

What You Make Possible



Deploying Business Services over DOCSIS (BSoD)

BRKSPG-2502

Agenda

- **The Case for Business Services over DOCSIS**
- Business VPN Services
- Layer 2 VPN Services over DOCSIS
- MPLS Layer 3 VPN Services over DOCSIS
- Quality of Service
- Choosing a Deployment Model
- COX New Orleans Case Study
- Summary

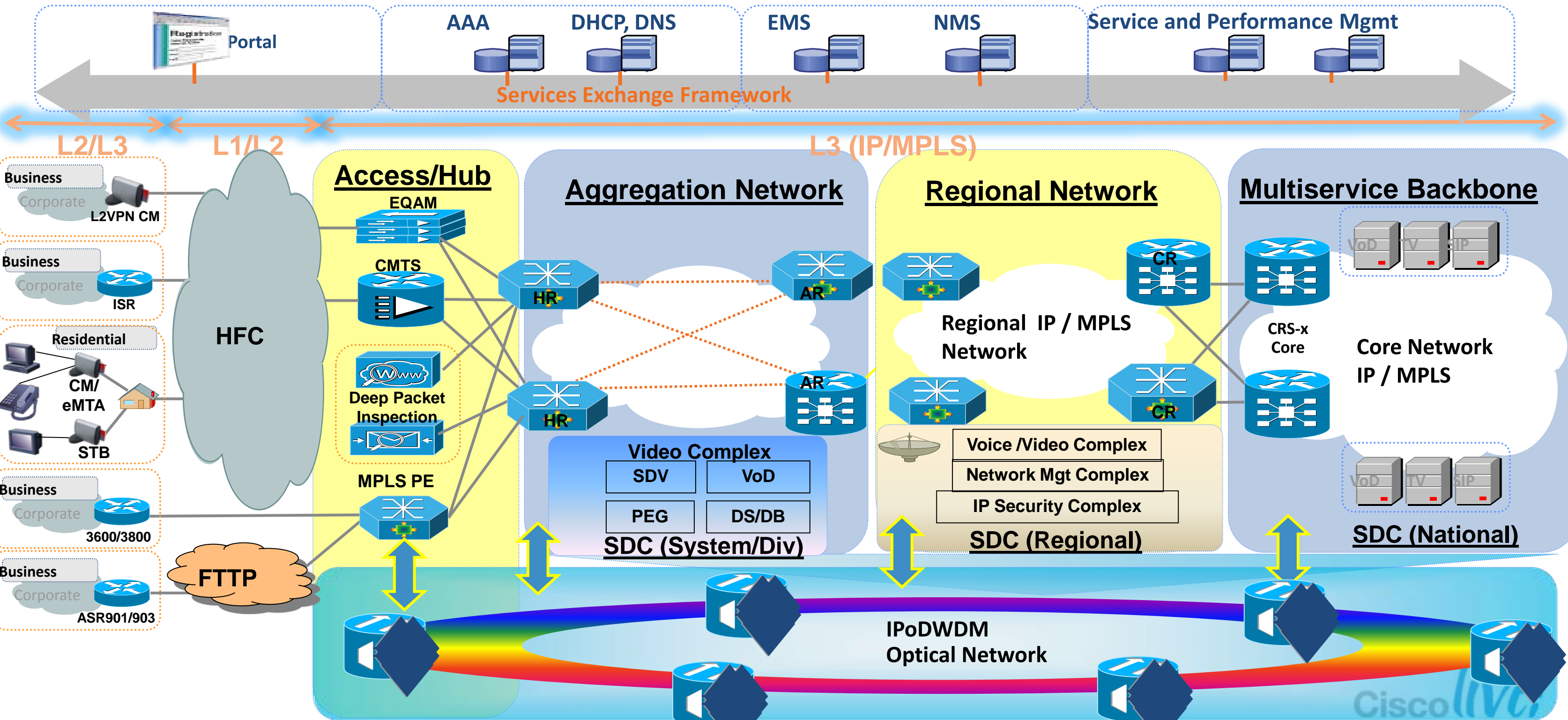
The Case for BSoD



CMTS Based Services

- Massive HFC infrastructure
- Huge DOCSIS footprint
- First wave of Services
 - Video
 - High Speed Data
 - Internet Access
- VoIP revolution
- New Revenue Stream
- Competitive pricing
- Cable is synonymous with Residential Services
- History of VPN over Fiber
- HFC plant underutilized in business hours
- Dual purpose HFC networks?
- Could BSoD be the next wave of evolution?
- No additional cost
- Same HFC infrastructure
- Additional Services
- Standardized services
- Zero touch CMTS provisioning
- Interop between Fiber and HFC
- L2 and L3 services

Cable Multi-Service Networks



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Business VPN Services



What Business VPN Services?

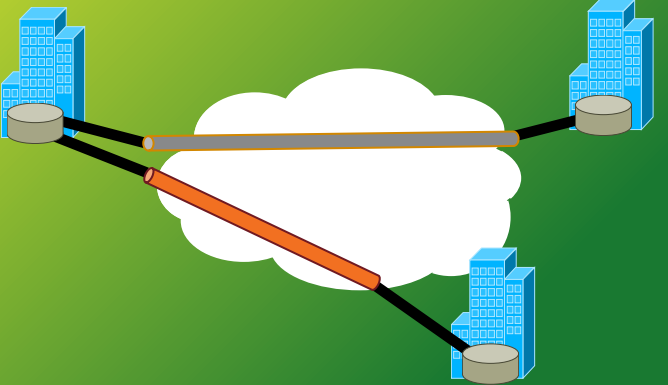
- Mass scale Carrier Ethernet Services adoption
- MPLS-based L3 VPN and L2 VPN services
- Standardized Carrier Ethernet L2VPN Services
 - Protocol Agnostic
 - Simpler to deploy
 - No protocol sharing
- MPLS L3VPN Services
 - Widely Deployed
 - Scalable and Flexible
- Both has Many Applications

MEF Defined Ethernet Services

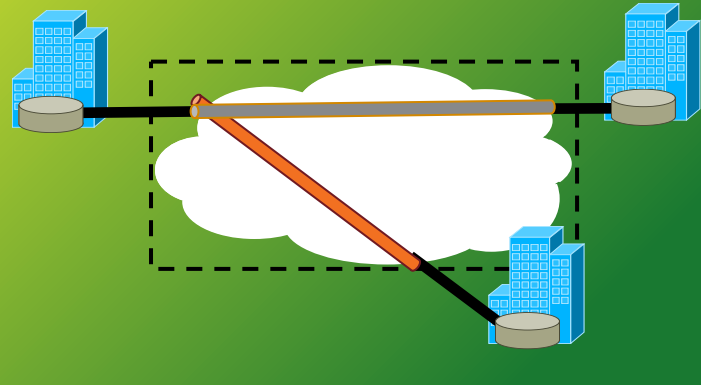
Port-based

VLAN-based

E-LINE Services

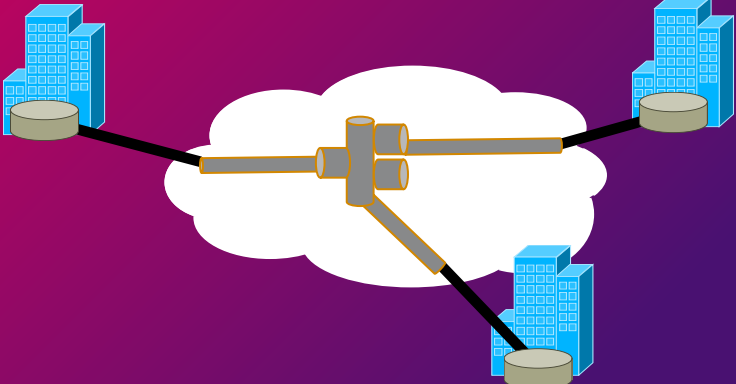


Ethernet Private Line (EPL)
 Replaces a TDM private line
 Dedicated UNIs for point-to-point connections
 Single Ethernet Virtual Connection (EVC) per UNI
 The most popular service due to its simplicity

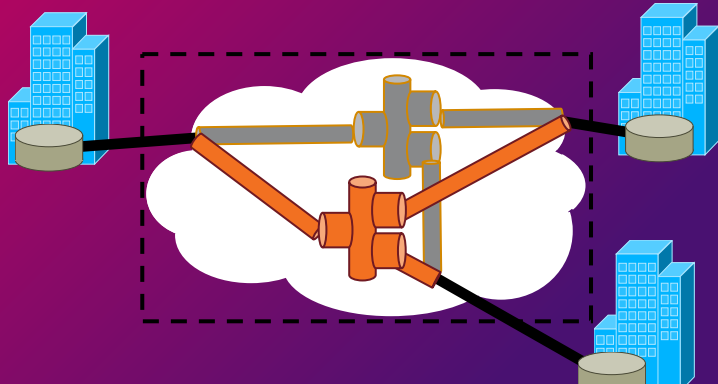


Ethernet Virtual Private Line (EVPL)
 Replaces Frame Relay or ATM services
 Supports multiplexed UNIs (multiple EVCs per UNI)
 Allows single physical connection (UNI) to customer premise equipment for multiple virtual connections

E-LAN Services



Ethernet Private LAN (EP-LAN)
 Supports dedicated UNIs
 Supports transparent LAN services
 Supports multipoint Layer 2 VPNs



Ethernet Virtual Private LAN (EVP-LAN)
 Supports service-multiplexed UNIs
 Supports multipoint Layer 2 VPNs

Business Services over DOCSIS



L2VPN BSoD

- Builds on standards by MEF
- Cable Labs specs available*
- Point to Point and multipoint services
- DOCSIS 3.0 offer new opportunities for BSOD
 - Channel bonding
 - Higher Speeds
 - Effective Competition against T1 and leased lines

L3VPN BSoD

- CMTS as L3VPN PE
- Same CMTS, more services
- Any to any services
- Allows effective interconnect with fiber
- New opportunities with DOCSIS 3.0
 - Channel bonding
 - Higher speed
 - Effective Competition against T1 and leased lines

- * <http://cable-labs.org/specifications/CM-SP-L2VPN-I09-100611.pdf>

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L2VPN BSoD



BSoD L2VPN Deployment Models

- Two distinct deployment models
- **Dot1Q-Based L2VPN BSoD**
 - CMTS “encapsulates” customer traffic in VLAN(s)
 - An evolution of Transparent LAN Services
- **MPLS-Based L2VPN BSoD**
 - CMTS acts as an MPLS PE
 - Encapsulate customer traffic in EoMPLS PW

Dot1Q-Based L2VPN BSoD Overview



- Cisco TLS over DOCSIS standardization by CableLabs
- Industry's **First** Cable System certified by MEF*
- Requires DOCSIS 2.0+
- Zero touch CMTS provisioning
 - No per site CMTS configuration required
 - Unique CM config file per L2VPN CM
- Up to 4 L2VPN's per CM based on service flow classification
 - Multiplexed (EVPL/EVPLAN) and non-multiplexed (EPL/EPLAN) services

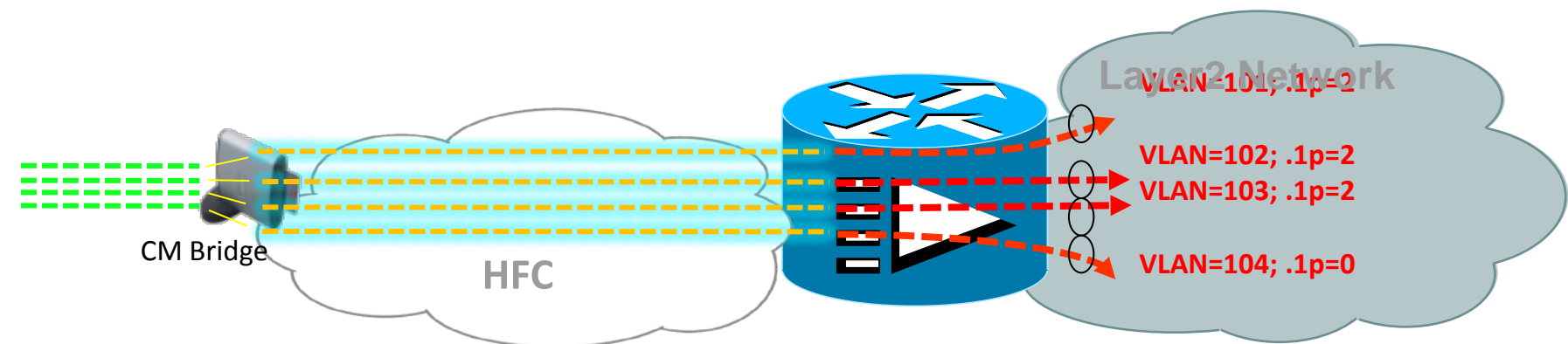
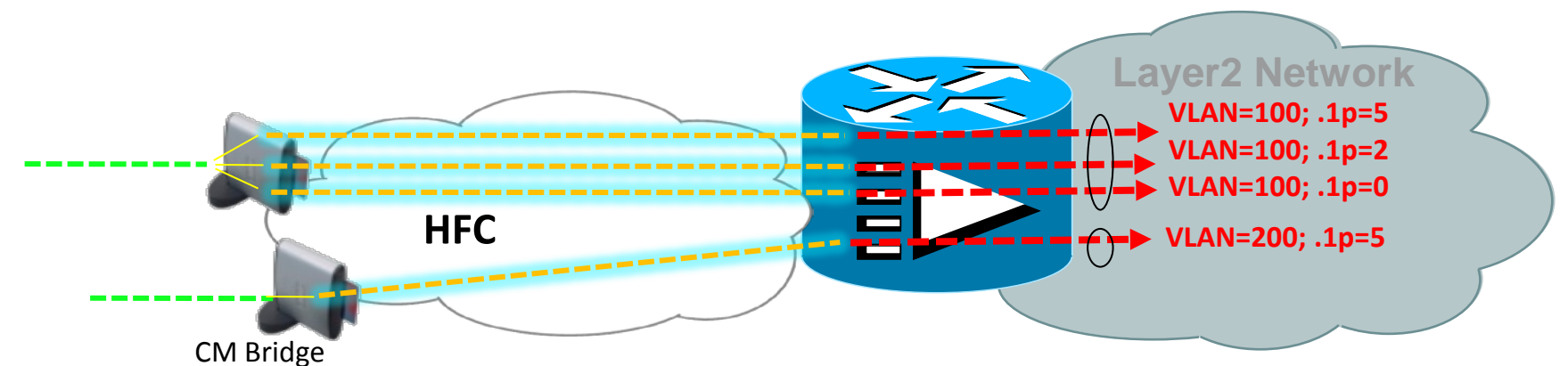
http://metroethernetforum.org/page_loader.php?p_id=33

Cisco *live!*

Dot1Q-Based L2VPN BSoD Services

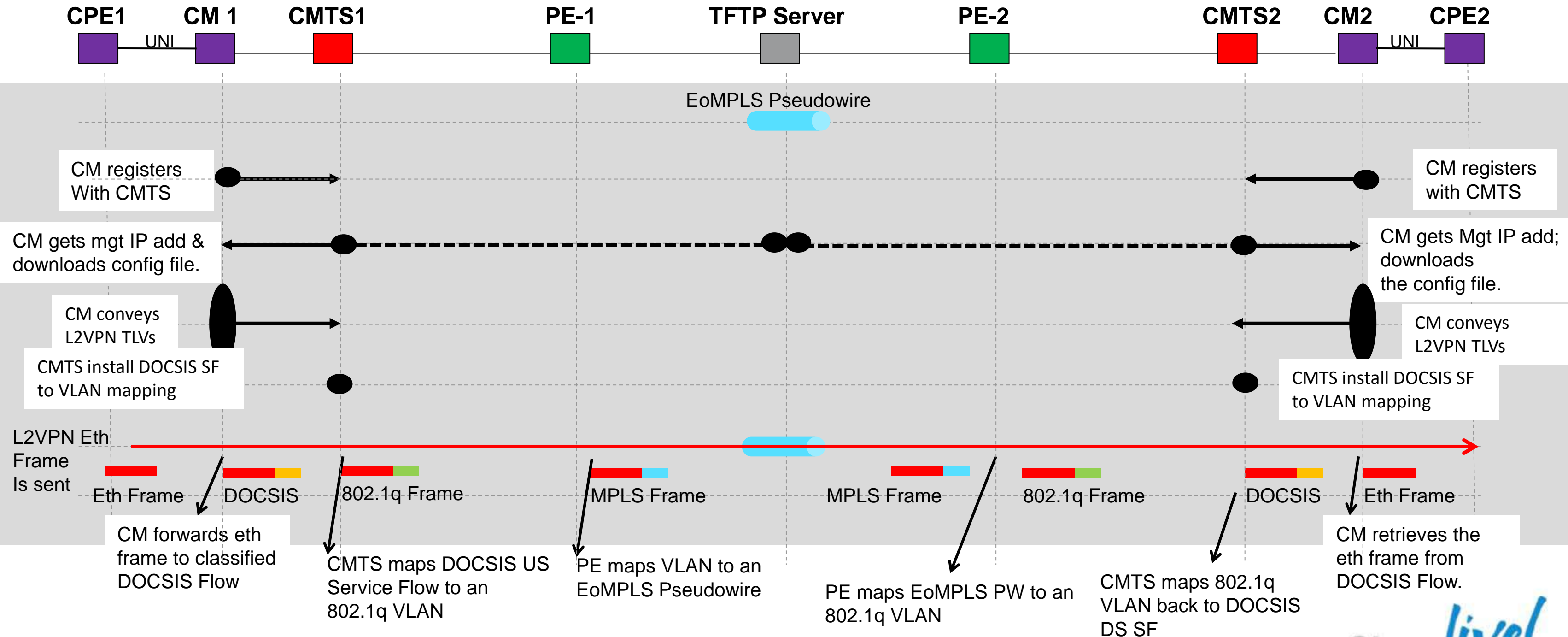
Service Multiplexing

- Service multiplexing on CM allowed by CableLabs
 - Allows for more services than TLS over DOCSIS
- Many US SFs to One VLAN
 - EPL type services
 - One VLAN for all traffic from CM
 - May use per SF 802.1p marking
 - Up to 8 US SFs
- One US SFs to One VLAN
 - EVPL type services
 - Up to 4 VLAN for a single CM
 - May use per SF 802.1p marking
 - Up to 8 US SFs total

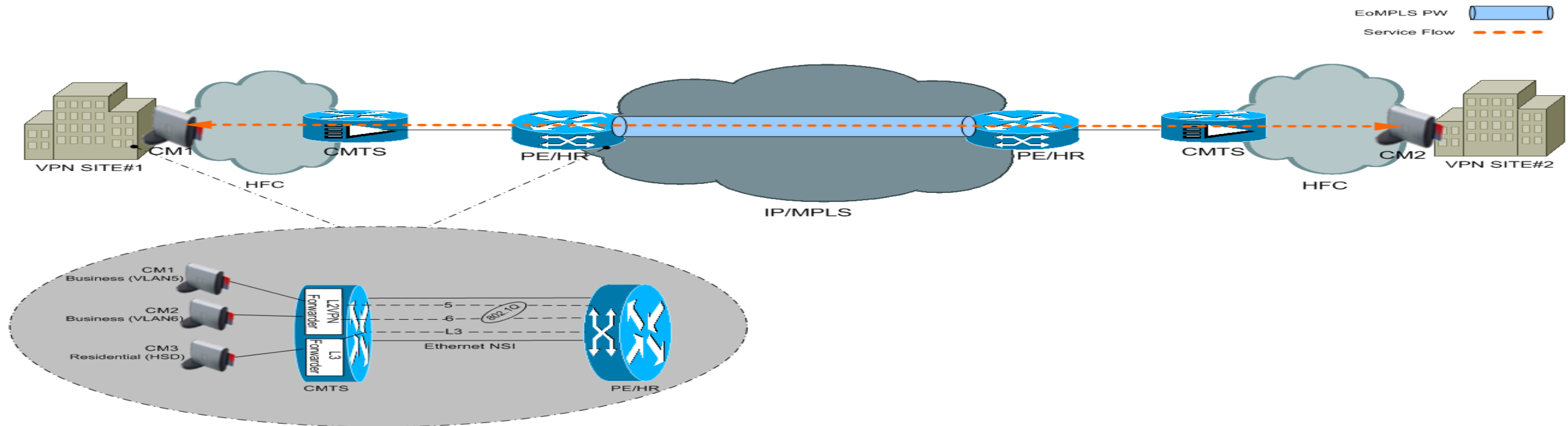


Dot1Q Based L2VPN BSoD

Control Plane and Data Plane Flow



End-To-End Dot1Q-Based L2VPN BSoD Service



CMTS

```
Cable l2-vpn-service xconnect nsi dot1q
```

```
cable l2-vpn-service xconnect nsi dot1q interface Gig1/1/0
```

NSI Encapsulation

Designated NSI Interface

MPLS PE

```
interface GigabitEthernet1/23.100
encapsulation dot1Q 100
xconnect 99.1.1.21 50 encapsulation mpls
```

Dot1Q-Based L2VPN BSoD Configuration

CM Config File Requirements

```
3,NetworkAccess,1,1
18,MaxCPE,1,0
24,UsServiceFlow
    1,ServiceFlowRef,2,1
    6,QosParamSetType,1,07
    43,VendorSpecificSubtype
        8,VendorIdentifier,3,FF FF FF
        5,L2VPNEncoding
        1,L2VPNIdentifier,9, DOT1Q BSoD
        8,IngressUserPriority,1,04
25,DsServiceFlow
    1,ServiceFlowRef,2,3
    6,QosParamSetType,1,07
29,GlobalPrivacyEnable,1,1
45,DUTFiltering
    1,DUTControl,1,01
43,GeneralExtensionInformation
    8,VendorIdentifier,3,FF FF FF
    5,L2VPNEncoding
    1,L2VPNIdentifier,9, DOT1Q BSoD
    2,NSIEncapsulation
        2,IEEE802.1Q,2,100
```

MIB's

```
SnmpMibObject cmAPMulticastPromiscuousMode.0 Integer 1; /* enable */
SnmpMibObject saCmBpiForward.0 Integer 2; /* allPackets */
SnmpMibObject saCmCpeMacAging.0 Integer 300 ;
SnmpMibObject saRgIpMgmtLanMode.32 Integer 1; (RG CM's only)
```

Vendor specific subtype for L2VPN.

Vendor ID for GEI

L2VPN Id=DOT1Q BSoD must be the same as what's specified in L2VPN Encoding.

.1p bits = 4 to be imposed by CMTS

L2VPN Id=MPLS BSoD must be the same as what's specified in L2VPN Encoding.

100 is 802.1q VLAN id to be imposed by CMTS

Dot1Q-Based BSoD Service Verification

- Verify CM is online as Dot1Q BSoD

```
CMTS-uBR10k#sh cable l2-vpn xconnect dot1q-vc-map 0022.3a61.7bcf verbose
```

```
MAC Address           : 0022.3a61.7bcf
Prim Sid              : 17
Cable Interface       : Cable5/1/0
L2VPNs provisioned   : 1
DUT Control/CMIM     : Enable/0x8000FFFF
VPN ID                : DOT1Q BSoD
L2VPN SAID            : 12302
Upstream SFID Summary : 29
Upstream SFID [29    ] : SID 17    UserPrio 4
Downstream CFRID[SFID]: Primary SF
CMIM                  : 0x60
Ethernet Interface    : GigabitEthernet3/1/0
DOT1Q VLAN ID        : 100
Total US pkts        : 0
Total US bytes       : 0
Total US pkt Discards : 0
Total US byte Discards: 0
Total DS pkts        : 0
Total DS bytes       : 0
Total DS pkt Discards : 0
Total DS byte Discards: 0
```


MPLS-Based L2VPN BSoD

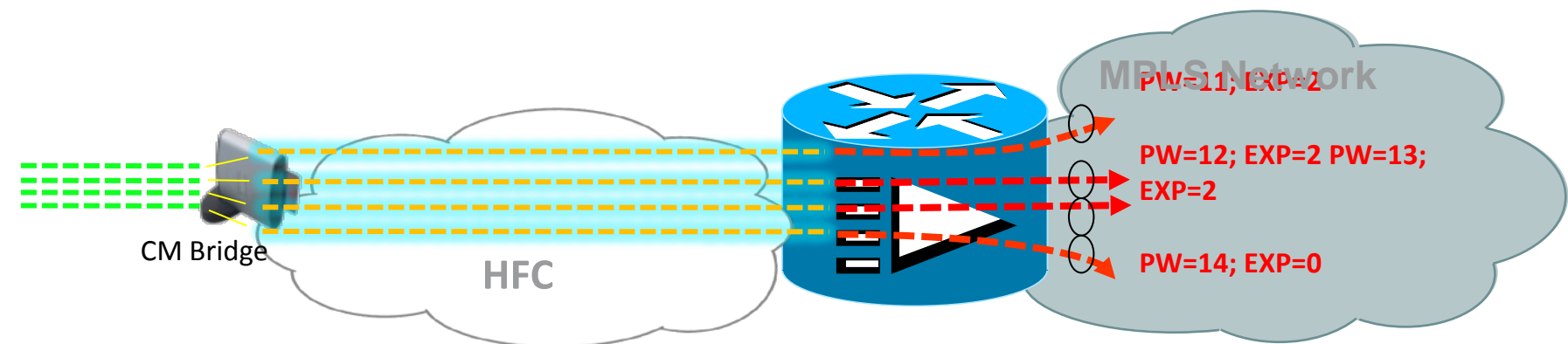
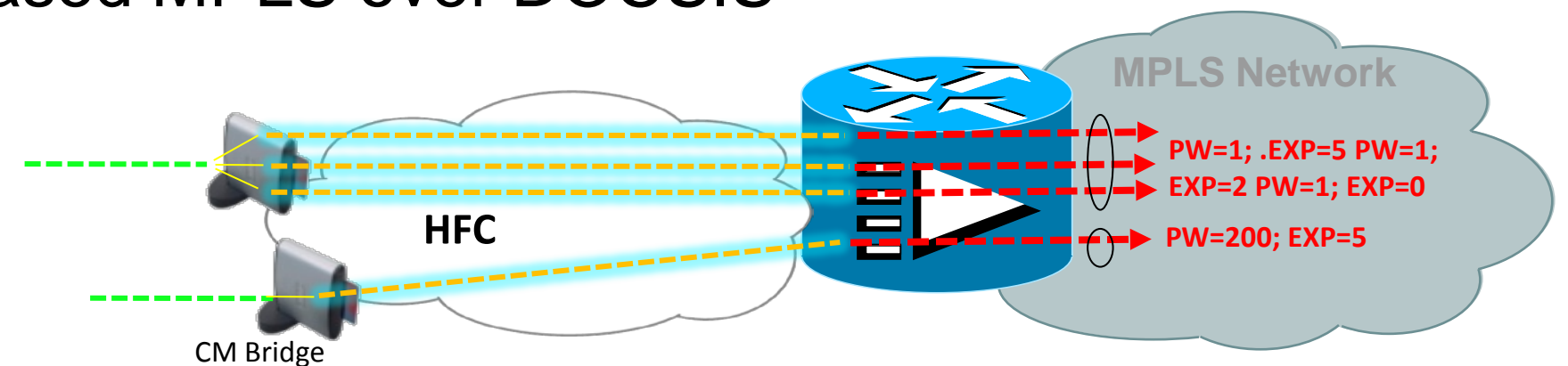


- Evolution of Dot1Q-Based BSoD Services
- EoMPLS on CMTS !!!
 - Supported on CMTS 12.2(33)SCC and later
- No need for upstream PE device
- Better scaling
 - No more 4000 VLAN limit
- Upstream redundancy and load-balancing
- NSI encapsulation set to MPLS
- CM maps Ethernet UNI to a DOCSIS service flow
- DOCSIS SF map to EoMPLS PW
 - Mapping defined by CM via config file
 - EoMPLS frames forwarded on any available MPLS uplink
- Zero Touch CMTS provisioning
 - Cable modem config file define PW
- QoS provided through MPLS EXP bits

MPLS-Based BSoD Services

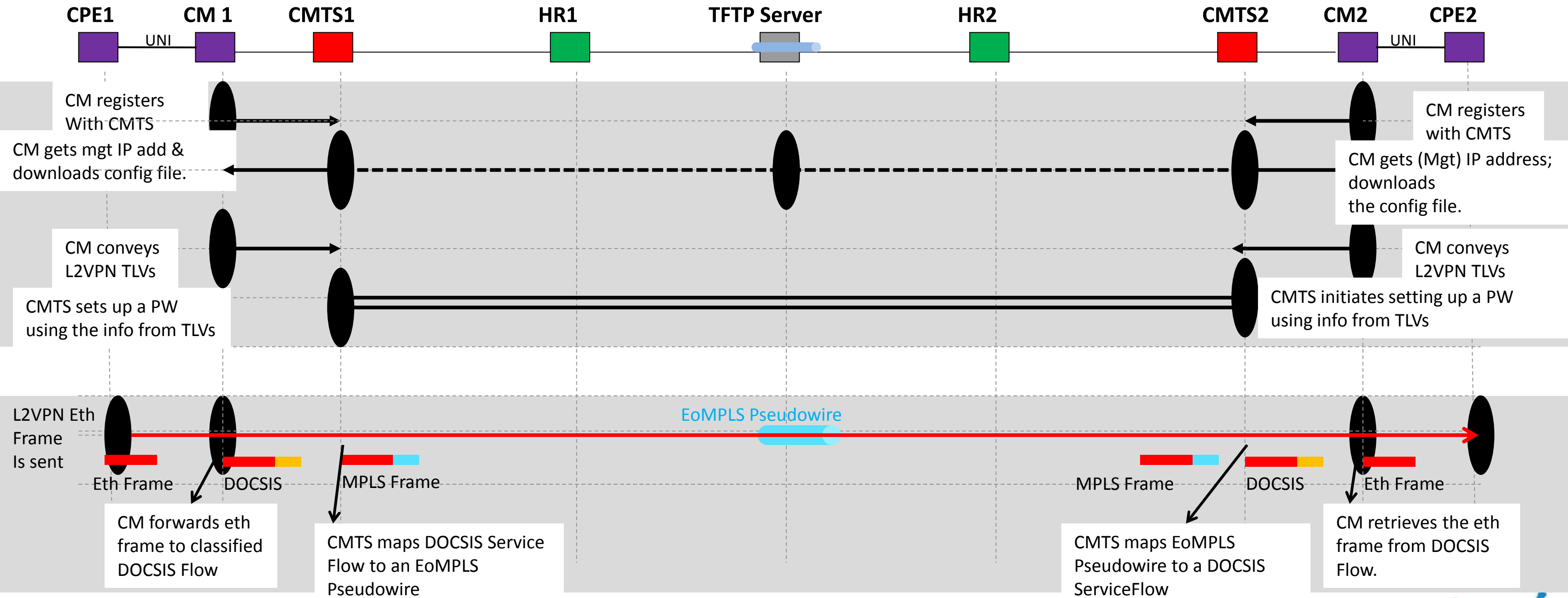
Service Multiplexing

- Service multiplexing on CM allowed by CableLabs
 - Allows for more services than CLI based MPLS over DOCSIS
- Many US SFs to One PW
 - EPL type services
 - One PW for all traffic from CM
 - May use per SF EXP marking
 - Up to 8 US SFs
- One US SFs to One PW
 - EVPL type services
 - Up to 4 PW for a single CM
 - May use per SF EXP marking
 - Up to 8 US SFs total

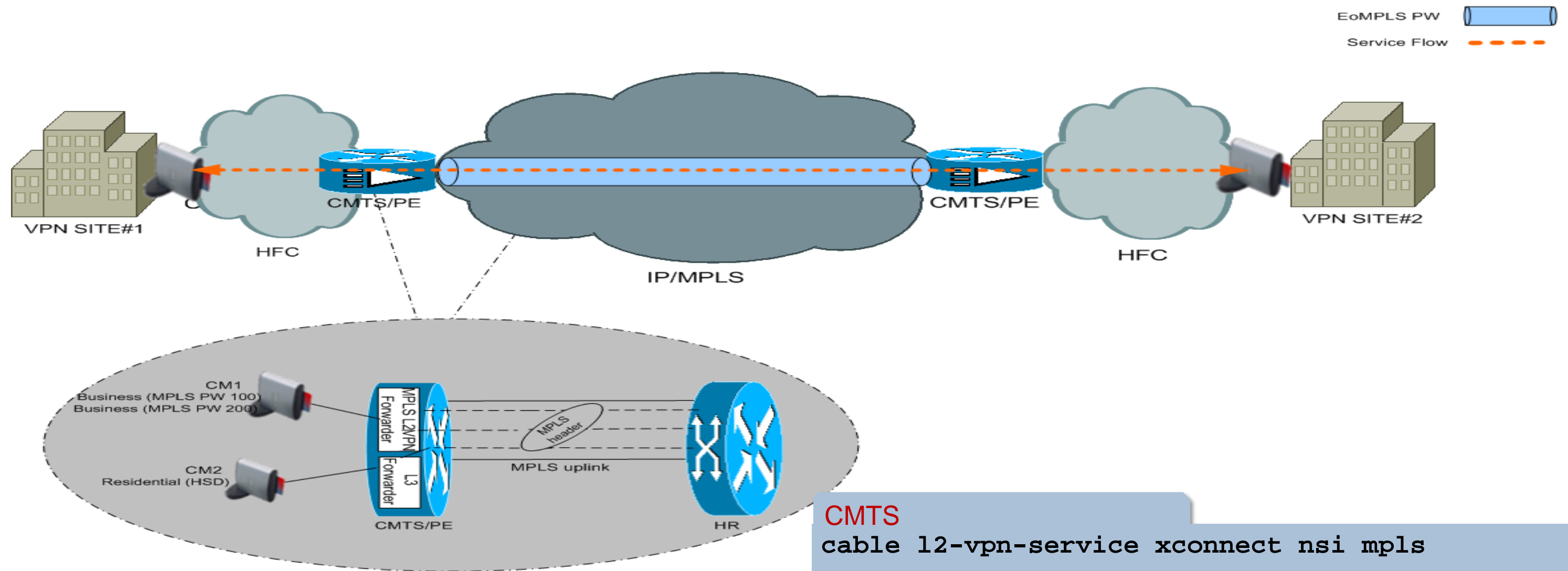


MPLS-Based L2VPN BSoD

Control Plane and Data Plane Flow



End-To-End MPLS-Based L2VPN BSoD Service



MPLS-Based L2VPN BSoD Configuration

```
3,NetworkAccess,1,1
18,MaxCPE,1,16
24,UsServiceFlow
    1,ServiceFlowRef,2,1
    6,QosParamSetType,1,07
    43,VendorSpecificSubtype
        8,VendorIdentifier,3,FF FF FF
        5,L2VPNEncoding
        1,L2VPNIdentifier,9, MPLS BSoD
        8,IngressUserPriority,1,04
25,DsServiceFlow
    1,ServiceFlowRef,2,3
    6,QosParamSetType,1,07
29,GlobalPrivacyEnable,1,1
45,DUTFiltering
    1,DUTControl,1,01
43,GeneralExtensionInformation
    8,VendorIdentifier,3,FF FF FF
    5,L2VPNEncoding
    1,L2VPNIdentifier,9, MPLS BSoD
    2,NSIEncapsulation
        4,MPLSIPv4Peer,5,1.99.1.1.22
        5,AttachmentGroupID,4,55 55 55 55
        6,SourceAttachmentIndividualID,4,00 00 07 d1
        7,TargetAttachmentIndividualID,4,00 00 07 d1
```

```
MIB's
SnmpMibObject cmAPMulticastPromiscuousMode.0 Integer 1; /* enable */
SnmpMibObject saCmBpiForward.0 Integer 2; /* allPackets */
SnmpMibObject saCmCpeMacAging.0 Integer 300 ;
SnmpMibObject saRgIpMgmtLanMode.32 Integer 1; (RG CM's only)
```

Optional: Vendor specific subtype for L2VPN.

Vendor ID for GEI

L2VPN Id=MPLS BSoD must be the same as what's specified in L2VPN Encoding.

MPLS EXP=4 to be imposed by CMTS

L2VPN Id=MPLS BSoD must be the same as what's specified in L2VPN Encoding.

99.1.1.22 is peer PE's IP address.

2001 is used as the PW-id.

Source All and Target All must be the same.

Cisco *live!*

MPLS-Based BSoD Service Verification

- Verify CM is online as MPLS BSOD

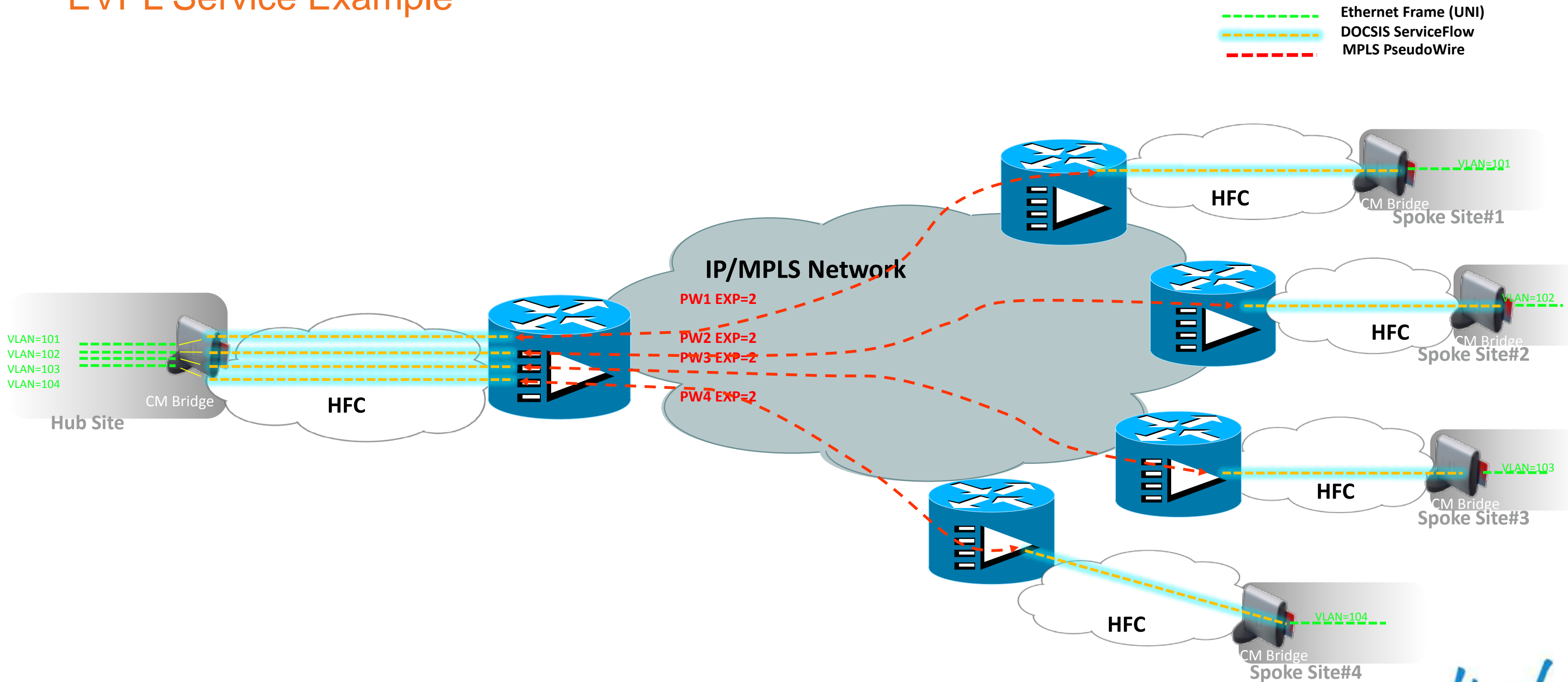
```
CMTS-uBR10k# sh cable l2-vpn xconnect mpls-vc-map 0022.3a61.7bcf verbose
MAC Address           : 0022.3a61.7bcf
Prim Sid              : 16
Cable Interface       : Cable5/1/0
L2VPNs provisioned    : 1
DUT Control/CMIM      : Enable/0x8000FFFF
VPN ID                : MPLS EPL1
L2VPN SAID            : 12296
SAII                  : 000007D1
TAII                  : 000007D1
Upstream SFID Summary : 27
Upstream SFID [27    ] : SID 16    MPLS-EXP 4
Downstream CFRID[SFID] Summary: Primary SF
CMIM                  : 0x60
MPLS PEER IPAddress   : 99.1.1.22
MPLS PW VCID          : 2001
MPLS PW TYPE          : Ethernet
MPLS PW Circuit ID    : Bu254:2001
MPLS PW Remote State  : Up
MPLS PW Local State   : UP
Total US pkts         : 0
Total US bytes        : 0
Total US pkt Discards : 0
Total US byte Discards : 0
Total DS pkts         : 0
Total DS bytes        : 0
Total DS pkt Discards : 0
Total DS byte Discards : 0
```

- Verify Xconnect is up

```
CMTS-uBR10k#sh mpls l2transport vc 2001
Local intf      Local circuit      Dest address      VC ID      Status
-----
Bu254          DOCSIS 2001        99.1.1.22        2001       Up
```

MPLS-Based L2VPN BSoD Service

EVPL Service Example



MPLS-Based L2VPN BSoD

Cable Modem Config File for EVPL

```
24,UsServiceFlow
    1,ServiceFlowRef,2,1
    6,QosParamSetType,1,07
    43,VendorSpecificSubtype
        8,VendorIdentifier,3,FF FF FF
        5,L2VPNEncoding
        1,L2VPNIdentifier,9,MPLS EVPL1
        8,IngressUserPriority,1,04
24,UsServiceFlow
    1,ServiceFlowRef,2,2
    6,QosParamSetType,1,07
    43,VendorSpecificSubtype
        8,VendorIdentifier,3,FF FF FF
        5,L2VPNEncoding
        1,L2VPNIdentifier,9,MPLS EVPL2
        8,IngressUserPriority,1,05
22,UsPacketClassifier
    1,ClassifierRef,1,1
    3,ServiceFlowRef,2,1
    11,IEEE802Classifier
        2, VlanID 100
22,UsPacketClassifier
    1,ClassifierRef,1,2
    3,ServiceFlowRef,2,2
    11,IEEE802Classifier
        2, VlanID 200
25,DsServiceFlow
    1,ServiceFlowRef,2,5
    6,QosParamSetType,1,07 25,DsServiceFlow
    1,ServiceFlowRef,2,6
    6,QosParamSetType,1,07
```

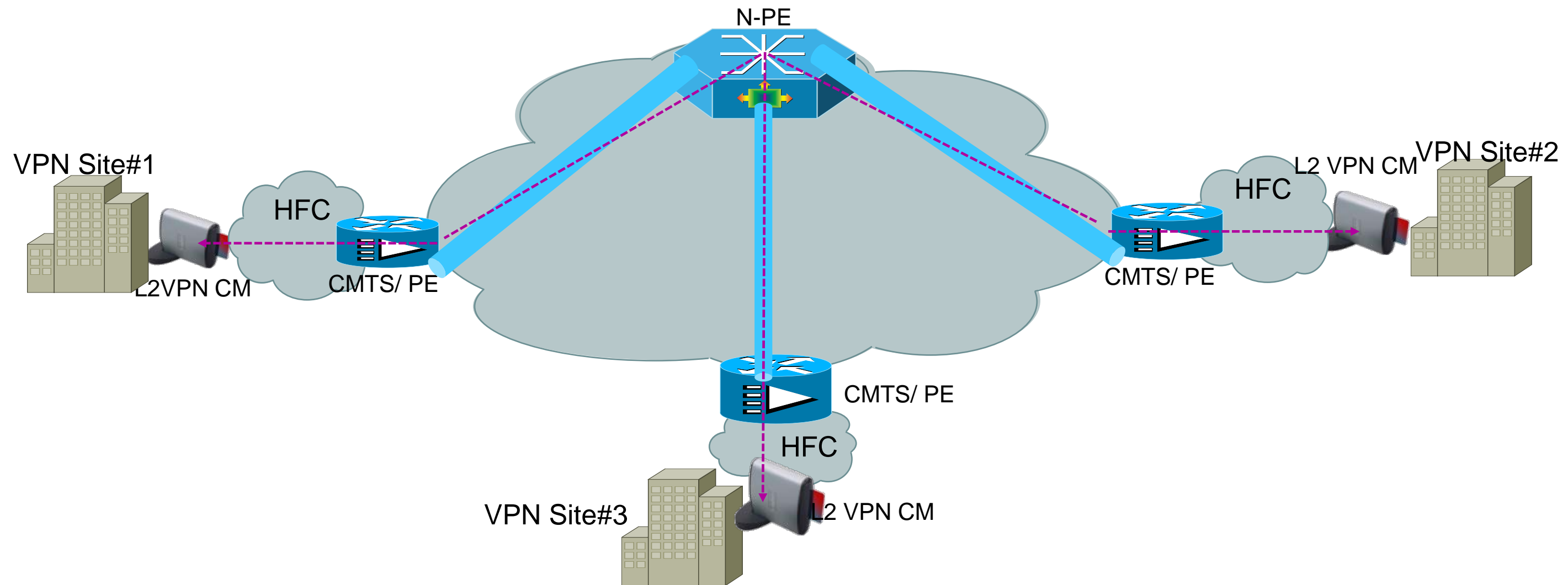
```
43,GeneralExtensionInformation
    8,VendorIdentifier,3,FF FF FF
    5,L2VPNEncoding
    1,L2VPNIdentifier,9, MPLS EVPL1
        2,NSIEncapsulation
            4,MPLSIPv4Peer,5,1.99.1.1.22
            5,AttachmentGroupID,4,55 55 55 55
            6,SourceAttachmentIndividualID,4,00 00 07 d1
            7,TargetAttachmentIndividualID,4,00 00 07 d1
43,GeneralExtensionInformation
    8,VendorIdentifier,3,FF FF FF
    5,L2VPNEncoding
    1,L2VPNIdentifier,9, MPLS EVPL2
        2,NSIEncapsulation
            4,MPLSIPv4Peer,5,1.99.1.1.23
            5,AttachmentGroupID,4,45 45 45 45
            6,SourceAttachmentIndividualID,4,00 00 07 d2
            7,TargetAttachmentIndividualID,4,00 00 07 d2
45,DUTFiltering
    1,DUTControl,1,01
```

```
MIB's
SnmpMibObject saCmL2vpnUsForwardingCriteria.0 Integer 1;
SnmpMibObject saCmBpiForward.0 Integer 2; /* allPackets */
SnmpMibObject saCmCpeMacAging.0 Integer 300 ;
SnmpMibObject saRgIpMgmtLanMode.32 Integer 1; (RG CM's only)
```

MPLS-Based L2VPN BSoD

Multipoint (E-LAN) Service

- Dedicated N-PE with H-VPLS



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MPLS L3VPN BSoD

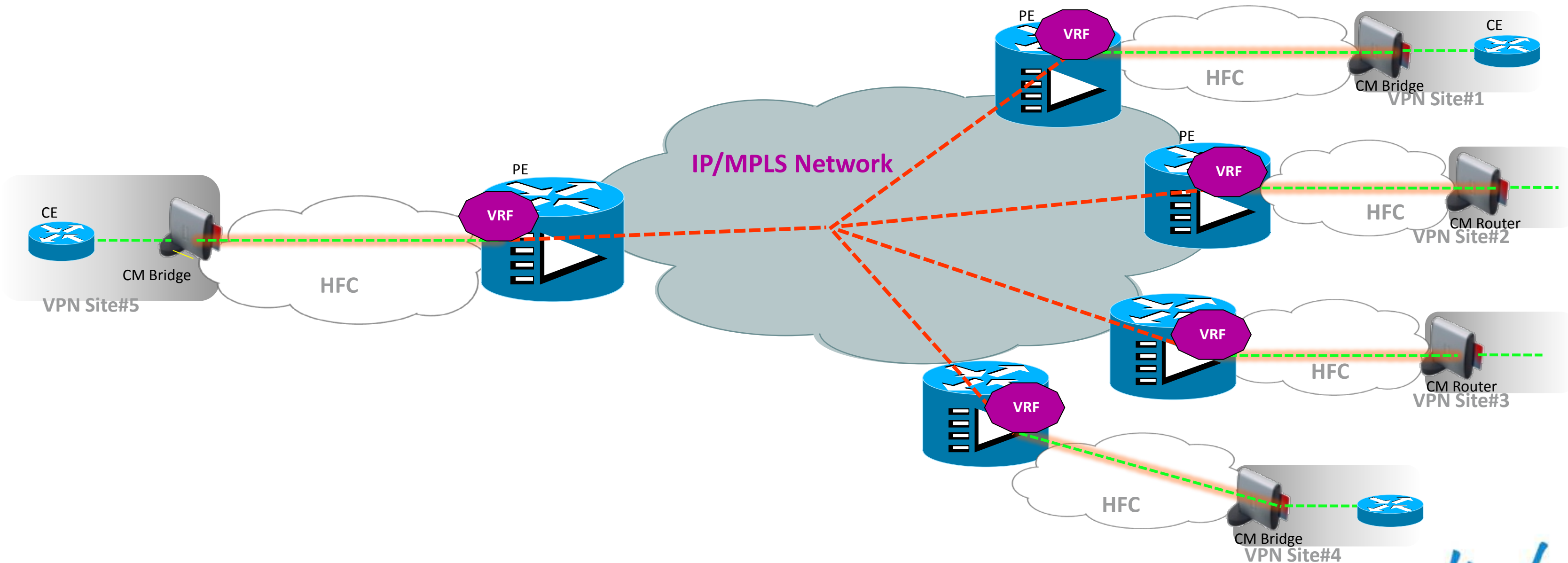


MPLS L3VPN BSoD Services

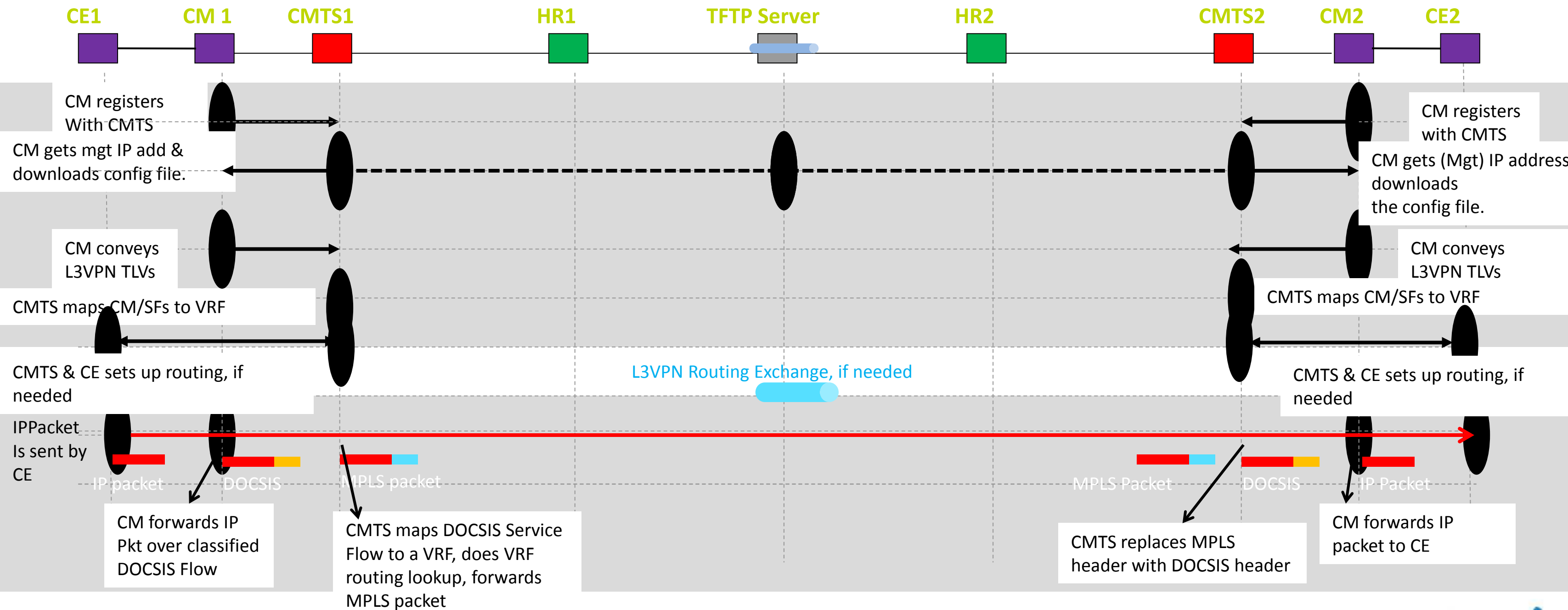
- Getting most out of CMTS
- CMTS as L3VPN PE Device!!!
- CMTS implements VPN PE functions
- Maps DOCSIS service flow to VRF
 - Mapping is defined in the CM config file
 - CMTS needs per-vrf sub-bundle interfaces
- CMTS & CE are IP connected over CM Bridge
 - CM Bridge may be integrated in CE (e.g. eRouter)
- Any D2.0+ CM
 - May be bridge or a Router
 - Configuration file includes L3VPN encodings*
- Automated L3VPN provisioning
 - CMTS needs standard L3VPN configuration
- UNI terminated at CMTS
 - CM provides the DOCSIS conduit
- IP DSCP transparency
- 8 DS, 8 US Service Flows possible

MPLS L3VPN over DOCSIS

Any-To-Any



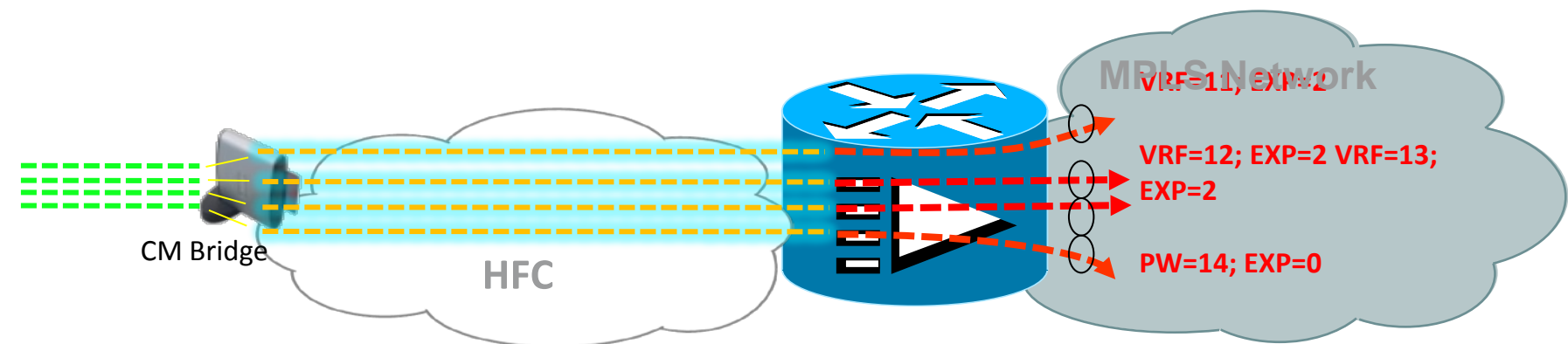
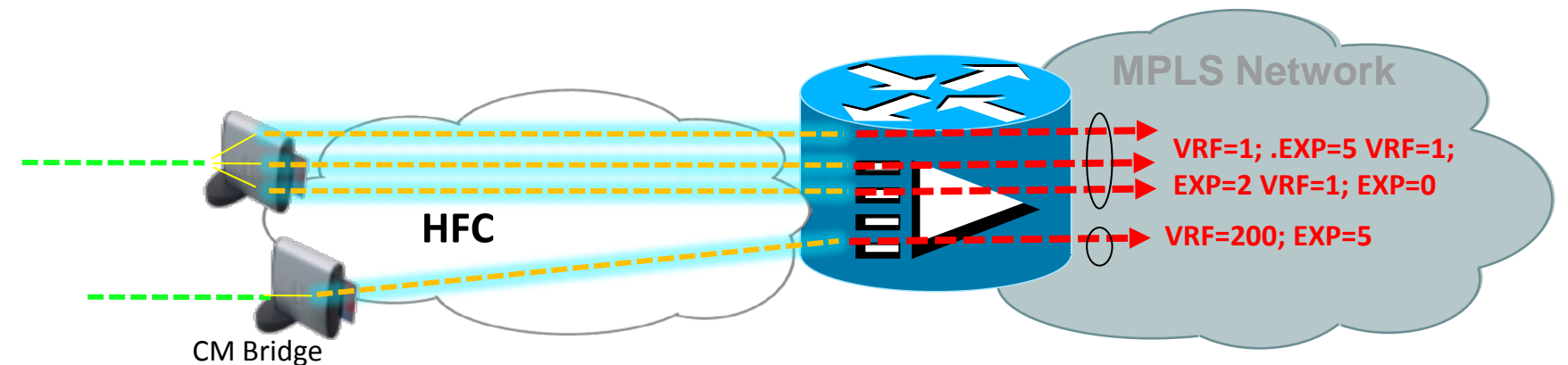
L3VPN over DOCSIS Packet Flow



MPLS L3VPN BSoD Services

Service Multiplexing

- Service multiplexing on CM allowed
- Many US SFs to One VRF
 - One VRF for all traffic may use per
 - SF EXP marking
 - Up to 8 US SFs
- One US SFs to One VRF
 - IP Packet mapped to one of many SF
 - Each SF mapped to unique VRF
 - May use per SF EXP marking
 - Up to 8 US SFs total



MPLS L3VPN CMTS Configuration

Configure VRF, RD, and RT:

```
ip vrf VRF_V2160
rd 101:2160
route-target export 101:2160
route-target import 101:2160
```

Configure Bundle and Sub-Bundle interface.

```
interface Bundle3
  no ip address
  no cable arp filter request-send
  no cable arp filter reply-accept
!
interface Bundle3.1
  ip address 20.0.32.1 255.255.255.0
  cable dhcp-giaddr policy
  cable helper-address 10.10.100.183
!
interface Bundle3.2160
  ip vrf forwarding VRF_V2160
  ip address 172.216.0.1 255.255.255.0
  cable dhcp-giaddr primary
  cable helper-address 10.10.100.183
```

Configure Routing Protocol to exchange routing information between CE and PE.

```
router rip
!
  address-family ipv4 vrf VRF_V2160
  redistribute bgp 101 metric 1
  network 172.216.0.0
  no auto-summary version 2 exit-address-family
!
  ip route vrf VRF2160 192.168.1.0 255.255.255.0 30.1.21.7
```

Configure BGP to exchange CE routing information between PE.

```
router bgp 101
!
  address-family ipv4 vrf VRF_V2160
  no synchronization redistribute connected metric 1
  redistribute rip metric 1 exit-address-family !
```

MPLS L3VPN DPC3925 CM Config. File

```
3,NetworkAccess,1,1
18,MaxCPE,1,16

24,UsServiceFlow
    1,ServiceFlowRef,2,1
    6,QosParamSetType,1,07

24,UsServiceFlow
    1,ServiceFlowRef,2,2
    6,QosParamSetType,1,07
    7,TrafficPriority,1,7
    8,MaxRateSustained,4,100000000
    9,MaxTrafficBurst,4,28000
    14,MaxConcatenatedBurst,2,28000
    43,GeneralExtensionInformation
        8,VendorIdentifier,3,00 00 0C
        4,Unknown,8,00 00 00 65 00 00 08 70

22,UsPacketClassifier
    1,ClassifierRef,1,1
    3,ServiceFlowRef,2,2
    10,LLCPacketClassifier
        2,SrcMacAddress,6,00:23:BE:93:29:D2

25,DsServiceFlow
    1,ServiceFlowRef,2,11
    6,QosParamSetType,1,07
    8,MaxRateSustained,4,350000000

25,DsServiceFlow
    1,ServiceFlowRef,2,12
    6,QosParamSetType,1,07

28,MaxClassifiers,2,20
29,GlobalPrivacyEnable,1,1
```

MIB's

Enable RIP Routing.

```
SnmpMibObject enterprises.1429.79.2.5.1.1.0 Integer 1 ;
SnmpMibObject enterprises.1429.79.2.5.1.2.0 Integer 2 ;
SnmpMibObject enterprises.1429.79.2.5.1.5.0 Integer 30 ; SnmpMibObject
enterprises.1429.79.2.5.1.6.0 Integer 1 ;
SnmpMibObject enterprises.1429.79.2.5.1.7.0 String "00 00 00 00" ;
```

Enable WAN Router DHCP.

```
SnmpMibObject enterprises.1429.79.2.3.9.1.1.0 Integer 1 ;
```

Enable Router Mode.

```
SnmpMibObject enterprises.1429.79.2.3.2.1.1.32 Integer 2 ;
```

Enable DHCP for host behind DPC3925.

```
SnmpMibObject enterprises.1429.79.2.3.2.1.8.32 Integer 1 ;
SnmpMibObject enterprises.1429.79.2.3.3.1.2.32 IPAddress 10.216.0.2 ;
SnmpMibObject enterprises.1429.79.2.3.3.1.4.32 IPAddress 10.216.0.254 ;
SnmpMibObject enterprises.1429.79.2.3.2.1.3.32 IPAddress 10.216.0.0 ;
SnmpMibObject enterprises.1429.79.2.3.2.1.5.32 IPAddress 255.255.255.0 ;
SnmpMibObject enterprises.1429.79.2.3.2.1.7.32 IPAddress 10.216.0.1 ;
```

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Quality of Service



QoS Overview

- QoS enables MSOs to offer end-to-end SLA
- Leverage both DOCSIS and MPLS QoS
- For DOCSIS QoS, the DOCSIS service flows should be defined in accordance with the speed packages,
- Three levels of DOCSIS priority scheduling
 - RTPS,
 - nRTPS,
 - Best Effort (BE)
- Following slides goes over scale test scenario, latency values and CM config file.

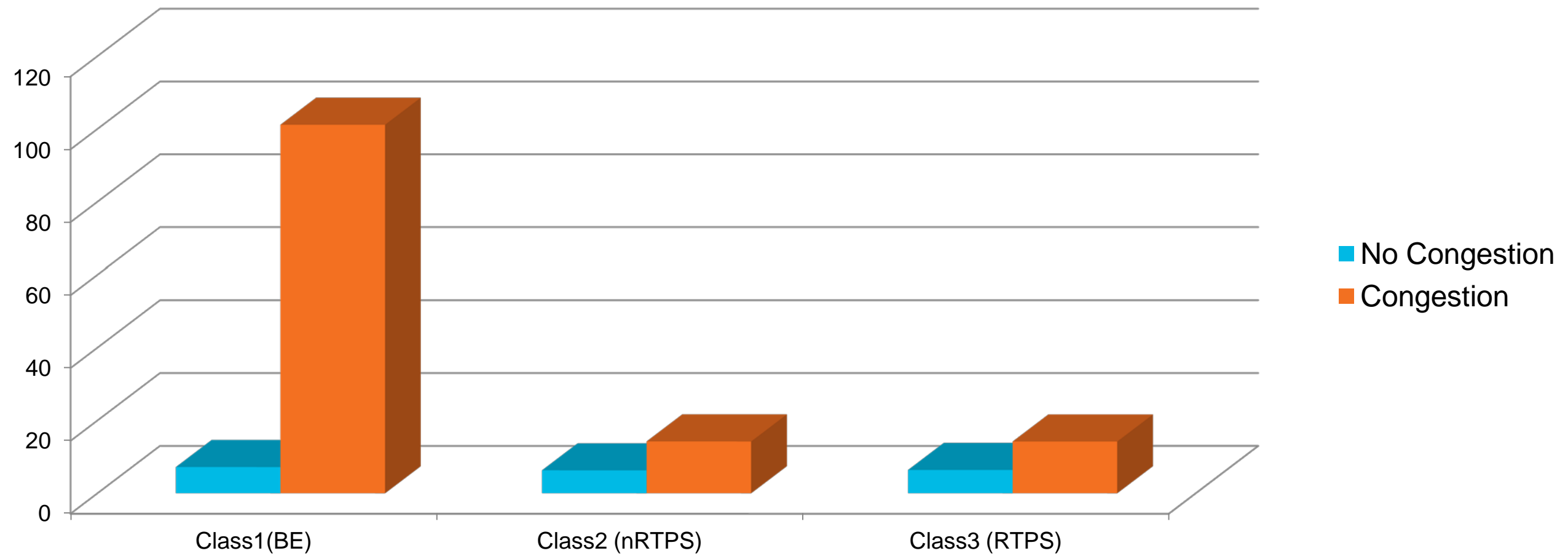
Sample BSoD QoS Results

- Characterize US latency values Multiple classes of service for L2VPN/L3VPN BSoD

Service Type	CM Type	Number of CMs	Total VRF/PW
HSD over IPv6	DOCSIS 3.0	300	NA
L3VPN over DOCSIS	DOCSIS 3.0	150	150
L3VPN over DOCSIS	GE Interface	NA	750
MPLS BSoD	DOCSIS 2.0, 3.0	550	2000

- Classes of service
 - Best Effort
 - nRTPS – Guaranteed Bandwidth
 - RTPS – High Priority, Low Latency

L2VPN/L3VPN BSoD QoS



MPLS L2VPN BSoD CM Configuration File With

43,GeneralExtensionInformation

```
8,VendorIdentifier,3,FF FF FF
5,L2VPN
```

```
1,L2VPNIdentifier,4,1400
2,NSIEncapsulationSubtype
4,MPLSPeer,5,1.99.1.1.21
6,SourceAttachmentIndividualID,4,00 00 05 78
7,TargetAttachmentIndividualID,4,00 00 05 78
```

24,UsServiceFlow

```
1,ServiceFlowRef,2,1
6,QosParamSetType,1,07
8,MaxRateSustained,4,3145728
9,MaxTrafficBurst,4,393216
10,MinReservedRate,4,0
14,MaxConcatenatedBurst,2,16000
```

15,SchedulingType,1,2

43,GeneralExtensionInformation

```
8,VendorIdentifier,3,FF FF FF
5,L2VPN
```

```
1,L2VPNIdentifier,4,1400
8,IngressUserPriority,1,0
```

24,UsServiceFlow

```
1,ServiceFlowRef,2,2
6,QosParamSetType,1,07
8,MaxRateSustained,4,3145728
9,MaxTrafficBurst,4,393216
10,MinReservedRate,4,1048576
14,MaxConcatenatedBurst,2,16000
```

15,SchedulingType,1,3

```
16,RequestOrTxPolicy,4,00 00 00 00
17,NominalPollInterval,4,20000
```

43,GeneralExtensionInformation

```
8,VendorIdentifier,3,FF FF FF
5,L2VPN
```

```
1,L2VPNIdentifier,4,1400
8,IngressUserPriority,1,2
```

22,UsPacketClassifier

```
1,ClassifierRef,1,1
3,ServiceFlowRef,2,1
11,IEEE802Classifier
1,UserPriority,2,7
2,VlanID,2,10
```

22,UsPacketClassifier

```
1,ClassifierRef,1,2
3,ServiceFlowRef,2,2
11,IEEE802Classifier
1,UserPriority,2,7
2,VlanID,2,20
```

25,DsServiceFlow

```
1,ServiceFlowRef,2,4
6,QosParamSetType,1,07
8,MaxRateSustained,4,3145728
9,MaxTrafficBurst,4,393216
10,MinReservedRate,4,0
```

25,DsServiceFlow

```
1,ServiceFlowRef,2,5
6,QosParamSetType,1,07
8,MaxRateSustained,4,3145728
9,MaxTrafficBurst,4,393216
10,MinReservedRate,4,1048576
```

23,DsPacketClassifier

```
1,ClassifierRef,1,4
3,ServiceFlowRef,2,4
43,VendorSpecificParams,17,08 03 FF FF FF 05 0A 01 04 31 34 30 30
09 02 00 03
```

23,DsPacketClassifier

```
1,ClassifierRef,1,5
3,ServiceFlowRef,2,5
43,VendorSpecificParams,17,08 03 FF FF FF 05 0A 01 04 31 34 30 30 09
02 04 05
```

Agenda

- The Case for Business Services over DOCSIS
- Business VPN Services
- Layer 2 VPN Services over DOCSIS
- MPLS Layer 3 VPN Services over DOCSIS
- Quality of Service
- **Choosing a Deployment Model**
- COX New Orleans Case Study
- Summary

Choosing a Deployment Model



Which BSoD Model to Use?

- No “One Size Fits All” answer
- Decision a function of various factors
- Technical Factors:
 - Scale and Performance
 - Fragmentation and Overhead
 - High Availability
 - Interworking with Fiber Access
- Operational Factors
 - CPE Cost
 - Ease of Deployment
 - CMTS Software and Configuration Changes

Business Services Comparison Matrix

Deployment Consideration	L3VPN BSoD	Dot1Q-Based BSOD	MPLS-Based BSoD
Scale	4000	4000	16000 (uBR10K)
Fragmentation & Overhead			
CMTS Uplink High Availability			
Separate PE Required?			
Fiber Interworking			
CPE Cost			
DOCSIS Backend Changes			*
CMTS Config Changes	Per Site	One Time	One Time*

* For time to market, Per Site L2VPN configuration on CMTS can be done via CLI, thus bypassing the DOCSIS backend changes requirement



Agenda

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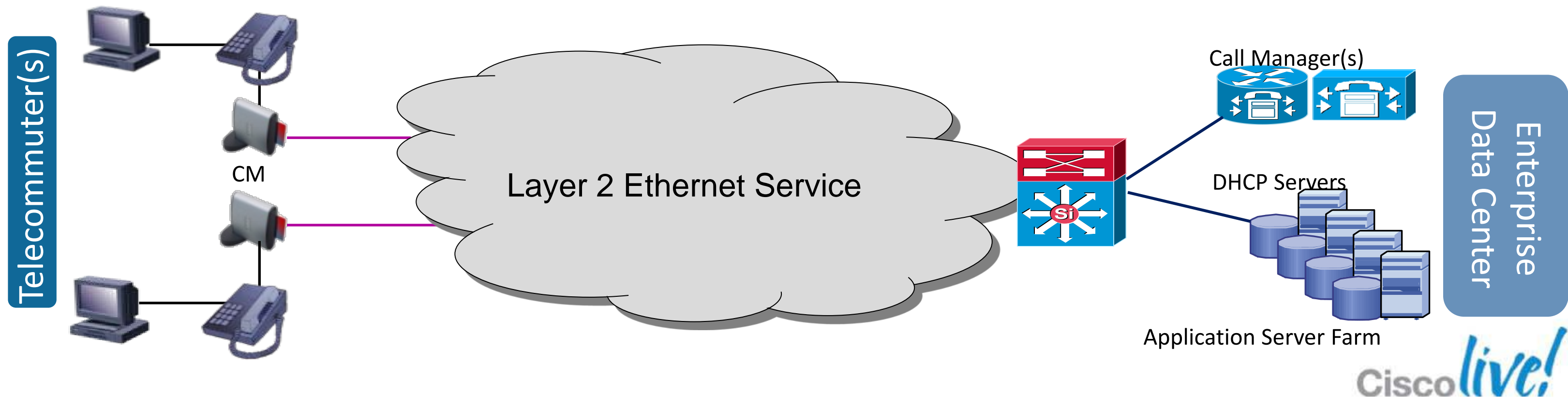
COX New Orleans Case Study



COX New Orleans Telecommuter Application

Service Objectives and Requirements

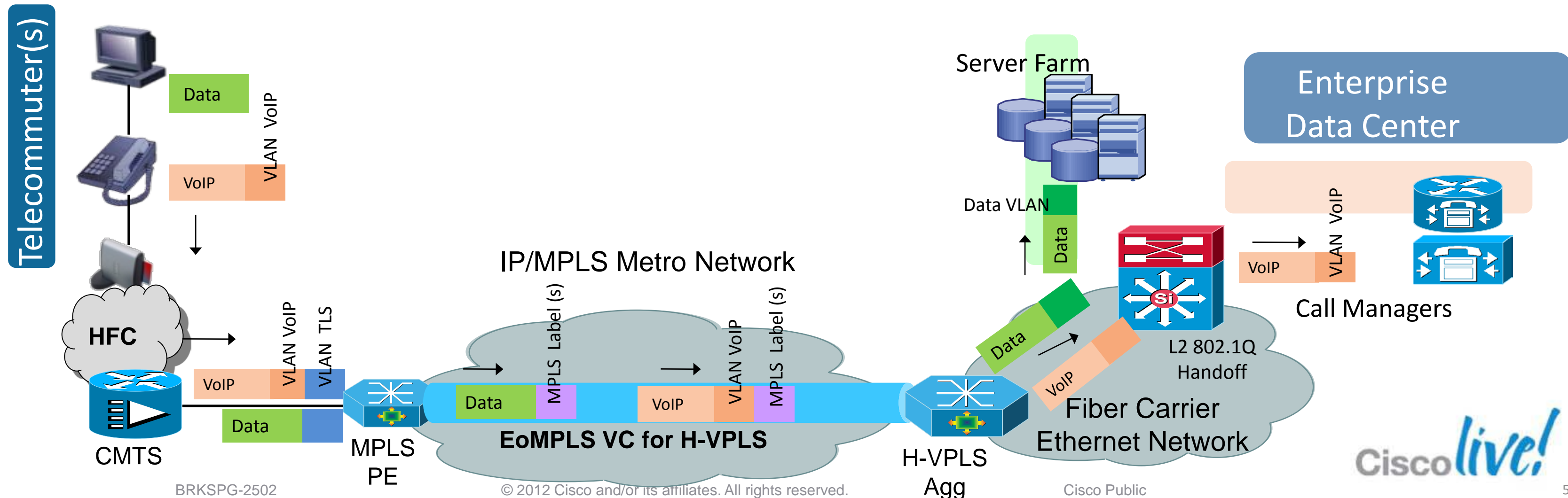
- Provide telecommuters with Layer 2 Access to Central Office using existing HFC
- Each Home Office contains:
 - IP Phone for Voice over IP traffic
 - PC for Data traffic
- VoIP and Data Traffic to use separate VLAN's in CO



COX New Orleans Telecommuter Application

Service Architecture – Phase 1

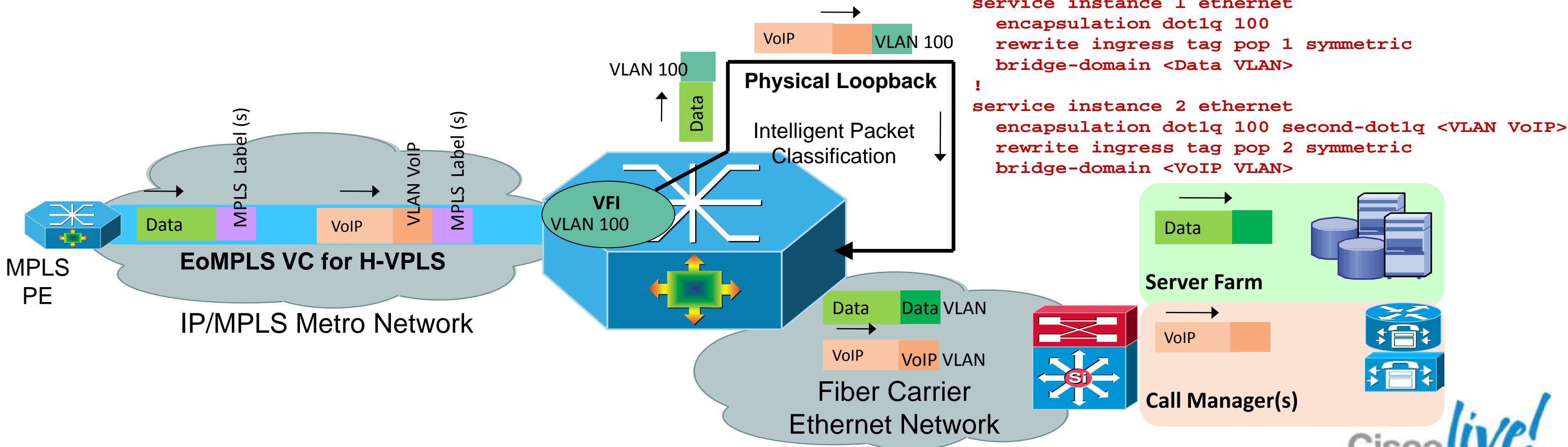
- H-VPLS to provide MAC learning and bridging at Central Location
- Transparent LAN Services over DOCSIS used on CM and CMTS
 - CMTS encapsulate all traffic from CM in a 802.1Q VLAN Tag
- Data traffic is untagged; VoIP is Tagged for service separation



COX New Orleans Telecommuter Application

Service Traffic Separation

- CMTS adds a TLS over DOCSIS tag to all traffic
 - Data Traffic is single tagged
 - VoIP is double tagged, with same S-VLAN as Data
- Flexible frame matching needed on upstream router



Service Deployment Challenges

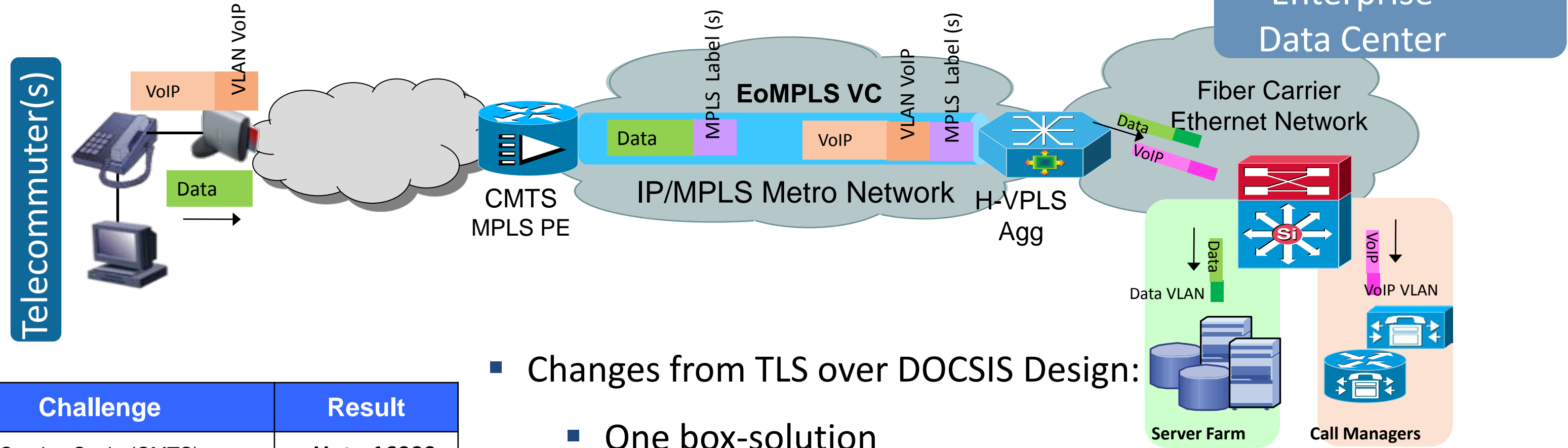
- End to End Traffic Isolation
 - Centralized solution difficult to troubleshoot
- Per Site CMTS Configuration
 - CMTS manually configured for each site
- L2 Problem Detection and Isolation
 - End to end troubleshooting tools are mainly Layer 3
 - Cable Modem down but L2 circuit active
- High Availability and Load Balancing
 - Only one forwarding interface per CMTS
- Service Scale
 - 4000 services (VLANs) total

Service Evolution

- Cable Labs compliant Business Services over DOCSIS (BSoD)
- 1) Dot1Q based BSoD
 - Similar to TLS over DOCSIS but supports:
 - Multiple VLAN's for single CM
 - Provisioning through Cable Modem Config file
- 2) MPLS based BSoD
 - Enables MPLS PE functionality on CMTS
 - Provisioning through CM Config file
 - MPLS based loadbalancing and High Availability

MPLS Based BSoD for Telecommuter Service

Service Architecture – Phase 2

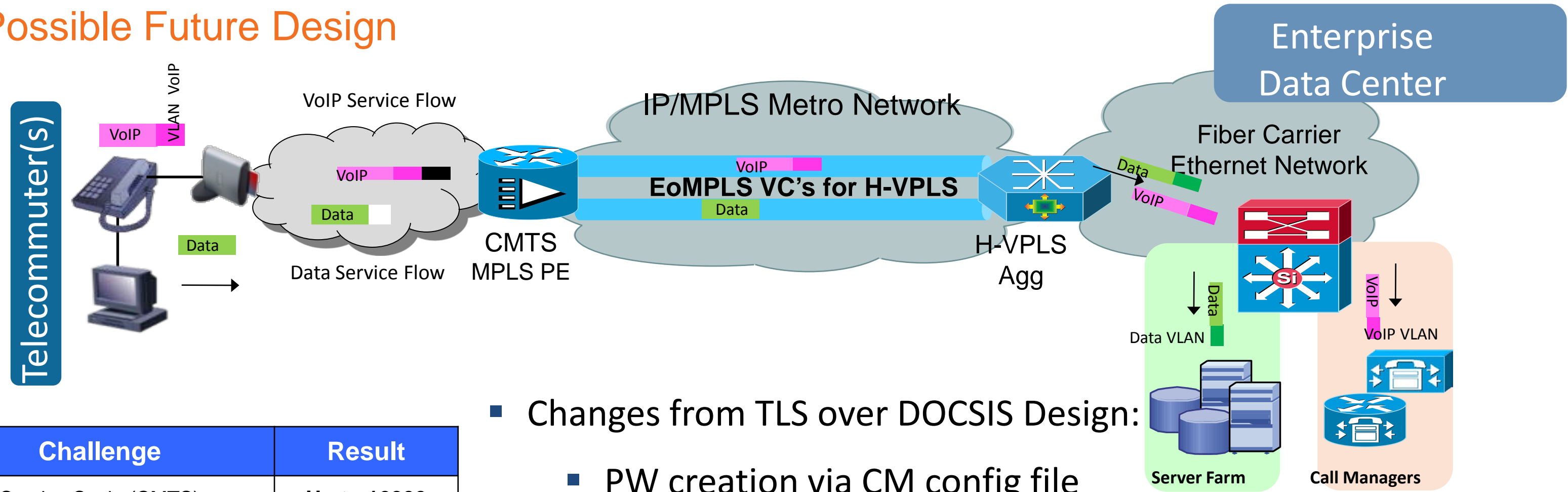


Challenge	Result
Service Scale (CMTS)	Upto 16000
High Availability and Load Balancing	✓
CM Down Propagation	✓
L2 Problem Detection	Future
Per-Site Configuration	Required
Traffic Isolation	No Change

- Changes from TLS over DOCSIS Design:
 - One box-solution
 - CMTS as MPLS PE !
 - Static configuration on CMTS
 - Uses MPLS Load-Balancing for CMTS Uplink
- Solves multiple challenges**

MPLS Based BSoD for Telecommuter Service

Possible Future Design



Challenge	Result
Service Scale (CMTS)	Up to 16000
High Availability and Load Balancing	✓
CM Down Propagation	✓
L2 Problem Detection	E-OAM (Future)
Per-Site Configuration	✓
End-to-End Traffic Isolation	✓

- Changes from TLS over DOCSIS Design:
 - PW creation via CM config file
 - Use multiple services flow with VLAN based Classification
 - Assign per-service flow EoMPLS PW
 - Use Cable modem Configuration file for CMTS side processing
- Simplest End to End Design !!

Summary



Summary

- Business Services over DOCSIS are here !!!
- Leverage existing HFC infrastructure, Cable Labs defined specs
- MEF Certified Services, Products and Architectural Solutions
- Multiple deployment option for Business Services over DOCSIS
- Metro network key for end-to-end Layer 2 transport
- BSOD provides enhanced functionality and flexibility
- Multiple decision factors
- Proven Real Life Applications

Q&A



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BUILT FOR
THE HUMAN
NETWORK

