Deploying Business Services over DOCSIS (BSoD)

BRKSPG-2502

Agenda

- The Case for Business Services over DOCSIS
- Business Services over DOCSIS Variations
- Layer 2 VPN over DOCSIS Deployment Models
- MPLS Layer 3 VPN Services over DOCSIC
- Quality of Service
- Choosing a Deployment Model
- Summary

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The Case for Business Services over DOCSIS

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CMTS-Based Services Landscape

- Massive investment in HFC Infrastructure
- HFC and DOCSIS footprint and coverage
- Predominantly High Speed Data, Internet Access
- Voice over IP Revolution
  - New revenue stream for Cable Service providers
  - Competitive pricing for consumers
- Is this the end of line for CMTS- and HFC-based services?
- Next revenue generating service over HFC/CMTS?

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The Next Wave of Evolution—BSoD

- Long history of VPN services over Fiber
- HFC plant under-utilized in Business hours
  - Dual purpose HFC networks
- Business Services over DOCSIS – BSoD
- No additional cost in most cases
- Same HFC network, additional services
- Zero touch CMTS provisioning
- Standardized service offerings

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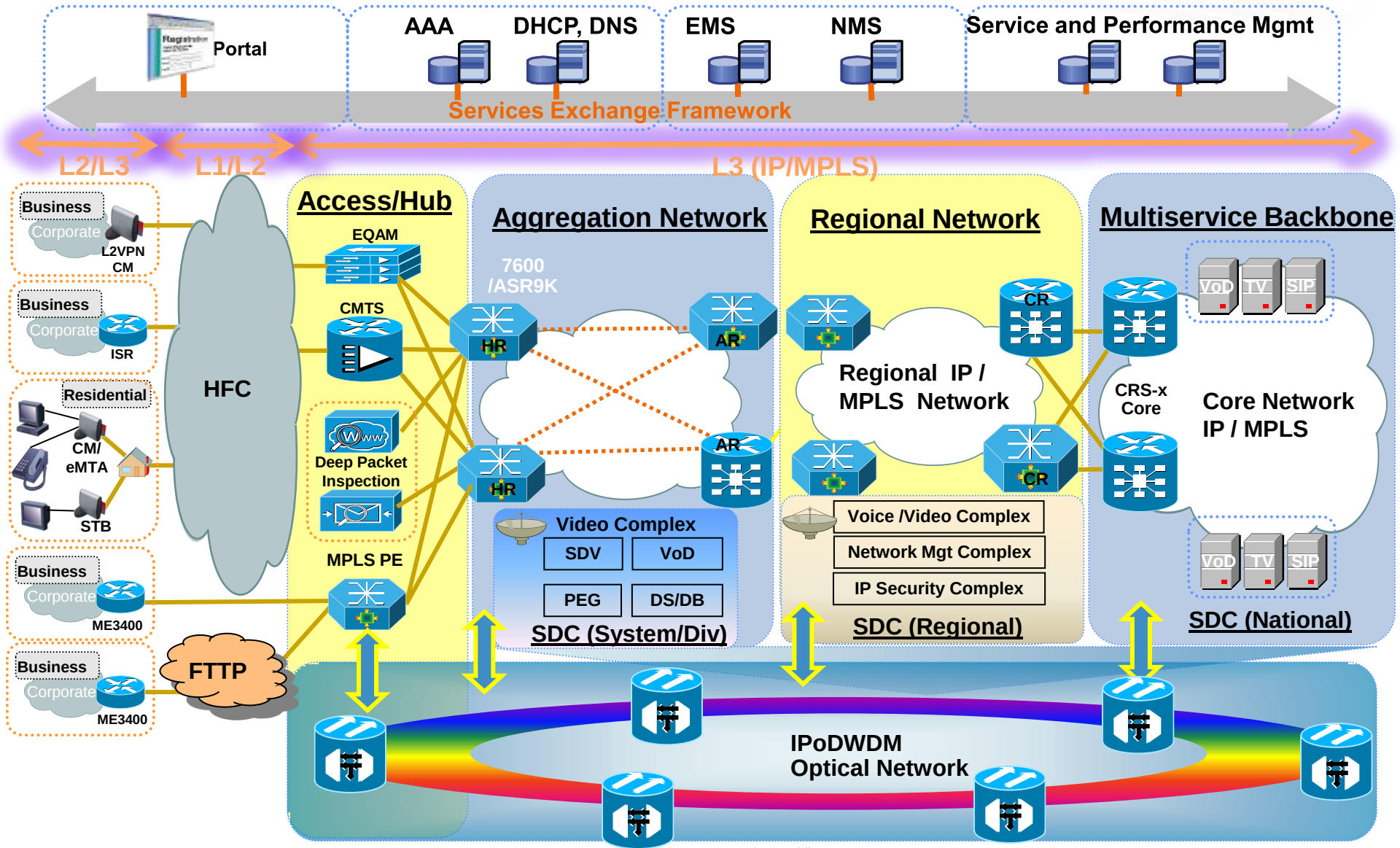
Cable Multi-Service Networks



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Business Services over DOCSIS Variations

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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

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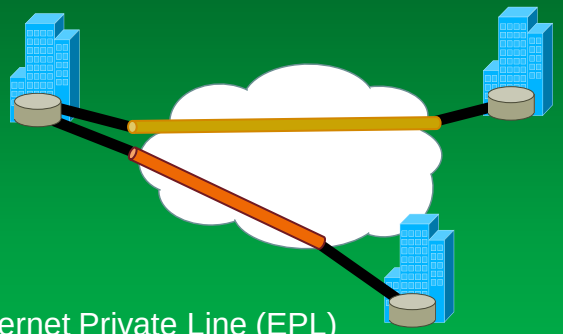
Carrier Ethernet L2VPN Services

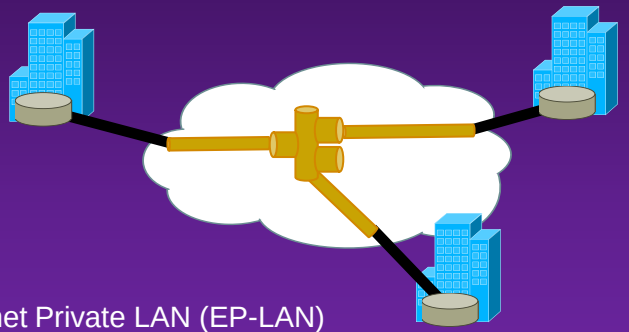
E-LINE Services

E-LAN Services

Port-based

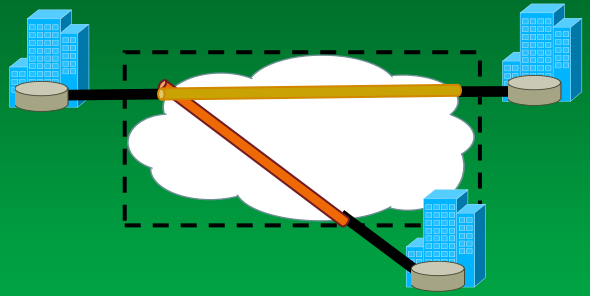


Ethernet Private Line (EPL)
Replaces a TDM private line
Dedicated UNIs for point-to-point connections
Single Ethernet Virtual Connection (EVC) per UNI
The most popular Ethernet service due to its simplicity

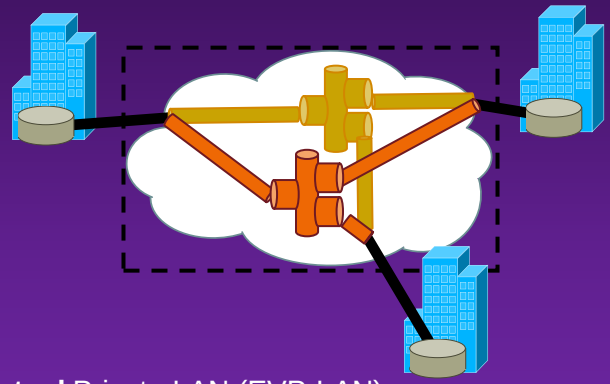


Ethernet Private LAN (EP-LAN)
Supports dedicated UNIs
Supports transparent LAN services
Supports multipoint Layer 2 VPNs

VLAN-based



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



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

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Layer 2 Business Services over DOCSIS

- Builds on standard defined by MEF
- Competitive advantage for Cable SPs due to HFC reach
- Cable Labs specs available* for L2VPNs
- DOCSIS 3.0 offer new opportunities for BSOD
  - Higher speed with Channel bonding
  - Effective Competition against T1, leased line and in some cases, fiber

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

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MPLS Layer3 VPN Services over DOCSIS

- Competitive advantage for Cable SPs due to HFC reach
- Enables the CMTS to function as the IP/VPN PE (per RFC4364)
- DOCSIS 3.0 offer new opportunities for BSOD
  - Higher speed with Channel bonding
  - Effective Competition against T1, leased line and in some cases, fiber

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Layer 2 VPN over DOCSIS Deployment Models

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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

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Dot1Q-Based L2VPN BSoD Overview

- Cisco TLS over DOCSIS standardization by CableLabs
- Industry's First and Only 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

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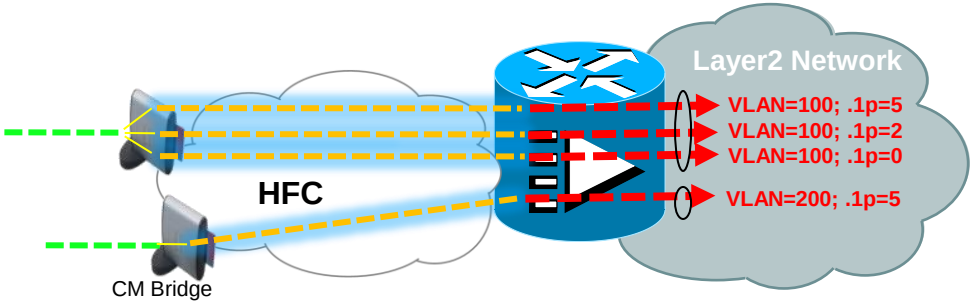
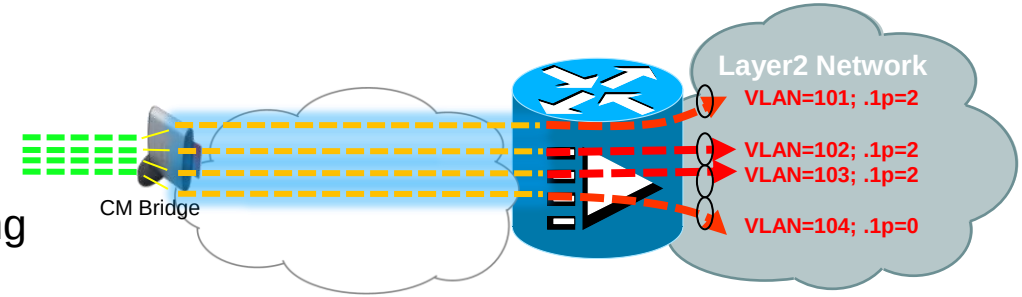
Dot1Q-Based L2VPN BSoD Services

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



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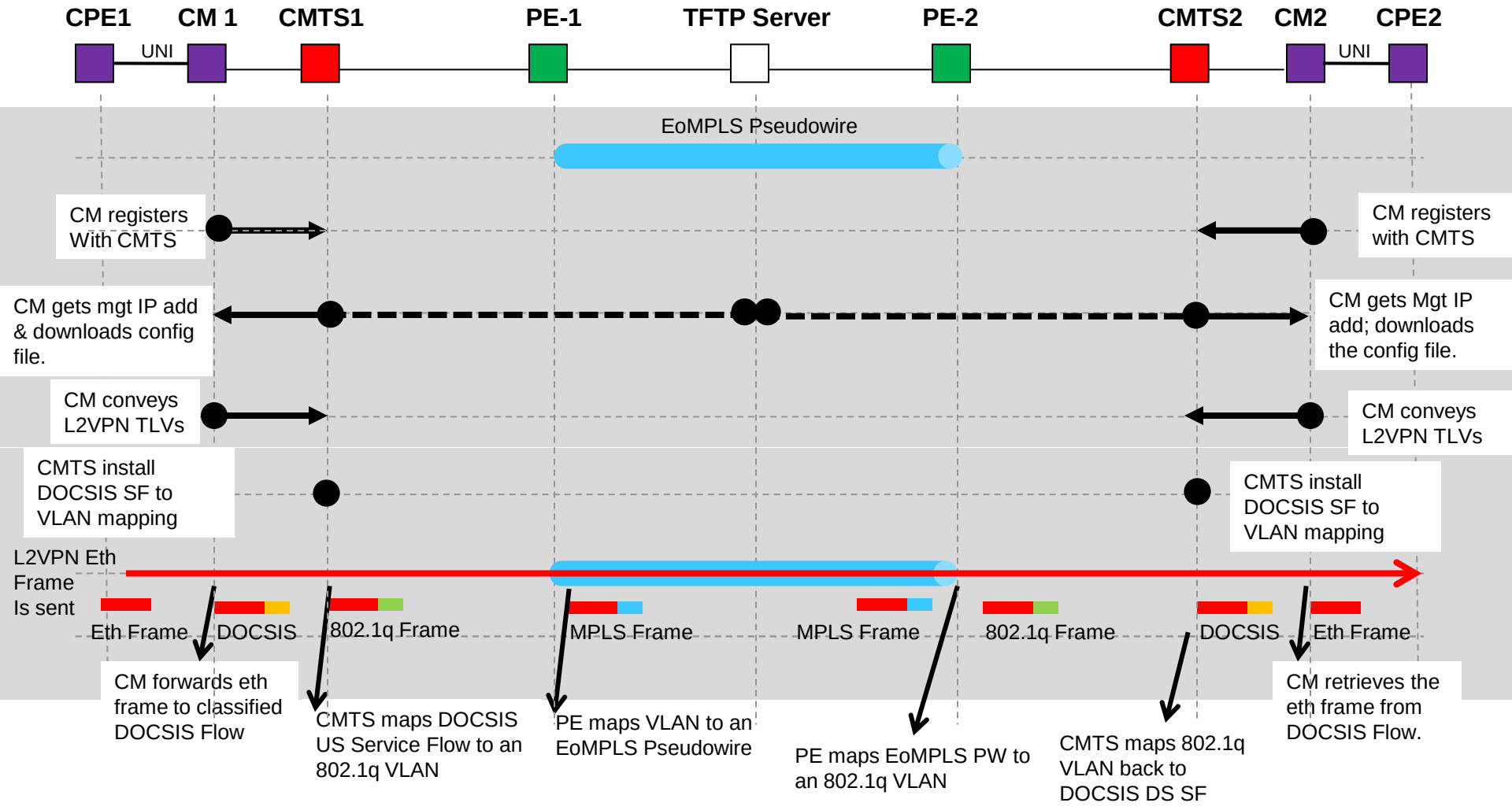
Dot1Q Based L2VPN BSoD

Control Plane and Data Plane Flow



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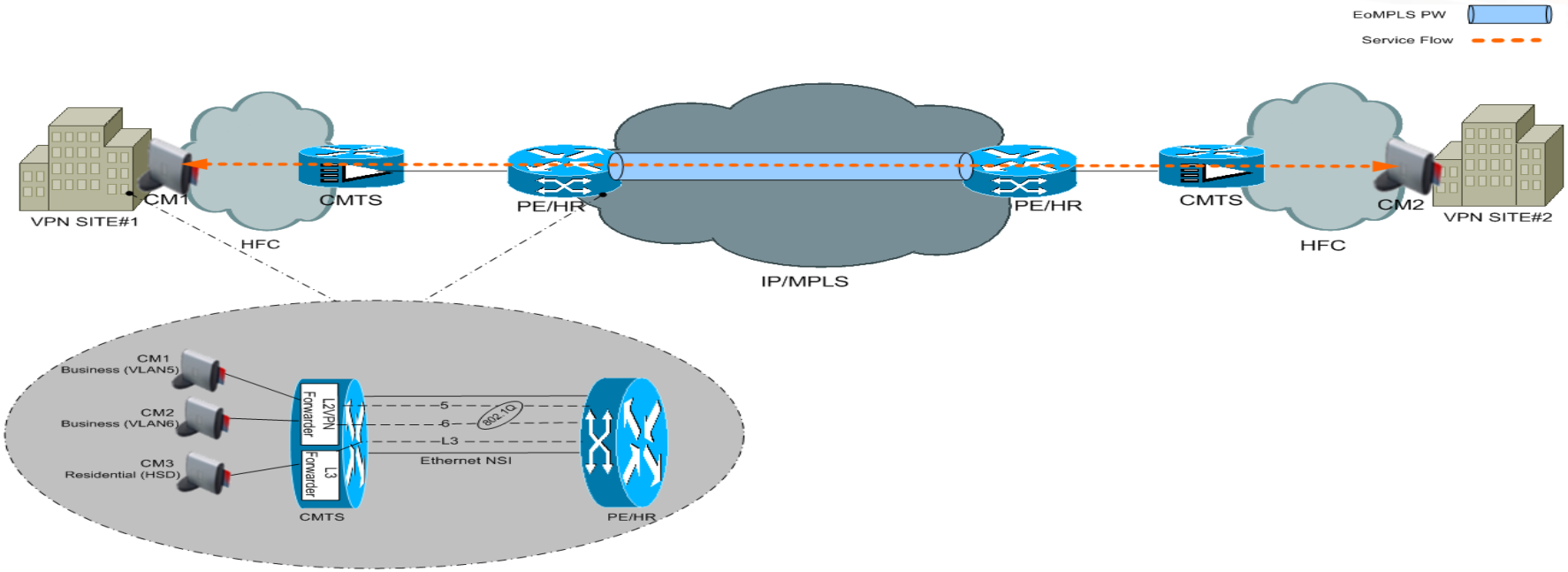
End-To-End Dot1Q-Based L2VPN BSoD Service



CMTS

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

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

Designated NSI Interface

NSI Encapsulation

MPLS PE

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

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

```
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)
```


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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
```


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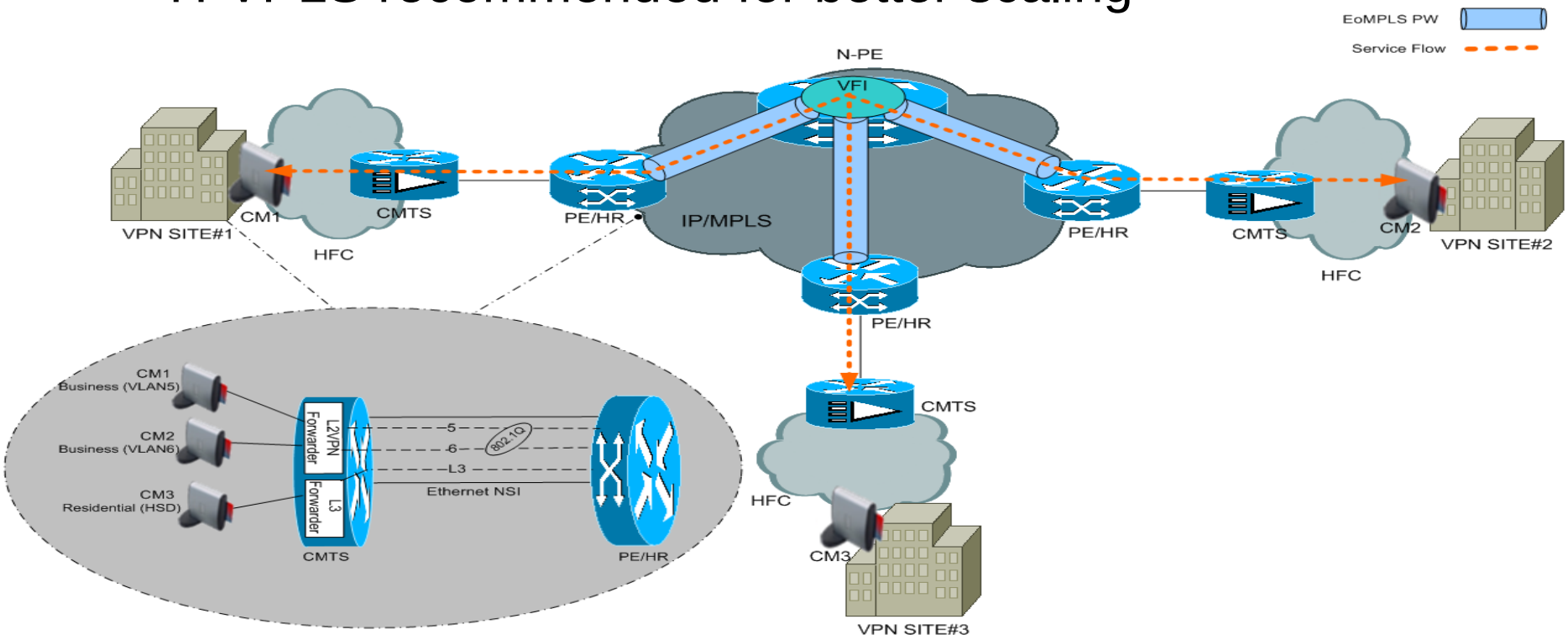
Dot1Q-Based L2VPN BSoD

Multipoint (E-LAN) Service

- Upstream routers implements the multipoint aspect
- H-VPLS recommended for better scaling



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MPLS-Based L2VPN BSoD Services

- Why settle for VLAN encapsulation on CMTS for 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

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MPLS-Based L2VPN BSoD Architecture

- NSI encapsulation is set to MPLS on CMTS
- CM maps Ethernet UNI to a DOCIS service flow
- DOCSIS service flow map to an EoMPLS PW
  - Mapping is defined by CM via CM config file
  - EoMPLS frames forwarded on any available MPLS uplink
- Zero Touch CMTS provisioning possible
  - Cable modem config file define PW parameters
- QoS provided through MPLS EXP bits

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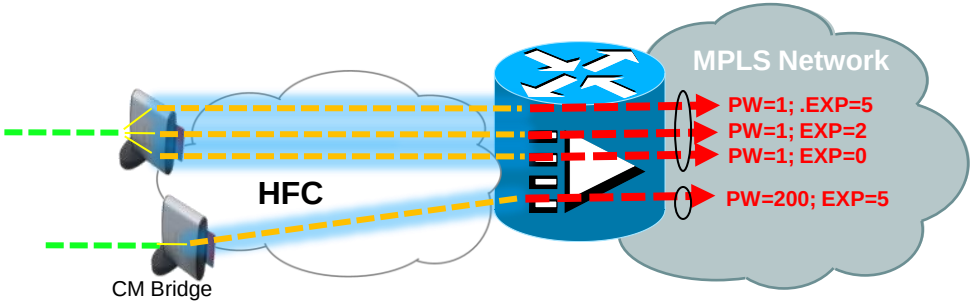
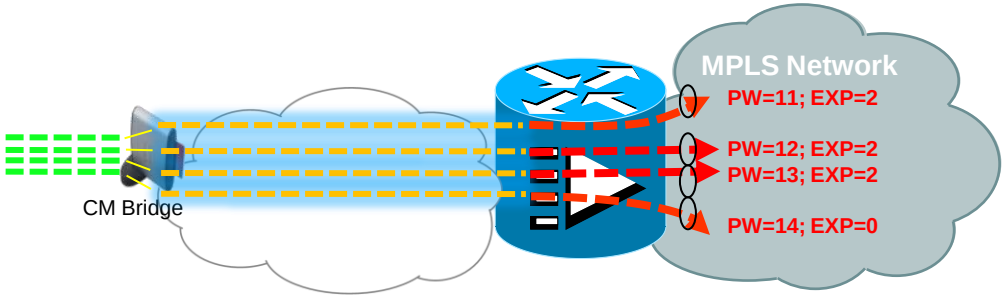
MPLS-Based BSoD Services

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



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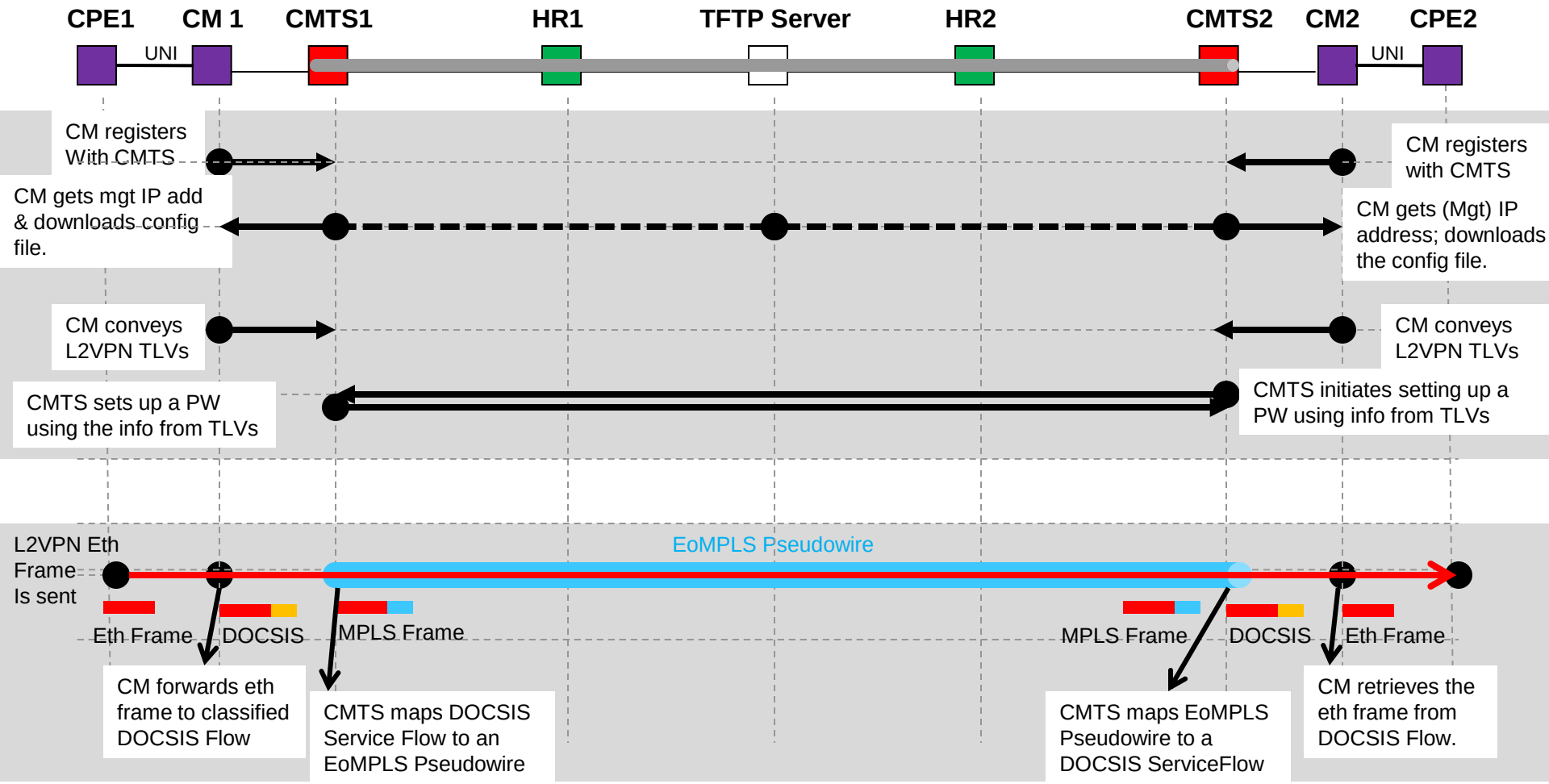
MPLS-Based L2VPN BSoD

Control Plane and Data Plane Flow



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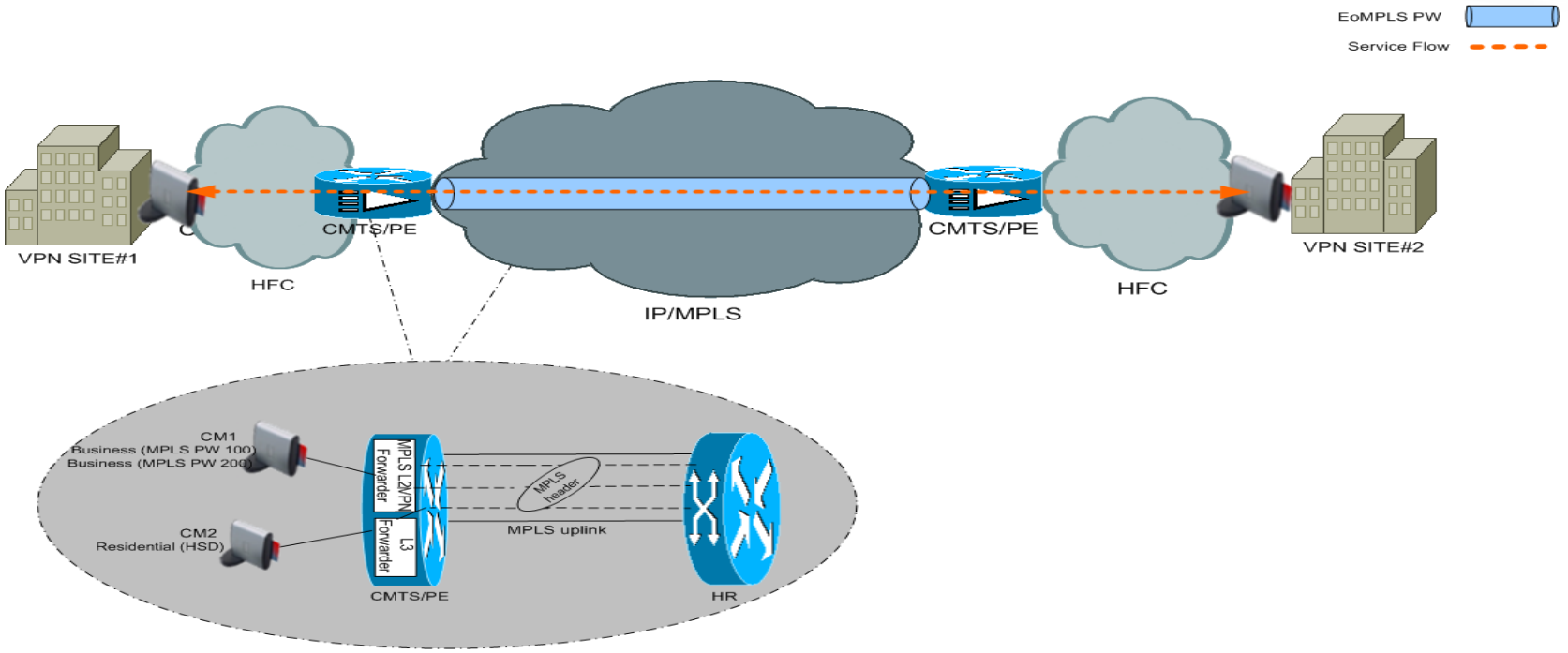
End-To-End MPLS-Based L2VPN BSoD Service



CMTS

```
cable l2-vpn-service xconnect nsi mpls
```

NSI Encapsulation

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MPLS-Based L2VPN BSoD Configuration

CM Config File Requirements

```
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
```

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 AII and Target AII must be the same.

```
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)
```

* Peer PE address may not be needed in the future.

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 the 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
```


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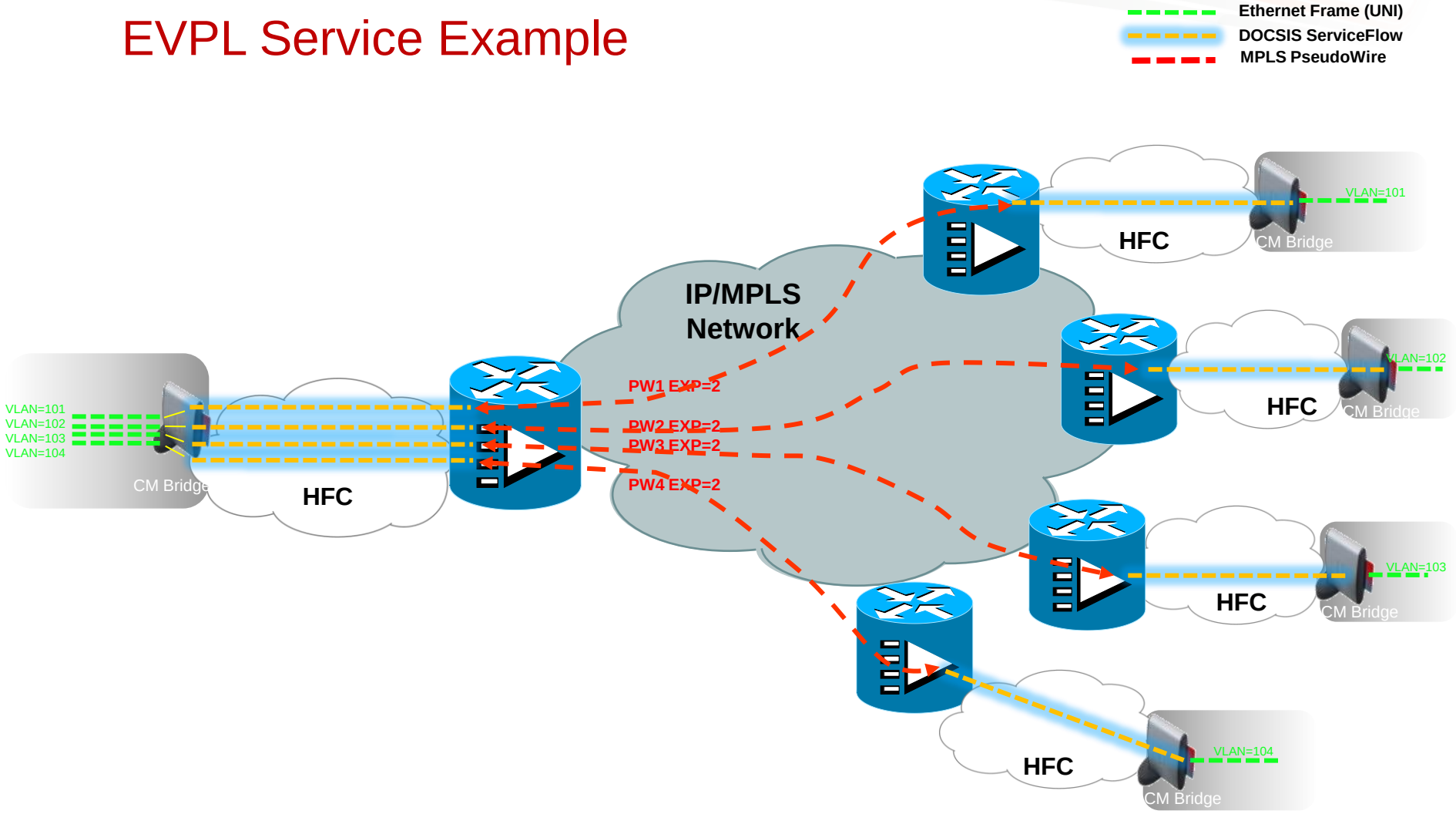
MPLS-Based L2VPN BSoD Service

EVPL Service Example



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MPL-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,L2VPNIdentifer,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,L2VPNIdentifer,9,MPLS EVPL2
              8,IngressUserPriority,1,05
22,UsPacketClassifer
            1,ClassifierRef,1,1
            3,ServiceFlowRef,2,1
            11,IEEE802Classifier
              2, VlanID 100
22,UsPacketClassifer
            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)
```


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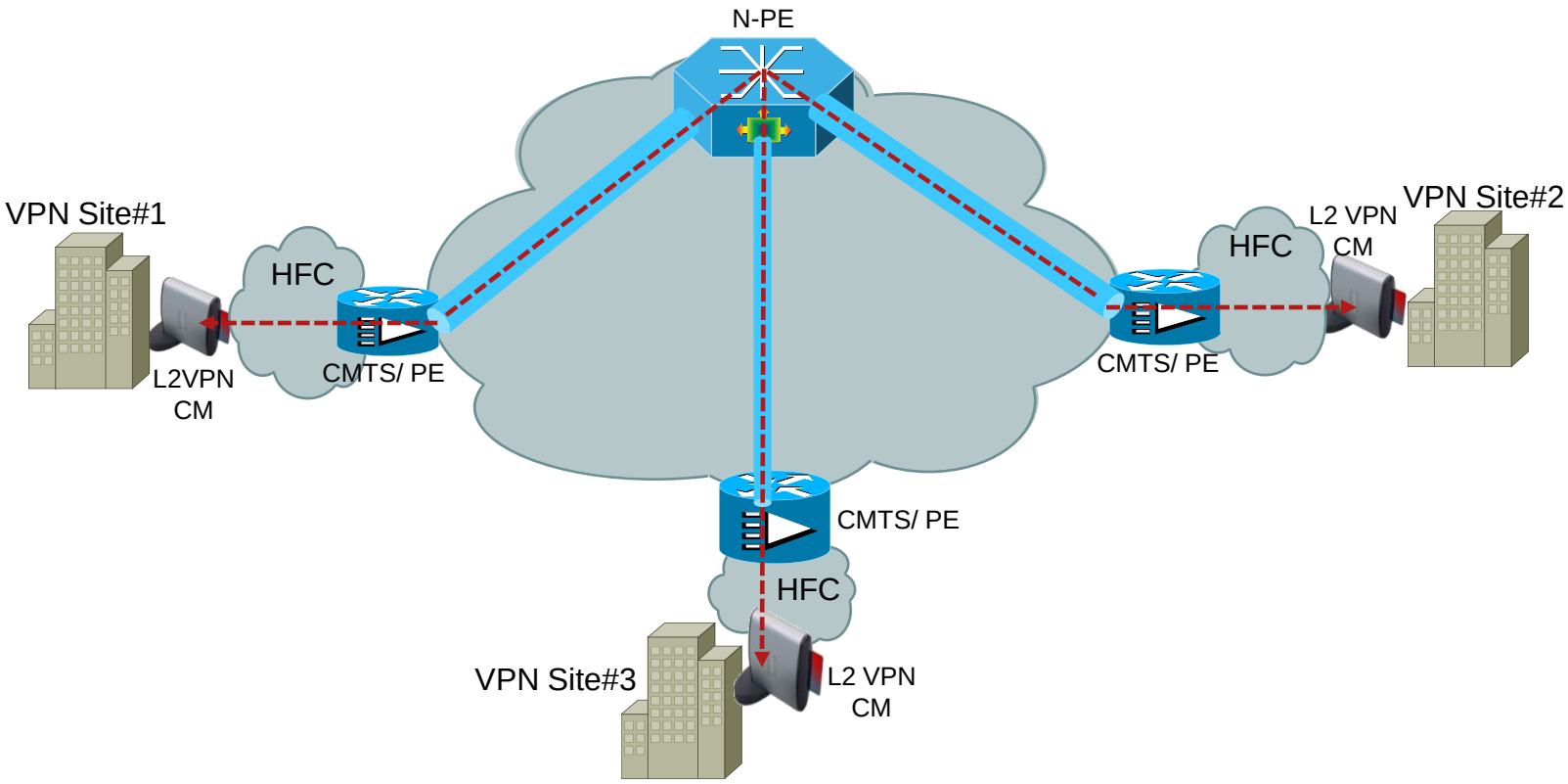
MPLS-Based L2VPN BSoD

Multipoint (E-LAN) Service

- Dedicated N-PE with H-VPLS



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MPLS Layer 3 VPN Services over DOCSIS

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MPLS L3VPN BSoD Services

- Who says Cisco CMTS is an MPLS L2 only PE???
- CMTS as L3VPN PE Device!!!
- CMTS implements IP/VPN PE function
- CMTS maps DOCSIS service flow to a VRF
  - Mapping is defined in the CM config file
  - CMTS to be provisioned with per-vrf sub-bundle interfaces
- CMTS & CE are IP connected over CM Bridge
  - CM Bridge may be integrated in CE (e.g. eRouter)

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MPLS L3VPN BSoD Architecture

- 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

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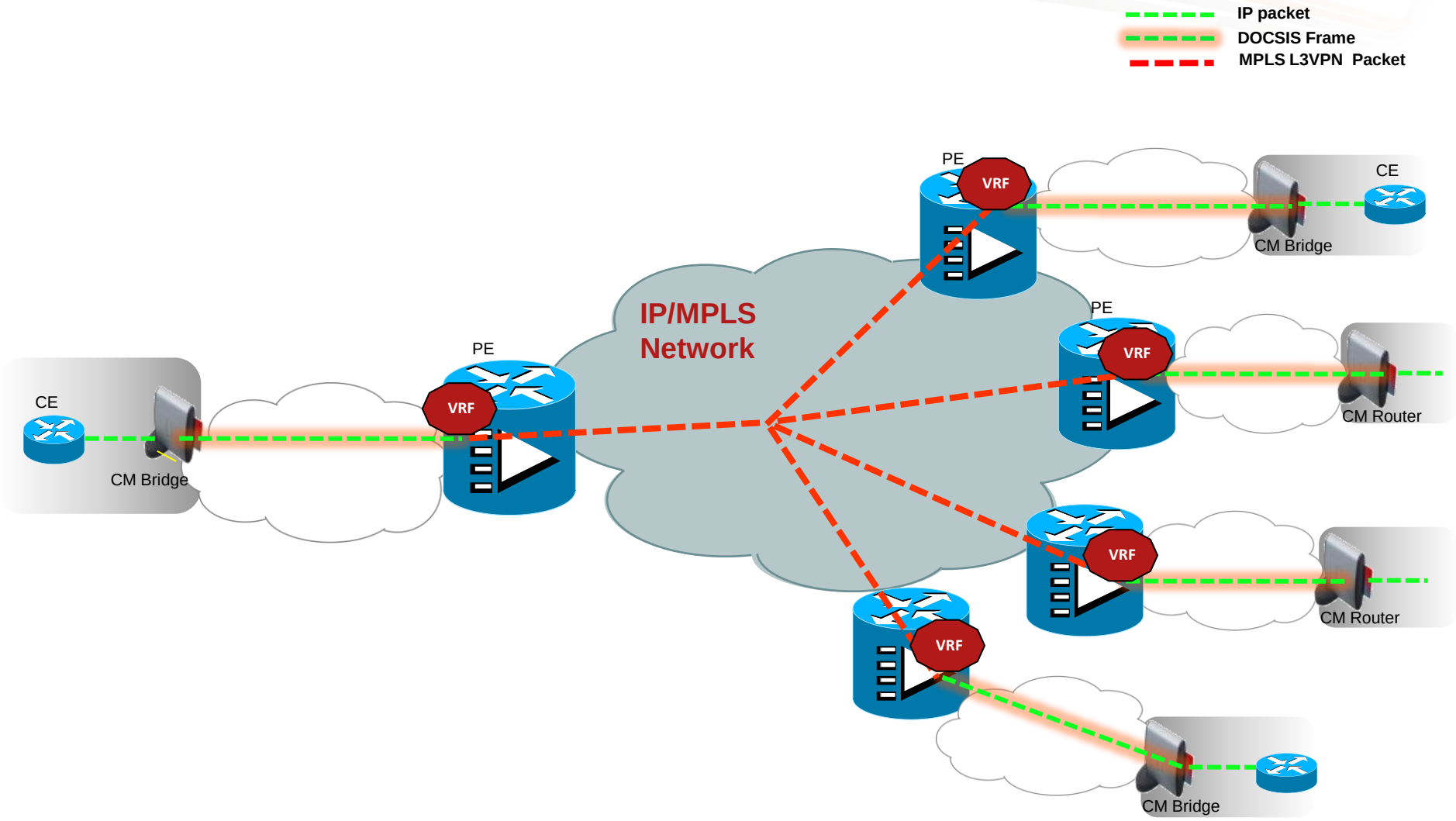
MPLS L3VPN over DOCSIS
Any-To-Any



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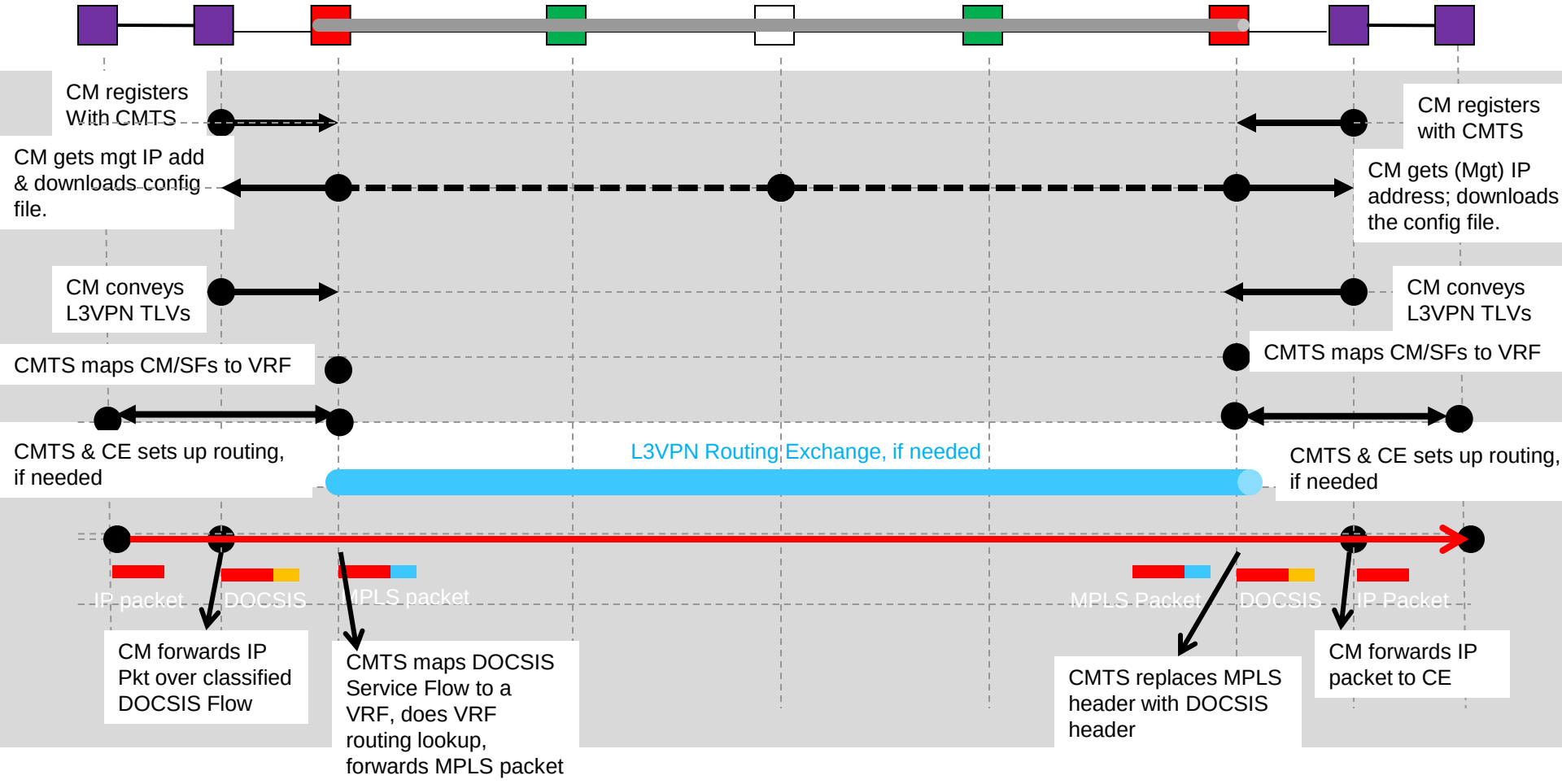
L3VPN over DOCSIS Packet Flow



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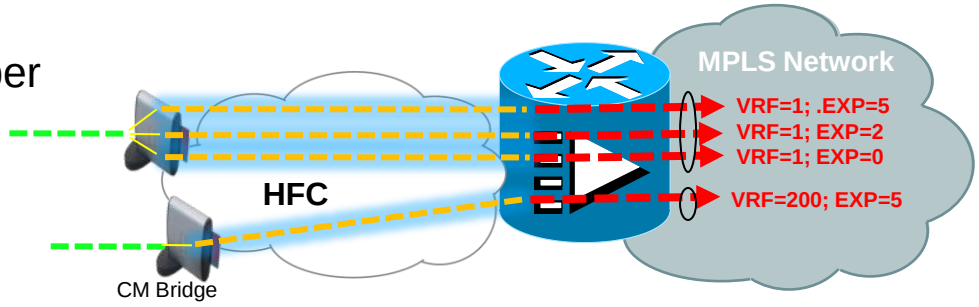
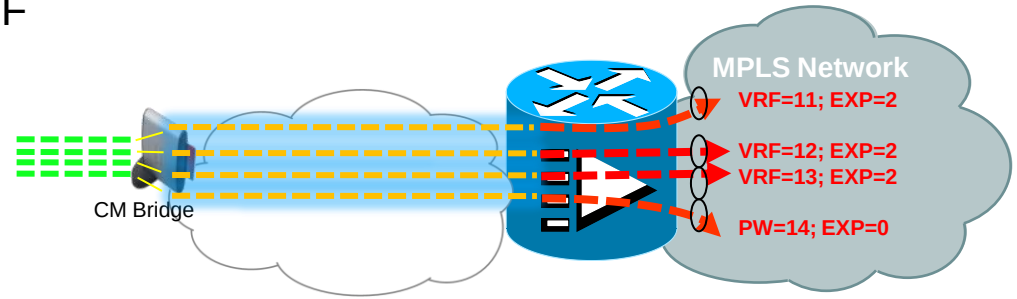
MPLS L3VPN BSoD Services

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





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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 !
```


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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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Agenda

- The Case for Business Services over DOCSIS
- Business Services over DOCSIS Variations
- Layer 2 VPN over DOCSIS Deployment Models
- MPLS Layer 3 VPN Services over DOCSIC
- Quality of Service
- Choosing a Deployment Model
- Summary

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Quality of Service

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QoS Overview

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

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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

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L2VPN/L3VPN BSoD QoS

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MPLS L2VPN BSoD CM Config. File with SLA

```
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
```


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Choosing a Deployment Model

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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

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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

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Summary

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Summary

- Business Services over DOCSIS picking up steam
- Leverage existing HFC infrastructure
- Certified MEF Carrier Ethernet Services
- Wide range of Deployment options
- Leverage widespread L3VPN deployments
- Flexible configuration options
- BSOD provides flexibility and enhanced functionality
- Multiple decision factors for correct BSoD model

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Q&A

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