Live-Demo: Layer 3 Microwave MPLS-based Services

Microwave Tests

- Bandwidth Notification
- Layer 3 Microwave MPLS-based Services*
- Layer 3 Microwave Transport Resiliency

* focus on this presentation/live-demo

Participating Vendors

- **Ericsson** (6371, 6691, 6693)
- **Intracom Telecom** (OmniBAS-2W)
- **Juniper Networks** (MX104)

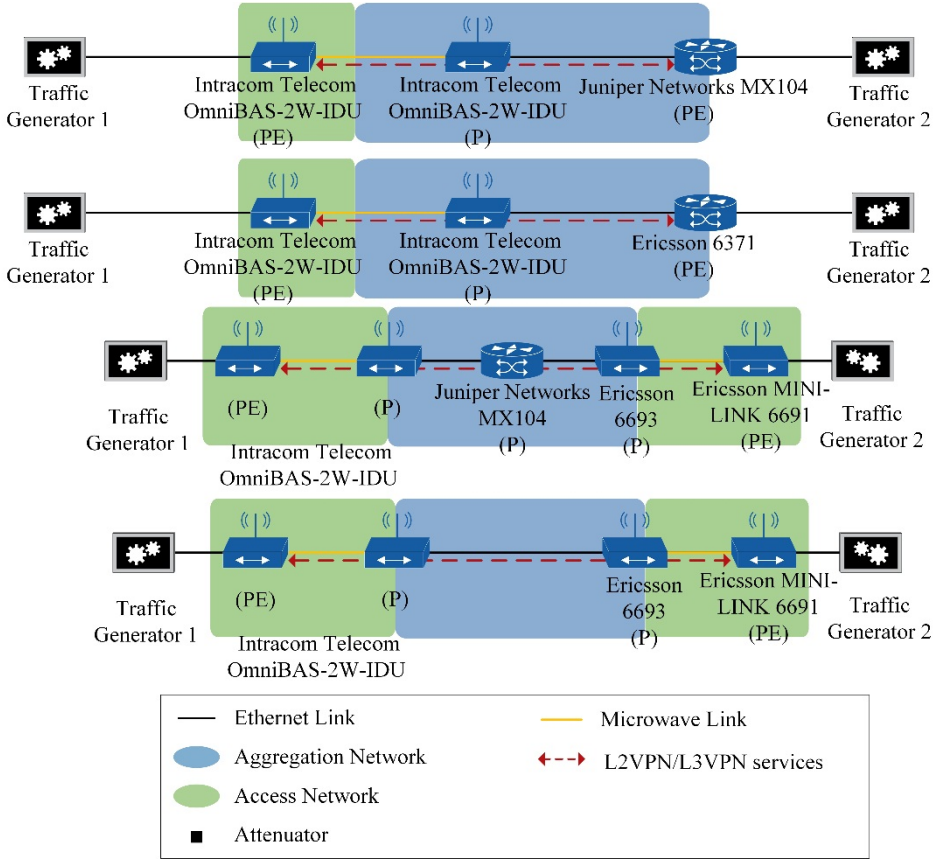
Test Purpose

- Verify the capability of microwave systems to establish IP/MPLS services, acting as PE and P nodes in existing infrastructure
- Confirm *interoperability of IP/MPLS control plane and data plane* between IP/MPLS capable microwave systems and IP/MPLS core routers in multi-vendor scenario
- Verify end-to-end L2VPN and L3VPN services for multiple profiles on IP/MPLS control plane

Test Description

- We tested four different combinations (test setups) relying on different transport profiles and verified that an L2VPN VPWS/VPLS service (in first and second combinations) / L3VPN service (in first, third, and fourth combinations) can be set up between IP/MPLS capable microwave systems and IP/MPLS aggregation routers in multi-vendor scenario
- In the first and second scenario (L3VPN and VPWS service, respectively), we used OSPF as the IGP protocol and LDP for the MPLS label allocation / distribution. In the third scenario (VPLS service), we changed the IGP to IS-IS with LDP
- In this live-demo we will focus on L3VPN service using OSPF as IGP protocol and LDP for the MPLS label allocation/distribution

Topologies / Test Setups



Test Procedure & Verification

Procedure

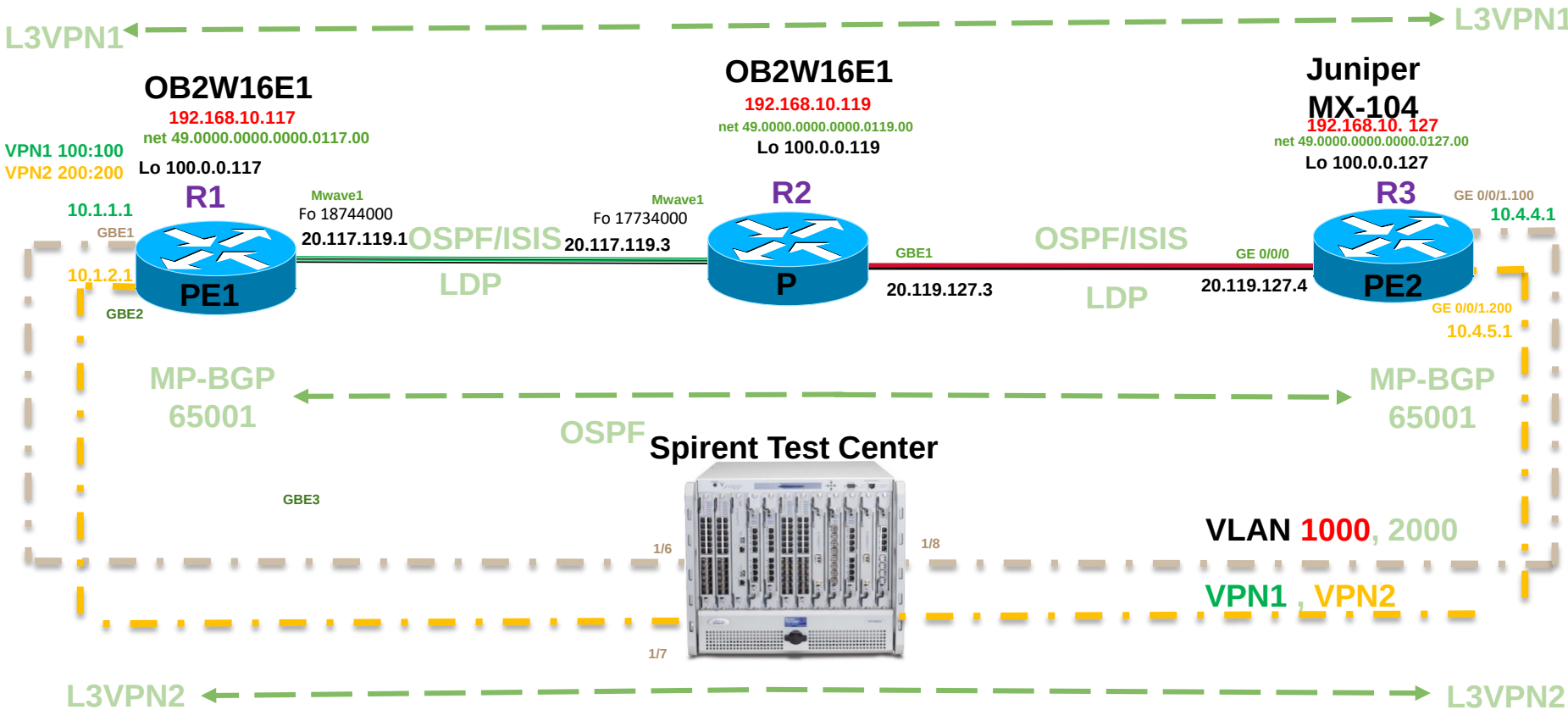
- Configure the IGP (OSPF) and MPLS transport (LDP) on PEs and Ps (all DUTs).
- Configure VRF and L3VPN transport (MP-BGP) on PEs.
- Configure the microwave links to use the maximum modulation (4096 QAM at 56 MHz)

Verification

- Verify IGP and MPLS transport on the DUTs.
  - IGP adjacencies are up and running.
  - MPLS signaling protocol sessions are up and DUTs have exchanged the transport labels.
- Verify service signaling protocol session state on all DUTs acting as PEs.
  - The service signaling protocol session should be established.
  - The DUTs have exchanged the service labels.
- Verify the modulation and channel bandwidth of the microwave links. The maximum modulation scheme is in use.
- Generate IPv4 traffic between the traffic generators at maximum rate.
  - No traffic loss is expected.

Results/Live-demo

Backup Slides – Topology / IP addressing



Backup Slides – Running Configurations

```
R1_117#show running-config
hostname R1_117
ip vrf management

ip vrf L3VPN1
 rd 100:100
 route-target both 100:100
!
ip vrf L3VPN2
 rd 200:200
 route-target both 200:200
!
router ldp
 router-id 100.0.0.117
!
interface gbe1
 ip vrf forwarding L3VPN1
 ip address 10.1.1.1/24
!
interface gbe2
 ip vrf forwarding L3VPN2
 ip address 10.1.2.1/24
!
interface lo
 ip address 127.0.0.1/8
 ip address 100.0.0.117/32 secondary
 ipv6 address ::1/128
!
interface lo.L3VPN1
 ip vrf forwarding L3VPN1
 ip address 127.0.0.1/8
 ipv6 address ::1/128
 mtu 1500
!
interface lo.L3VPN2
 ip vrf forwarding L3VPN2
 ip address 127.0.0.1/8
 ipv6 address ::1/128
 mtu 1500
!
interface mwave1
 ip address 20.117.119.1/24
 label-switching
 enable-ldp ipv4
!
router ospf
 ospf router-id 100.0.0.117
 network 20.117.119.0 0.0.0.255 area 0.0.0.0
 network 100.0.0.117 0.0.0.0 area 0.0.0.0
 cspf disable-better-protection
!
router ospf 1 L3VPN1
 redistribute bgp
 network 10.1.1.0 0.0.0.255 area 0.0.0.1
 cspf disable-better-protection

router ospf 2 L3VPN2
 redistribute bgp
 network 10.1.2.0 0.0.0.255 area 0.0.0.2
 cspf disable-better-protection

router bgp 65001
 mpls-resolution
 neighbor 100.0.0.127 remote-as 65001
 neighbor 100.0.0.127 update-source 100.0.0.117
 address-family vpnv4 unicast
 neighbor 100.0.0.127 activate
 exit-address-family
 !
 address-family ipv4 vrf L3VPN1
 redistribute connected
 redistribute ospf 1
 exit-address-family
 !
 address-family ipv4 vrf L3VPN2
 redistribute connected
 redistribute ospf 2
 exit-address-family
ip route 0.0.0.0/0 192.168.10.1
end
```

Backup Slides – Verification Commands #1

```
R1_117#show ip route vrf all
IP Route Table for VRF "default"
Gateway of last resort is 192.168.10.1 to network 0.0.0.0
S*      0.0.0.0/0 [1/0] via 192.168.10.1, eth0
C       20.117.119.0/24 is directly connected, mwave1
O       20.119.127.0/24 [110/2] via 20.117.119.3, mwave1, 16:31:40
C       100.0.0.117/32 is directly connected, lo
O       100.0.0.119/32 [110/11] via 20.117.119.3, mwave1, 16:31:28
O       100.0.0.127/32 [110/2] via 20.117.119.3, mwave1, 16:31:40
C       127.0.0.0/8 is directly connected, lo
C       192.168.10.0/23 is directly connected, eth0
C       192.168.255.0/24 is directly connected, eth0
IP Route Table for VRF "management"
IP Route Table for VRF "L3VPN1"
C       10.1.1.0/24 is directly connected, gbe1
B       10.4.4.0/24 [200/0] via 100.0.0.127, 00:51:19
O IA    11.0.0.0/24 [110/3] via 10.1.1.2, gbe1, 00:20:17
O IA    11.0.1.0/24 [110/3] via 10.1.1.2, gbe1, 00:20:17
O IA    11.0.2.0/24 [110/4] via 10.1.1.2, gbe1, 00:20:17
O IA    11.0.3.0/24 [110/4] via 10.1.1.2, gbe1, 00:20:17
O IA    11.0.4.0/24 [110/5] via 10.1.1.2, gbe1, 00:20:17
C       127.0.0.0/8 is directly connected, lo.L3VPN1
IP Route Table for VRF "L3VPN2"
C       10.1.2.0/24 is directly connected, gbe2
B       10.4.5.0/24 [200/0] via 100.0.0.127, 00:51:18
O IA    21.0.0.0/24 [110/12] via 10.1.2.2, gbe2, 00:16:56
O IA    21.0.1.0/24 [110/12] via 10.1.2.2, gbe2, 00:16:56
O IA    21.0.2.0/24 [110/13] via 10.1.2.2, gbe2, 00:16:56
O IA    21.0.3.0/24 [110/13] via 10.1.2.2, gbe2, 00:16:56
O IA    21.0.4.0/24 [110/14] via 10.1.2.2, gbe2, 00:16:56
C       127.0.0.0/8 is directly connected, lo.L3VPN2
```

Backup Slides – Verification Commands #2

```
R1_117#show ldp session
Peer IP Address           IF Name    My Role    State      KeepAlive  UpTime
100.0.0.119               mwave1     Passive   OPERATIONAL   30    00:36:48
100.0.0.118               gbe3       Passive   OPERATIONAL   30    00:01:33
R1_117#show mpls forwarding-table
Codes: > - installed FTN, * - selected FTN, p - stale FTN,
       B - BGP FTN, K - CLI FTN, t - tunnel
       L - LDP FTN, R - RSVP-TE FTN, S - SNMP FTN, I - IGP-Shortcut,
       U - unknown FTN

Code    FEC                 FTN-ID    Tunnel-id   Pri   LSP-Type        Out-Label    Out-Intf       Nexthop
   L>    20.119.127.0/24     2         0           Yes   LSP_DEFAULT     3            mwave1         20.117.119.3
   L>    100.0.0.119/32      4         0           Yes   LSP_DEFAULT     3            mwave1         20.117.119.3
   L>    100.0.0.127/32      5         0           Yes   LSP_DEFAULT     52484        mwave1         20.117.119.3
R1_117#
```

Backup Slides – Verification Commands #3

```
R1_117#show mpls ilm-table
Codes: > - installed ILM, * - selected ILM, p - stale ILM
        K - CLI ILM,T - MPLS-TP

Code  FEC               ILM-ID      In-Label    Out-Label   In-Intf     Out-Intf     Nexthop                  LSP-Type
  >   11.0.2.0/24       29          53124       N/A         N/A         gbe1         10.1.1.2                 LSP_DEFAULT
  >   10.1.1.0/24       11          53120       N/A         N/A         gbe1         0.0.0.0                  LSP_DEFAULT
  >   20.119.127.0/24   38          52481       3           N/A         mwave1       20.117.119.3             LSP_DEFAULT
  >   100.0.0.119/32    40          52483       3           N/A         mwave1       20.117.119.3             LSP_DEFAULT
  >   100.0.0.127/32    41          52484       52484       N/A         mwave1       20.117.119.3             LSP_DEFAULT
  >   11.0.0.0/24       27          53122       N/A         N/A         gbe1         10.1.1.2                 LSP_DEFAULT
  >   10.1.2.0/24       16          53121       N/A         N/A         gbe2         0.0.0.0                  LSP_DEFAULT
  >   11.0.1.0/24       28          53123       N/A         N/A         gbe1         10.1.1.2                 LSP_DEFAULT
  >   21.0.1.0/24       33          53128       N/A         N/A         gbe2         10.1.2.2                 LSP_DEFAULT
  >   11.0.4.0/24       31          53126       N/A         N/A         gbe1         10.1.1.2                 LSP_DEFAULT
  >   11.0.3.0/24       30          53125       N/A         N/A         gbe1         10.1.1.2                 LSP_DEFAULT
  >   21.0.0.0/24       32          53127       N/A         N/A         gbe2         10.1.2.2                 LSP_DEFAULT
  >   21.0.3.0/24       35          53130       N/A         N/A         gbe2         10.1.2.2                 LSP_DEFAULT
  >   21.0.2.0/24       34          53129       N/A         N/A         gbe2         10.1.2.2                 LSP_DEFAULT
  >   21.0.4.0/24       36          53131       N/A         N/A         gbe2         10.1.2.2                 LSP_DEFAULT
R1_117#
```

Backup Slides – Verification Commands #4

```
R1_117#show ip bgp vpnv4 all tags
Network          Next Hop      In Label/Out Label
Route Distinguisher: 100:100 (Default for VRF L3VPN1)
*> 10.1.1.0/24      0.0.0.0         53120(mwave1)/aggregate(L3VPN1)
*>i10.4.4.0/24      100.0.0.127     notag/20
*> 11.0.0.0/24      10.1.1.2        53122(mwave1)/aggregate(L3VPN1)
*> 11.0.1.0/24      10.1.1.2        53123(mwave1)/aggregate(L3VPN1)
*> 11.0.2.0/24      10.1.1.2        53124(mwave1)/aggregate(L3VPN1)
*> 11.0.3.0/24      10.1.1.2        53125(mwave1)/aggregate(L3VPN1)
*> 11.0.4.0/24      10.1.1.2        53126(mwave1)/aggregate(L3VPN1)
Route Distinguisher: 100:100
*>i10.4.4.0/24      100.0.0.127     notag/20
Route Distinguisher: 200:200 (Default for VRF L3VPN2)
*> 10.1.2.0/24      0.0.0.0         53121(mwave1)/aggregate(L3VPN2)
*>i10.4.5.0/24      100.0.0.127     notag/21
*> 21.0.0.0/24      10.1.2.2        53127(mwave1)/aggregate(L3VPN2)
*> 21.0.1.0/24      10.1.2.2        53128(mwave1)/aggregate(L3VPN2)
*> 21.0.2.0/24      10.1.2.2        53129(mwave1)/aggregate(L3VPN2)
*> 21.0.3.0/24      10.1.2.2        53130(mwave1)/aggregate(L3VPN2)
*> 21.0.4.0/24      10.1.2.2        53131(mwave1)/aggregate(L3VPN2)
Route Distinguisher: 200:200
*>i10.4.5.0/24      100.0.0.127     notag/21
R1_117#
```

Backup Slides – Verification Commands #5

```
Omnibas_R1_163#show bgp vrf all
BGP table version is 1, local router ID is 100.0.0.117
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              l - labeled, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

    Network          Next Hop            Metric    LocPrf       Weight Path

BGP Route Table for VRF L3VPN2
*>i  10.4.5.0/24      100.0.0.127          0         100           0        i

Total number of prefixes 1

BGP Route Table for VRF L3VPN1
*> l 10.1.1.0/24      0.0.0.0              0         100           32768    ?
*>i  10.4.4.0/24      100.0.0.127          0         100           0        i

Total number of prefixes 2
Omnibas_R1_163#
```

Backup Slides – Verification Commands #6

```
R1_117#show microwave 1
Microwave link 1
  Link status: Up
  Tx modulation: 4096 QAM
  Rx modulation: 4096 QAM
  Channel bandwidth: 56 MHz
  Tx Bandwidth: 555044 kbps
  Rx Bandwidth: 555044 kbps

R1_117#

DUT2
R3_119#show microwave 1
Microwave link 1
  Link status: Up
  Tx modulation: 4096 QAM
  Rx modulation: 4096 QAM
  Channel bandwidth: 56 MHz
  Tx Bandwidth: 555044 kbps
  Rx Bandwidth: 555044 kbps

R3_119#
```

Backup Slides – Verification Commands #7 MX104

```
intracom@MX104-1> show ldp session
  Address                         State       Connection  Hold time  Adv. Mode
100.0.0.119                       Operational Open          29         DU
intracom@MX104-1>
intracom@MX104-1> show route forwarding-table family mpls
Routing table: default.mpls
MPLS:
Destination        Type RtRef Next hop           Type Index    NhRef Netif
default            perm     0                    dscd       50     1
0                  user     0                    rtbl        1     3
0(S=0)             user     0                    rtbl        3     4
1                  user     0                    recv       49     2
2                  user     0                    rtbl        2     3
2(S=0)             user     0                    rtbl        3     4
13                 user     0                    recv       49     2
16                 user     0 20.119.127.3       Swap 52482      579     2 ge-0/0/0.0
17                 user     0 20.119.127.3       Pop        580     2 ge-0/0/0.0
17(S=0)            user     0 20.119.127.3       Pop        581     2 ge-0/0/0.0
18                 user     0 20.119.127.3       Swap 52480      582     2 ge-0/0/0.0
19                 user     0 20.119.127.3       Swap 52481      583     2 ge-0/0/0.0
20                 user     0                    Pop        633     2 lsi.0
21                 user     0                    Pop        627     2 lsi.1

Routing table: __mpls-oam__.mpls
MPLS:
Enabled protocols: Bridging, Single VLAN, Dual VLAN,
Destination        Type RtRef Next hop           Type Index    NhRef Netif
default            perm     0                    dscd      552     1
```

Backup Slides – Verification Commands #8 MX104

```
R1_117#intracom@MX104-1> show route forwarding-table vpn L3VPN1
Routing table: L3VPN1.inet
Internet:
Enabled protocols: Bridging, All VLANs,
Destination        Type RtRef Next hop           Type Index    NhRef Netif
default            perm     0                    rjct      594     1
0.0.0.0/32         perm     0                    dscd      592     1
10.1.1.0/24        user     0                    indr  1048574     2
                              20.119.127.3      Push 53120, Push 52480(top)      588     2 ge-0/0/0.0
10.4.4.0/24        intf     0                    rslv      637     1 ge-0/0/1.100
10.4.4.0/32        dest     0 10.4.4.0           recv      635     1 ge-0/0/1.100
10.4.4.4/32        intf     0 10.4.4.4           locl      636     2
10.4.4.4/32        dest     0 10.4.4.4           locl      636     2
10.4.4.5/32        dest     0 0:10:94:0:0:a      ucst      590     1 ge-0/0/1.100
10.4.4.255/32      dest     0 10.4.4.255         bcst      634     1 ge-0/0/1.100
11.0.0.0/24        user     0                    indr  1048576     2
                              20.119.127.3      Push 53122, Push 52480(top)      642     2 ge-0/0/0.0
11.0.1.0/24        user     0                    indr  1048577     2
                              20.119.127.3      Push 53123, Push 52480(top)      643     2 ge-0/0/0.0
11.0.2.0/24        user     0                    indr  1048578     2
                              20.119.127.3      Push 53124, Push 52480(top)      644     2 ge-0/0/0.0
11.0.3.0/24        user     0                    indr  1048579     2
                              20.119.127.3      Push 53125, Push 52480(top)      645     2 ge-0/0/0.0
11.0.4.0/24        user     0                    indr  1048580     2
                              20.119.127.3      Push 53126, Push 52480(top)      646     2 ge-0/0/0.0
224.0.0.0/4        perm     0                    mdsc      593     1
224.0.0.1/32       perm     0 224.0.0.1          mcst      596     1
255.255.255.255/32 perm     0                    bcst      597     1
```

Backup Slides – Verification Commands #9 MX104

```
intracom@MX104-1> show route forwarding-table vpn L3VPN2
Routing table: L3VPN2.inet
Internet:
Enabled protocols: Bridging, All VLANs,
Destination        Type RtRef Next hop           Type Index    NhRef Netif
default            perm     0                    rjct      603     1
0.0.0.0/32         perm     0                    dscd      601     1
10.1.2.0/24        user     0                    indr  1048575     2
                              20.119.127.3      Push 53121, Push 52480(top)      589     2 ge-0/0/0.0
10.4.5.0/24        intf     0                    rslv      641     1 ge-0/0/1.200
10.4.5.0/32        dest     0 10.4.5.0           recv      639     1 ge-0/0/1.200
10.4.5.4/32        intf     0 10.4.5.4           locl      640     2
10.4.5.4/32        dest     0 10.4.5.4           locl      640     2
10.4.5.5/32        dest     0 0:10:94:0:0:b      ucst      591     1 ge-0/0/1.200
10.4.5.255/32      dest     0 10.4.5.255         bcst      638     1 ge-0/0/1.200
21.0.0.0/24        user     0                    indr  1048581     2
                              20.119.127.3      Push 53127, Push 52480(top)      647     2 ge-0/0/0.0
21.0.1.0/24        user     0                    indr  1048582     2
                              20.119.127.3      Push 53128, Push 52480(top)      648     2 ge-0/0/0.0
21.0.2.0/24        user     0                    indr  1048583     2
                              20.119.127.3      Push 53129, Push 52480(top)      649     2 ge-0/0/0.0
21.0.3.0/24        user     0                    indr  1048584     2
                              20.119.127.3      Push 53130, Push 52480(top)      650     2 ge-0/0/0.0
21.0.4.0/24        user     0                    indr  1048585     2
                              20.119.127.3      Push 53131, Push 52480(top)      651     2 ge-0/0/0.0
224.0.0.0/4        perm     0                    mdsc      602     1
224.0.0.1/32       perm     0 224.0.0.1          mcst      605     1
255.255.255.255/32 perm     0                    bcst      606     1
```

Backup Slides – Verification Commands #10 MX104