TOMORROW starts here.
Deploying Carrier Ethernet Features on Cisco ASR 9000

BRKSPG-2202

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Technical Marketing Engineer
Agenda

- Carrier Ethernet Overview
- Cisco ASR 9000 Overview
- EFP Overview and Configurations
- Ethernet Services Overview, Configurations and Verification (VPLS, VPWS, H-VPLS, Bridging)
- Access Gateway Feature Overview, Configurations and Verification
- EOAM Overview and Configurations
- Best Practices and Case Studies
Agenda

- Carrier Ethernet Overview
- Cisco ASR 9000 Overview
- EFP Overview and Configurations
- Ethernet Services Overview, Configurations and Verification (VPLS, VPWS, H-VPLS, Bridging)
- Access Gateway Feature Overview, Configurations and Verification
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- Best Practices and Case Studies
Carrier Ethernet Overview
Why Carrier Ethernet?

- Proliferation and Advantage of ETHERNET.
- CARRIER ETHERNET - Suite of protocols that help you extend Ethernet Over WAN.
  - Standardized Services
  - Reliability
  - Scalability
  - Quality Of Service
  - Service Management
Carrier Ethernet Network

- **L2 Access Network**
  - STP/REP
  - 802.1Q

- **Local VLAN Significance**
- **Flexible service mapping**
- **Security features**

- **EoMPLS**
- **VPLS**

- **STP/REP**
- **802.1Q**

- **Corporate**
- **Residential**

- **Pon Node**
- **Aggregation Node**
- **Distribution Node**
- **Aggregation Network**
- **MPLS/IP**

- **Portal**
- **AAA**
- **DHCP, DNS**
- **EMS**
- **NMS**
- **Service and Performance Mgmt**
- **SIP**
- **VoD**
- **Content Network**
- **Core Network**
- **IP / MPLS**

- **RAN Access Network**
- **MPLS/IP**
- **EoMPLS**
- **VPLS**

- **Remote Access**
  - **L2 Access Network**
  - **Security features**
Ethernet Virtual Connection (EVC) and types

- An association of two or more UNIs
- Three types:
  - Point-to-point EVC (E-line)
  - Multipoint-to-multipoint EVC (E-LAN)
  - Rooted-multipoint EVC (E-tree)
EVC Configuration Points in the Network

- Configure the PE Physical interface facing the CE to Classify the Services Traffic - EFP
- Configure one or many Pseudo Wires to transport the Services Traffic across the Core network to the remote PE – L2VPN
Carrier Ethernet Overview
# Cisco ASR 9000 Portfolio

<table>
<thead>
<tr>
<th>Chassis</th>
<th>ASR 9001</th>
<th>ASR 9006</th>
<th>ASR 9010</th>
<th>ASR 9000v</th>
<th>ASR 9922</th>
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<tr>
<td>Max. Linecards per Chassis</td>
<td>2 IO Slots</td>
<td>4 LC</td>
<td>8 LC</td>
<td>Fixed Ports</td>
<td>20 LC</td>
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<tr>
<td>Max. Linecard Bandwidth</td>
<td>Modular + 4x10GE</td>
<td>360 Gbps</td>
<td>360 Gbps</td>
<td>44xGE + 4x10GE</td>
<td>360 Gbps</td>
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<tr>
<td>Max. Slot Bandwidth</td>
<td>440 Gbps</td>
<td>440 Gbps</td>
<td>1.2 Tbps</td>
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<tr>
<td>Chassis Bandwidth</td>
<td>120 Gbs</td>
<td>3.5 Tbps</td>
<td>7.0 Tbps</td>
<td>80 Gbs</td>
<td>48 Tbps</td>
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</tbody>
</table>
ASR 9000 System Architecture “Highlights”

- Fully Distributed Architecture
- True Modular OS – IOS XR
- Active-Active Fabric system
- Intelligent Multicast Replication
ASR 9000 Carrier Ethernet Foundation Summary
Flexible, Scalable and Complete!

Flexible EVC Infrastructure
- Flexible frame matching
- Flexible VLAN tag manipulation
- Flexible service mapping

Scalable and Efficient
- IOS-XR fully distributed OS
- Fully distributed hardware resource
- Hardware based MAC learning and feature assist.

Standard Based with Full Service Support
- Standard compliant: MEF, IETF, IEEE, ITU
- Full service support: E-LINE, E-LAN, E-Tree, Native L2 and L2VPN, IRB, L3
ASR 9000 Flexible Ethernet SW Infrastructure

- **EFP (Ethernet Flow Point)** or sub-interface
- Flexible VLAN tag classification
- Flexible VLAN tag rewrite
- Flexible Ethertype (.1Q, QinQ, .1ad)

**Flexible service mapping and multiplexing**
L2 and L3, P2P and MP services concurrently on the same port
EFP (Ethernet Flow Point)
Overview and Configurations
EFP Overview

interface 0/0/slot/port.<sub-intf no.> \textit{l2transport}

\textit{<match criteria commands>} \hspace{1cm} (VLAN tags, MAC, Ether type)

\textit{<rewrite commands>} \hspace{1cm} (VLAN tags pop/push/translation)

\textit{<feature commands>} \hspace{1cm} (QoS, ACL etc)
EFP Flexible Tag Classification

- Match up to 2 VLAN tags
- Match unique, multiple, or range of VLAN tags
- Match Untagged frame for control protocols
- Match Default
- Match 802.1ad

RP/0/RSP0/CPU0:PE2-asr(config-subif)#encapsulation?
- default: Packets unmatched by other service instances
- dot1ad: IEEE 802.1ad VLAN-tagged packets
- dot1q: IEEE 802.1Q VLAN-tagged packets
- untagged: Packets with no explicit VLAN tag

RP/0/RSP0/CPU0:PE2-asr(config-subif)#encapsulation dot1q 100-200,205?
- comma: comma
- exact: Do not allow further inner tags
- second-dot1q: IEEE 802.1Q VLAN-tagged packets

RP/0/RSP0/CPU0:PE2-asr(config-subif)#encapsulation dot1q 100 second-dot1q 10-20,35?
- comma: comma
- exact: Do not allow further inner tags
EFP Flexible Tag Classification
Exact vs. Non-Exact Match

interface GigabitEthernet0/2/0/11.100 l2transport encapsulation dot1q 10
!

interface GigabitEthernet0/3/0/11.200 l2transport encapsulation dot1q 10 exact
!

interface GigabitEthernet0/4/0/11.300 l2transport encapsulation dot1q 10 second-dot1q 100
!

interface GigabitEthernet0/5/0/11.400 l2transport encapsulation dot1q 10 second-dot1q 100 exact
!
EFP Flexible Tag Classification
The Longest Match Rule and the default option

- Only longest tag is supported with in the same physical port

```
int Gig 0/3/0/0
default
```

```
dot1q 10
```

```
dot1q 10 sec 100 exact
```

```
dot1q 10 sec 128-133
```

```
10
```

```
10 100
```

```
10 130 200
```

```
20 130 200
```
EFP Flexible VLAN Tag rewrite

- Pop tag 1 or 2
- Push tag 1 or 2
- Tag translation
  1-1, 1-2, 2-1, 2-2

- “Symmetric” option

```
RP/0/RSP0/CPU0:PE2-asr(config-subif)#rewrite ingress tag ?
  pop          Remove one or more tags
  push         Push one or more tags
  translate    Replace tags with other tags

RP/0/RSP0/CPU0:PE2-asr(config-subif)#rewrite ingress tag pop ?
  1   Remove outer tag only
  2   Remove two outermost tags

RP/0/RSP0/CPU0:PE2-asr(config-subif)#rewrite ingress tag push ?
  dot1ad    Push a Dot1ad tag
  dot1q     Push a Dot1Q tag

RP/0/RSP0/CPU0:PE2-asr(config-subif)#rewrite ingress tag push dot1q 100 ?
  second-dot1q   Push another Dot1Q tag
  symmetric      All rewrites must be symmetric

RP/0/RSP0/CPU0:PE2-asr(config-subif)#rewrite ingress tag translate ?
  1-to-1  Replace the outermost tag with another tag
  1-to-2  Replace the outermost tag with two tags
  2-to-1  Replace the outermost two tags with one tag
  2-to-2  Replace the outermost two tags with two other tags
```
Ethernet Services
Local Connect, Local Bridging, Pseudowire and IRB Services.
There are two types:
1. Point to Point
   - Local Connect
   - VPWS/EoMPLS
2. Multi Point
   - Local Bridging
   - VPLS
   - H-VPLS

Ethernet Services are always configured under “l2vpn” CLI

```
l2vpn
xconnect group name1
p2p name1
!
!
bridge group name1
bridge-domain name1
!
!
end
```
Point to Point Services
Local Connect

- To Connect 2 local interfaces (Physical or Virtual)
- No MAC address learning

```
l2vpn
xconnect group CISCO
p2p LCONNECT
interface GigabitEthernet0/0/0/4.1
interface GigabitEthernet0/0/0/5.1
```
interface GigabitEthernet0/2/0/8.100 l2transport
  encapsulation dot1q 100
!
interface GigabitEthernet0/2/0/9.100 l2transport
  encapsulation dot1q 100
!
l2vpn
  xconnect group lab1
    p2p lab1
      interface GigabitEthernet0/2/0/8.100
      interface GigabitEthernet0/2/0/9.100
!
!
end
Point to Point Services
Local Connect – Verification commands

RP/0/RSP0/CPU0:PR-ASR9K-1#sh l2vpn xconnect group
lab1 detail

Group lab1, XC lab1, state is up; Interworking none
**AC: GigabitEthernet0/2/0/8.100, state is up**
  Type VLAN; Num Ranges: 1
  VLAN ranges: [100, 100]
  MTU 1504; XC ID 0x104000c; interworking none
  Statistics:
    packets: received 561494, sent 0
    bytes: received 278501024, sent 0
    drops: illegal VLAN 0, illegal length 0
**AC: GigabitEthernet0/2/0/9.100, state is up**
  Type VLAN; Num Ranges: 1
  VLAN ranges: [100, 100]
  MTU 1500; XC ID 0x104000d; interworking none
  Statistics:
    packets: received 0, sent 561494
    bytes: received 0, sent 278501024
    drops: illegal VLAN 0, illegal length 0
Point to Point Services
VPWS/EoMPLS

- Point to Point Psuedowire/L2VPN.
- No MAC address learning.

```
l2vpn
xconnect group CISCO
p2p VPWS
interface GigabitEthernet0/0/0/4.1
neighbor 1.1.1.1 pw-id 100
```
interface GigabitEthernet0/2/0/8.200 l2transport
  encapsulation dot1q 200
  rewrite ingress tag pop 1 symmetric

l2vpn
  pw-class vpws
  encapsulation mpls

xconnect group lab2
  p2p vpws
    interface GigabitEthernet0/2/0/8.200
    neighbor 172.16.0.23 pw-id 200
    pw-class vpws

end
Point to Point Services
VPWS– Verification commands – Local PE

RP/0/RSP0/CPU0:PR-ASR9K-1#sh l2vpn xconnect Group lab2 detail

Group lab2, XC vpws, state is up; Interworking none

**AC: GigabitEthernet0/2/0/8.200, state is up**
- Type VLAN; Num Ranges: 1
- VLAN ranges: [200, 200]
- MTU 1500; XC ID 0x104000e; interworking none
- Statistics:
  - packets: received 13499325, sent 0
  - bytes: received 6695665200, sent 0
  - drops: illegal VLAN 0, illegal length 0

**PW: neighbor 172.16.0.23, PW ID 200, state is up (established)**
- PW class vpws, XC ID 0x104000e
- Encapsulation MPLS, protocol LDP
- PW type Ethernet, control word disabled, interworking none
- PW backup disable delay 0 sec
- Sequencing not set

<table>
<thead>
<tr>
<th>MPLS</th>
<th>Local</th>
<th>Remote</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Label</strong></td>
<td>16011</td>
<td>36</td>
</tr>
<tr>
<td><strong>Group ID</strong></td>
<td>0x8000280</td>
<td>0x0</td>
</tr>
<tr>
<td><strong>Interface</strong></td>
<td>GigabitEthernet0/2/0/8.200</td>
<td>unknown</td>
</tr>
<tr>
<td><strong>MTU</strong></td>
<td>1500</td>
<td>1500</td>
</tr>
<tr>
<td><strong>Control word</strong></td>
<td>disabled</td>
<td>disabled</td>
</tr>
<tr>
<td><strong>PW type</strong></td>
<td>Ethernet</td>
<td>Ethernet</td>
</tr>
<tr>
<td><strong>VCCV CV type</strong></td>
<td>0x2</td>
<td>0x6</td>
</tr>
<tr>
<td><strong>VCCV CC type</strong></td>
<td>0x6</td>
<td>0x6</td>
</tr>
</tbody>
</table>

- (LSP ping verification) (BFD PW FD only)
- (router alert label) (router alert label)
- (TTL expiry) (TTL expiry)

MIB cpwVcIndex: 4294705162
Create time: 07/10/2011 20:49:18 (00:55:08 ago)
Last time status changed: 07/10/2011 20:49:23 (00:55:03 ago)
Statistics:
- packets: received 0, sent 13499325
- bytes: received 0, sent 6695665200
Local interface: Gi1/9 up, line protocol up, Eth VLAN 200 up
Destination address: 172.16.0.11, VC ID: 200, VC status: up
Output interface: Gi1/40, imposed label stack \{16007 16011\}
Preferred path: not configured
Default path: active
Next hop: 172.16.123.1
Create time: 00:54:05, last status change time: 00:53:45
Signaling protocol: LDP, peer 172.16.0.11:0 up
Targeted Hello: 172.16.0.23(LDP Id) -> 172.16.0.11, LDP is UP
Status TLV support (local/remote) : enabled/not supported
LDP route watch : enabled
Label/status state machine : established, LruRru
Last local dataplane status rcvd: No fault
Last BFD dataplane status rcvd: No sent
Last local SSS circuit status rcvd: No fault
Last local SSS circuit status sent: No fault
Last local LDP TLV status sent: No fault
Last remote LDP TLV status rcvd: Not sent
Last remote LDP ADJ status rcvd: No fault
MPLS VC labels: local 36, remote 16011
PWID: 16469
Group ID: local 0, remote 134218368
MTU: local 1500, remote 1500
Remote interface description: GigabitEthernet0_2_0_8.200
Sequencing: receive disabled, send disabled
Control Word: Off (configured: autosense)
VC statistics:
transit packet totals: receive 13499325, send 0
transit byte totals: receive 6749662500, send 0
transit packet drops: receive 0, seq error 0, send 0
Multipoint Services
Concept of Bridge Domain

- Bridge Domain is the basic building block of Multipoint Services.
- Data Frames are switched with a Bridge Domain based on the destination MAC addresses.
MultiPoint Services
Layer 2 Bridging

I2vpn
bridge group CISCO
bridge-domain BD1
interface TenGigE0/1/0/0.1
interface TenGigE0/1/1/0.1
interface TenGigE0/1/2/0.1
interface GigabitEthernet0/2/0/8.300 l2transport
  encapsulation dot1q 300
!
interface GigabitEthernet0/2/0/9.300 l2transport
  encapsulation dot1q 300
!
interface GigabitEthernet0/2/0/10.300 l2transport
  encapsulation dot1q 300
!
l2vpn
  bridge group lab4
  bridge-domain lab4
    interface GigabitEthernet0/2/0/8.300
    !
    interface GigabitEthernet0/2/0/9.300
    !
    interface GigabitEthernet0/2/0/10.300
    !
!
end
MultiPoint Services

Layer 2 Bridging – Verification commands

RP/0/RSP0/CPU0:PR-ASR9K-1#sh l2vpn bridge-domain
bd-name lab4 detail
Sat Oct  8 00:16:28.113 UTC
Bridge group: lab4, bridge-domain: lab4, id: 1, state: up,
Shgld: 0, MSTi: 0
  MAC learning: enabled
  MAC withdraw: enabled
    MAC withdraw for Access PW: enabled
Flooding:
  Broadcast & Multicast: enabled
  Unknown unicast: enabled
MAC aging time: 300 s, Type: inactivity
MAC limit: 4000, Action: none, Notification: syslog
MAC limit reached: no
MAC port down flush: enabled
MAC Secure: disabled, Logging: disabled
Split Horizon Group: none
Dynamic ARP Inspection: disabled, Logging: disabled
IP Source Guard: disabled, Logging: disabled
DHCPv4 snooping: disabled
IGMP Snooping profile: none
Bridge MTU: 1500

MIB cvplsConfigIndex: 2
Filter MAC addresses:
Create time: 07/10/2011 23:10:10 (01:06:17 ago)
No status change since creation
ACs: 3 (3 up), VFIs: 0, PWs: 0 (0 up), PBBs: 0 (0 up)
List of ACs:
  AC: GigabitEthernet0/2/0/10.300, state is up
    Type VLAN; Num Ranges: 1
    VLAN ranges: [300, 300]
    MTU 1500; XC ID 0x1040014; interworking none
    MAC learning: disabled (Admin)
    Flooding:
      Broadcast & Multicast: enabled
      Unknown unicast: enabled
    MAC aging time: 300 s, Type: inactivity
    MAC limit: 4000, Action: none, Notification: syslog
    MAC limit reached: no
    MAC port down flush: enabled
    MAC Secure: disabled, Logging: disabled
    Split Horizon Group: none
    Dynamic ARP Inspection: disabled, Logging: disabled
    IP Source Guard: disabled, Logging: disabled
    DHCPv4 snooping: disabled
    IGMP Snooping profile: none
    Bridge MTU: 1500
DHCPv4 snooping: disabled
  IGMP Snooping profile: none
  Storm Control: disabled
  Static MAC addresses:
  Statistics:
    packets: received 0, sent 16403420
    bytes: received 0, sent 8136096264
  Storm control drop counters:
    packets: broadcast 0, multicast 0, unknown unicast 0
    bytes: broadcast 0, multicast 0, unknown unicast 0
  Dynamic ARP inspection drop counters:
    packets: 0, bytes: 0
  IP source guard drop counters:
    packets: 0, bytes: 0

AC: GigabitEthernet0/2/0/8.300, state is up
  Type VLAN; Num Ranges: 1
  VLAN ranges: [300, 300]
  MTU 1500; XC ID 0x1040012; interworking none
  MAC learning: disabled (Admin)
  Flooding:
    Broadcast & Multicast: enabled
    Unknown unicast: enabled
  MAC aging time: 300 s, Type: inactivity
  MAC limit: 4000, Action: none, Notification: syslog
  MAC limit reached: no
  MAC port down flush: enabled
  MAC Secure: disabled, Logging: disabled
  Split Horizon Group: none
  Dynamic ARP Inspection: disabled, Logging: disabled
  IP Source Guard: disabled, Logging: disabled
  DHCPv4 snooping: disabled
  IGMP Snooping profile: none
  Storm Control: disabled
  Static MAC addresses:
  Statistics:
    packets: received 24352205, sent 13828732
    bytes: received 12078693680, sent 6859051072
  Storm control drop counters:
    packets: broadcast 0, multicast 0, unknown unicast 0
    bytes: broadcast 0, multicast 0, unknown unicast 0
  Dynamic ARP inspection drop counters:
    packets: 0, bytes: 0
  IP source guard drop counters:
    packets: 0, bytes: 0
Multi Point Services
Concept of Split Horizon and Split Horizon groups.

- Split Horizon is disabled on AC by default
- Split Horizon is enabled on PW by default
- 3 Split Horizon groups are defined in XR
  - Group 0 is default.
  - Group 1 – Any PW configured under the “vfi”
  - Group 2 – Any AC configured with “split-horizon” keyword.
MultiPoint Services
VPLS

l2vpn
bridge group CISCO
bridge-domain BD1
interface TenGigE0/1/0/0.1
interface TenGigE0/1/1/0.1
vfi CISCO
neighbor 1.1.1.1 pw-id 100
neighbor 2.2.2.2 pw-id 100
interface GigabitEthernet0/2/0/8.400 l2transport
  encapsulation dot1q 400 second-dot1q 500 exact
  rewrite ingress tag pop 2 symmetric
!
interface GigabitEthernet0/2/0/9.400 l2transport
  encapsulation dot1q 400 second-dot1q 500 exact
  rewrite ingress tag pop 2 symmetric
!
l2vpn
  bridge group lab5
    bridge-domain lab5
      interface GigabitEthernet0/2/0/8.400
        !
      interface GigabitEthernet0/2/0/9.400
        !
vfi lab5
  vpn-id 101
    neighbor 172.16.0.12 pw-id 100
    !
    neighbor 172.16.0.23 pw-id 100
    !
  !
MultiPoint Services
VPLS - Verification

RP/0/RSP0/CPU0:PR-ASR9K-1#sh l2vpn bridge-domain group lab5 detail
Sat Oct 8 04:04:41.980 UTC
Bridge group: lab5, bridge-domain: lab5, id: 2, state: up,
ShgId: 0, MSTi: 0
  MAC learning: enabled
  MAC withdraw: enabled
    MAC withdraw for Access PW: enabled
Flooding:
  Broadcast & Multicast: enabled
  Unknown unicast: enabled
MAC aging time: 300 s, Type: inactivity
MAC limit: 4000, Action: none, Notification: syslog
MAC limit reached: no
MAC port down flush: enabled
MAC Secure: disabled, Logging: disabled
Split Horizon Group: none
Dynamic ARP Inspection: disabled, Logging: disabled
IP Source Guard: disabled, Logging: disabled
DHCPv4 snooping: disabled
IGMP Snooping profile: none
Bridge MTU: 1500

MIB cvplsConfigIndex: 3
  Filter MAC addresses:
  Create time: 08/10/2011 03:03:50 (01:00:51 ago)
  No status change since creation
  ACs: 2 (2 up), VFIs: 1, PWs: 2 (2 up), PBBs: 0 (0 up)
  List of ACs:
  AC: GigabitEthernet0/2/0/8.400, state is up
    Type VLAN; Num Ranges: 1
    Outer Tag: 400
    VLAN ranges: [500, 500]
    MTU 1500; XC ID 0x1040016; interworking none
    MAC learning: enabled
    Flooding:
      Broadcast & Multicast: enabled
      Unknown unicast: enabled
    MAC aging time: 300 s, Type: inactivity
    MAC limit: 4000, Action: none, Notification: syslog
    MAC limit reached: no
    MAC port down flush: enabled
    MAC Secure: disabled, Logging: disabled
    Split Horizon Group: none
MultiPoint Services
VPLS - Verification

Dynamic ARP Inspection: disabled, Logging: disabled
IP Source Guard: disabled, Logging: disabled
DHCPv4 snooping: disabled
IGMP Snooping profile: none
Storm Control: disabled
Static MAC addresses:
Statistics:
  packets: received 1625928, sent 8807355
  bytes: received 806460288, sent 4368448080
Storm control drop counters:
  packets: broadcast 0, multicast 0, unknown unicast 0
  bytes: broadcast 0, multicast 0, unknown unicast 0
Dynamic ARP inspection drop counters:
  packets: 0, bytes: 0
IP source guard drop counters:
  packets: 0, bytes: 0
AC: GigabitEthernet0/2/0/9.400, state is up
  Type VLAN; Num Ranges: 1
  Outer Tag: 400
  VLAN ranges: [500, 500]
  MTU 1500; XC ID 0x1040017; interworking none
  MAC learning: enabled

Flooding:
  Broadcast & Multicast: enabled
  Unknown unicast: enabled
  MAC aging time: 300 s, Type: inactivity
  MAC limit: 4000, Action: none, Notification: syslog
  MAC limit reached: no
  MAC port down flush: enabled
  MAC Secure: disabled, Logging: disabled
  Split Horizon Group: none
  Dynamic ARP Inspection: disabled, Logging: disabled
  IP Source Guard: disabled, Logging: disabled
  DHCPv4 snooping: disabled
  IGMP Snooping profile: none
  Storm Control: disabled
  Static MAC addresses:
  Statistics:
    packets: received 0, sent 8585354
    bytes: received 0, sent 4258335584
  Storm control drop counters:
    packets: broadcast 0, multicast 0, unknown unicast 0
    bytes: broadcast 0, multicast 0, unknown unicast 0
Dynamic ARP inspection drop counters:
  packets: 0, bytes: 0
IP source guard drop counters:
  packets: 0, bytes: 0
List of Access PWs:
List of VFIs:
VFI lab5
  PW: neighbor 172.16.0.12, PW ID 100, state is up (established)
    PW class not set, XC ID 0xfffc000b
    Encapsulation MPLS, protocol LDP
    PW type Ethernet, control word disabled, interworking
    PW backup disable delay 0 sec
    Sequencing not set

MPLS      Local                         Remote
-------------------- ---------------------------
Label      16034                        16032
Group ID   0x2                          0x0
Interface  lab5                         lab5
MTU        1500                         1500

Control word disabled    disabled
  PW type    Ethernet       Ethernet
  VCCV CV type 0x2        0x2
    (LSP ping verification) (LSP ping verification)
  VCCV CC type 0x6        0x6
    (router alert label)  (router alert label)
    (TTL expiry)          (TTL expiry)

MIB cpwVcIndex: 4294705163
Create time: 08/10/2011 03:03:50 (01:00:51 ago)
Last time status changed: 08/10/2011 03:29:09 (00:35:32 ago)
MAC withdraw message: send 0 receive 0
Static MAC addresses:
Statistics:
  packets: received 4, sent 393978
  bytes: received 1952, sent 192261264
DHCPv4 snooping: disabled
IGMP Snooping profile: none
PW: neighbor 172.16.0.23, PW ID 100, state is up (established)
  PW class not set, XC ID 0xfffc000c
  Encapsulation MPLS, protocol LDP
### MultiPoint Services

**VPLS - Verification**

PW type Ethernet, control word disabled, interworking none
PW backup disable delay 0 sec
Sequencing not set

<table>
<thead>
<tr>
<th>MPLS</th>
<th>Local</th>
<th>Remote</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**VCCV CC type** 0x6
(router alert label)
(TTL expiry)

---

- **Label**: 16036
- **Group ID**: 0x2
- **Interface**: lab5
- **MTU**: 1500
- **Control word disabled**: disabled
- **PW type**: Ethernet
- **VCCV CV type**: 0x2
  - (LSP ping verification)

**VCCV CC type** 0x6
(router alert label)
(TTL expiry)

---

- **MIB cpwVcIndex**: 4294705164
- **Create time**: 08/10/2011 03:03:50 (01:00:51 ago)
- **Last time status changed**: 08/10/2011 03:18:07 (00:46:34 ago)
- **MAC withdraw message**: send 0 receive 0
- **Static MAC addresses**: none
- **Statistics**: 8807354, 1625928
- **DHCPv4 snooping**: disabled
- **IGMP Snooping profile**: none
- **VFI Statistics**: 4297988752, 793452864
- **VPLS**: (BFD PW FD only)
MultiPoint Services

H-VPLS

l2vpn
bridge group CISCO
bridge-domain BD1
neighbor 11.1.1.1 pw-id 200
neighbor 22.2.2.2 pw-id 201
vfi CISCO
neighbor 1.1.1.1 pw-id 100
interface GigabitEthernet0/2/0/8.400 l2transport
encapsulation dot1q 400 second-dot1q 500 exact
rewrite ingress tag pop 2 symmetric
!
interface GigabitEthernet0/2/0/9.400 l2transport
encapsulation dot1q 400 second-dot1q 500 exact
rewrite ingress tag pop 2 symmetric
!
l2vpn
bridge group lab5
  bridge-domain lab5
    neighbor 1.1.1.1 pw-id 200
    !
    neighbor 2.2.2.2 pw-id 201
    !
vfi lab5
  vpn-id 101
  neighbor 172.16.0.12 pw-id 100
  !
!
ASR 9000 MAC Learning Overview

- Distributed and Hardware based MAC address learning.
- MAC synchronization achieved by special MAC notification.

MAC learning/aging/flushing is done by hardware and fully distributed on each NP independently.
Looking at MAC address table

```
RP/0/RSP1/CPU0:PR-ASR9K-1#sh l2vpn forwarding bridge-domain MS:MS mac-address location 0/3/CPU0

To Resynchronize MAC table from the Network Processors, use the command...
    l2vpn resynchronize forwarding mac-address-table location <r/s/i>

<table>
<thead>
<tr>
<th>Mac Address</th>
<th>Type</th>
<th>Learned from/Filtered on</th>
<th>LC learned</th>
<th>Resync Age</th>
<th>Mapped to</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000.0000.0011</td>
<td>dynamic</td>
<td>Gi0/2/0/8.301</td>
<td>0/3/CPU0</td>
<td>0d 0h 0m 0s</td>
<td>N/A</td>
</tr>
</tbody>
</table>
```
Integrated Routing and Bridging (IRB)
What’s IRB?

- IRB allows you to route a given protocol between routed interfaces and bridge groups within a single switch router.
- IRB is old technology on Router platform for over 10 years.
- IRB uses BVI (Bridge-group virtual interface) for L3 routing. BVI represents logical L3 interface for a group of L2 ports.
- BVI is considered as regular L3 logical interface, which has IP address and other L3 feature.
IRB
CLI Example

Interface gig 0/0/0/1.50 l2transport encapsulation dot1q 50 rewrite ingress tag pop 1 Symmetric

Interface gig 0/0/0/5.20 encapsulation dot1q 20 ipv4 address 2.2.2.2 255.255.255.0

Interface bvi 20 ← BVI ipv4 address 1.1.1.1 255.255.255.0

I2vpn
bridge group cisco bridge-domain domain50
Interface gig 0/0/0/1.50 Interface gig 0/0/0/2 routed interface bvi 20 ← BVI
neighbor 1.2.3.4 pw-id 55 vfi 60 neighbor 2.3.4.5 pw-id 60
Access Gateway (AG)
Access Gateway

- An innovative solution from Cisco!
- Used in dual Homed scenarios
- Light weight implementation of access protocols (MST, PVST and REP)
- Loop free access
- Detect and reconverge on failures.
- Standard based
  - Faster Convergence
  - Better Scalability
Simple Working!

- PE (MST Gateway) sends pre-canned BPDUs to the access network.
- Reacts to “Topology Change Notifications” from access.
- Sends MAC withdrawal to the VPLS domain.
**Access Gateway**

**MST AG - Configuration**

Interface gig 0/0/0/10.1
encapsulation untagged
spanning-tree mstag ring1
interface GigabitEthernet0/0/0/10.1
name cisco
revision 1
bridge-id 0000.0000.0001
instance 0 ↔ I'm the root
root-id 0000.0000.0001
priority 4096
root-priority 4096
!
instance 1
vlan-ids 101,103,105,107
root-id 0000.0000.0002
priority 8192
root-priority 4096
!
instance 2 ↔ I'm the root
vlan-ids 20-4094
root-id 0000.0000.0001
priority 4096
root-priority 4096

MST root bridge for instance 0 and 2

MST root bridge for instance 1

Aggregation

Interface gig 0/0/0/10.1
encapsulation untagged
spanning-tree mstag ring1
interface GigabitEthernet0/0/0/10.1
name cisco
revision 1
bridge-id 0000.0000.0001
instance 0 ↔ I'm the root
root-id 0000.0000.0001
priority 4096
root-priority 4096
!
instance 1
vlan-ids 101,103,105,107
root-id 0000.0000.0002
priority 8192
root-priority 4096
!
instance 2 ↔ I'm the root
vlan-ids 20-4094
root-id 0000.0000.0001
priority 4096
root-priority 4096
**Access Gateway**

**MST AG – Verification**

RP/0/RSP0/CPU0:Miami#sh spanning-tree mstag r1

Sun May 6 20:22:41.953 UTC

GigabitEthernet0/3/0/1.1

- Pre-empt delay is disabled
- Name: 0000:0000:0001
- Revision: 1
- Max Age: 20
- Provider Bridge: no
- Bridge ID: 0000.0000.0001
- Port ID: 1
- External Cost: 0
- Hello Time: 2
- Active: yes
- BPDUs sent: 87

MSTI 0 (CIST):
- VLAN IDs: 1-19
- Bridge Priority: 4096
- Port Priority: 128
- Cost: 0
- Root Bridge: 0000.0000.0001
- Root Priority: 4096
- Topology Changes: 4

MSTI 1
- VLAN IDs: 20-4094
- Bridge Priority: 4096
- Port Priority: 128
- Cost: 0
- Root Bridge: 0000.0000.0002
- Root Priority: 4096
- Topology Changes: 3
Access Gateway
REP AG – Overview and Configuration

- Gateway doesn’t run REP code.
- Uses the TCN BPDU to trigger MAC withdrawal.
- Neighboring access switches run in REP no neighbor state.

```c
interface GigabitEthernet0/0/0/20.1 l2transport
encapsulation untagged

spanning-tree repag ring1
interface GigabitEthernet0/0/0/20.1
```
Ethernet OAM
Why Ethernet OAM?

- L2 Virtual Circuits same common network infrastructure.
- How do you monitor these individual Virtual circuits?
- Traditional Network Monitoring tools Monitor Network and Physical Layer – Not Service Layer
- “Need service layer visibility” – EOAM!
Ethernet OAM – Where They Play

- Link OAM - Any point-point 802.3 link – Link Level OAM
- CFM - End-to-End UNI to UNI – Service Level OAM
interface GigabitEthernet0/0/0/30
  ethernet oam
  
ethernet oam profile EOAM_PROF
  
!
Ethernet OAM
Link OAM Verification

RP/0/RSP0/CPU0:Miami#sh ethernet oam discovery interface gigabitEthernet 0/3/0$
Mon May  7 02:28:48.346 UTC
GigabitEthernet0/3/0/1:
Local client
-------------
Administrative configuration:
PDU revision: 3
Mode: Active
Unidirectional support: N
Link monitor support: Y
Remote loopback support: N
MIB retrieval support: N
Maximum PDU size: 1500
Mis-wiring detection key: 71CF

Operational status:
Port status: Operational
Loopback status: None
Interface mis-wired: N

Remote client
-------------
MAC address: 0023.ea95.e40d
Vendor (OUI): 00.00.0C (Cisco)

Administrative configuration:
PDU revision: 0
Mode: Active
Unidirectional support: N
Link monitor support: Y
Remote loopback support: N
MIB retrieval support: N
Maximum PDU size: 1518
Ethernet OAM
CFM configuration

Customer X

ASR9K1

Provider Level (ISP1)

Customer X

ASR9K1

MEP

MEP

ASR9K-1

ethernet cfm
domain ISP1 level 1
service ISP1_SRV10 xconnect group OAM p2p OAM
continuity-check interval 10s
!
!
!

interface GigabitEthernet0/3/0/1.100 l2transport
ethernet cfm
mep domain ISP1 service ISP1_SRV10 mep-id 11
!

ASR9K-2

ethernet cfm
domain ISP1 level 1
service ISP1_SRV10 xconnect group OAM p2p OAM
continuity-check interval 10s
!
!
!

interface GigabitEthernet0/3/0/19.100 l2transport
ethernet cfm
mep domain ISP1 service ISP1_SRV10 mep-id 10
Case Studies and Best Practices
Case Studies
Consolidating the Edge

Mobile Services Router

Residential/Business Data Services Router

Video Data Services Router

Multi-Services Router

Data, Video, Voice

Mobile

2G/3G/4G Node

Business
Corporate

Residential

ST B

ST

Residential

Corporate

ST B

Residential

Mobile

2G/3G/4G Node
Case Studies
Data Center Interconnect

Objectives
- Connectivity to SP Core and DC
- Feature set to support multiple services
- Maximize ROI

ASR-9000 Value-add
- Single converged multipurpose platform
- Provide IP/MPLS PE connectivity to DC Core
- Application agnostic scalable L2 and/or L3 Data center interconnect
- Ability to implement collapsed DC edge as well as DCI
Case Studies

Data Center Interconnect

- DC Connectivity to SP core via ASR-9000 PE
- May also be used for Data Center Interconnect
- Collapsed DC PE/DCI design provides maximum ROI
- Removes need for additional single purpose device
- Ability to support L2/L3 DCI
Best Practices

- Port Distribution – Distribute the Traffic across different NPs
- POP VLAN tags – To avoid interoperability issues.
  - Verify MTU: VPWS changes MTU based on AC config
- Define Group Names – Better Configuration Management.
- Moderate L2 Control Traffic – Define L2 ACL to moderate L2 control traffic (STP BPDUs, CDP, VTP).
- l2transport – Use l2transport keyword always while configuring L2 parameters
Summary

- Carrier Ethernet and ASR 9000
- EFP
- Ethernet Services
- Access Gateway
- OAM
Q & A
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