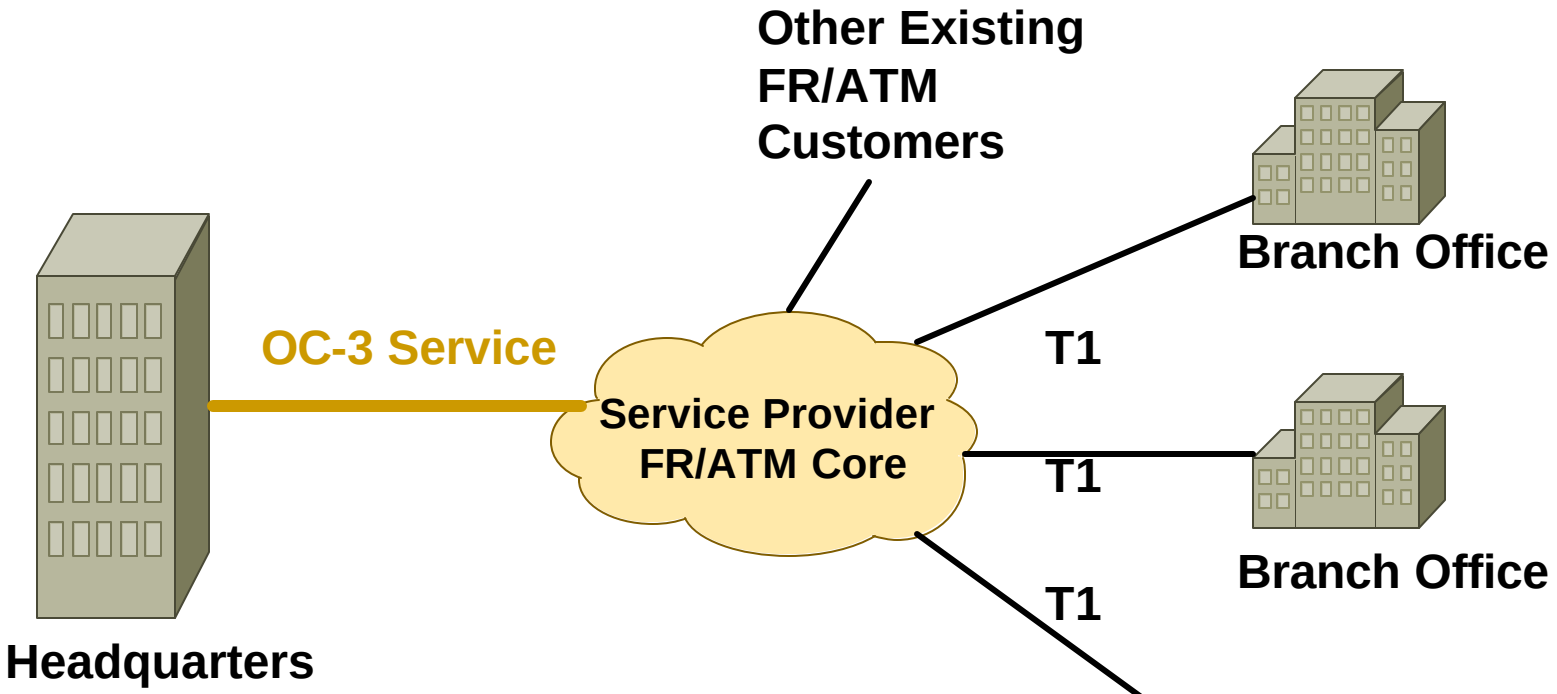
Service provider offerings limited: n x T1
n x T3

FR/ATM Services today



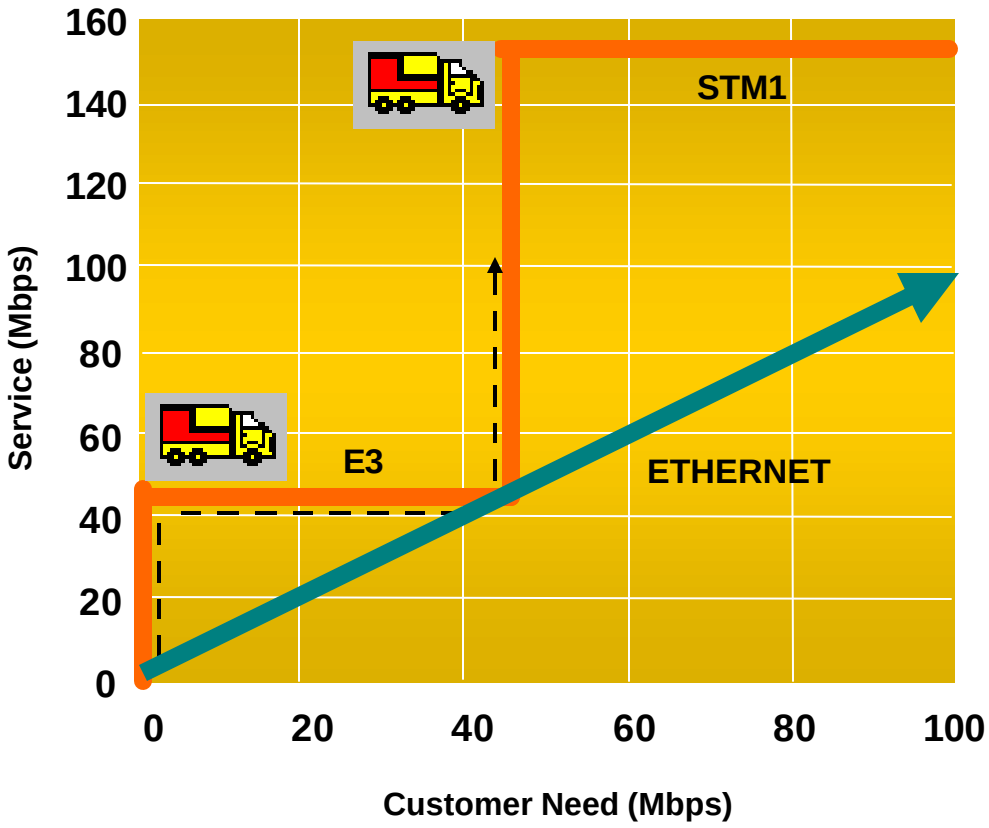
Service provider offerings limited: n x T1
n x T3

FR/ATM Services today



Service provider offerings limited: n x T1, n x T3

Metro Ethernet Service Provider Value



Meet End Customer's Growing Bandwidth Requirement Without Network Infrastructure Change

Reduce CapEx & OpEx

Why Ethernet in the MAN/WAN?

- **Ethernet is the ubiquitous transport in LAN and MAN**
- **IP friendly, cost effective interface**
- **Relatively inexpensive and flexible bandwidth offerings**
- **Scalable 10/100/1000/10000 bandwidth**
- **Geographical independence**
- **Enables new and innovative services**

  IP telephony, storage over IP, managed services (firewall, IDS), etc..

Application Requirements Drive Metro Networking Solution

- LAN interconnect
- Service aggregation
- Interconnect data centers
- Backup and disaster recovery
- Connect to hosting services
- Value-added Services

Transparent Services

High Availability

High Bandwidth

Low Latency

Cost Effective

Manageable and Secure

What Problems Are Enterprises Trying to Solve?

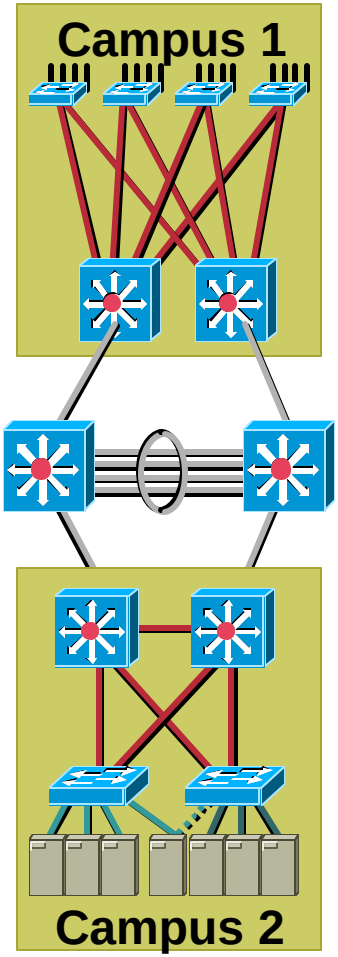
The Requirement Is for Enterprise Applications To Be Available and Perform Well

Networks that Deliver on This Requirement:

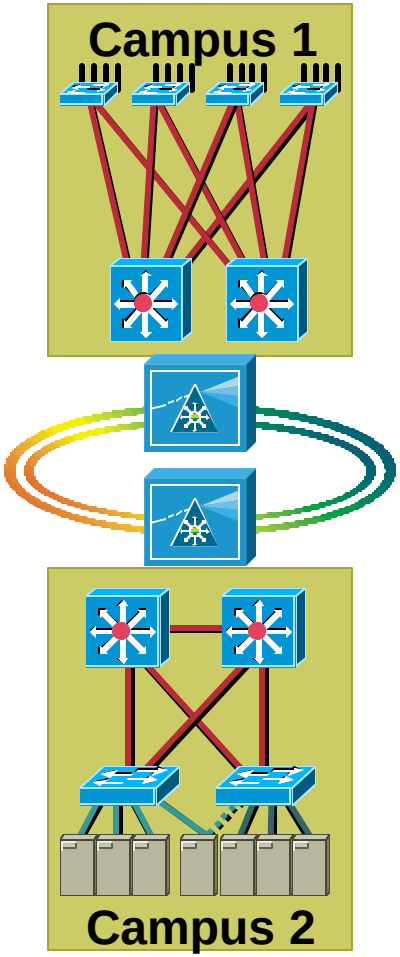
- Have consistently high performance packet forwarding
- Are reliable and available
- Are service enabling
- Are cost efficient

How You Deliver This Is Largely Irrelevant Metro Ethernet Is Simply a Tool in the Tool Box

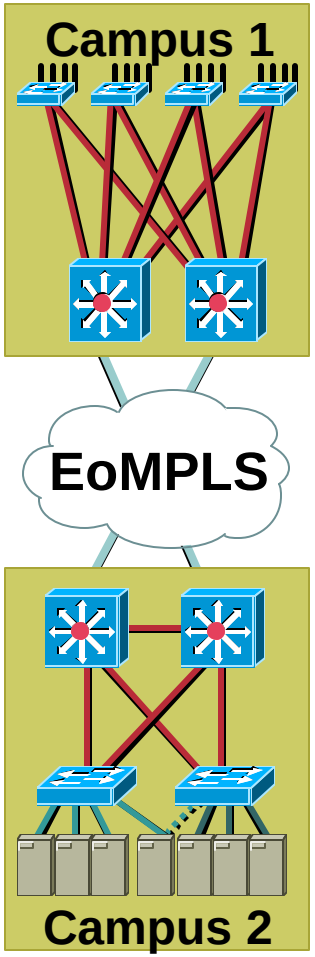
Enterprise Deployment Options for MAN/WAN



"Do-It-Yourself" Dark Fiber



Lease Wavelengths or Managed Services From a Provider



Purchase Ethernet Services from a Provider as You Would Frame Relay

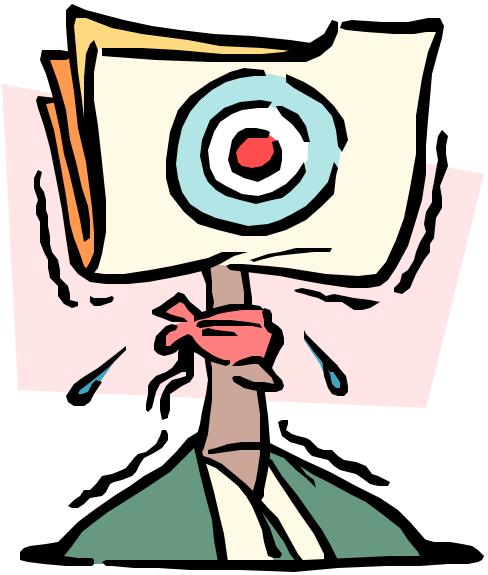
Which Technologies Do I Use?

Application Requirements

- LAN interconnect
- Service aggregation
- Data center interconnect
- Backup and disaster recovery
- Bulk data replication
- Storage consolidation
- Connection to hosting services

What Exists Today

- Dark Fiber
- Existing edge equipment
  - Ethernet
  - SONET
  - Frame Relay
  - ATM
  - DWDM
- Bandwidth requirements



Metro Ethernet: Revolution or Evolution?

- **Question: How does metro Ethernet change the way we design and deploy networks?**
- **Answer: Nothing changes; the same principles of structure and hierarchy still hold true**
- **Be aware that the service will dictate design considerations**

Deploying Metro Ethernet in the Enterprise

Agenda

- Metro Services Evolution
- **Designing with Fiber**
- Designing with 10 Gigabit Ethernet
- Ethernet TLS
- Design Principles
- Metro Ethernet Design Recommendations
- Cisco Metro Solutions

Dark Fiber

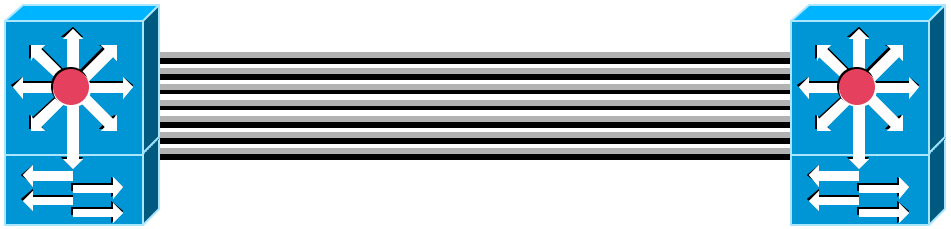
- **Access to dark fiber enables many technology choices to be made, but depends upon physical characteristics of fiber plant**
  - **How long is the fiber?**
  - **What is the fiber quality and type?**
  - **What is the optical power budget?**
  - **What is the attenuation/loss of the system?**
  - **Will amplification be required?**
  - **What are the dispersion characteristics?**
  - **Do I need to consider non-linear effects?**
- **All these questions must be considered and understood**

Dark Fiber: The Choices

- **Once the physical characteristics are understood, then a technology and topology choice can be made**
  - **Point-to-point vs. ring**
  - **CWDM vs. DWDM**

Dark Fiber: Point-to-Point

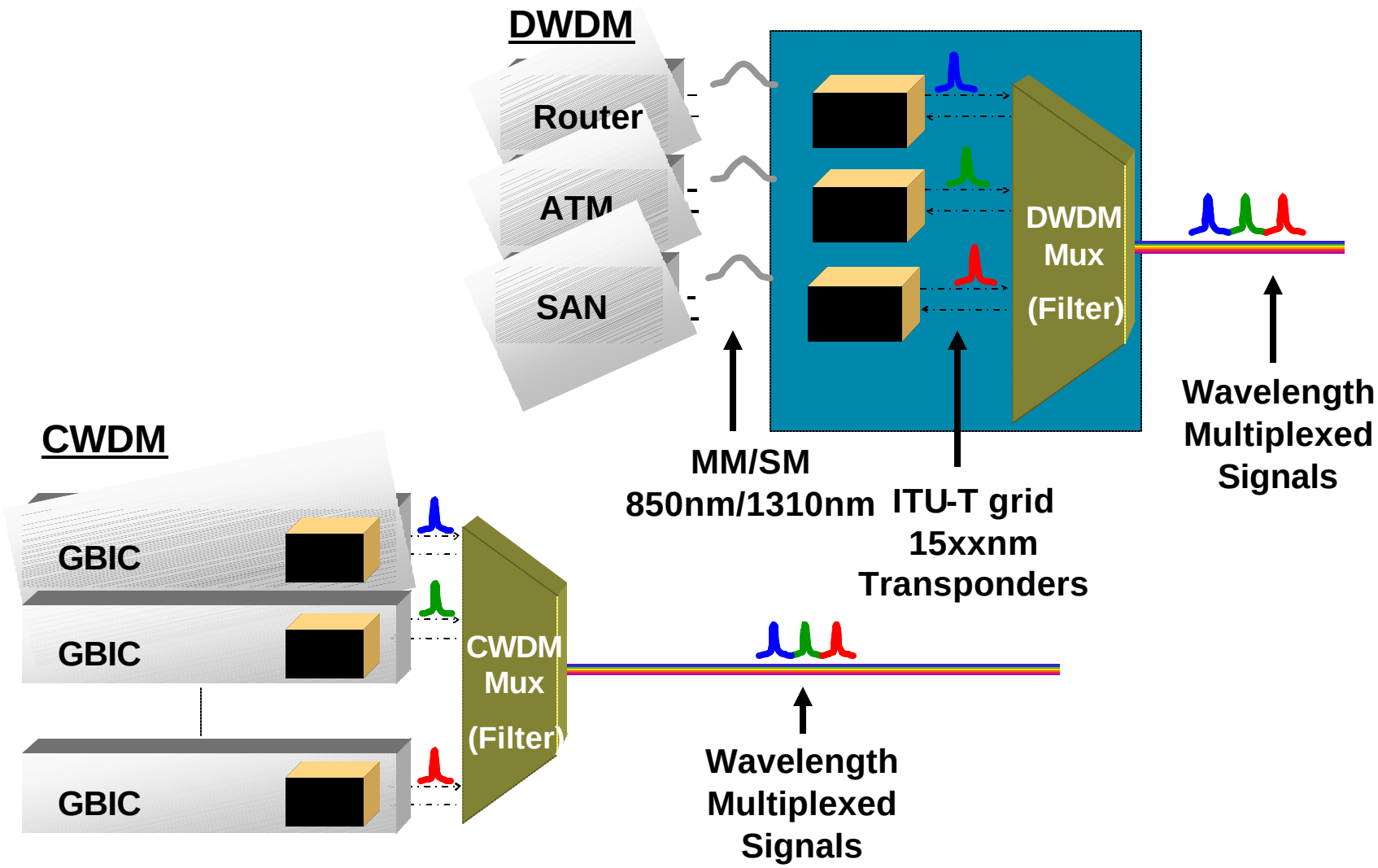
- **Use Etherchannel (IEEE 802.3ad) to add additional bandwidth**
  - **Up to 8 physical ports per channel**
    - **Across any module in a chassis**
  - **Single L2/L3 adjacency**
  - **Sub-second convergence**
  - **Load balance on layer 2, layer 3 or layer 4 information**
    - **Catalyst 6500 and 4000 Supervisor III**
  - **Distance limitation**
    - **GE~100km using ZX and CWDM GBICs**
    - **10GE~40km using 1550nm optics**



Dark Fiber: Ring Topologies

- **GE rings are cost effective solution if…**
  - **Traffic patterns and convergence characteristics are known and understood**
- **However, be aware of…**
  - **Multi-hop routing or switching**
  - **Blocking using 802.1d/w/s**
  - **Traffic aggregation will occur**
    - **Need to understand traffic patterns**
- **Solutions:**
  - **Make ring appear as point-to-point connection using CWDM or DWDM**

Dark Fibre:
Wavelength Division Multiplexing



Dark Fiber: CWDM

- **Coarse wavelength division multiplexing**
  - **Similar to DWDM but at coarser wavelengths**
    - **1470nm, 1490nm, 1510nm, 1530nm, 1550nm, 1570nm, 1590nm, 1610nm**
  - **GBIC form factor**
  - **Single technology (gigabit Ethernet)**
    - **DWDM recommended for FibreChannel, ESCON, etc.**
  - **Very cost effective**
  - **Long drive distance**
    - **~30dB budget = ~100Km**
  - **Cannot be optically amplified, only Ethernet**

CWDM - Value Proposition

Cisco Coarse Wavelength Division Multiplexing (CWDM) Gigabit Interface Converter (GBIC) Solution

- **Easy deployment and flexible implementation**
  - **"Plug and play," no configuration of CWDM components**
  - **Enable point-to-point, hub-and-spoke, ring, and meshed architectures on top of SMF ring**
- **High availability**
  - **Use multipath protection of ring architecture**
  - **Use redundancy mechanism at circuit endpoints for fast reconvergence (~250 ms) after fiber cuts**
- **Scalability**
  - **Provide scalable Ethernet bandwidth between 1 and 8 Gbps over SMF**
- **Investment protection**
  - **Use existing standard GBIC ports on Cisco switches and routers**
  - **Increase bandwidth on existing SMF infrastructure**

Cisco CWDM GBIC Solution Building Blocks

CWDM GBICs:

- 8 different “colored” GBICs
- Plug into GBIC slot on Cisco Catalyst® switch; connect to CWDM optical add-drop module (OADM) via SMF

CWDM OADM:

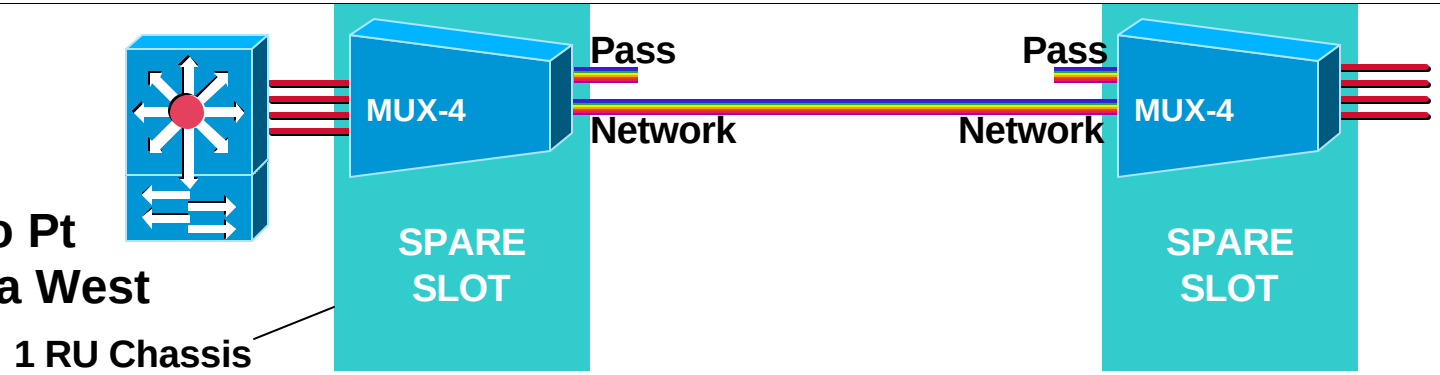
- 3 versions for 1, 4, and 8 wavelengths (color)
- Mounted in 1-RU chassis
- OADMs connected via optical ring

Dark Fibre:
CWDM Deployment - Point-to-Point

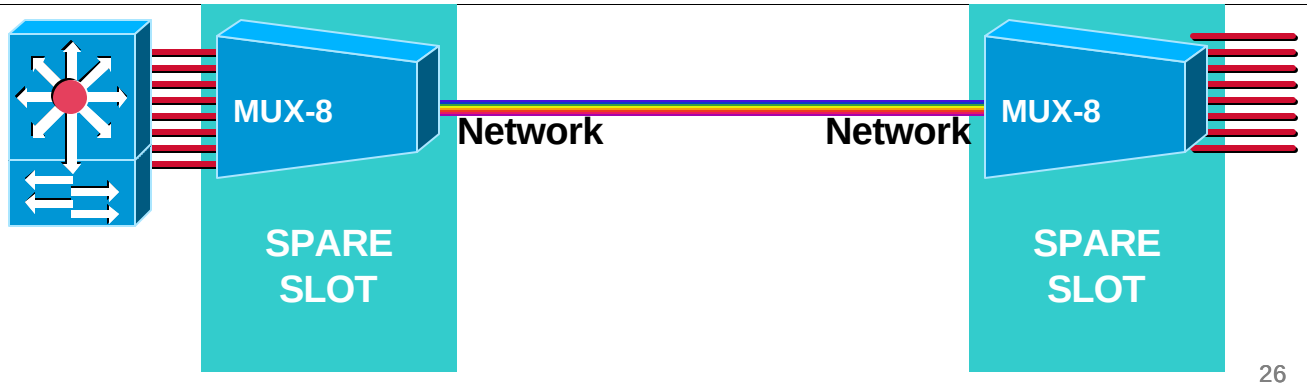
Single Lambda - 1 Channel
Unprotected Pt to Pt

All that is required is one of CWDM-GBIC-XXXX at each end

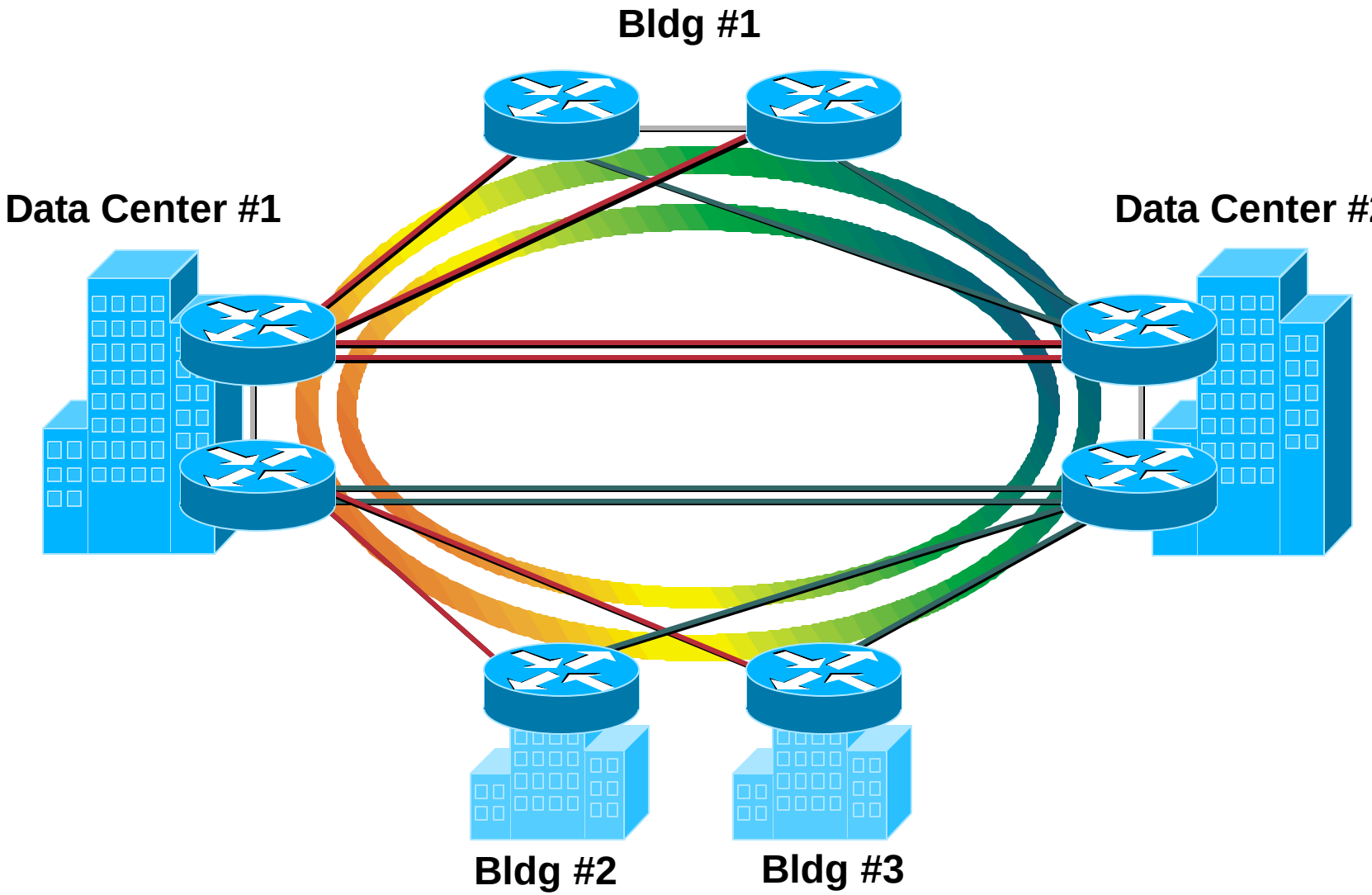
4 Lambda
Unprotected Pt to Pt
Add/Drop only via West



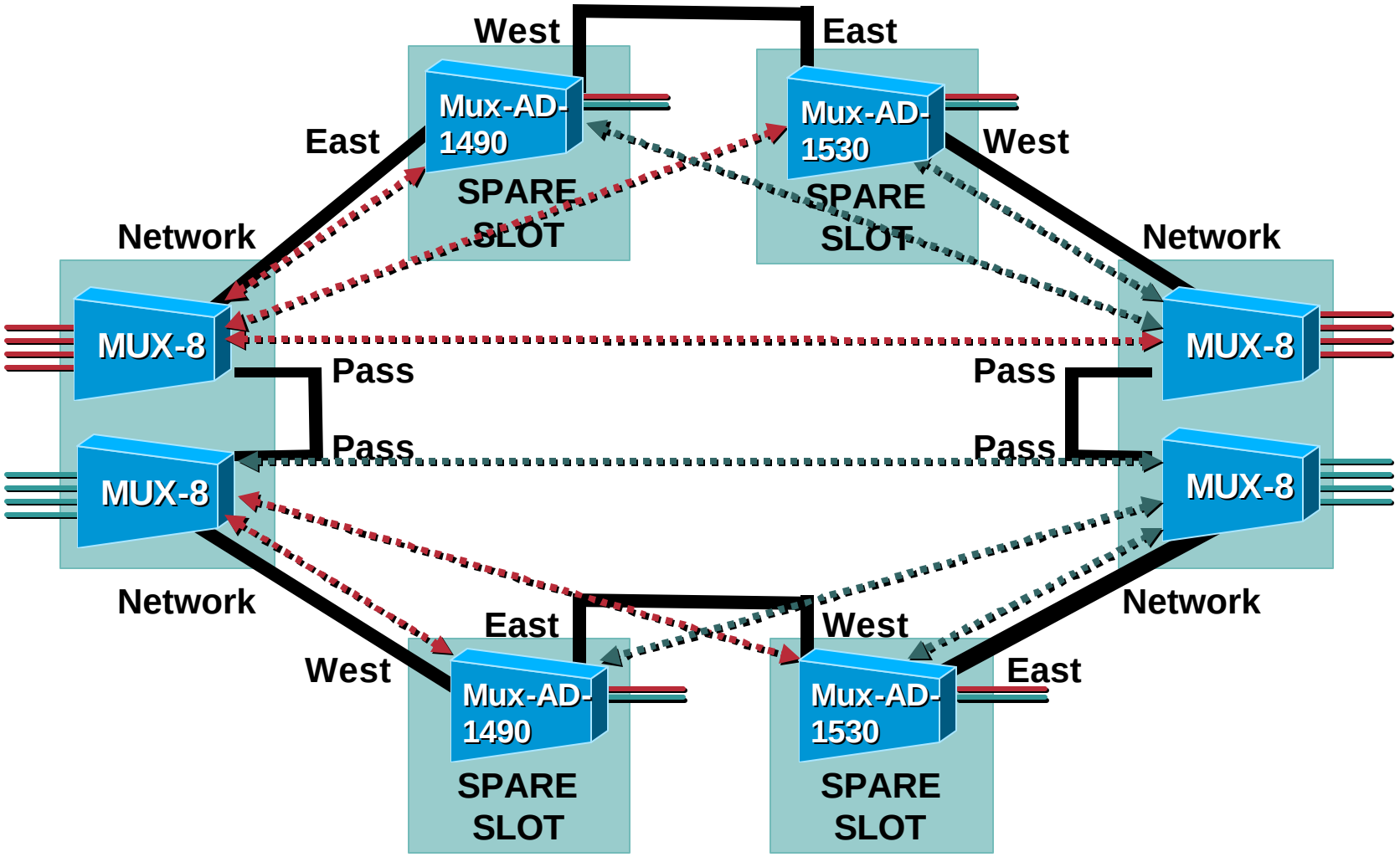
8 Lambda - 8 Channel
Unprotected Pt to Pt



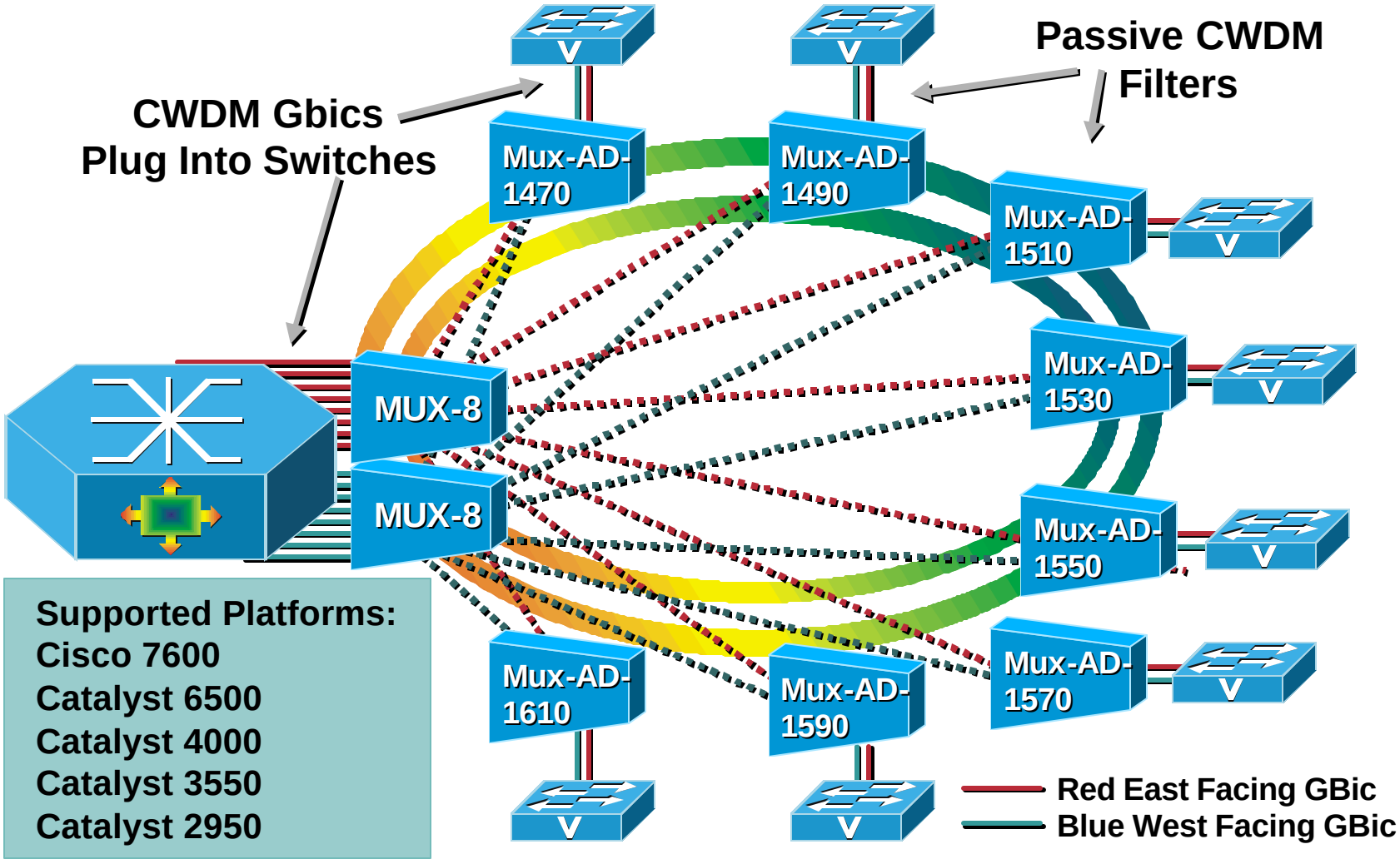
CWDM: Logical Core Topology



CWDM: Physical Core Design



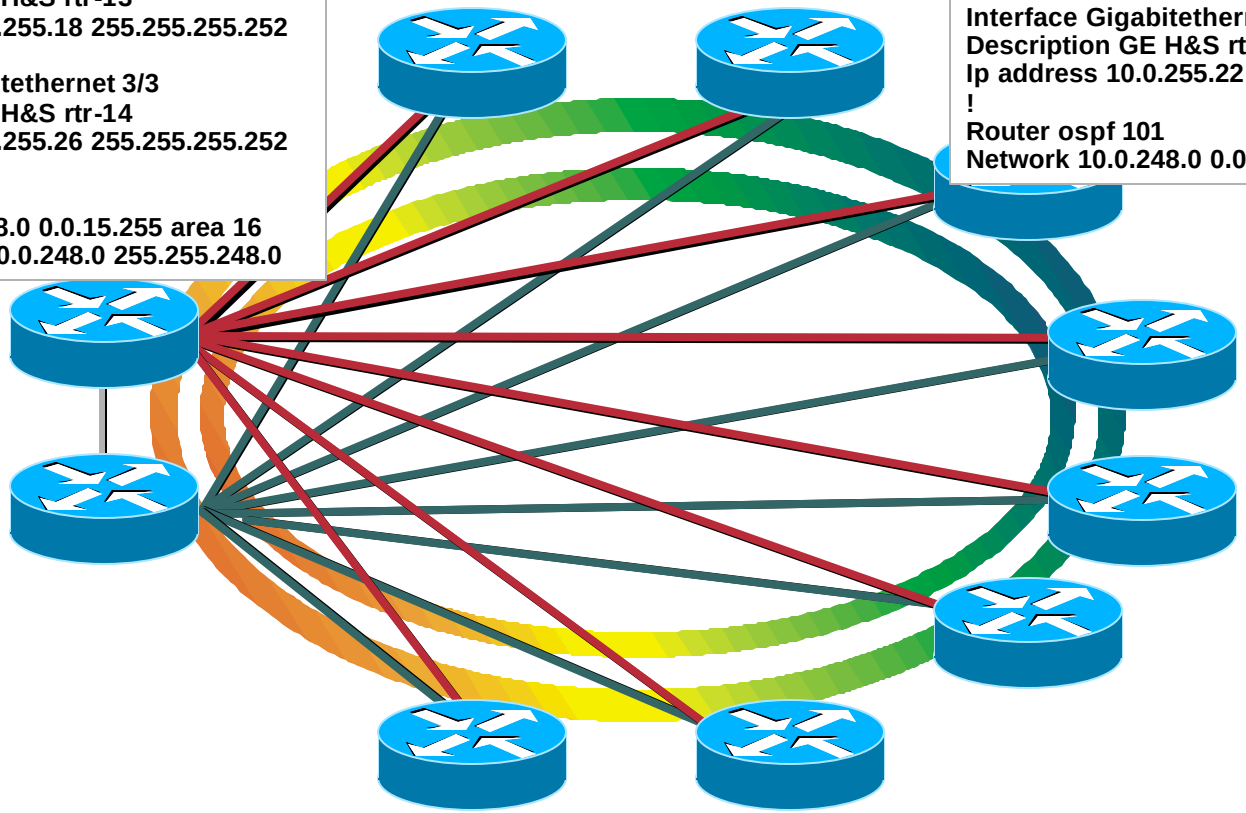
CWDM: Logical Hub and Spoke



CWDM: Logical Hub and Spoke


```
hostname rtr-1
!
interface Gigabitethernet 3/2
 description GE H&S rtr-13
 ip address 10.0.255.18 255.255.255.252
!
interface Gigabitethernet 3/3
 description GE H&S rtr-14
 ip address 10.0.255.26 255.255.255.252
!
router ospf 101
network 10.0.248.0 0.0.15.255 area 16
Area 16 range 10.0.248.0 255.255.248.0
```

```
Hostname rtr-13
!
Interface Gigabitethernet 0/0
Description GE H&S rtr-1
Ip address 10.0.255.18 255.255.255.252
!
Interface Gigabitethernet 0/1
Description GE H&S rtr-2
Ip address 10.0.255.22 255.255.255.252
!
Router ospf 101
Network 10.0.248.0 0.0.15.255 area 16
```



DWDM and CWDM

- **DWDM if you have multiple transport technologies is bit rate and transport transparent**
  - **Best choice**
    - **Fiber channel, ESCON, SONET/SDH and LAN**
  - **Supports ring, BUS and star topologies**
  - **Supports wavelength protection switching**
    - **BLSR, UPSR, etc..**
  - **Can be amplified**
- **CWDM GBICs are a single transport technology**
  - **Good choice if gigabit Ethernet only is required**
  - **Evolution to 1550nm DWDM friendly optics**
  - **Good drive distance**
    - **~100km point-to-point**
    - **~30km ring (8 node ring)**

CWDM Summary

- **Flexible design options using optical add/drop multiplexors**
- **Relatively inexpensive introduction to DWDM**
- **Viable alternative to 10GE using GEC**
- **Cost effective method of increasing fiber capacity**
- **Cost effective method of simplifying network topologies**
  - **Install coloured GBICs and implement optical add/drop muxes later**
- **Supported on Cisco 7600 and Catalyst 6500, 4000, 3550 and 2950 products**

Deploying Metro Ethernet in the Enterprise

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- Metro Services Evolution
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- **Designing with 10 Gigabit Ethernet**
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Dark Fiber: 10GE Attributes

- **IEEE 802.3ae 10gigabit Ethernet**
  - **Preserves 802.3 Ethernet frame format**
  - **Preserves 802.3 min/max frame size**
  - **Full duplex operation only**
  - **Fiber cabling only**
  - **10.0 Gbps at MAC-PHY interface**
    - **LAN PHY data rate of 10 gbps**
    - **WAN PHY data rate of ~9.29 gbps**

10GE Optical Transceivers Physical Layer Dependant (PMD)

PMD	Fiber Supported	Diameter (Microns)	Bandwidth (MHz*km)	Distance (Meters)
850 nm Serial	Multimode	50*	400	66
1310 nm CWDM	Multimode Single Mode	62.5 9.0**	160 NA	300 10 k
1310 nm Serial	Single Mode	9.0	NA	10 k
1550 nm Serial	Single Mode	9.0	NA	40 k

NOTES:

Distances Current with IEEE 802.3 Draft 3.3

***Draft 3.0 of the 802.3ae Specification References the Higher Bandwidth (2000 MHz*km) 50 Micron MM Fiber**The 9.0 Micron Value is the Core Diameter; ANSI/TIA/EIA-568-A Specifies That the Nominal "Mode Field Diameter "Shall be 8.7 to 10.0 Microns with a Tolerance of +/- 0.5 Micron at 1310 nm**

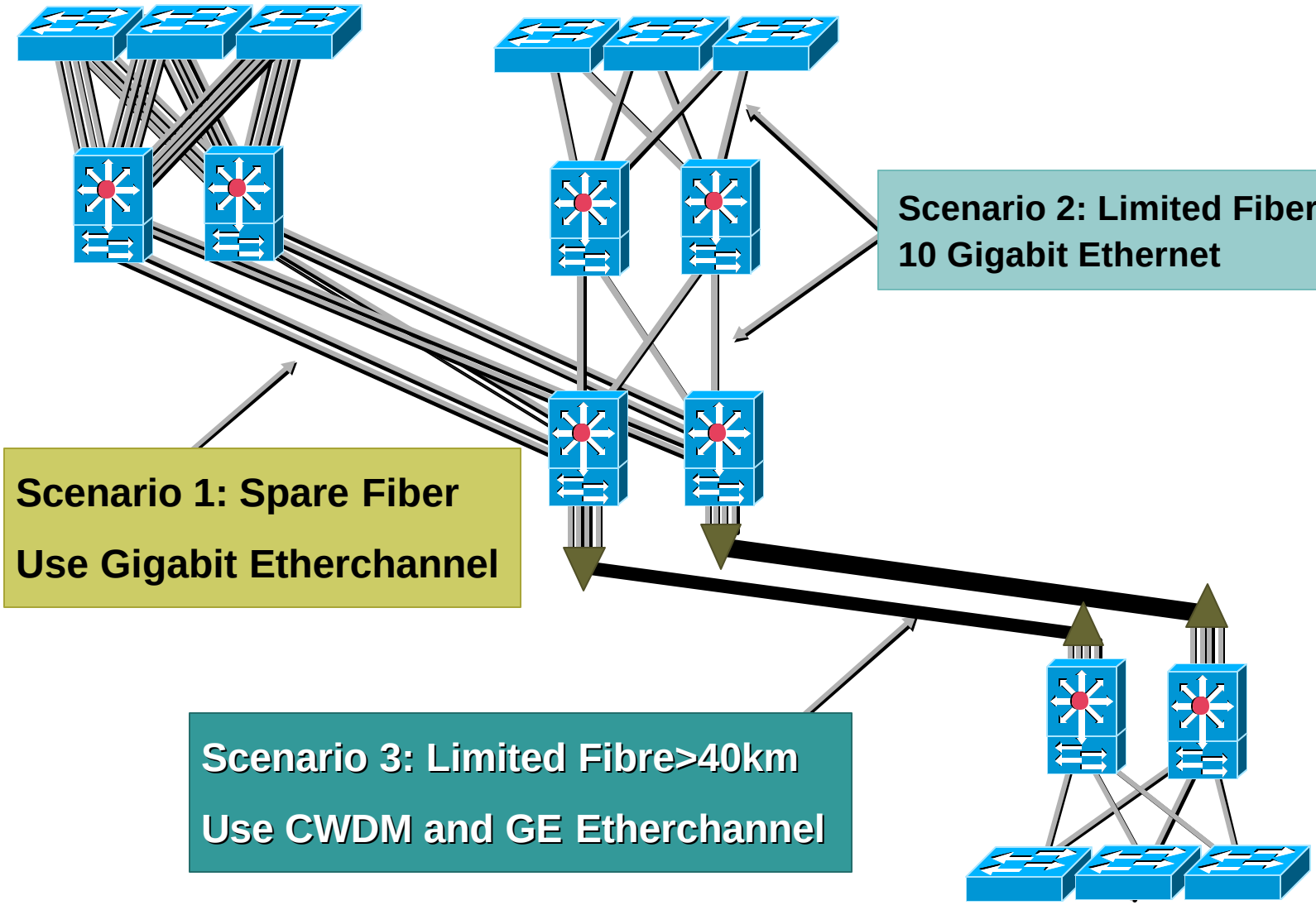
Metro Ethernet: 10GE Summary

Cisco.com

- 10GE runs on single mode fiber today
- Standard is complete 802.3ae
- Pull single mode for new installations
- Issues involving multimode fiber support are complex
- Cost effective MAN technology
- Cisco is shipping 10GE on Catalyst 6500/7600 and 12000 today

  Raising the bandwidth for L2–L7 services

GEC, 10GE and CWDM Deployment Scenarios



Scenario 2: Limited Fiber <40km
10 Gigabit Ethernet

Scenario 1: Spare Fiber
Use Gigabit Etherchannel

Scenario 3: Limited Fibre>40km
Use CWDM and GE Etherchannel

10GE and CWDM Decision Criteria

- **If you have multimode fiber**
  - **Probably within campus so use GEC**
- **If you have single mode fiber**
  - **And have GBIC interfaces and spare fibres<10Km,**
    - **Use gigabit EtherChannel, or**
    - **Use gigabit Etherchannel and CWDM, or**
    - **10GBASE-LR interface**
  - **>10km<50km**
    - **Use 1550nm 10GBASE-EX4 interface**
  - **>50km**
    - **Consider CWDM and gigabit EtherChannel (assuming single fiber); or**
    - **GE ZX GBICs (assuming spare fibers)**

10GE and CWDM and DWDM

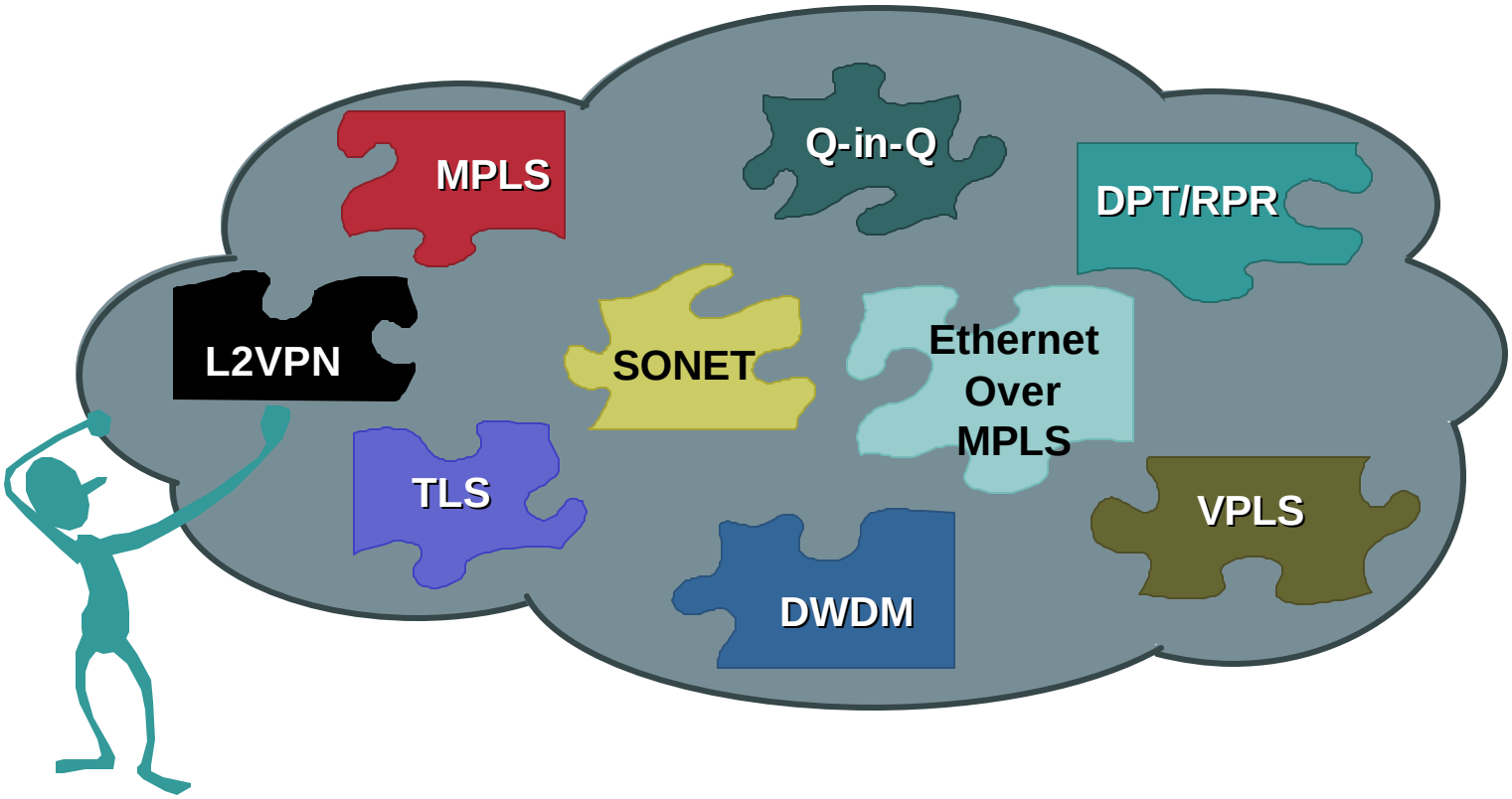
- **10GE, CWDM and DWDM are complimentary solutions**
- **Cisco CWDM provides flexible, cost effective Ethernet solutions today**
- **Wide Cisco support for CWDM across products**
  - **Cisco 7600 and Catalyst 6500, 4000, 3550 and 2950 products**
- **10GE is an economical, future proof solution today**
  - **Supported on Cisco 7600 and Catalyst 6500**
- **Cisco DWDM provides flexible, multi-transport optical solutions today**

Deploying Metro Ethernet in the Enterprise

Agenda

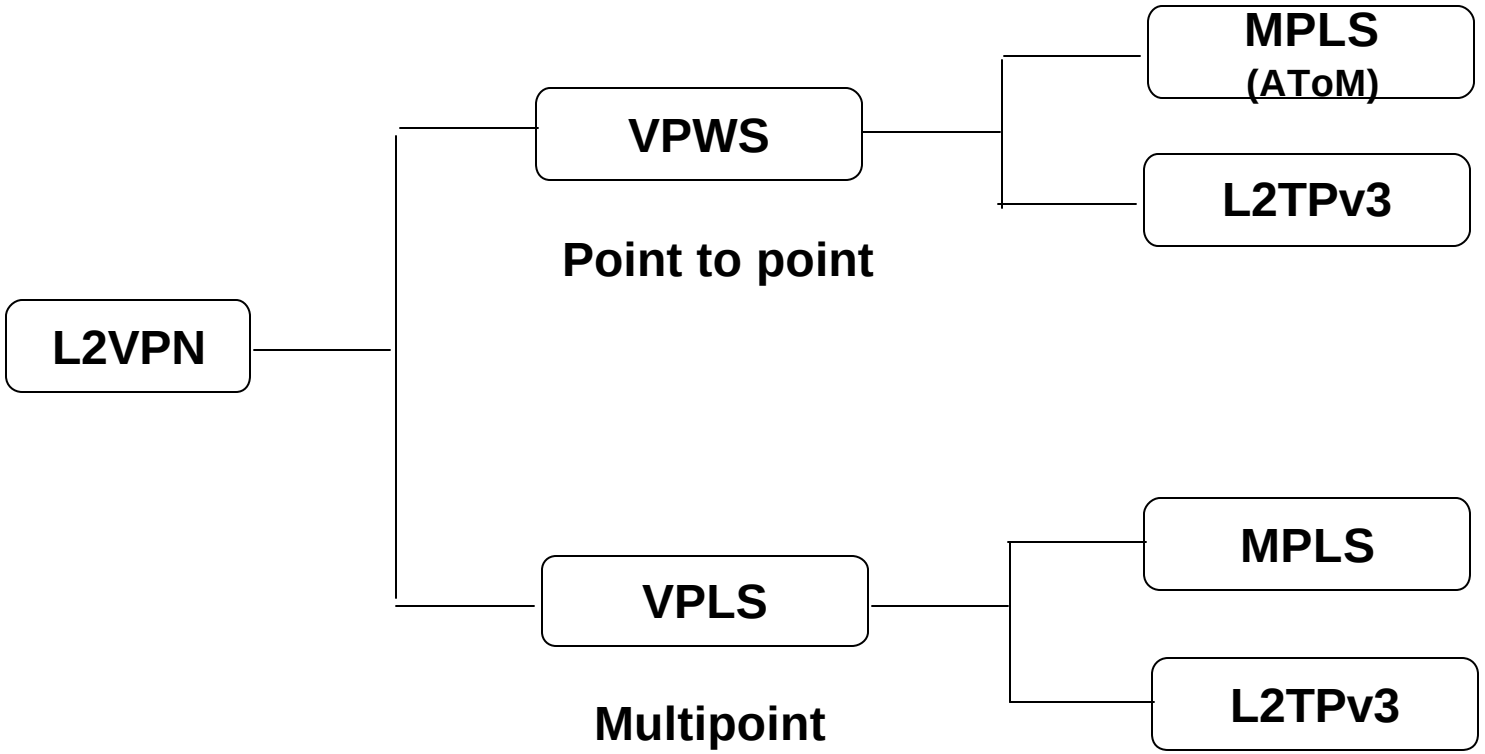
- Metro Services Evolution
- Designing with Fiber
- Designing with 10 Gigabit Ethernet
- **Ethernet TLS**
- Design Principles
- Metro Ethernet Design Recommendations
- Cisco Metro Solutions

Acronym Soup—What Does It All Mean?

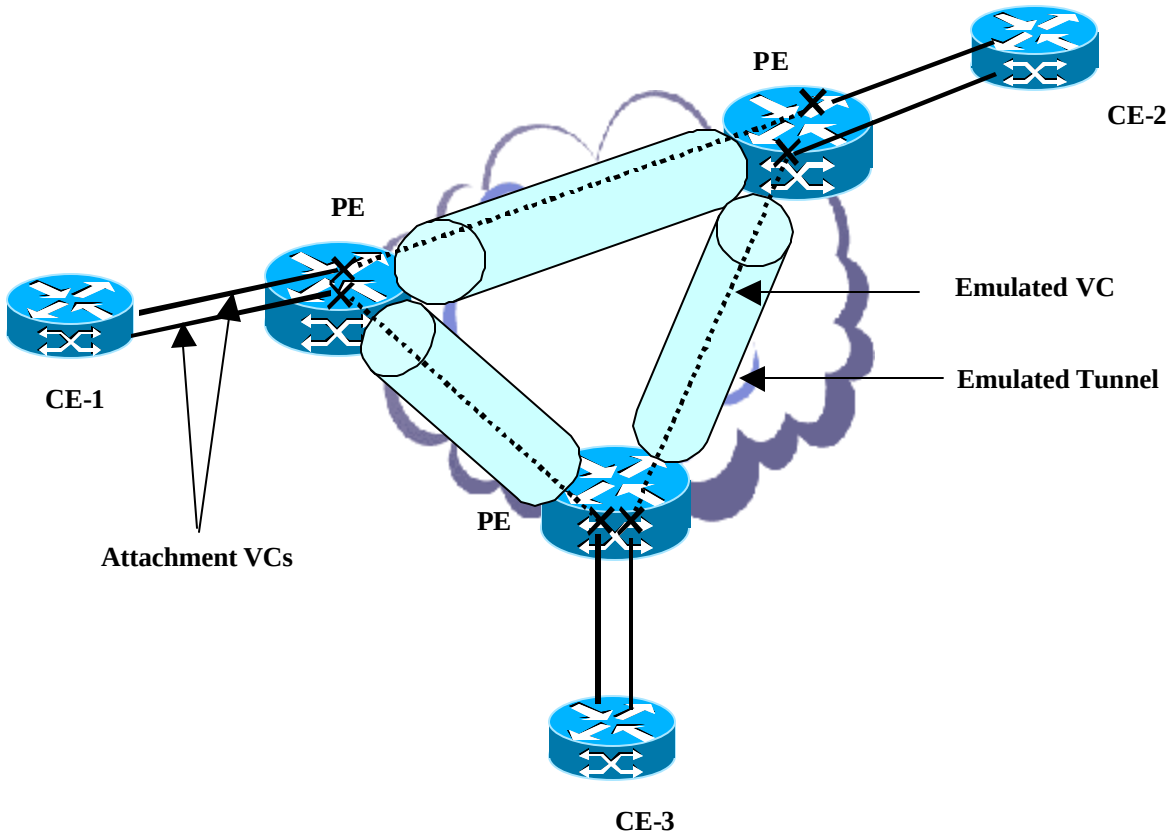


Ethernet L2VPN Overview

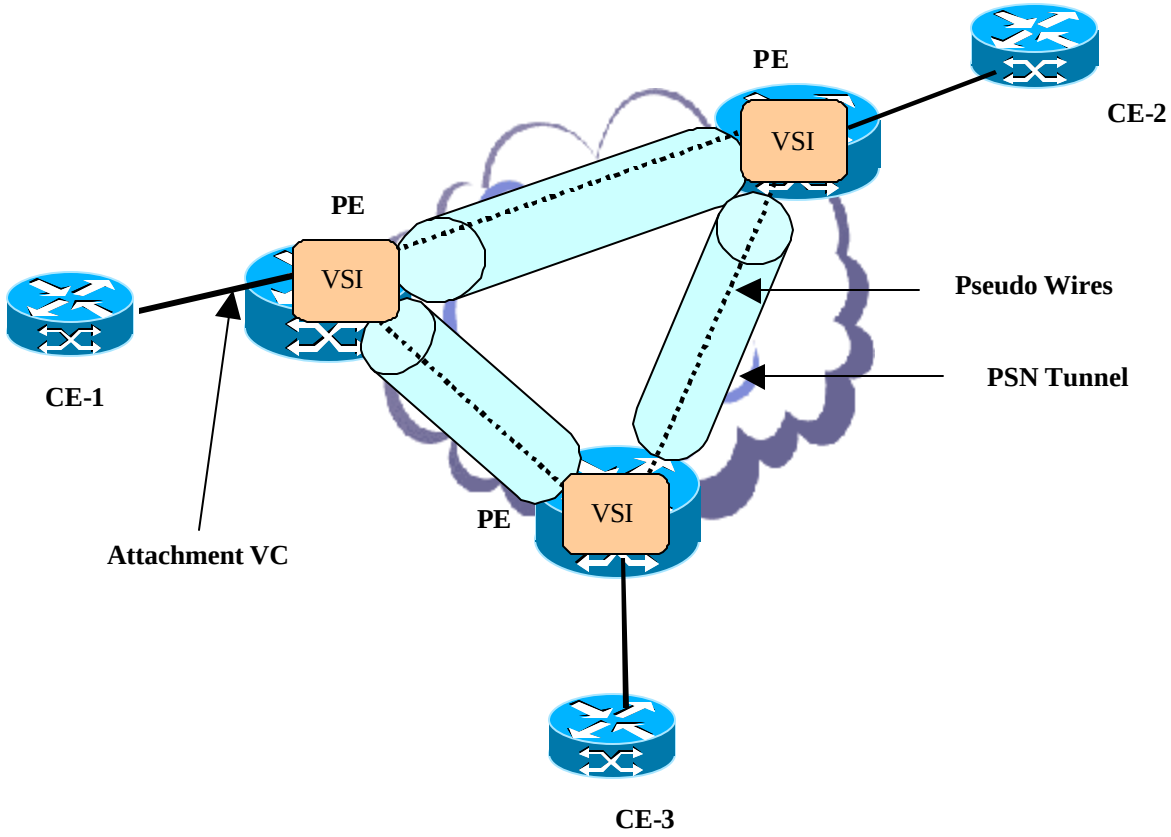
Cisco.com



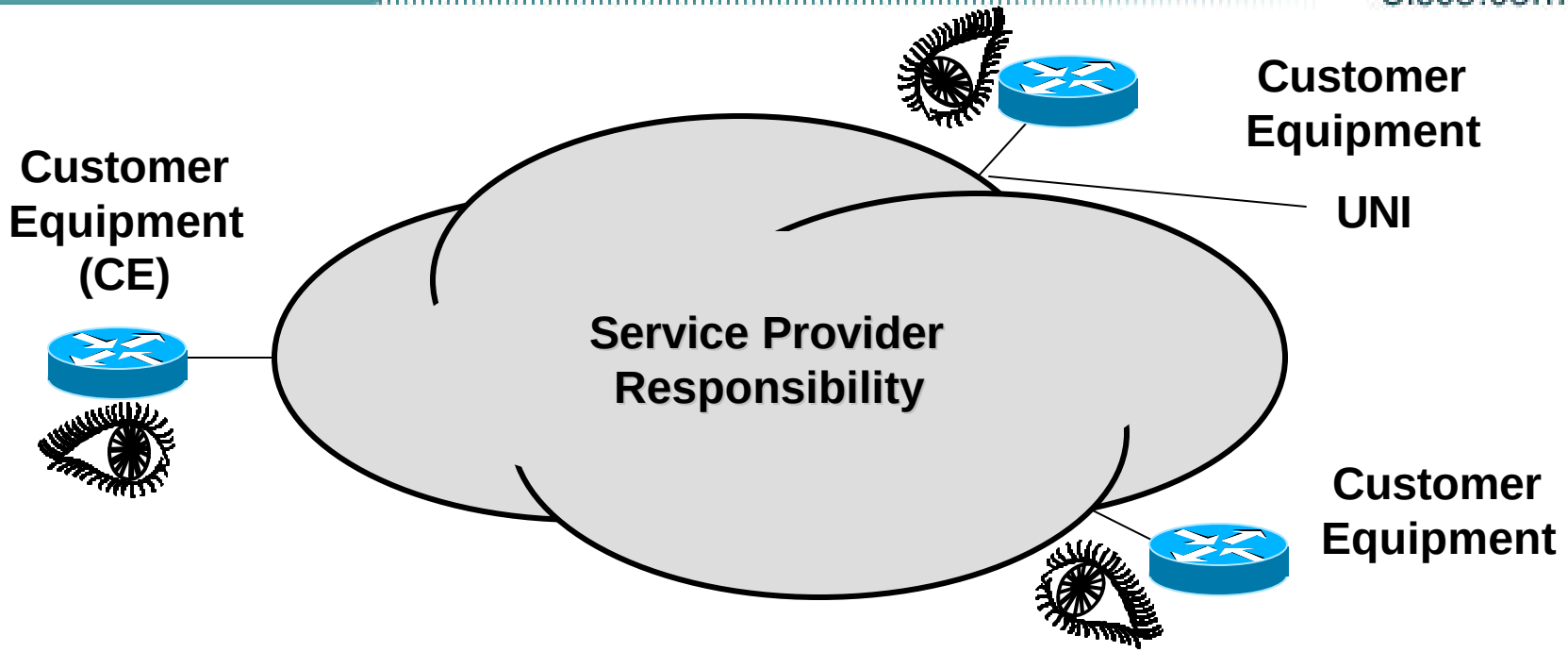
VPWS



VPLS

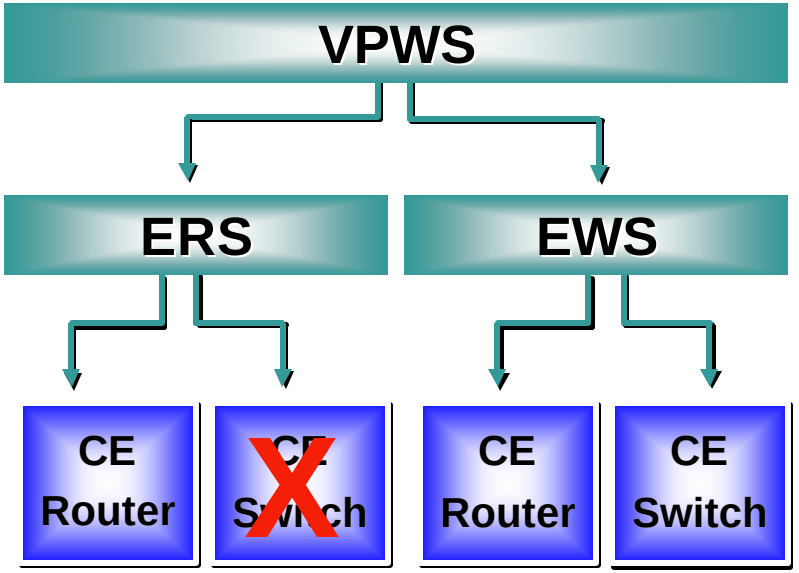


Metro Ethernet Service Model



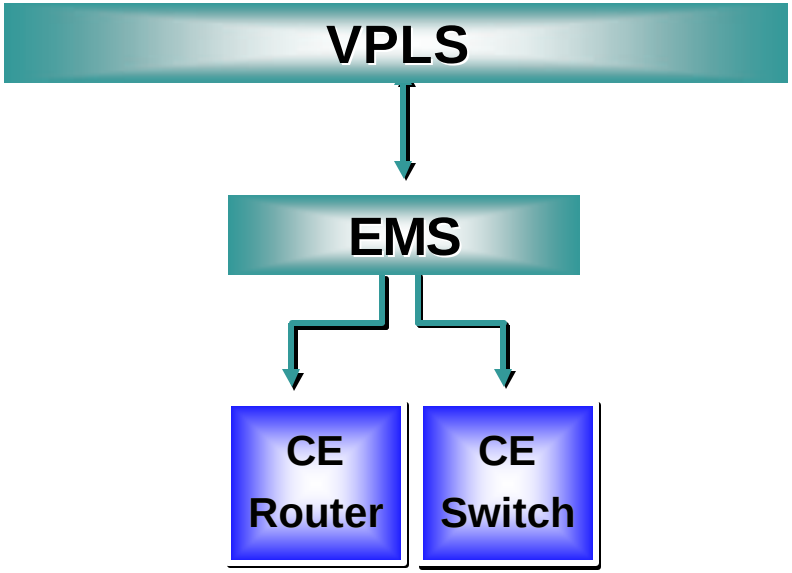
- Service is what the Service User's equipment sees:
  - Protocol(s) at User Network Interface (UNI)
  - Number of reachable UNIs
  - Security features
  - Performance levels
- Implementation details in the cloud are invisible to the CE

Service Definitions: A Summary



Similar to a Frame Relay service where the DLCI becomes a VLAN and where a CIR + Burst is provided on a per VLAN basis.

Similar to a Private Line service. Provided on a Shared Packet Network versus a TDM/Optical Network (EPL). The CE-located equipment can be a router or a switch.



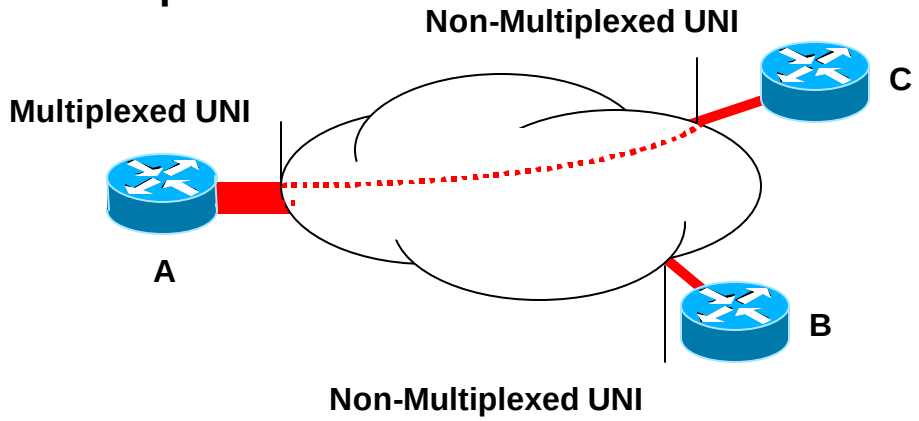
Any-to-Any transport service that can be an alternative to unmanaged MPLS-VPN (or CsC). By using CE-routers there is NO issue with MAC table size in the PE's. Layer 2 access is Ethernet only.

Ethernet Relay Service (ERS)

The Frame Relay Analog

Required Feature: Service Multiplexing (SM)

Service Multiplexing enables multiple instances of service to be multiplexed onto a single UNI, allowing that UNI to be in multiple ERS. Such a UNI is referred to as a Multiplexed UNI. When a UNI is in a single EVC, it is referred to as a Non-Multiplexed UNI.



Using SM, service to B and C can be implemented at A without requiring two physical ports on the Customer Equipment at A

Note: ERS requires a 1:1 mapping association between CE-VLANs and ERS

Ethernet Wire Service (EWS)

The Private Line Analog

Required Features: VLAN Transparency (VT), All-to-One Bundling (B*), and Layer 2 Control Protocol Tunneling

VLAN Transparency

In a VLAN Transparent EVC, the CE-VLAN tag (including untagged) of an egress frame is always identical to the CE-VLAN tag on the corresponding ingress frame.

All-to-One Bundling

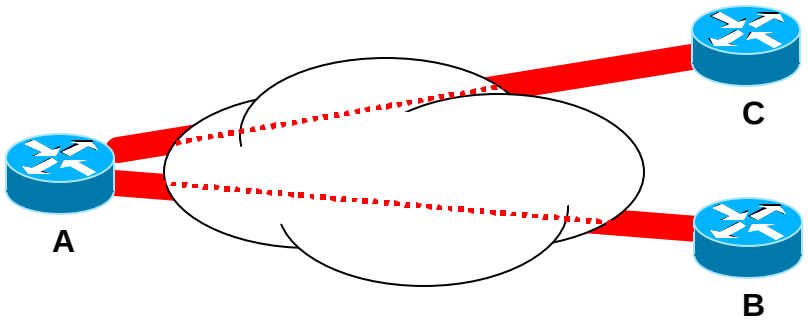
Bundling enables multiple CE-VLANs to be mapped to an EVC at the UNIs belonging to the EVC

All-to-One Bundling (B*) is a case of Bundling where at each UNI in a given EVC, *all* CE-VLANs are mapped to that EVC. All UNIs in such an EVC therefore are Non-Multiplexed.

Layer 2 Control Protocol Tunneling

Per-EVC Layer 2 Control Protocol Tunneling enables the Service User's control packets to pass through the Metro Ethernet Network in a manner consistent with other data packets.

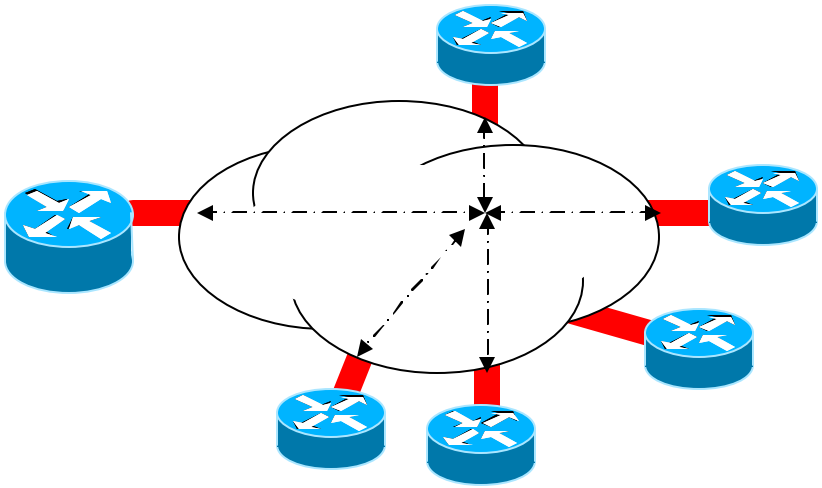
EWS - Private Line Analog



Physical Port to Physical Port

Good Fit for Switches and Routers

Ethernet Multipoint Service (EMS)



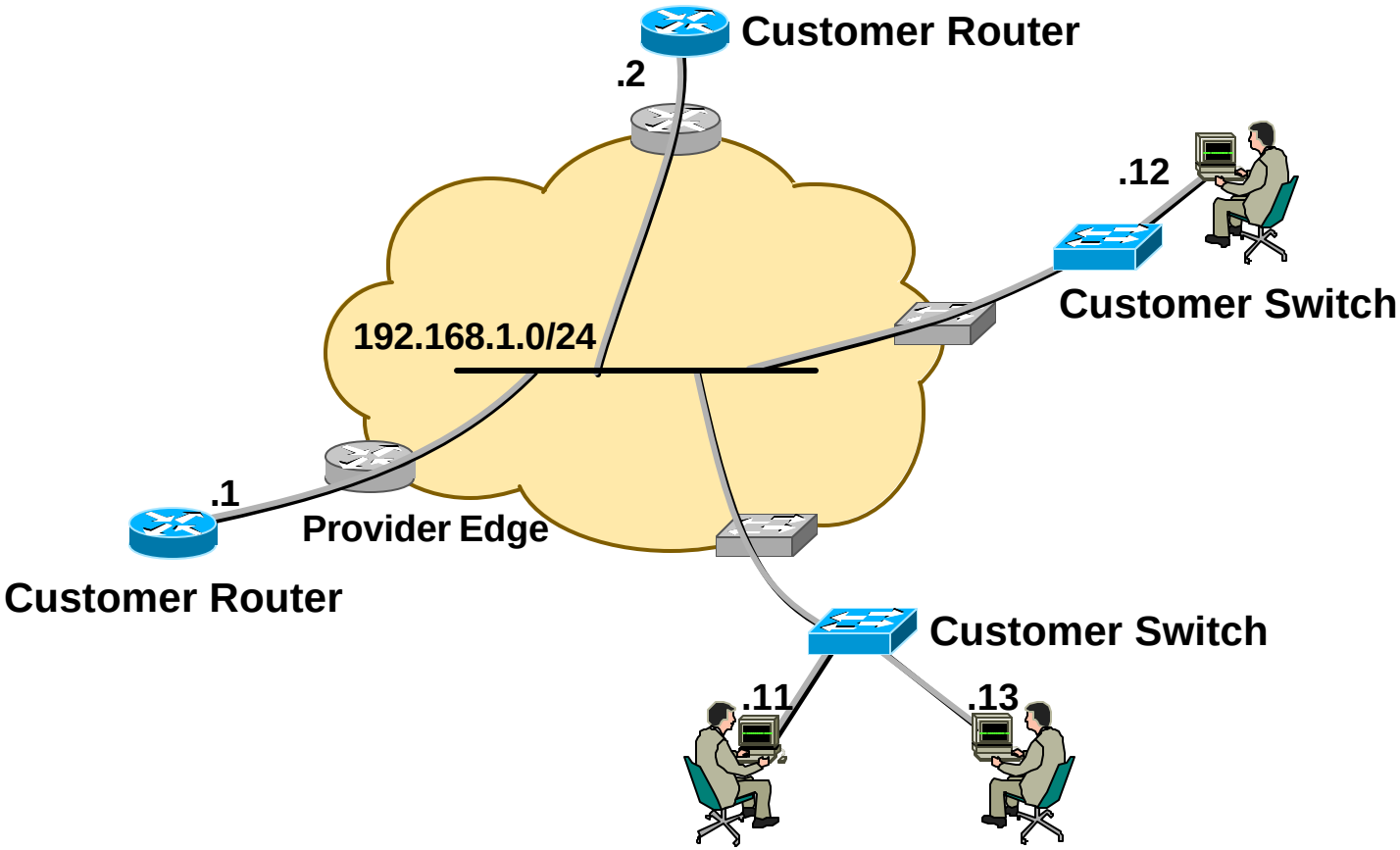
Applicable Service Features

- **VLAN Transparency**
- **All-to-One Bundling**
- **Layer 2 Control Protocol Tunneling**
  - **Done in Multicast fashion, with BPDUs being transmitted to all UNIs**

Service suitable for both routers and switches

Ethernet Multipoint Service (VPLS): A Customers Perspective

"Emulated LAN" Model



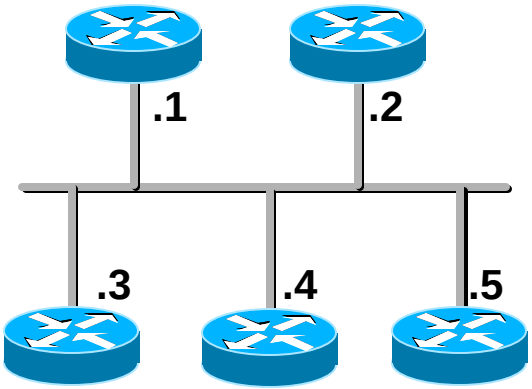
Ethernet Multipoint Service (VPLS):

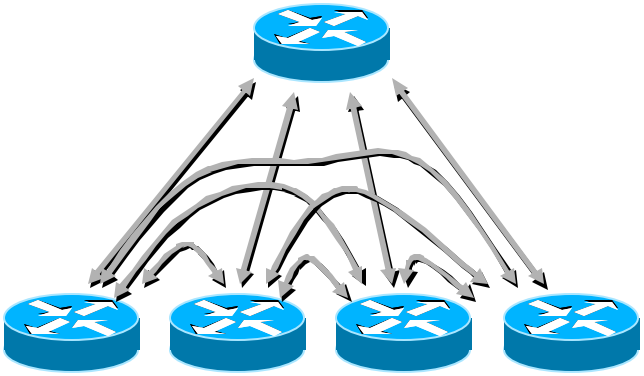
- **The issues:**

  Although the enterprise “sees” a virtual Ethernet, the actual service may be a full mesh of VCs

  If a single VC breaks what is the effect on traffic, the network, the applications?

  How do you troubleshoot?



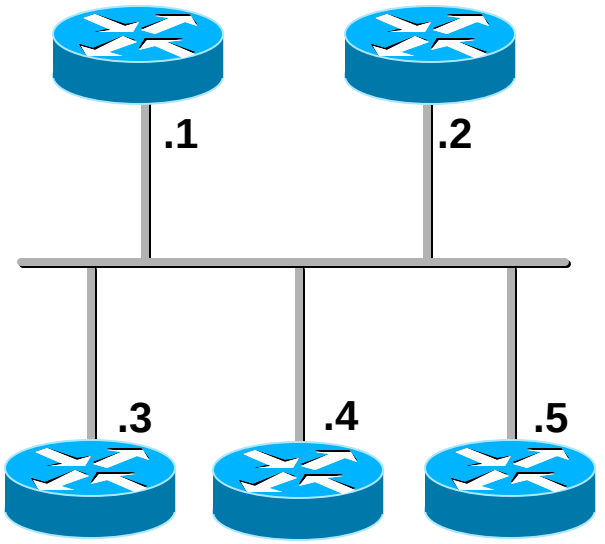


Ethernet Multipoint Service (VPLS):

- **“Emulated” LAN model**
  - **Each device is now a peer in it’s own right and consideration must be taken of…**
    - **Routing protocol interaction**
    - **Traffic patterns**
    - **QoS policies**
    - **Security policies**
    - **Troubleshooting**

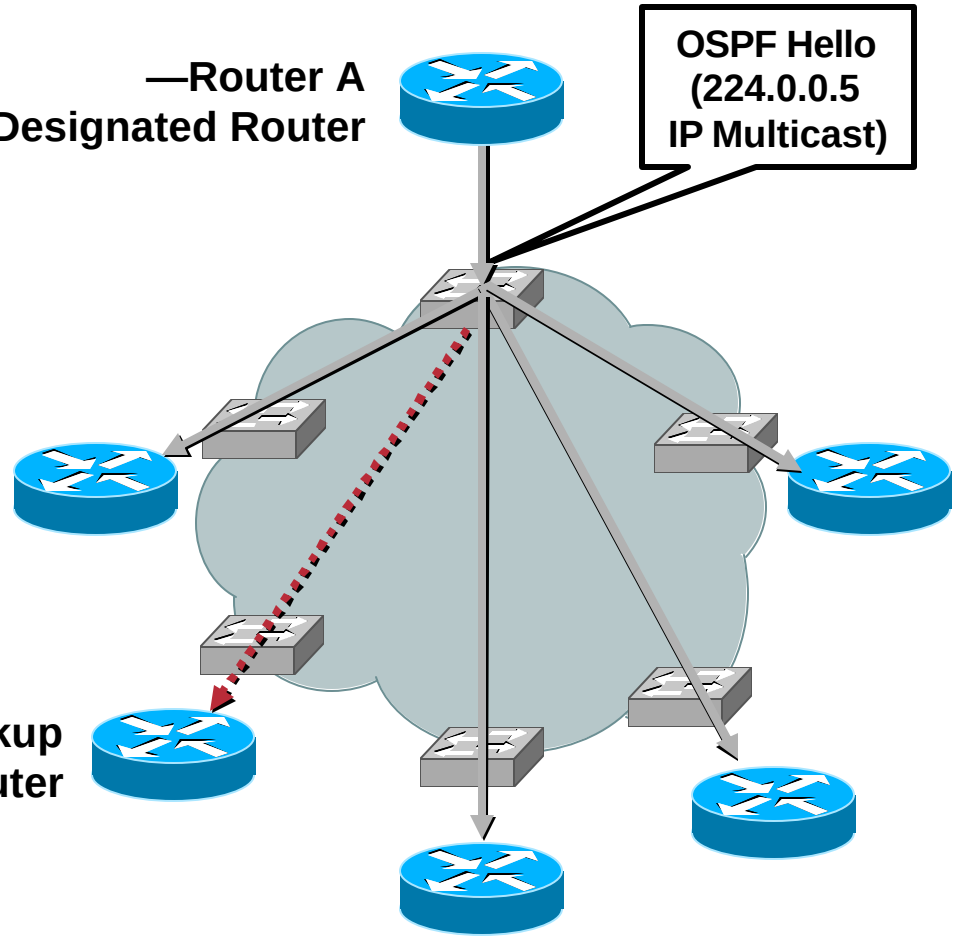
Routing Protocol Interaction

- **Routing protocol interaction**
  - **All routers seen as direct peers**
  - **“Plug and play”**
  - **Optimal routing between sites**



IP Multicast: OSPF and EIGRP

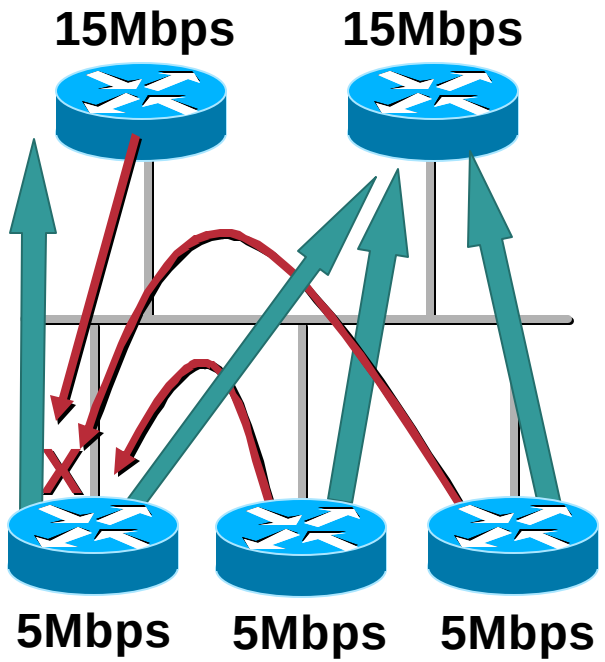
- **Use caution when a portion of your network emulates a multi-access network but may not have consistent broadcast or multicast performance**



Example: SP Ethernet Transparent LAN Service

Ethernet Multipoint Service (VPLS): QoS Issues

- Unpredictable traffic flows cause issues for QoS in that flows may aggregate in undesirable patterns
- Careful consideration needs to be taken for Interactive services such as video and IP telephony
- Best to model your applications first to understand the behaviour



Ethernet Multipoint Service (VPLS): QoS Issues

- **To manage this, device must have a QoS policy configured to meet the business requirements for the applications**
  - **Needs careful consideration of bandwidth requirements for peer-to-peer (IP telephony) as well as core applications**
  - **QoS policy management becomes problematic**

Metro Ethernet: Security

- **Layer two switches present unique security concerns.**
- **DoS attacks**
  - MAC address flooding/storms
  - Spanning tree attacks
  - CDP
- **However, several mechanisms exist within Cisco IOS to increase security and protection of switched networks**
- **Need to protect yourself from the provider and vice versa**

  They will be protecting themselves too

Metro Ethernet: Security Recommendations

Cisco.com

- **Disable VTP on edge switches**
  - **Could be used as a denial of service attack**
- **Disable CDP on all devices**
  - **Advertises device, IP and software versions**
  - **Could be used as a DOS attack**
- **Disable DTP on edge switches**
  - **Define only the VLANs that you require for connectivity**
- **Configure spanning tree ROOT guard**
  - **If switches are used to connect to provider network**

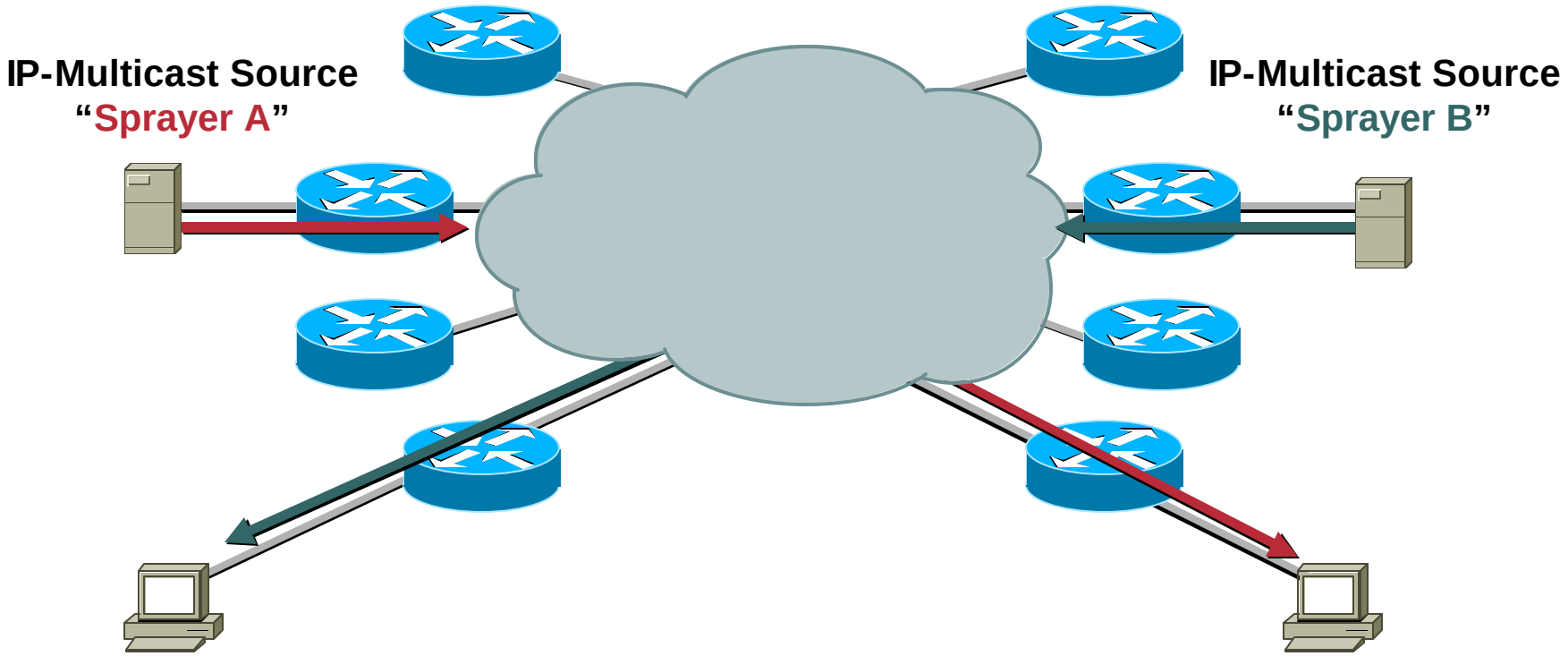
Metro Ethernet: Security Recommendations

Cisco.com

- **Make sure to secure the console and telnet ports of the device**
  - **Use SSH not Telnet**
  - **Use TACACS+**
  - **Use imaginative passwords for login and enable passwords**
    - **Use upper case, lower case and numeric characters (example: 3bmChtr)**
  - **Change SNMP community strings**
  - **Use IP filters to block SNMP access**

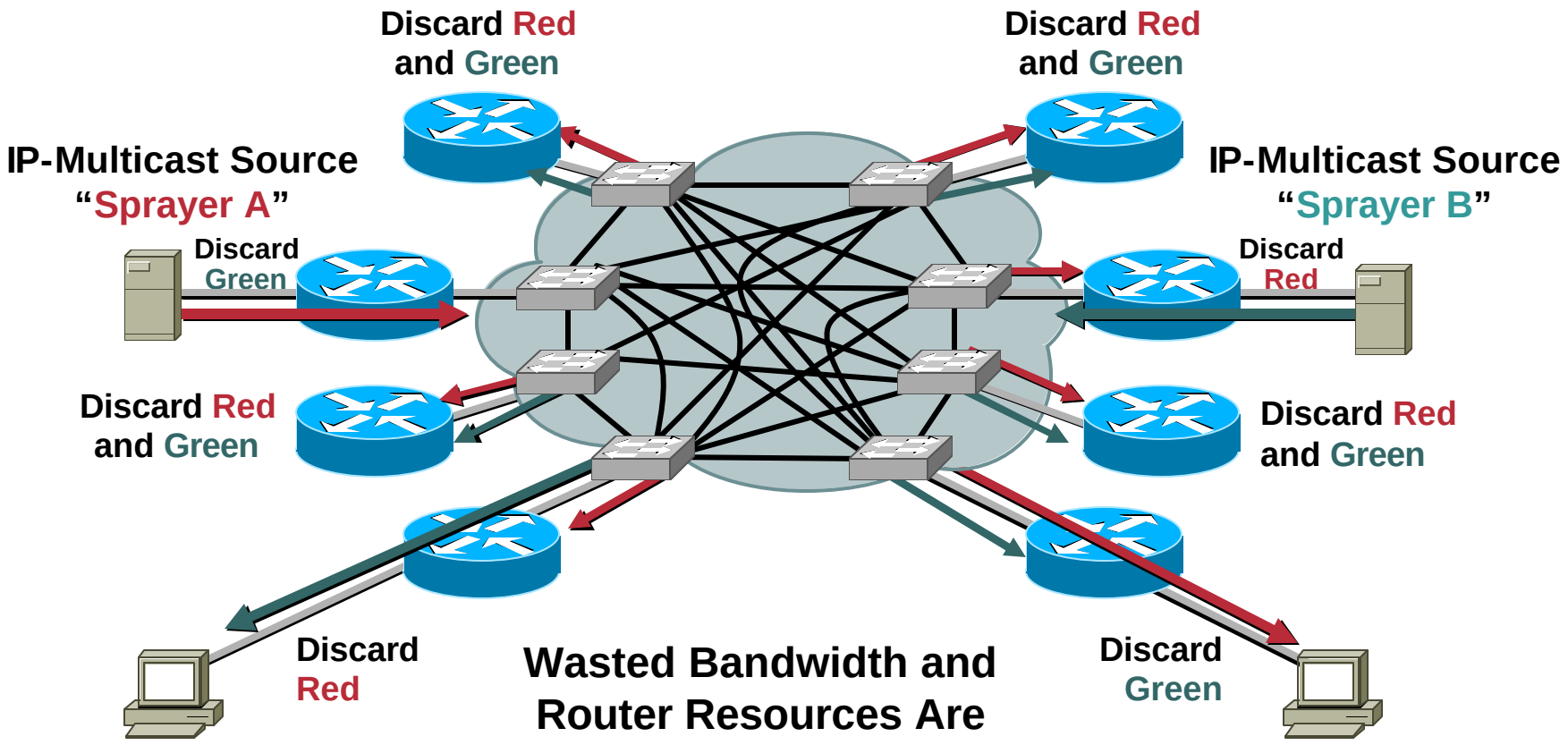
Metro Ethernet: The Impact of IP Multicast

This is What We Expect…



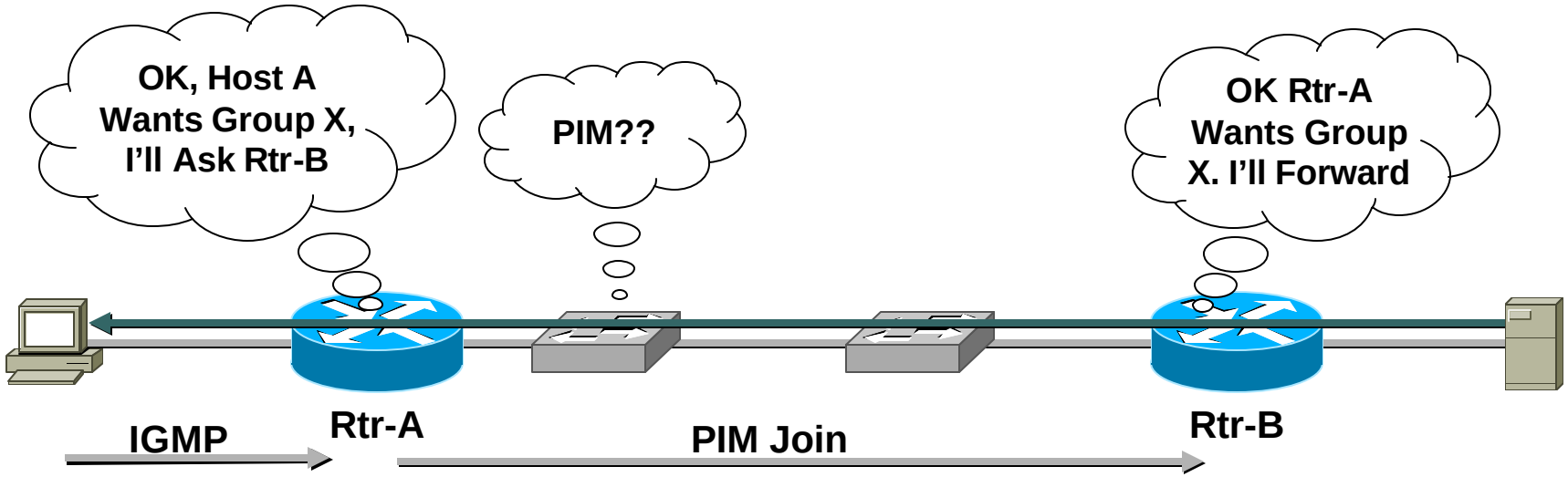
Metro Ethernet: IP Multicast

And This is What We Get…



Metro Ethernet: IP Multicast

- **The issue is that the routers are using PIM to join the multicast tree, and the switches use IGMP join messages to constrain forwarding**



Metro Ethernet
Constrained Multicast Flooding

- **L2 switches will flood broadcasts, multicasts and unknown unicasts**
- **L2 switches will use static multicast mac-address entries to constraint the flooding of multicast packets through:**

  CGMP: Control Plane Protocol between mcast router (Server) and CGMP-capable switch (Client), triggered by IGMP messages received by the CGMP Server

  IGMP Snooping : L2 switch itself will snoop IGMP v2 join/leave message and install appropriate static cam entry

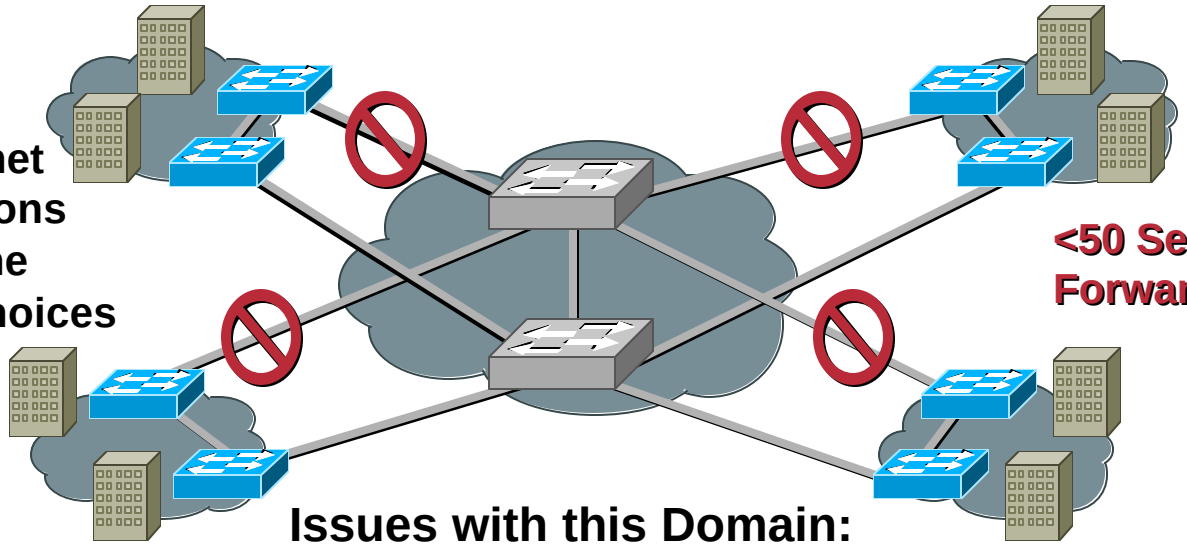
  RGMP: to constraint flooding of mcast router to mcast router packets

  Manual configuration

Metro Ethernet: Controlling Failure Domains

This L2 Metro Ethernet Defines a Failure Domain

SP Metro Ethernet Service Limitations Will Vary with the Architectural Choices They Make



<50 Seconds Until Forwarding Again

Issues with this Domain:

No Loops

Wasted B/W (STP Blocking)

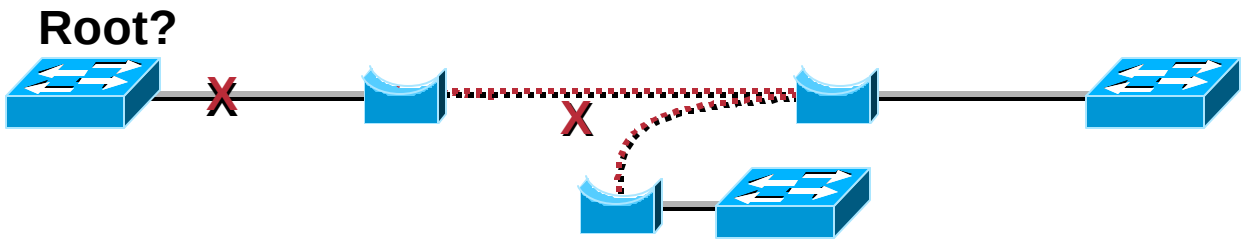
Spanning Tree Convergence Time

Link Failure Behavior

Root Determination

IEEE 802.1w Rapid Spanning Tree Protocol

- **IEEE 802.1w provides for a significant improvement to IEEE 802.1d**
  - **Explicit handshake before port can forward**
  - **Convergence can be in milli-seconds but depends on direct interface failure**
  - **Indirect failures cannot be detected except for max-age or 3*hello timeout**
  - **Most VPLS drafts assuming full mesh of VCs in core to prevent running spanning tree within the core**
  - **Split horizon forwarding**



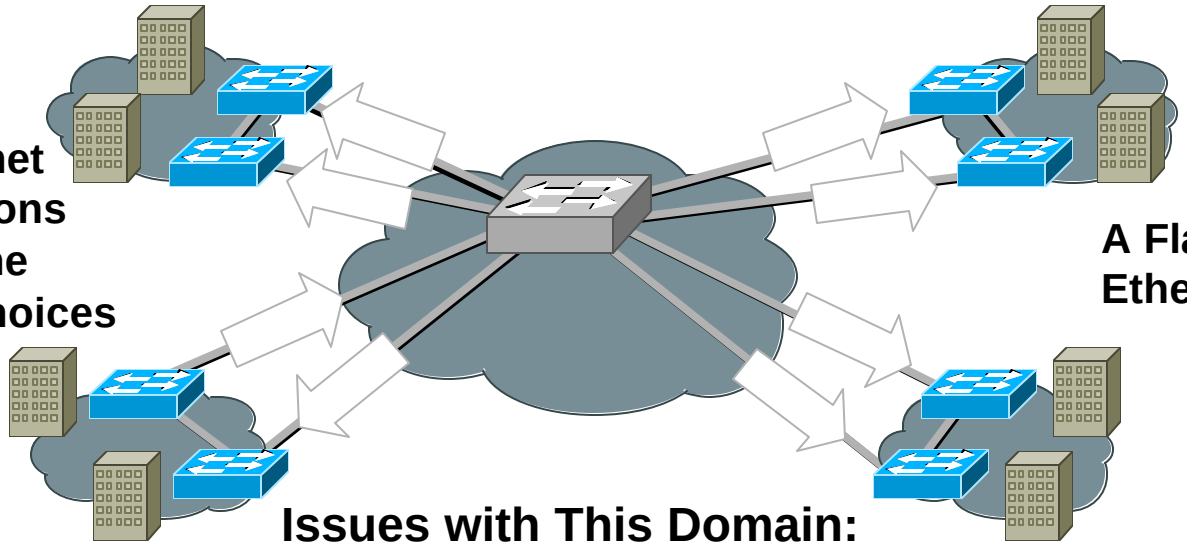
This Does Not Solve All Issues with Layer 2—Bridged Domains

Metro Ethernet: Spanning Tree

- **Ethernet has no explicit end-to-end signaling**
  - **Max-age or 3*BPDU hellos may have to expire to detect failure.**
  - **Slow convergence even using 802.1w**
    - **Relies upon 3*keepalive loss**
  - **Dependant upon providers core for convergence characteristics**
  - **Ethernet LMI currently being defined**

Failure Domains: Broadcast and Multicast Radiation

SP Metro Ethernet Service Limitations Will Vary with the Architectural Choices They Make

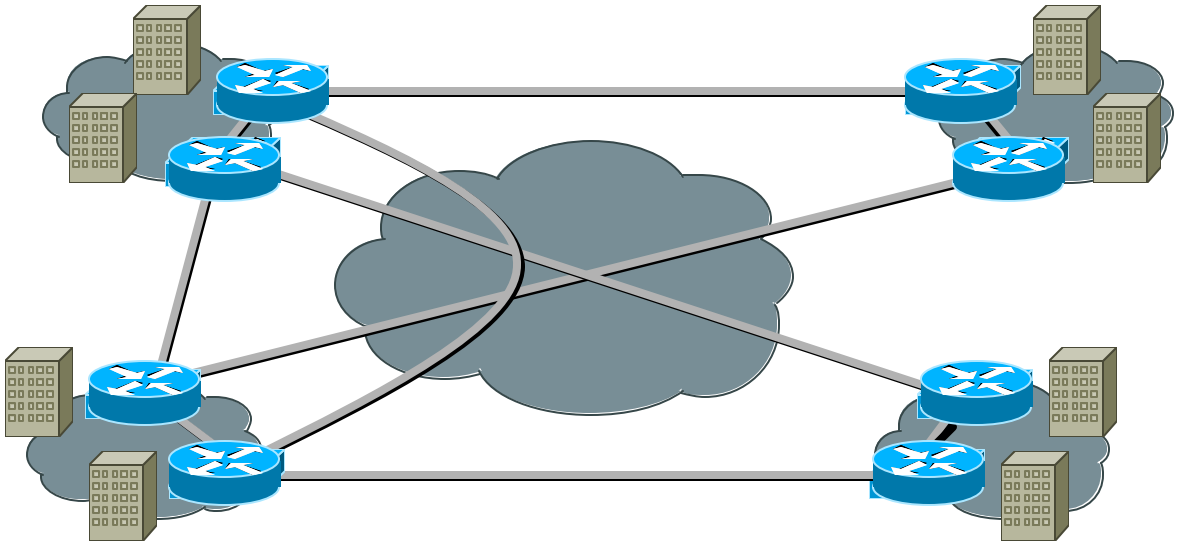


A Flat Metro Ethernet Service

Issues with This Domain:
Broadcast Flooding
Multicast Flooding

Metro Ethernet Service

How Do We Solve These Issues? Use Routing



Network Modeled as Point-to-Point Links
Controlled Routing Protocol Adjacencies, Easily Defined QoS Parameters, Simplified Troubleshooting

Deploying Metro Ethernet in the Enterprise

Agenda

- Metro Services Evolution
- Designing with Fiber
- Designing with 10 Gigabit Ethernet
- Ethernet TLS
- **Design Principles**
- Metro Ethernet Design Recommendations
- Cisco Metro Solutions

Design Principles

- When designing a network several factors
  - Performance
  - Scalability
  - Reliability and availability
  - Cost efficiency
  - Security
- …Need to be considered irrespective of technology to support critical business objectives, i.e. the applications

Design Principles: Hierarchy

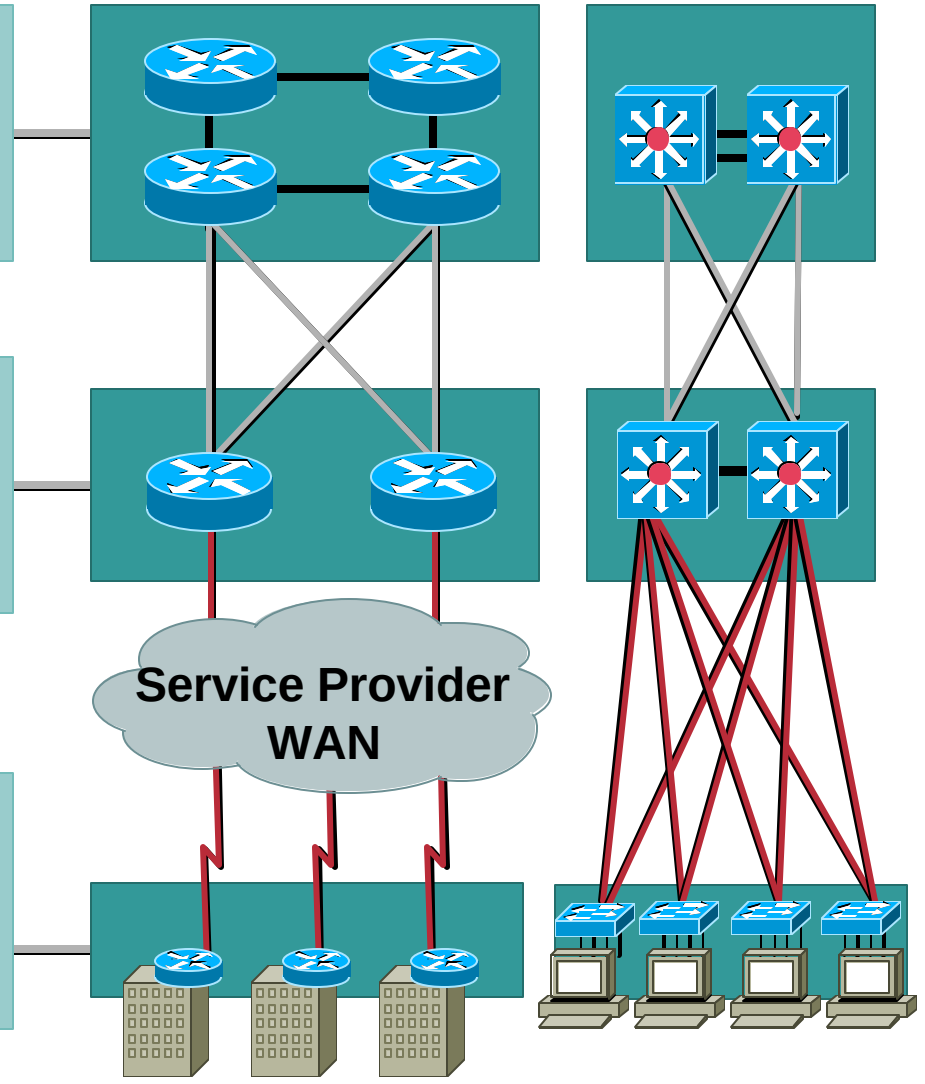
- To design a network with the correct attributes hierarchy is used to define functional blocks…
  - Access
  - Distribution
  - Core
- …Which provide the “right” fault isolation, scaling, security, QoS and scaling characteristics

Each Layer Provides Unique Functionality

Core Layer Provides Optimal Transport Between Core and Distribution

Distribution Layer Provides Policy-Based Connectivity, Peer Reduction and Aggregation

Access Layer Provides Common Group Access to the Internetworking Environment



Attributes of Modularity

- **Designing and building networks in modules that are then plugged together to build a large hierarchical network provides several benefits:**
  - **Ease of growth**
  - **Allows component scaling**
  - **Streamlined training**
  - **Distributed management**
  - **Fault isolation—troubleshooting**

The "Building Block" Approach

Structure and Hierarchy: Summary

- **Routed hierarchies enable…**
  - **Scalable network architectures**
  - **Improved application performance**
  - **Managed change**
  - **Improve service**
  - **Simplified management and troubleshooting**
  - **Reduced cost of ownership**

Structure and Hierarchy: Scalable Routing

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- **Hierarchy enables us to…**
  - **Control the impact of failures**
  - **Manage change**
  - **Enable effective, deterministic routing behavior**
  - **Define fault, QoS, security, domains**
  - **Reduces the routing protocol processing overhead**
  - **Hierarchical (modular) topologies must be used with protocols such as OSPF, IS-IS or EIGRP**

Deploying Metro Ethernet in the Enterprise

Agenda

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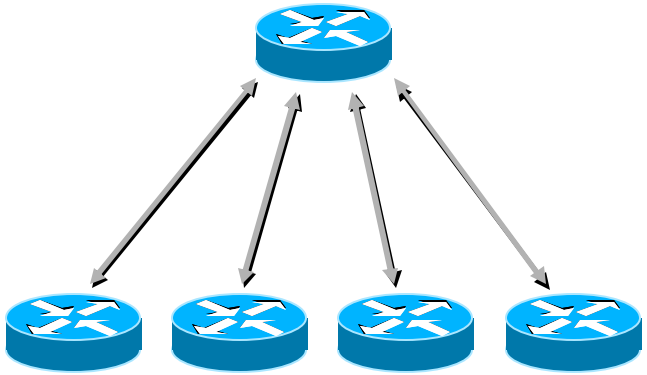
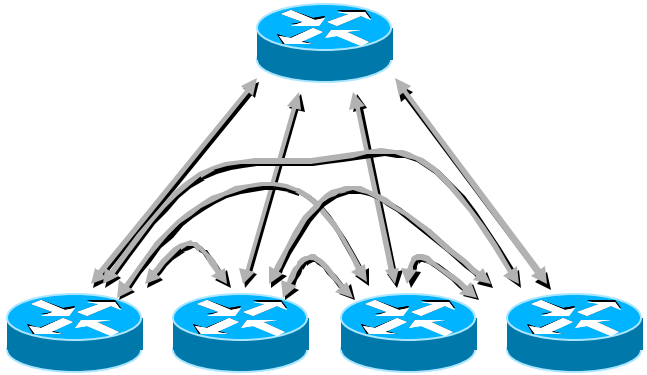
- Design Principles
- **Metro Ethernet Design Recommendations**
- Cisco Metro Solutions

Metro Ethernet Distribution Hub and Spoke vs. EMS

- **Hub and spoke**
  - Predictable traffic patterns
  - Simple QoS and security policy definition
  - Simple IGP peering
  - Simple IP multicast behaviour
  - Simple troubleshooting



- **Emulated LAN**
  - Unpredictable traffic patterns
  - Complex QoS and security policy definition
  - Complex IGP peering
  - Complex IP multicast behaviour
  - Complex troubleshooting



Metro Ethernet: EMS Decision Criteria

- **An Ethernet Multipoint service may be considered, if…**
  - **A small number of sites are considered**
  - **Limited number of devices/hosts**
  - **Multicast is not a big requirement**
- **Use ERS service if these criteria cannot be met**
  - **Design for the future**
  - **Easier to implement as point-to-point than migrate later**
- **Layer 3 service**

The MAN and WAN Edge: Switches or Routers?

- **Pros**
  - Very cost effective
  - Easy to implement
- **Cons**
  - Little filtering or intelligence
    - Not true for newer switches
  - Policing, typically no shaping
  - Broadcast flooding
  - Spanning tree dangers if not utilized correctly
  - “Fuzzy” demarcation between enterprise and SP

- **Pros**
  - Traffic segmentation
  - Address structuring and management
  - Fault isolation and control
  - Policing and shaping
  - Layer 2 broadcast and multicast segmentation
  - No spanning tree; greater control w/ routing protocols
- **Cons**
  - More costly to implement

Metro Ethernet: Switched Edge Recommendations

- **Suitable for data only services**
  - **IP telephony/interactive applications need careful consideration**
- **Suitable for very small, simple applications**
  - **~2–10 sites, ~10–20 hosts per site**
- **Use broadcast suppression**
  - **Set to low% of committed rate**
- **Use intelligent switches and police using VACLs to define QoS policies**
  - **Note: traffic shaping is not typically supported**

Metro Ethernet: Switched Edge Recommendations

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- **From a security perspective…**
  - **Configure port security internally**
    - **Consider IEEE 802.1x**
    - **There should only be one MAC address per port**
  - **Disable VTP on edge switches**
    - **Could be used as a denial of service attack**
  - **Disable CDP on edge ports**
    - **Advertises device, IP and software versions**
    - **Could be used as a DOS attack**
  - **Disable DTP on edge switches**
    - **Define only the VLANs that you require for connectivity**
  - **Configure spanning tree ROOT guard**

Metro Ethernet: Why Routers?

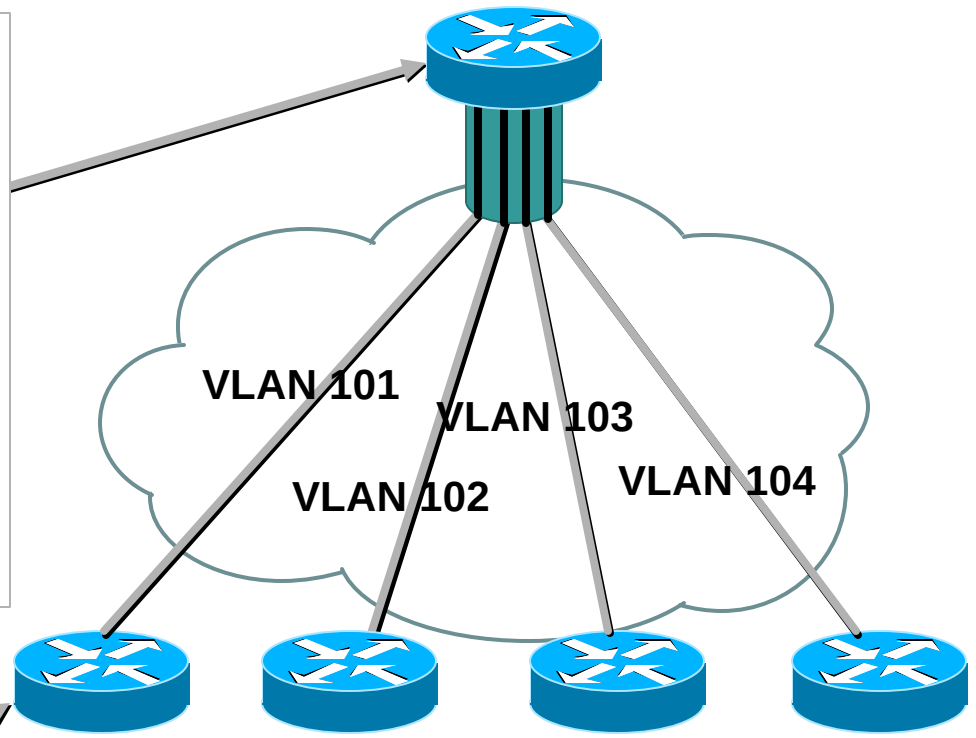
- **Sophisticated traffic management**
  - **LLQ, CBQ, CAR, etc.**
- **Sophisticated security management**
  - **ACLs, firewall features, etc.**
- **Structured address management**
  - **IP addresses**
- **Simplified policy management**
  - **QoS, security, etc.**
- **Simple fault determination and convergence**
  - **Explicit one-to-one relationships**
  - **Robust routing protocol support**

Metro Ethernet: Distribution Hub and Spoke

- **Deploy metro Ethernet as virtual leased lines**
  - **Deploy routers as the edge device of choice**
    - **Enables key features such as IP multicast routing, content services, security, etc.**
  - **Model links as frame relay or ATM PVCs**
  - **Use VLANs as sub interfaces**
  - **Use VLAN tags like DLCI or PVCs**
  - **Apply same QoS and security policies as existing Frame Relay networks**

Metro Ethernet Deployment


```
Interface gigabitethernet0/0
No ip address
!
Interface ge0/0.1
ip address 192.168.255.1 255.255.255.252
Encapsulation dot1q 101
!
Interface ge0/0.2
ip address 192.168.255.5 255.255.255.252
Encapsulation dot1q 102
!
Interface ge0/0.3
ip address 192.168.255.9 255.255.255.252
Encapsulation dot1q 103
!
Interface ge0/0.4
ip address 192.168.255.13 255.255.255.252
Encapsulation dot1q 104
```




```
Interface fastethernet0/0
No ip address
!
Interface fastethernet0/0.1
ip address 192.168.255.2 255.255.255.252
Encapsulation dot1q 101
```

- **Implement as Point-to-point interfaces**
- **Use sub-interfaces as these allow flexibility later if additional connections are required.**

Metro Edge:
Why Routers? Policing and Shaping?

- Shaping is required to allow flexibility in the way bandwidth is managed
- Policing is a “hard” limit, congestion unaware mechanism
  - Within contract yes/no decision
- Metro Ethernet will be a sub-rate service
  - I.e. 10Mbps within a 100Mbps connection
  - Provider will police your traffic
- Shaper ensures that congestion is notified on interface even if there is no actual congestion
  - “Virtual” queue

Metro Edge:
Why Routers? Policing and Shaping?

- **An example**
  - **Assume that we have a 100Mbps connection and a 20Mbps access rate**
  - **4Mbps allocated for IP voice**
  - **6Mbps allocated for video traffic**
  - **6Mbps allocated for business critical traffic**
  - **4Mbps allocated for everything else**
- **But, in the absence of higher or lower priority traffic, I want to be a able to burst into those classes**
- **Solution: Combine police and shaping**

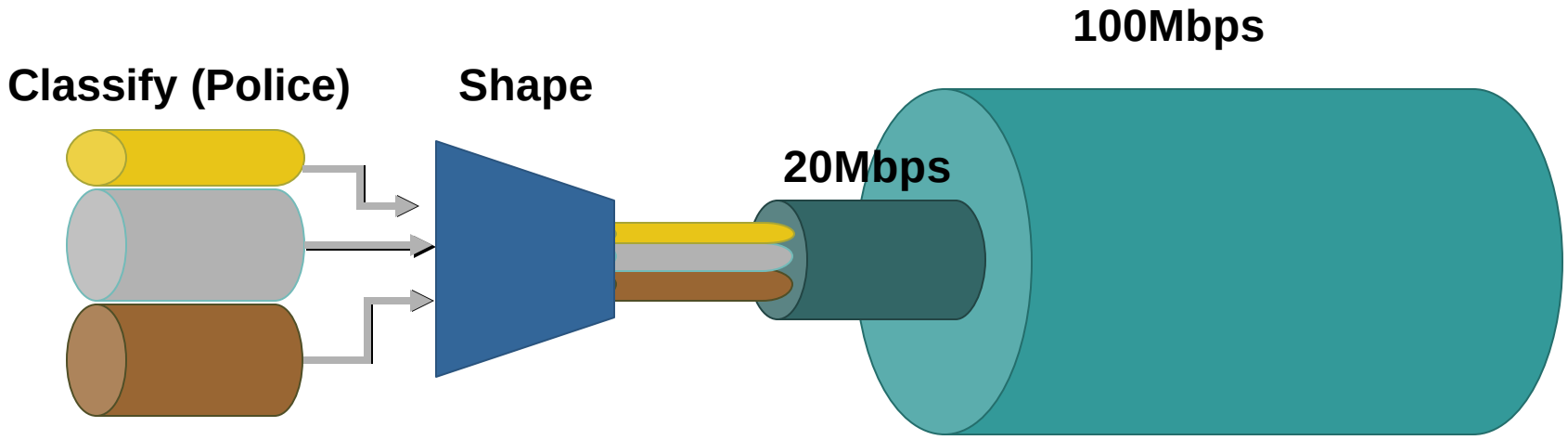
Metro Edge:
Why Routers? Policing and Shaping?

- "Optical" configuration

```
policy-map customer_classes
  class VOICE
    police 4000000 conform-action set-prec-transmit 5 exceed-action drop
    priority 4000
  class MISSION-CRITICAL
bandwidth 20000
   service-policy customer_classes bandwidth 6000
    police 6000000 conform-action set-prec-transmit 3 exceed-action set-
prec-transmit 0
  class VIDEO
   bandwidth 6000
   police 6000000 conform-action set-prec-transmit 2 exceed-action set-
prec-transmit 0
  class BEST-EFFORT
   bandwidth 4000
     police 4000000 conform-action set-prec-transmit 0 exceed-action set-
prec-transmit 0
 policy-map shape_output
  class ALL-CUSTOMER-CLASSES
   shape average 20000000
```

Metro Edge:
Why Routers? Policing and Shaping?

- **Classification and policing of in-and out of profile traffic at ingress**
- **Shaper at egress allows “elastic” bandwidth sharing**



Metro Ethernet: ERS Recommendation

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- **Point-to-point ERS service modelled as existing Frame Relay or ATM deployments today**
  - **Optimum scaling characteristics**
  - **Optimum QoS policy**
  - **Optimum security policy**
  - **Optimum troubleshooting and management**
- **Leverages existing expertise**
  - **Well understood and widely deployed model in Frame Relay and ATM networks today**

Metro Ethernet ERS: Network Design Practice

- **Improved performance**

  Support for deterministic traffic engineering designs for routing protocols

  Deterministic convergence

  Traffic load share on equal cost paths

  Minimize downtime: By providing redundancy and alternative path routing where appropriate

Metro Ethernet ERS: Good Network Design Practice

- **Improved management**

  Ease change: Building block approach, plus well-defined boundaries

  Minimize downtime: By provided redundancy and alternative path routing

  Maximize services: QoS, rate limiting, voice, etc…implemented at appropriate levels of the network

  Distribute the security policy and processing load by creating well-defined functional layers

Deploying Metro Ethernet in the Enterprise

Agenda

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- Design Principles
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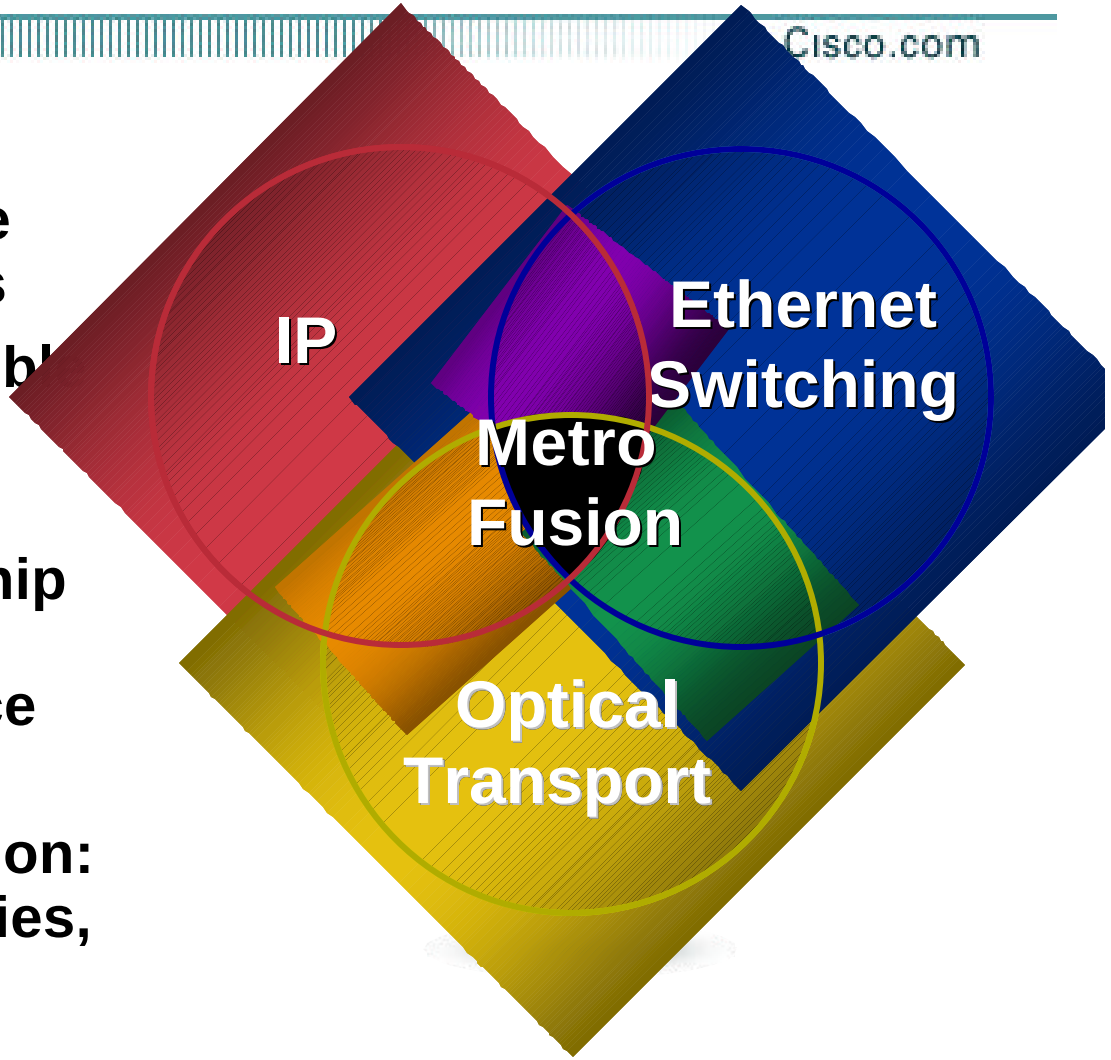
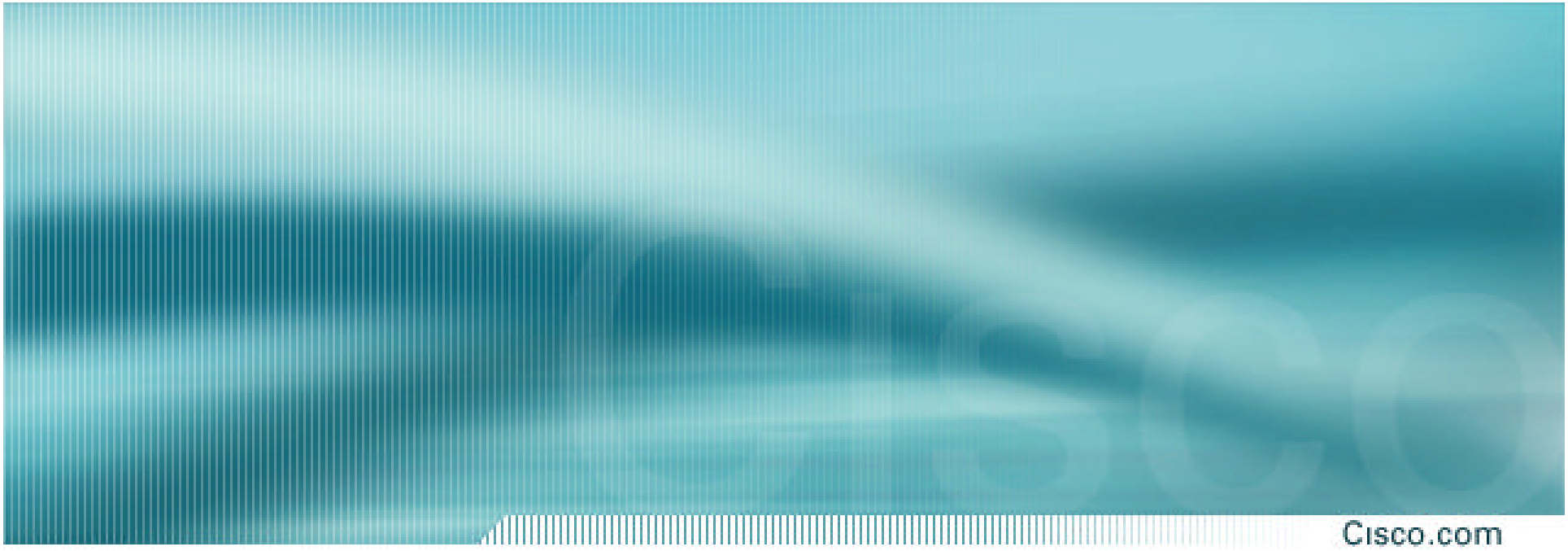
- **Cisco Metro Solutions**

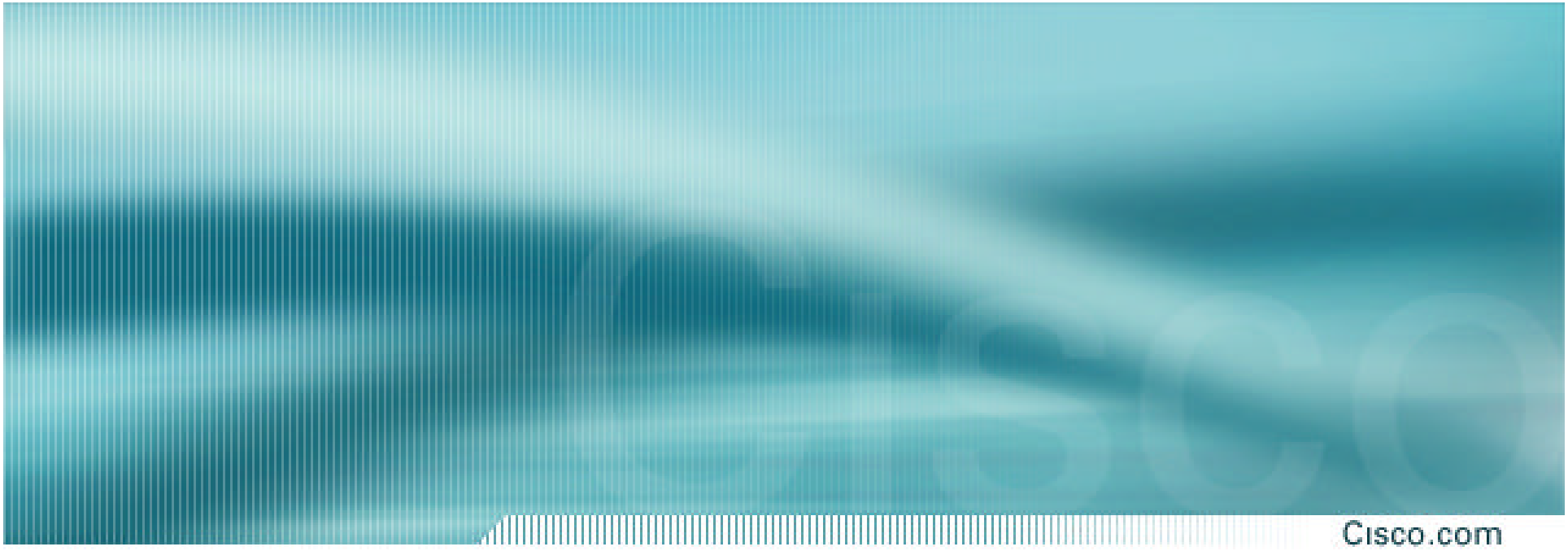
Cisco Metro Fusion

- Comprehensive service portfolio meeting diverse application requirements
- Deliver efficient and flexib design options and architectures
- Proven industry leadership delivering unparalleled network scale and service availability
- Driving industry innovation: architectures, technologies, standards





Deploying Metro Ethernet Solutions



Please Complete Your Evaluation Form

Session – Deploying Metro Ethernet Solutions