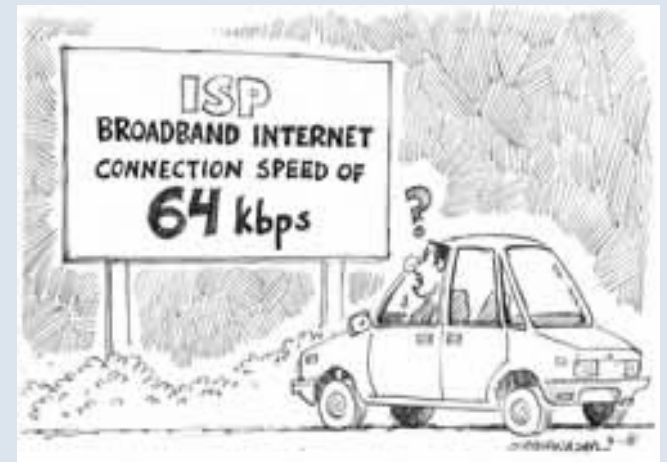**CISCO SYSTEMS**

Metro Ethernet deployments and challenges
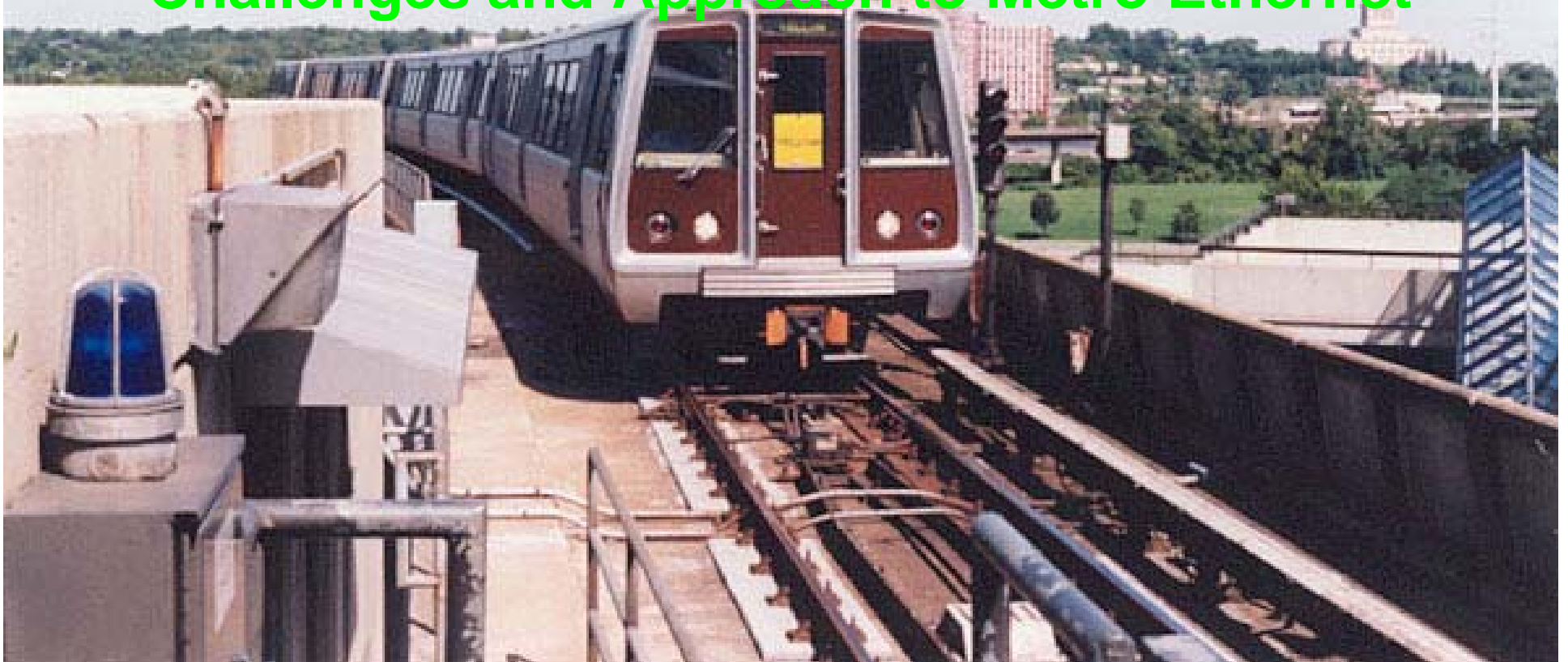
Yogesh Jiandani (yogeshj@cisco.com)
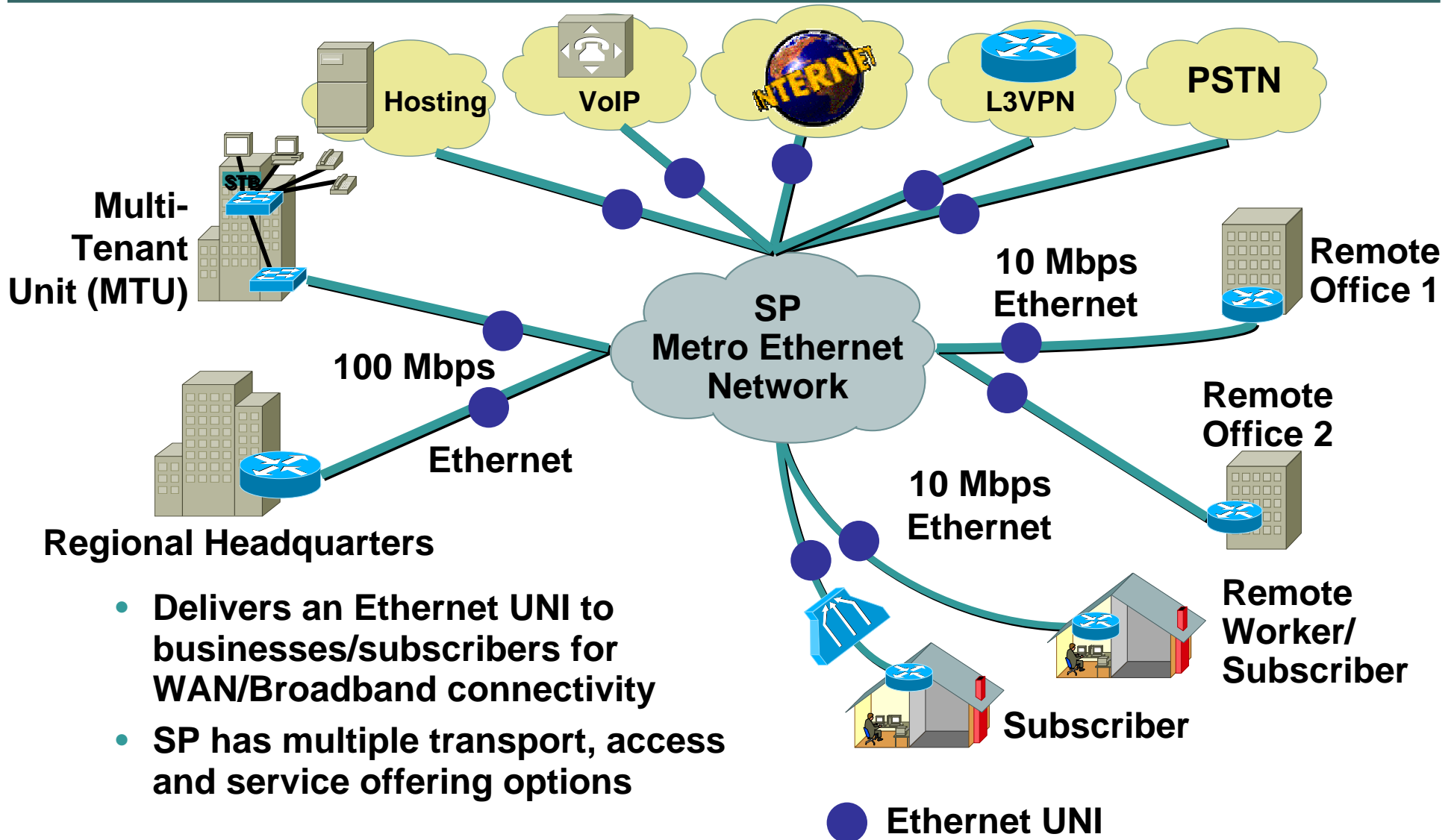
Consulting Systems Engineer, Cisco Systems

Agenda

- **SP Ethernet and applications**

- **Metro Ethernet Basics and Service definitions**

- **Challenges and Approach to Metro Ethernet**

What Is SP Metro Ethernet?

Hosting

VoIP

INTERNET

L3VPN

PSTN

Multi-Tenant Unit (MTU)

STB

SP Metro Ethernet Network

100 Mbps

Ethernet

Regional Headquarters

10 Mbps Ethernet

Remote Office 1

Remote Office 2

10 Mbps Ethernet

Subscriber

Remote Worker/ Subscriber

- **Delivers an Ethernet UNI to businesses/subscribers for WAN/Broadband connectivity**
- **SP has multiple transport, access and service offering options**

● **Ethernet UNI**

Benefits to Residential customers

Cis...

ETTx Focus

Content screening – Parental control

Streaming:
Audio, Video
Virtual VCR
Video on Demand
Conferencing

Family management; Home-Network Device Management

Corporate access: IP VPN, Voice, Video

Ethernet UNI

Security; Video Surveillance

Internet access   **Entertainment - Gaming**

Benefits to Business customers

ETTB Focus

- **Ethernet everywhere – in the LAN and the WAN**

- **Cheaper Bandwwwwidth**

- **New services viz L3VPN, L2VPN, Ethernet Private Line ..and more to come**

  - **Handle traffic according to business objectives**

  - **Support mix of different applications with different QoS requirements and traffic profiles – delay/jitter/loss/bandwidth/availability/sequence preservation – bursty & non-bursty traffic types**

Not just connectivity… its all about packaging

Large Business and Business Parks

Centralization of servers
Storage, video transfer
Disaster recovery
Mega Internet, Web hosting, e-mail
Branch-office VPNs
IP telephony, SANs, CDNs

Schools, Hospital Libraries, Public

- Reduced Local Loop Cost
- Mega Internet
- Web hosting, e-mail
- HD images - telemedicine
- IP phone on each teacher's or doctor's desk
- Surveillance real time

Universities, Research Institutes

Intranet: lectures, materials
Internet - surf, research, E-mail
IP video, telephony
E-learning

Small Business, Shops and SOHO

- Internet – surf
- E-commerce
- Hard-disk storage
- Videoconference
- Voice flat fee
- Surveillance

Buildings Owners Buildings Managers

- Surveillance real time
- Digital recording

Residential

Triple Play
Basic package: Internet, mailboxes, voice +
Captive portal +
Video on demand DV
Video broadcast
Gaming
nPVR

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Metro Ethernet Architecture and Terminology

Integrated System

Efficient **Access**	Large Scale **Aggregation**	Intelligent **Edge**	Multiservice **Core**	Intelligent **Edge**	Efficient **Access**

User Facing Provider Edge (U-PE)

Aggregator (PE-AGG)

Metro A

U-PE

PE-AGG

GE Ring

10/100/ 1000 Mbps

Metro C

Hub and Spoke

U-PE

10/100/ 1000 Mbps

N-PE

Metro B

DWDM/ CDWM

U-PE

N-PE

P   P

MPLS/IP/TDM

P   P

N-PE

RPR SONET/SDH

10/100/ 1000 Mbps

U-PE

10/100/ 1000 Mbps

Metro D

Network Facing Provider Edge (N-PE)

Some Basic Metro Ethernet Concepts

VLAN?
BPDU?
802.1x?
802.3ad?
802.3ah
…

Customer
Equipment

UNI
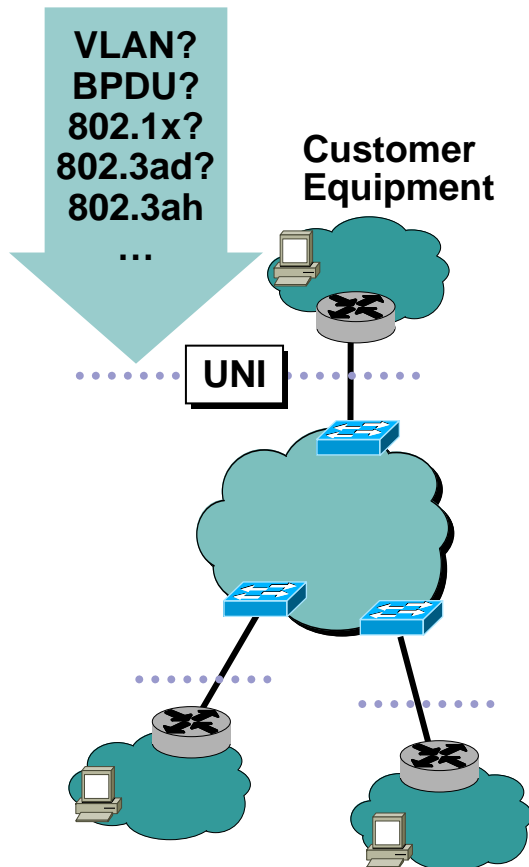
- **User Network Interface (UNI)**—Demarcation point between service provider and service user responsibilities

- **Ethernet Virtual Connection (EVC)**—Association of two or more UNIs; frames can only be exchanged among the associated UNIs

- **VLAN transparency**—Ingress and egress customer VLANs are identical

- **Layer 2 control protocol tunneling**—The SP tunnels customer L2 control protocols in a manner that is consistent with the data packets

- **Bundling**—Multiple customer VLANs can map through a single Ethernet service on the UNI; **all-to-one bundling** is a special case whereby all customer VLANs map to a single Ethernet service at the UNI

- **Service multiplexing**—The service provider can multiplex multiple EVCs per a single customer UNI

Ethernet Wire Service (EWS) – Leased Line equivalent
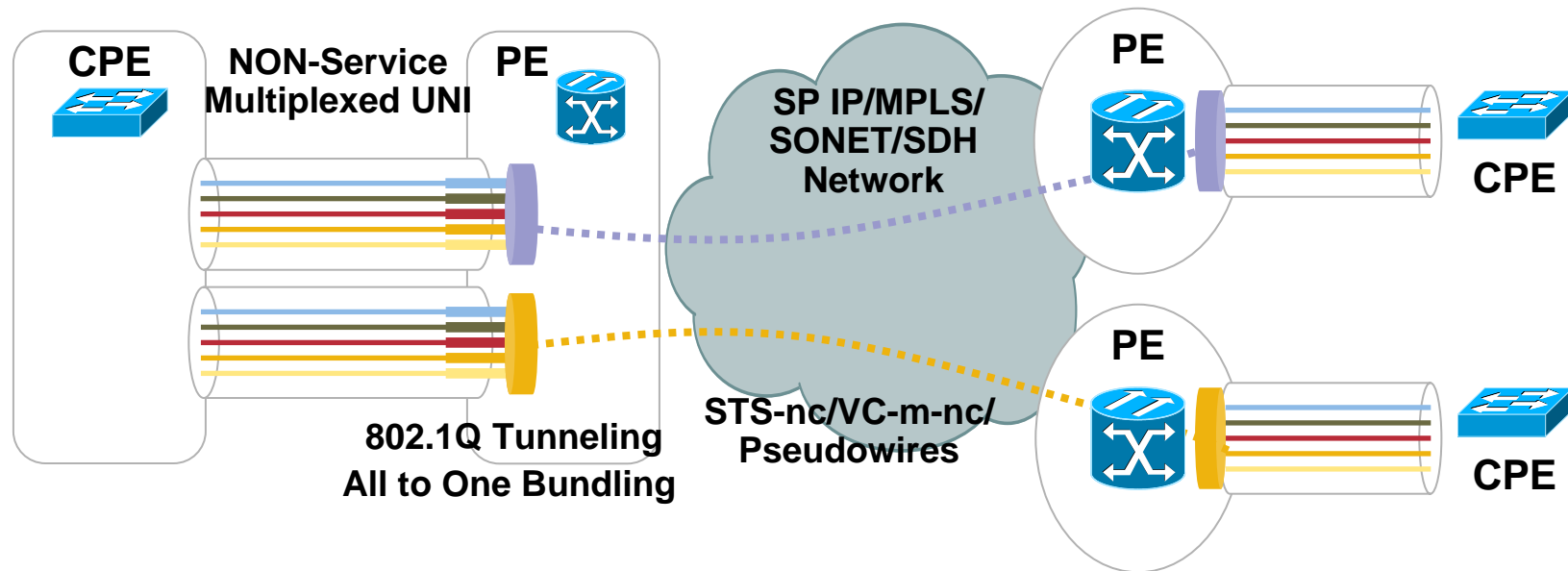
- Defines a **point-to-point**, **port-based** service
- **No service multiplexing**—"all-to-one" bundling
- **Transparent** to customer BPDUs
- Allows for **over-subscription** using stat muxing
- Routers and/or switches as CPE devices

Ethernet Private Line (EPL) – Leased line equivalent
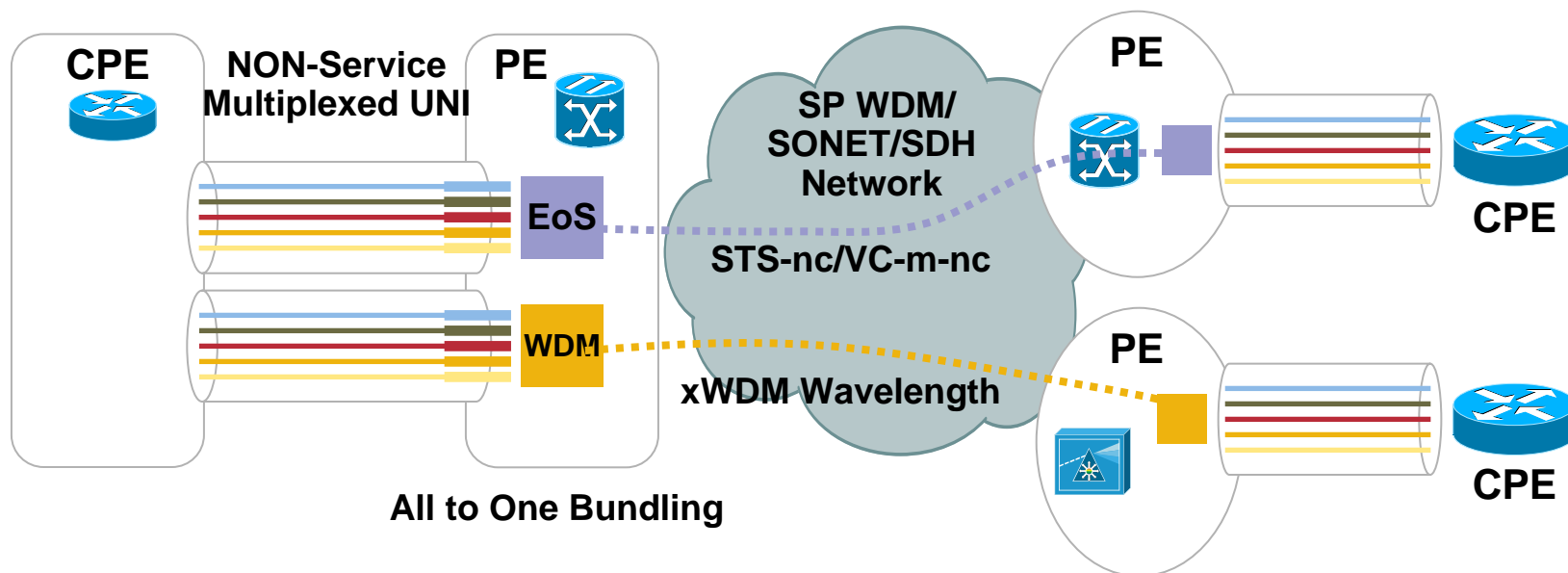
- Defines a **point-to-point**, **port-based** service
- **No service multiplexing**—"all-to-one" bundling
- **Transparent** to customer BPDUs
- No oversubscription—delivered via EoS or WDM
- Routers and/or switches as CE devices

Ethernet Relay Service (ERS) – FR equivalent
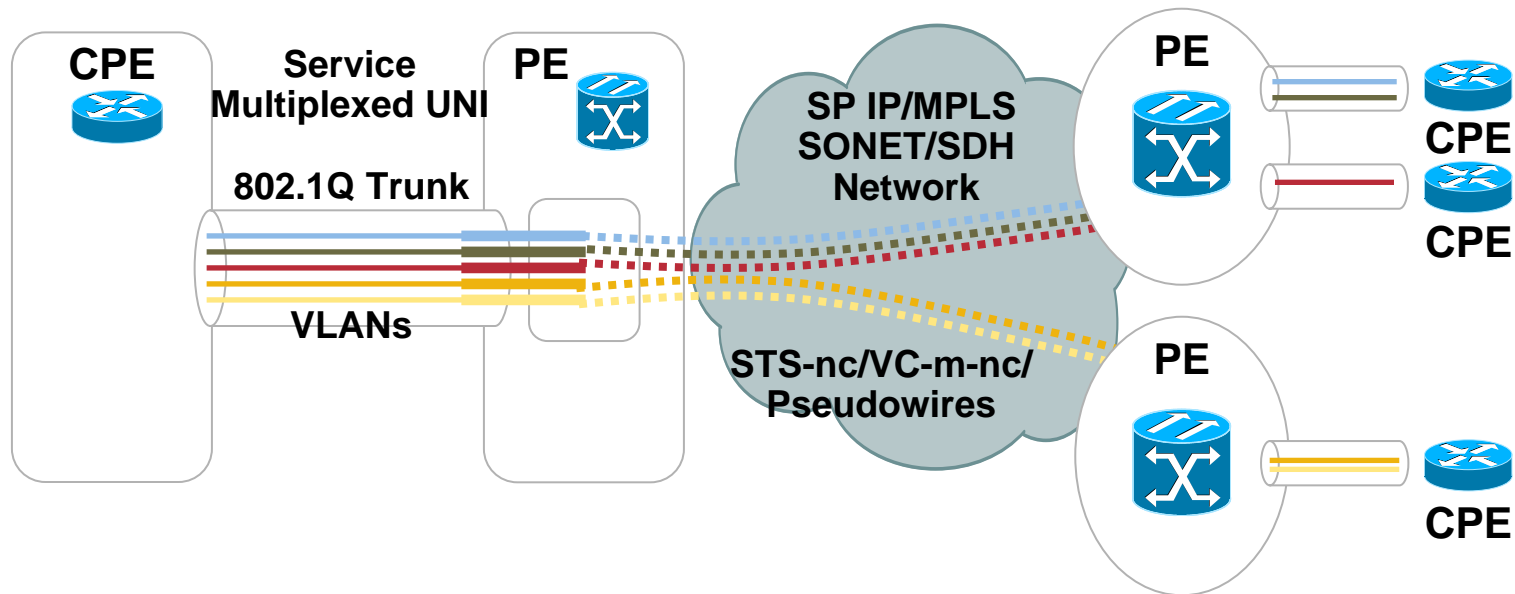
- **Defines a point-to-point service (analogous to Frame Relay using VLAN tags as VC IDs)**

- **Service multiplexed UNI (e.g., 802.1Q trunk)**

- **Opaque to customer PDUs (e.g., BPDUs)**

- **Recommend a router as CPE device**

Ethernet Multipoint Service (EMS) a.k.a. VPLS
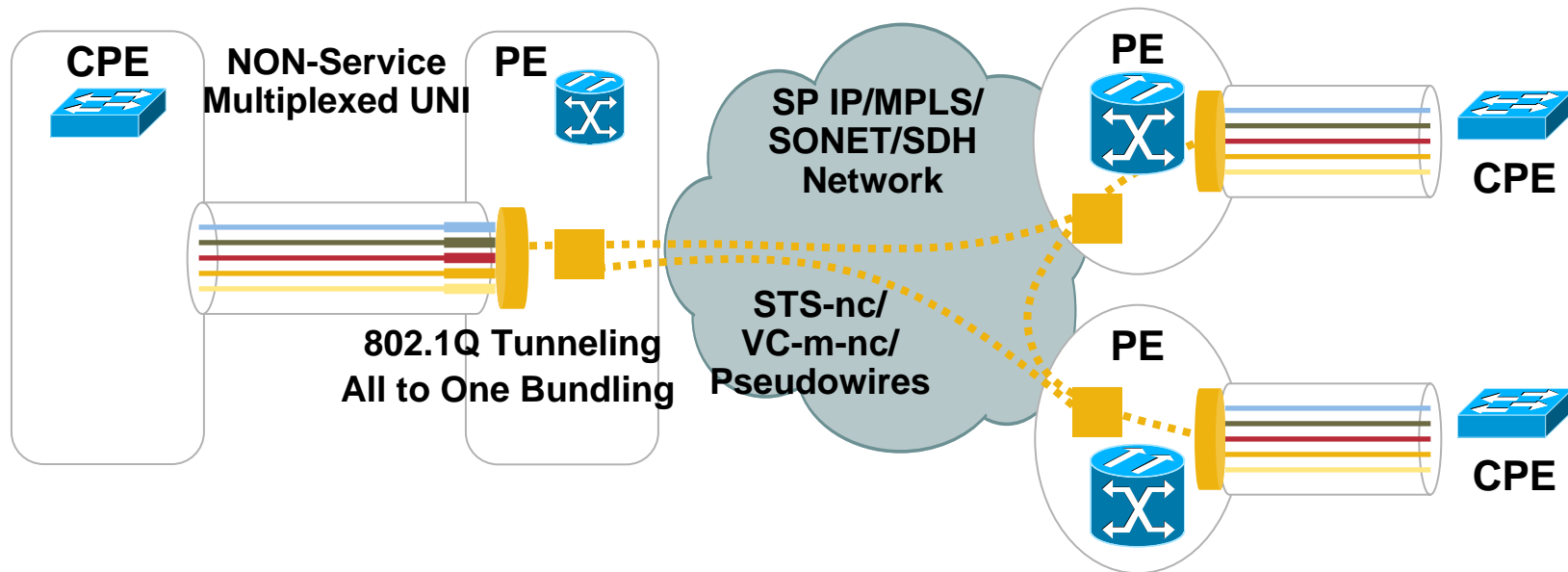
- **Multipoint** service where all devices are direct peers
- **No service multiplexing**—all VLANs are presented to all sites ("all-to-one" bundling)
- **Transparent** to customer BPDUs
- Also called transparent LAN service (TLS), E-LAN, or VPLS
- Routers and/or switches as CPE devices

L2 Access to the Internet and L3 VPN
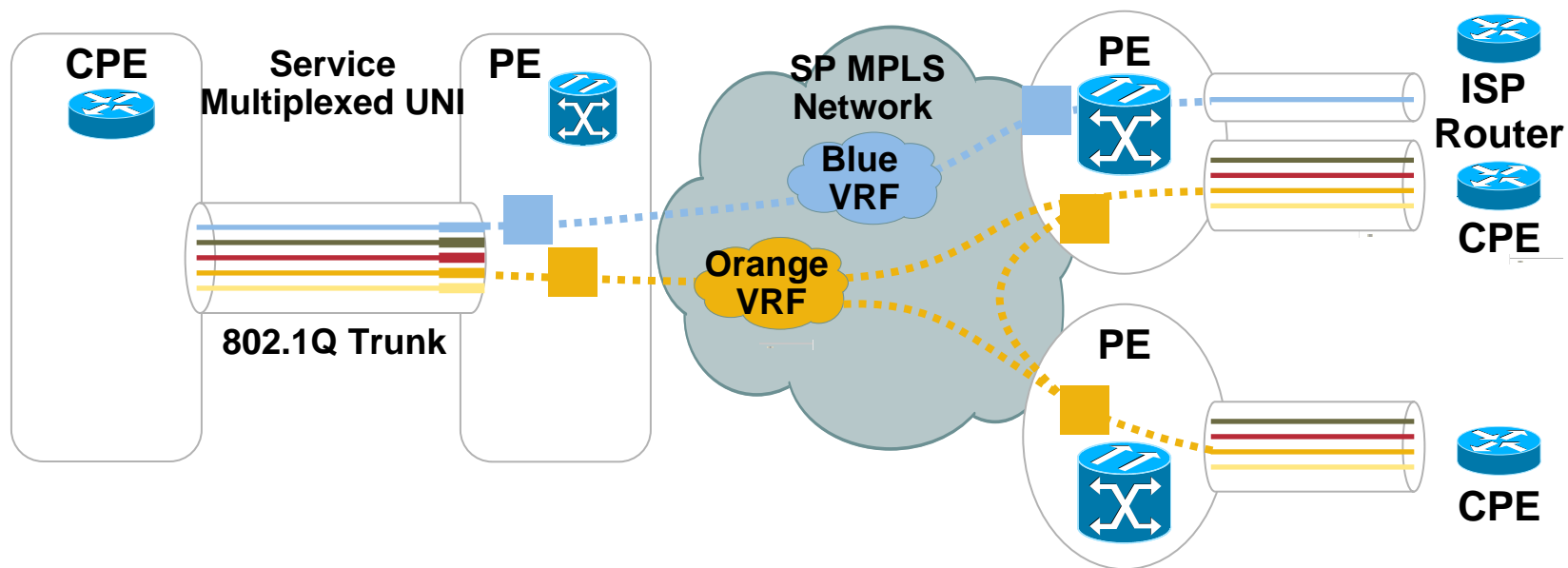
- **ERS UNI** that maps to MPLS VPN on PE

- **L3 multipoint** service that maps VLANs to VRFs

- **Service multiplexed** UNI (e.g., 802.1Q trunk)

- **Opaque** to customer PDUs (e.g., BPDUs)

- Recommend a **router** as CPE device

Summary of Ethernet-based Services
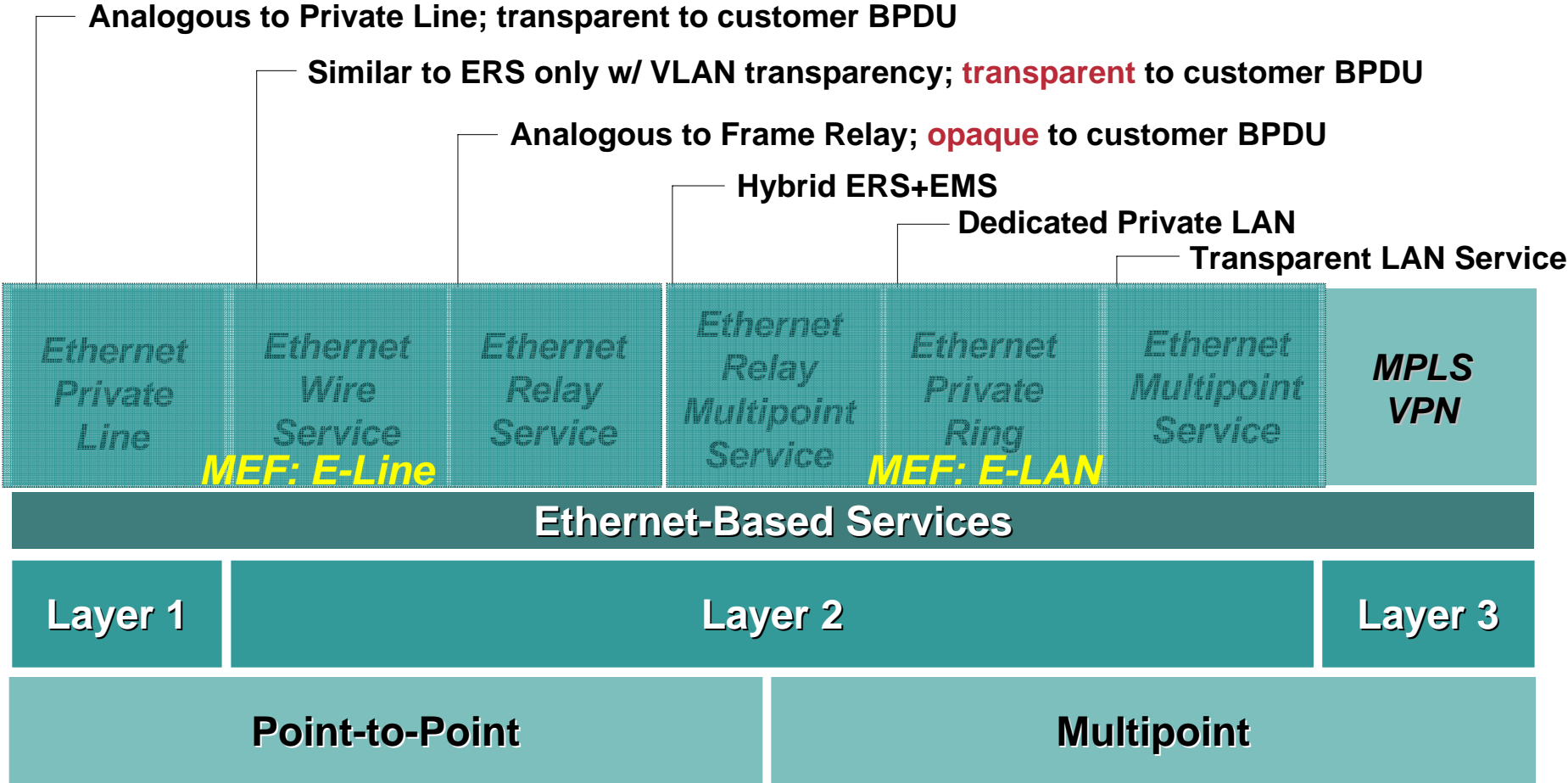
Analogous to Private Line; transparent to customer BPDU

Similar to ERS only w/ VLAN transparency; **transparent** to customer BPDU

Analogous to Frame Relay; **opaque** to customer BPDU

Hybrid ERS+EMS

Dedicated Private LAN

Transparent LAN Service

Ethernet Private Line	*Ethernet Wire Service*	*Ethernet Relay Service*	*Ethernet Relay Multipoint Service*	*Ethernet Private Ring*	*Ethernet Multipoint Service*	**MPLS VPN**
	MEF: E-Line			*MEF: E-LAN*		

Ethernet-Based Services

Layer 1	**Layer 2**	**Layer 3**

Point-to-Point	**Multipoint**

Agenda

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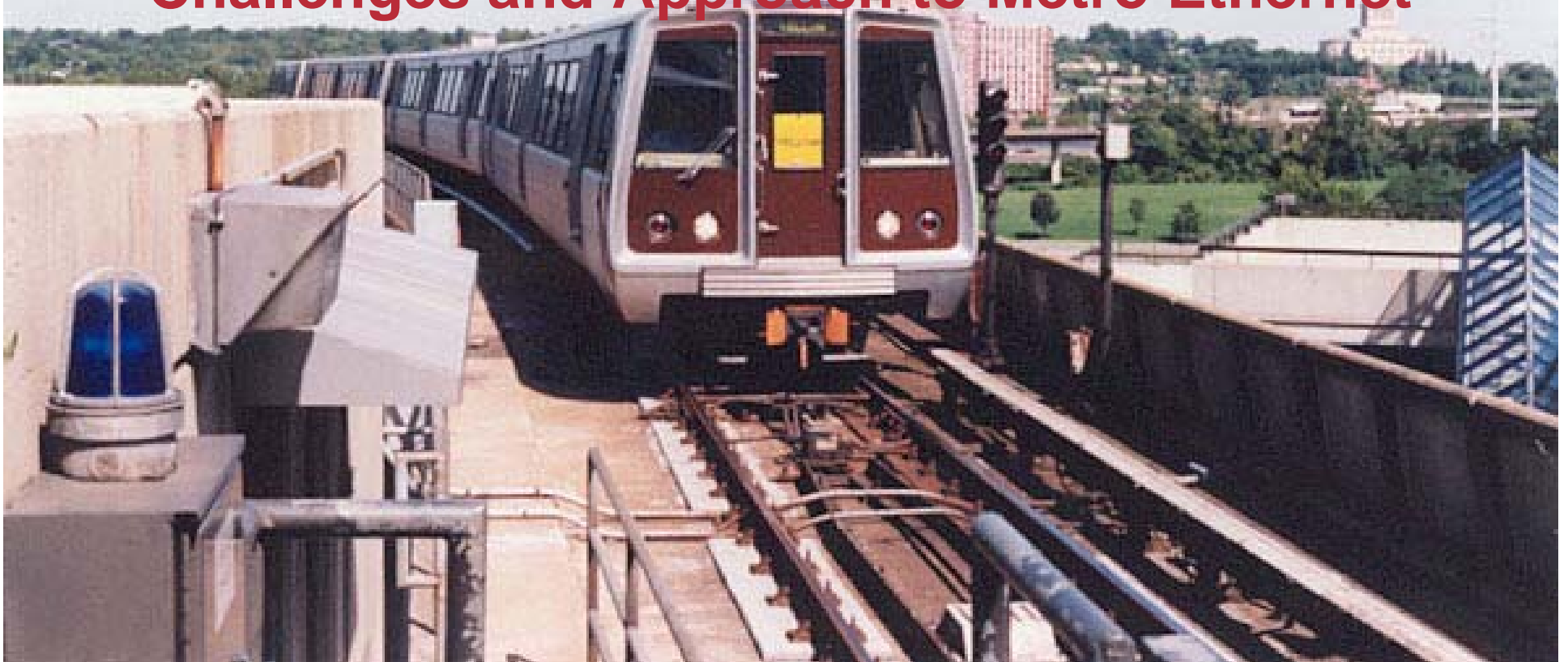
Residential & Business Service Ready Networks
Challenges faced by SPs today

Policy-Service

Access | Aggregation | Edge

Customer Equipment

Enterprise

SG

Core

PW

Residential
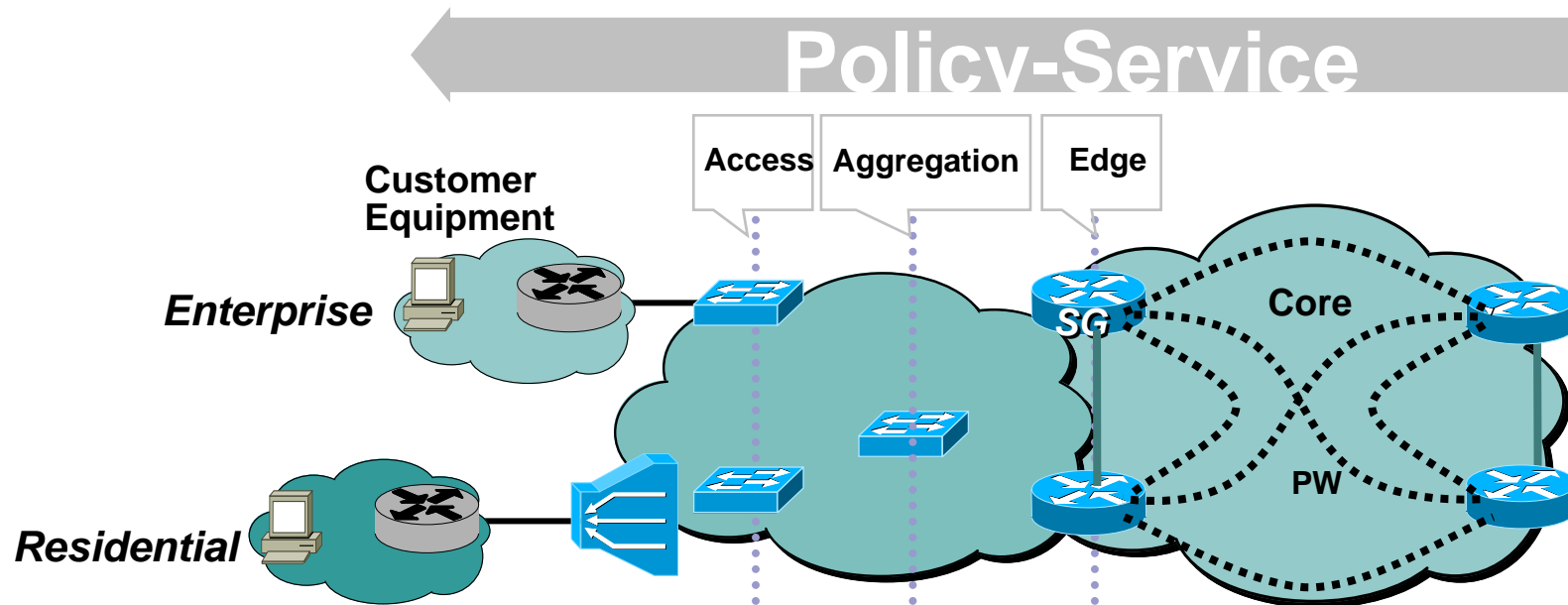
Customer Equipment	UNI Definition	How to Build the Ethernet Access	How to Build the Interconnect Media
Enable Home- Networking Multiple SP support Residential & Business	Customer control protocol handling Service Definition LMI	Standard IEEE Bridges Customer VLAN transp. DSL/Wireless/Fiber MAC address scalability Redundancy OAM&P,…	MPLS/L2TPv3 Redundancy; PW – encap & signal. Auto-Discovery; EA & IM connection; OAM&P,…

Challenges of the Metro Ethernet Network Design

- **Technology choice – Switching/Optical, MPLS/L2TPv3 to the access or in the aggregation, Interworking with FR/ATM/LL**

- **Deployment – Rings/FTTx based on density**

- **Where – Upto the end customer or only for DSL aggregation**

- **Scaling - # of VLANs and MAC addresses**

- **Security – Preventing IP address theft, MAC address limiting, DHCP Snooping, DDOS,**

- **OAM – Troubleshooting the service end to end**

- **QoS – DSCP transparency, CAC for VoD**

- **Multicast – Latency in joins**

- **Resiliency/Redundancy – faster convergence in the access with standards based deployments**

MEN Life Cycle

Solution choice based on business needs

Service Definition

Service Definition: Layer 2 VPN - EMS/ERMS/EWS/ERS/EPL
Layer 3 VPN
Higher Layer Service Integration (Content etc.)

SLA Definition

SLA Models
based on the business aspects

Solution Architecture

Cable layout – FTTX, CTTX
Physical layout – Rings/Spur, Hub and Spoke, Distances, Cable quality
Technology – QinQ, VLAN, MPLS, L2TPv3
Scalability - # of users, type of users, services (V/V/D) BRAS/PPPoE
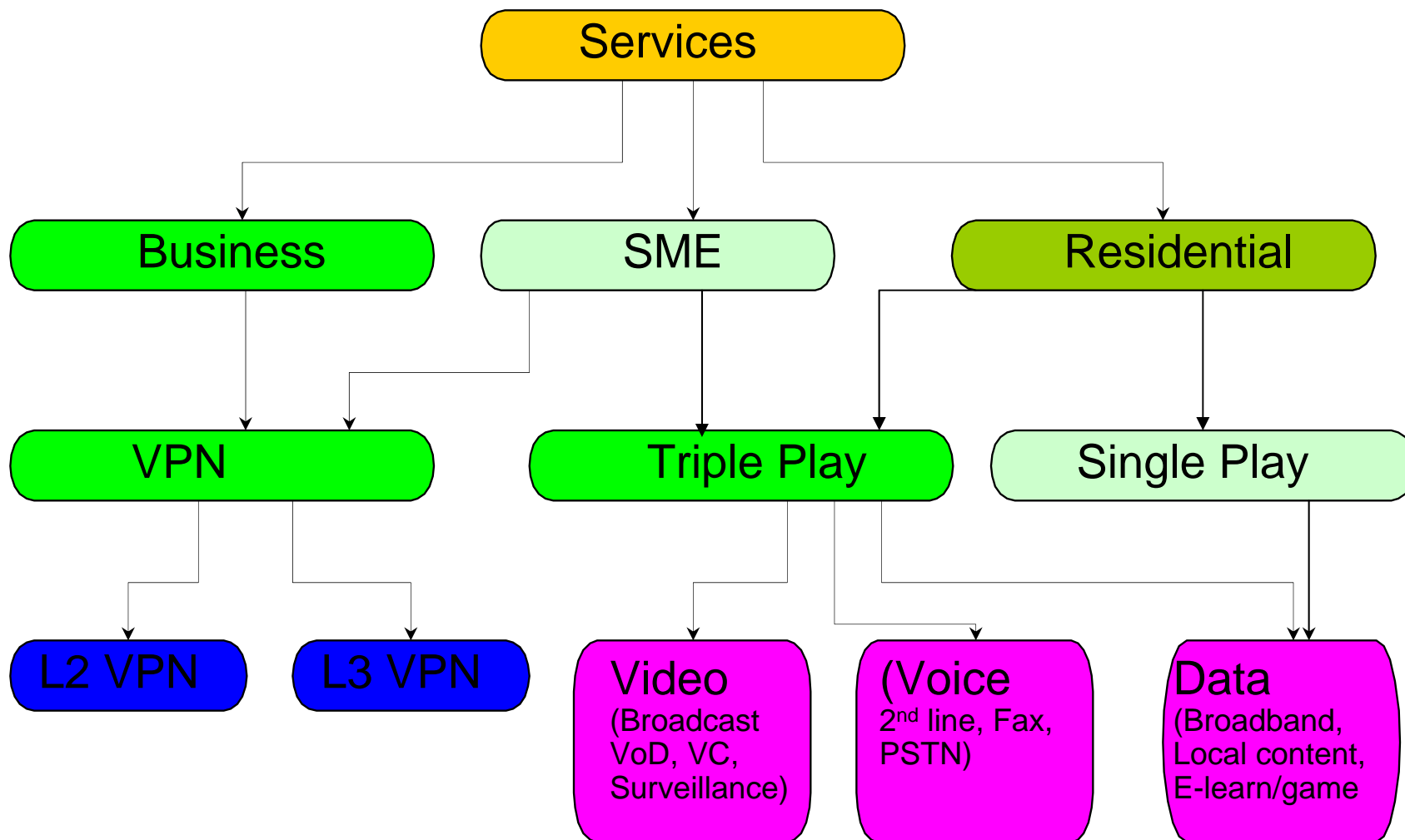*Devices/Equipment – Roles*
Optical – DWDM/CWDM/SONET/SDH/RPR

Technology Deployment

Service Interworking (Ethernet to leased line, Ethernet to FR, Ethernet to any), Availability (95%/98%/99%/99.9%/99.999%), Multicast, QoS for SLA delivery,VPLS/VPWS, Redundancy, Security, Cost identification and control

Solution Deployment

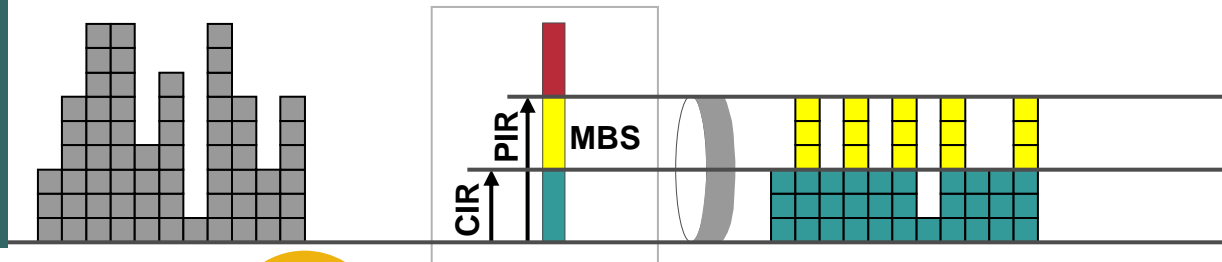Delivery of service architecture: Optical, Switching, Routing

1) Start with the Service definition

```
                          ┌──────────┐
                          │ Services │
                          └──────────┘
          ┌──────────────────┼──────────────────┐
    ┌──────────┐        ┌──────────┐       ┌──────────────┐
    │ Business │        │   SME    │       │ Residential  │
    └──────────┘        └──────────┘       └──────────────┘
          └────────┐         │         ┌────────┐        │
              ┌──────────┐   ┌──────────────┐   ┌──────────────┐
              │   VPN    │   │ Triple Play  │   │ Single Play  │
              └──────────┘   └──────────────┘   └──────────────┘
```

| L2 VPN | L3 VPN |

| Video (Broadcast VoD, VC, Surveillance) | (Voice 2nd line, Fax, PSTN) | Data (Broadband, Local content, E-learn/game |

2) Continue with SLA definitions
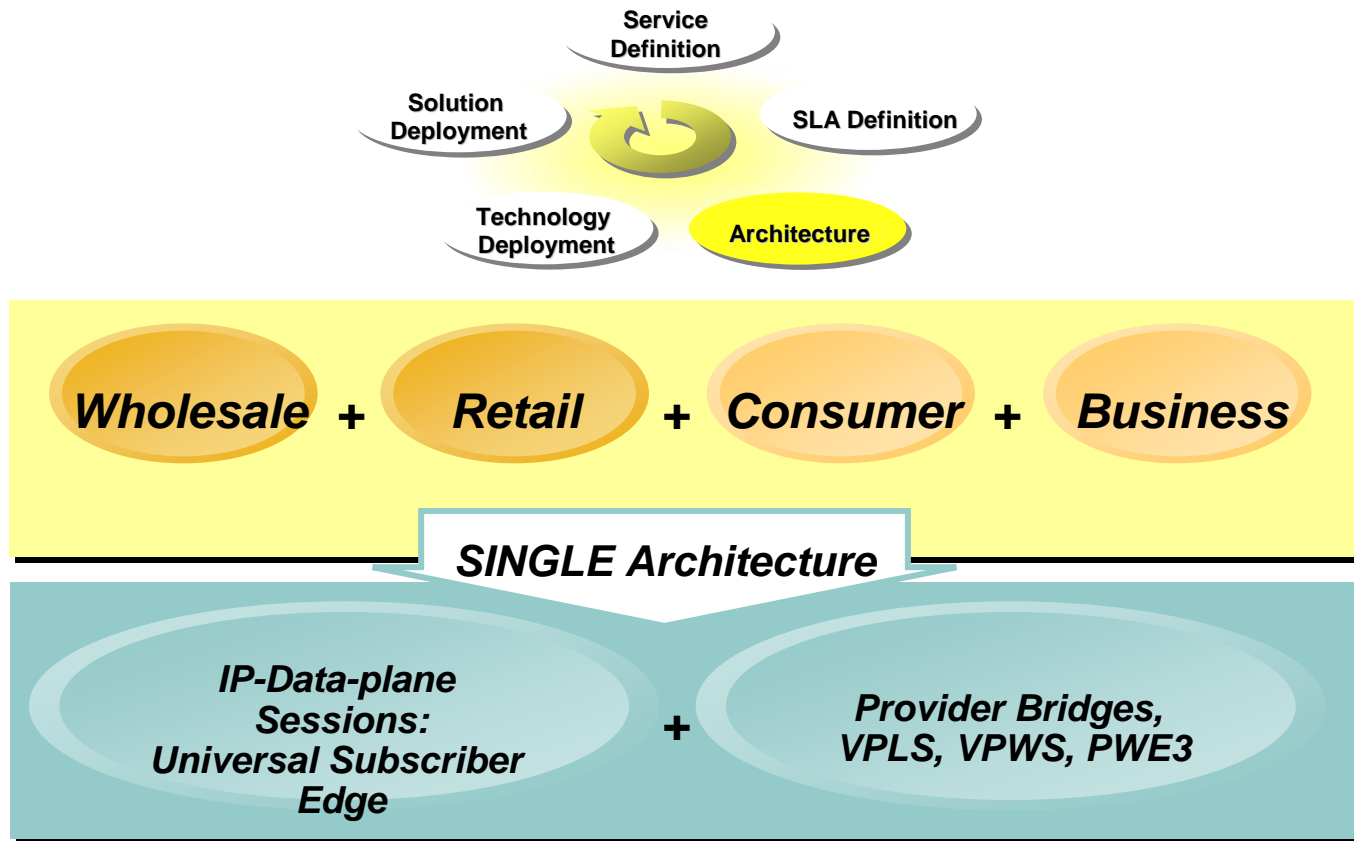
- **Bandwidth profiles**

  Similar to Frame Relay—PIR/CIR/MBS

  Well-known, simple—limited traffic differentiation and per application network capacity planning

- **Service classes**

  Differentiate and traffic-engineer accordingly

3) Look at the architecture approach

Service
Definition

Solution
Deployment

SLA Definition

Technology
Deployment

Architecture

Wholesale + **Retail** + **Consumer** + **Business**

SINGLE Architecture

IP-Data-plane Sessions: Universal Subscriber Edge + *Provider Bridges, VPLS, VPWS, PWE3*

Remember the KiSS principle

Case Study

Building switch (U-PE)

- Metro Core connects the MANs to the Regional core

- Regional Core connects different type of access media to the service

- National Core connects various regional cores

- EADs connect to the NPE

- EVC/Internet access from the NPE

Spur- Optional (H&S) 1 GE

National Core

Regional Core

Metro Core

Multiple rings

N-PE

Aggregation (PE-Agg)/

Access switch (U-PE)

Ethernet Access Domain