

Overview

Consider the following topology:

Figure 1: Sample Topology Depicting Converged Packet-based Fronthaul Scenario



In this topology, a centralized RAN is deployed for Fronthaul and is applicable to both, 4G LTE and 5G NR Radio Systems. The broadband unit (BBU) is used for CPRI packet generation as well as the Primary Reference Clock for timing and synchronization.

Port-3 of the BBU is configured as the CPRI Master, while the CPRI Interface of the Cisco NCS 540-FH-CSR-SYS (R4) (GE0/0/0/7) connected to it, is configured as the CPRI Slave. Port-3 is also configured as the Primary Reference clock or Source Clock to derive the time. The clock is transmitted over the Ethernet interfaces towards the core devices. Port-1 on the radio unit (RU) reads the clock from the CPRI frame it receives over the CPRI Interface, which in turn is connected to another Cisco N540-FH-CSR-SYS (R4) on the other side.

The CPRI traffic is carried over by a P2P Xconnect running between the two Cisco NCS 540-FH routers (R3 and R4) that create the packetized network to carry the Radio Traffic. The core network runs the IGP and SR-MPLS. The signaling protocol for L2VPN is targeted-LDP.

There are two modes of operation:

1. Type 0 or Tunneling Mode: This mode works as a simple Ethernet tunnel. It does not remove any line coding bits and cannot interpret any special characters.

- **2.** Type 1: This mode is Line Coding aware. It removes the line coding bits and saves approximately 20% of the bandwidth.
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Prerequisites

The following prerequisites are required to bring up the underlay for the CPRI circuit. Underlay is the transport (IGP+SR-MPLS) that should be built to bring up the CRPI services. To do this, ISIS, SR-MPLS, and TI-LFA are configured under IS-IS.

1. On the router connected to the baseband unit (R3):

```
router isis Core
is-type level-2-only
net 49.0000.0000.0001.00
segment-routing global-block 16000 23999
address-family ipv4 unicast
 metric-style wide
 router-id Loopback0
 segment-routing mpls sr-prefer
 1
interface Loopback0
 address-family ipv4 unicast
  prefix-sid index 1001
  !
 1
interface TenGigE0/0/0/15
 point-to-point
  address-family ipv4 unicast
  fast-reroute per-prefix
   fast-reroute per-prefix ti-lfa
  1
 1
interface TenGigE0/0/0/17
 point-to-point
  address-family ipv4 unicast
  fast-reroute per-prefix
  fast-reroute per-prefix ti-lfa
  1
```

2. On the router (R4) connected to the radio unit:

```
router isis Core
is-type level-2-only
net 49.0000.0000.0004.00
segment-routing global-block 16000 23999
address-family ipv4 unicast
metric-style wide
router-id Loopback0
segment-routing mpls sr-prefer
!
interface Loopback0
```

L

```
address-family ipv4 unicast
 prefix-sid index 1004
 1
1
interface TenGigE0/0/0/14
point-to-point
address-family ipv4 unicast
 fast-reroute per-prefix
 fast-reroute per-prefix ti-lfa
1
Т
interface TenGigE0/0/0/16
point-to-point
address-family ipv4 unicast
 fast-reroute per-prefix
 fast-reroute per-prefix ti-lfa
 I.
```

3. On R1 (connected to R3):

```
router isis Core
is-type level-2-only
net 49.0000.0000.0002.00
 segment-routing global-block 16000 23999
 address-family ipv4 unicast
 metric-style wide
 router-id Loopback0
 segment-routing mpls sr-prefer
 1
 interface Loopback0
 address-family ipv4 unicast
  prefix-sid index 1002
 1
 Т
interface TenGigE0/0/0/20
 point-to-point
 address-family ipv4 unicast
  fast-reroute per-prefix
  fast-reroute per-prefix ti-lfa
 1
 !
 interface TenGigE0/0/0/21
 point-to-point
 address-family ipv4 unicast
  fast-reroute per-prefix
   fast-reroute per-prefix ti-lfa
```

4. On R2 (connected to R4):

```
router isis Core
is-type level-2-only
net 49.0000.0000.0003.00
address-family ipv4 unicast
 metric-style wide
 router-id Loopback0
 segment-routing mpls sr-prefer
 !
interface Loopback0
 address-family ipv4 unicast
  prefix-sid index 1003
 1
 1
interface TenGigE0/0/0/20
 point-to-point
 address-family ipv4 unicast
```

```
fast-reroute per-prefix
fast-reroute per-prefix ti-lfa
!
interface TenGigE0/0/0/21
point-to-point
address-family ipv4 unicast
fast-reroute per-prefix
fast-reroute per-prefix ti-lfa
```

Connecting the Port to the Baseband Unit

1. Enable controller optics on which CPRI role and CPRI Option Rate are enabled. The following example shows the Proxy Slave port connected to the BBU/DU. The CPRI Option configured is 3 and the rate therefore is 2.457 Gbps.

```
controller Optics0/0/0/7
  port-mode cpri role slave datarate-list 2457
'
```

- 2. Define the RoE profile with:
 - a. Ethernet link

```
roe
  ethlink 1
  destination-MAC aaaa.bbbb.cccc
  source-MAC 1234.5678.abcd
```

Ensure the destma matches the srcmac and the srcmac matches the destmac of the RoE Profile Ethernet link on the Cisco N540-FH-CSR-SYS facing the RU.

- **b.** Order-Info Both, sequence number and timestamp must be used.
- c. Map-Flow-ID Should match the Demap-flow-ID on the N540-FH-CSR-SYS facing the RU
- d. Mapper-Type Should point to Structure Agnostic Type-0 (Simple Tunneling Mode)
- e. Retimer-Buf Size of the retimer buffer in De-mapper



Note It is recommended that you *do not* change the default values.

- f. DeMap-Flow-ID Should match the Map-flow-ID on the N540-FH-CSR-SYS facing the RU
- g. Idle-Frame-Size -Size of the idle-frame buffer configured for the port



Note It is recommended that you *do not* change the default values.

h. Idle-Frame-Thresh – Number of consecutive idle frames to be sent before which link will be brought down



i. By default, hyperframe number synchronization (HFN Sync) for CPRI is enabled only for Structure Agnostic tunneling mode (Type-0) mapper type config in non auto-negotiation CPRI port. You can disable this configuration using the following command in RoE Profile.

```
roe
profile 108
hfn-sync-disable
```

3. Associate an Ethernet link to the RoE Profile.

```
roe
profile 1
  ethlink 1
  order-info SEQ-NUM-AND-TIMESTAMP
map-flow-id 123
mapper-type STR-AGN-TYPE0
retimer-buf-size 0
demap-flow-id 123
idle-frame-thresh 0
!
```

4. Attach the RoE Mapper profile to the CPRI controller.

```
controller CPRI0/0/0/7
attach-roe-profile 1
!
```

5. Enable Synchronous Ethernet (SyncE) globally. Frequency and Timing Synchronization distribute precision frequency around a network. Specify the Quality Level and ensure the same level is specified on the Interface.

```
frequency synchronization quality itu-t option 1
```

6. Enable SyncE on CPRI over Ethernet (CPRIoE) interface to retrieve the timing from BBU/DU.

```
interface CPRIoE0/0/0/7
mtu 9600
frequency synchronization
selection input
wait-to-restore 0
ssm disable
quality receive exact itu-t option 1 PRC
```



```
Note
```

For clock design, see the Best Practices Guide for Cisco Converged Fronthaul Systems.

7. On R3, enable MTU and layer 2 transport on the CPRIoE interface.

```
interface CPRIoE0/0/0/7
mtu 9600
l2transport
```

Connecting Port to Radio Unit

1. Enable controller optics on which CPRI role and CPRI Option Rate are enabled. The following example shows the Proxy Master port connected to the Radio Unit. The CPRI Option configured is 3 and the rate therefore is 2.457 Gbps.

```
controller Optics0/0/0/7
port-mode cpri role master datarate-list 2457
```

- 2. Define the RoE profile with:
 - a. Ethernet link

```
roe
  ethlink 1
  destination-MAC 1234.5678.abcd
  source-MAC aaaa.bbbb.cccc
```

 $Ensure \ the \ {\tt destma}\ matches \ the \ {\tt srcmac}\ matches \ the \ {\tt srcmac}\ of \ the \ RoE \ Profile \ Ethernet \ link \ on \ the \ Cisco \ N540-FH-CSR-SYS \ facing \ the \ BBU/DU.$

- **b.** Order-Info Both, sequence number and timestamp must be used.
- c. Map-Flow-ID Should match the Demap-flow-ID on the N540-FH-CSR-SYS facing the RU
- d. Mapper-Type Should point to Structure Agnostic Type-0 (Simple Tunneling Mode)
- e. Retimer-Buf Size of the retimer buffer in De-mapper



Note It is recommended that you *do not* change the default values.

- f. DeMap-Flow-ID Should match the Map-flow-ID on the N540-FH-CSR-SYS facing the RU
- g. Idle-Frame-Size -Size of the idle-frame buffer configured for the port



Note It is recommended that you *do not* change the default values.

h. Idle-Frame-Thresh – Number of consecutive idle frames to be sent before which link will be brought down



Note It is recommended that you *do not* change the default values.

i. By default, hyperframe number synchronization (HFN Sync) for CPRI is enabled only for Structure Agnostic tunneling mode (Type-0) mapper type config in non auto-negotiation CPRI port. You can disable this configuration using the following command in RoE Profile.

```
roe
profile 108
hfn-sync-disable
```

3. Associate an Ethernet link to the RoE Profile.

```
roe
profile 1
  ethlink 1
  order-info SEQ-NUM-AND-TIMESTAMP
map-flow-id 123
mapper-type STR-AGN-TYPE0
retimer-buf-size 0
demap-flow-id 123
idle-frame-thresh 0
'
```

4. Attach the RoE Mapper profile to the CPRI controller.

```
controller CPRI0/0/0/7
attach-roe-profile 1
```

5. Enable Synchronous Ethernet on this interface to retrieve the timing from Core Routers (that retrieved the timing from the N540-FH-CSR-SYS facing the BBU/DU)

```
interface TenGigE0/0/0/14
  description "Connected to BB1 || SR-MPLS/ISIS Core || TenGigE0/0/0/20"
  mtu 9600
  ipv4 address 10.1.4.1 255.255.255.0
  load-interval 30
  frequency synchronization
   selection input
   wait-to-restore 0
   ssm disable
   quality receive exact itu-t option 1 PRC
 interface TenGigE0/0/0/16
  description "Connected to BB2 || SR-MPLS/ISIS Core || TenGigE0/0/0/20"
  mtu 9600
  ipv4 address 10.1.5.1 255.255.255.0
  load-interval 30
  frequency synchronization
   selection input
   wait-to-restore 0
   ssm disable
   quality receive exact itu-t option 1 PRC
```

Note For clock design, see the Best Practices Guide for Cisco Converged Fronthaul Systems.

6. On R4, enable MTU and layer 2 transport on the CPRIoE interface

```
interface CPRIoE0/0/0/7
mtu 9600
l2transport
```

Enabling EVPN

EVPN provides an end-to-end layer 2 connection.

Prerequisites

• BGP EVPN Address Family must be configured on R3 and R4.

1. On the router (R3) connected to the baseband unit:

```
router bgp 108
bgp router-id 11.11.11.11
address-family 12vpn evpn
!
neighbor 44.44.44.44
remote-as 108
update-source Loopback0
address-family 12vpn evpn
!
```

2. On the router (R4) connected to the radio unit:

```
router bgp 108
bgp router-id 44.44.44.44
address-family 12vpn evpn
!
neighbor 11.11.11.11
remote-as 108
update-source Loopback0
address-family 12vpn evpn
!
```

Configuring EVPN VPWS

1. On R3:

```
evpn
evi 108
!
l2vpn
xconnect group evpn-vpws108
p2p evpn108
interface CPRIoE0/0/0/7
neighbor evpn evi 108 service 108
```

2. On R4:

```
evpn
evi 108
!
l2vpn
xconnect group evpn-vpws108
p2p evpn108
interface CPRIoE0/0/0/7
neighbor evpn evi 108 service 108
```

For more einformation on configuring EVPN, see the L2VPN and Ethernet Services Configuration Guide for Cisco NCS 540 Series Routers.

Configuring PTP

Adding PTP to a network can compensate for latency and delay problems by correctly adjusting device clocks so that they stay synchronized with one another.

To configure PTP globally:

ptp clock

```
domain 24
 profile g.8275.1 clock-type T-GM
 timescale PTP
 time-source GPS
 clock-class 6
profile slave
 transport ethernet
 sync frequency 16
 announce frequency 8
 delay-request frequency 16
1
profile master
 multicast target-address ethernet 01-1B-19-00-00-00
 transport ethernet
 port state master-only
 sync frequency 16
 clock operation one-step
 announce frequency 8
 delay-request frequency 16
Т
physical-layer-frequency
1
```

To configure PTP on every interface:

```
interface HundredGigE0/0/0/26
description From T-GM
ptp
 profile slave
 multicast target-address ethernet 01-1B-19-00-00-00
 transport ethernet
 port state slave-only
 local-priority 10
 1
frequency synchronization
 selection input
 priority 1
 wait-to-restore 0
 ssm disable
 quality receive exact itu-t option 1 PRC
 !
Т
interface HundredGigE0/0/0/27
description To T-BC Felidae Proxy-Master
ptp
 profile master
 multicast target-address ethernet 01-1B-19-00-00-00
 transport ethernet
 port state master-only
 sync frequency 64
 clock operation one-step
 announce frequency 16
 delay-request frequency 64
 Т
frequency synchronization
wait-to-restore 0
```

For more information on configuring PTP, see the:.

- Best Practices Guide for Cisco Converged Fronthaul Systems
- Configuring PTP chapter in the Network Synchronization Configuration Guide for Cisco NCS 540 Routers.

Configuring QoS

QoS is configured to improve performance for critical network traffic.

To configure QoS globally:

```
class-map match-any exp5
match mpls experimental topmost 5
end-class-map
!
policy-map Radio_Interface_Xhaul
class class-default
 set traffic-class 7
 set qos-group 5
 1
end-policy-map
!
policy-map Core Interface Xhaul
class exp5
 set traffic-class 7
 !
end-policy-map
!
```

To configure QoS on radio interfaces:

```
interface CPRIoE0/0/0/0
mtu 9600
load-interval 30
!
l2transport
service-policy input Radio Interface Xhaul
```

For more information on configuring QoS, see the:.

- Best Practices Guide for Cisco Converged Fronthaul Systems
- Modular QoS Configuration Guide for Cisco NCS 540 Routers.

Configuring Low Latency Queuing for Specific QoS Flows

Table 1: Feature History Table

| Feature Name | Release Information | Feature Description |
|---|---------------------|---|
| Low Latency Queuing for Specific QoS Flows | Release 7.3.2 | This feature allows you to configure low latency or priority for specific QoS flows at the class-level within a policy map. It enables delay-sensitive data to be prioritized and transmitted before other packets in other queues. |

This feature allows you to configure low latency or priority for specific QoS flows at the class-level within a policy map. It enables delay-sensitive data to be prioritized and transmitted before other packets in other queues.

Low Latency Queuing (LLQ) is achieved by enabling low delay IPS profile for the designated Virtual Output Queuing (VOQ).

Configuring Low Latency Queuing for Specific QoS Flows

Ingress Class Map Configurations

```
class-map match-any inDSCP_CS6
match dscp cs6
end-class-map
!
class-map match-any inDSCP_CS7
match dscp cs7
end-class-map
!
```

Egress Class Map Configuration

```
class-map match-any outCM6
match traffic-class 6
end-class-map
!
class-map match-any outCM7
match traffic-class 7
end-class-map
!
```

Ingress Policy Map Configurations

```
policy-map Ingress
class inDSCP_CS6
set traffic-class 6
!
class inDSCP_CS7
set traffic-class 7
!
class class-default
!
end-policy-map
!
```

Egress Policy Map Configuration

```
policy-map Egress
class outCM6
priority level 2
low-latency-profile
```

```
!
class outCM7
priority level 1
low-latency-profile
!
```

Verification

Router# show controllers npu voq-usage interface all instance all location all Sat Jul 24 23:33:07.038 UTC

Node ID: 0/RP0/CPU0 Intf Intf NPU NPU PP Sys VOQ Flow VOQ Port name handle # core Port Port base base port speed (hex) type Hu0/0/0/24 3c000048 0 0 9 9 1032 5384 local 100G Hu0/0/0/25 3c0000a8 0 0 21 21 1040 5392 local 100G RP/0/RP0/CPU0:Lion#show controllers fia diagshell 0 "diag cosq voq id=1046 det=1 " location 0/RP0/CPU0 Sat Jul 24 23:34:18.904 UTC Node ID: 0/RP0/CPU0 R/S/I: 0/0/0 Core 0: Basic info Q type: voq num cos: 8, cosq class: 6 Base queue id: 1040, base queue gport: 0x24000410 Credit request type: BCM_COSQ_DELAY_TOLERANCE_100G_LOW_DELAY Adjusted for low delay 100Gb ports Watchdog enable in common status message mode Is queue in credit watchdog queue range:True Credit watchdog message time: 0 Delete queue time: 512 Backoff enter queue credit balance threshold: 98304 Backoff exit queue credit balance threshold: 98304 Backlog enter queue credit balance threshold: 7168 Backlog exit queue credit balance threshold: 7168 Empty queue satisfied credit balance threshold: 6720 Max empty queue credit balance threshold: 11200 Exceed max empty queue credit balance threshold: 1 Off-To-Slow credit balance threshold: -11264 Off-To-Normal credit balance threshold: -11264 Slow-To-Normal credit balance threshold: -11264 Normal-To-Slow credit balance threshold: -11264 Delay Tolerance is OCB only

Limitations

- No support on logical interfaces and sub-interfaces.
- Device on which low latency is enabled, throughput may be degraded.
- We recommend that you enable only one high priority traffic class (TC) per port for low latency. Enabling multiple TC with low latency may result in burst.



Configurations are restricted on any TCs, but it is recommended that you enable LLQ on only one TC.

Verifying the Fronthaul Configuration

Verifying MPLS Transport

On R3:

RP/0/RP0/CPU0:R3# show isis adjacency

```
Mon Jan 20 17:30:14.923 UTC
IS-IS Core Level-2 adjacencies:
System Id
             Interface
                                      SNPA
                                                    State Hold Changed NSF IPv4 IPv6
                                                                          BFD BFD
              Te0/0/0/15
                                      *PtoP*
                                                          23
                                                              6d00h
BB1
                                                    αU
                                                                       Yes None None
BB2
              Te0/0/0/17
                                      *PtoP*
                                                         21
                                                              5d23h
                                                    Up
                                                                       Yes None None
RP/0/RP0/CPU0:R3#show isis segment-routing label table
Mon Jan 20 17:30:30.242 UTC
IS-IS Core IS Label Table
Label
             Prefix/Interface
_____
             _____
17001
            Loopback0
17002
            22.22.22.22/32
17003
            33.33.33.33/32
17004
            44.44.44.44/32
RP/0/RP0/CPU0:R3# show mpls label table
Mon Jan 20 17:31:12.590 UTC
Table Label Owner
                                           State Rewrite
_____ _____
0
     0
             LSD(A)
                                            InUse Yes
0
     1
             LSD(A)
                                            InUse
                                                  Yes
                                           InUse Yes
0
    2
            LSD(A)
    13
                                           InUse Yes
0
            LSD(A)
0
   15000 LSD(A)
                                           InUse No
    16000
            ISIS(A):Core
0
                                           InUse No
     24000
0
             ISIS(A):Core
                                            InUse
                                                  Yes
                                           InUse Yes
0
     24001
             ISIS(A):Core
0
     24005
            L2VPN(A)
                                           InUse Yes
0
    24007
            ISIS(A):Core
                                           InUse Yes
0
     24008
            ISIS(A):Core
                                           InUse Yes
RP/0/RP0/CPU0:R3#
RP/0/RP0/CPU0:R3# show isis fast-reroute sr-only
Mon Jan 20 17:31:44.919 UTC
IS-IS Core IPv4 Unicast FRR backups
Codes: L1 - level 1, L2 - level 2, ia - interarea (leaked into level 1)
      df - level 1 default (closest attached router), su - summary null
      C - connected, S - static, R - RIP, B - BGP, O - OSPF
      E - EIGRP, A - access/subscriber, M - mobile, a - application
      i - IS-IS (redistributed from another instance)
      D - Downstream, LC - Line card disjoint, NP - Node protecting
      P - Primary path, SRLG - SRLG disjoint, TM - Total metric via backup
Maximum parallel path count: 8
L2 22.22.22.22/32 [20/115]
    via 10.1.1.2, TenGigE0/0/0/15, BB1, SRGB Base: 16000, Weight: 0
      Backup path: TI-LFA (link), via 10.1.2.2, TenGigE0/0/0/17 BB2, SRGB Base: 16000,
Weight: 0, Metric: 40
        P node: JAG2.00 [44.44.44.44], Label: 17004
        Prefix label: 17002
        Backup-src: BB1.00
L2 33.33.33.33/32 [20/115]
    via 10.1.2.2, TenGigE0/0/0/17, BB2, SRGB Base: 16000, Weight: 0
      Backup path: TI-LFA (link), via 10.1.1.2, TenGigE0/0/0/15 BB1, SRGB Base: 16000,
Weight: 0, Metric: 40
        P node: JAG2.00 [44.44.44.44], Label: 17004
        Prefix label: 17003
        Backup-src: BB2.00
L2 44.44.44.44/32 [30/115]
    via 10.1.1.2, TenGigEO/0/0/15, BB1, SRGB Base: 16000, Weight: 0
      Backup path: LFA, via 10.1.2.2, TenGigE0/0/0/17, BB2, SRGB Base: 16000, Weight: 0,
Metric: 30
    via 10.1.2.2, TenGigE0/0/0/17, BB2, SRGB Base: 16000, Weight: 0
```

Backup path: LFA, via 10.1.1.2, TenGigE0/0/0/15, BB1, SRGB Base: 16000, Weight: 0, Metric: 30 RP/0/RP0/CPU0:R3#

On R4:

RP/0/RP0/CPU0:R4# show isis adjacency Mon Jan 20 17:34:46.196 UTC IS-IS Core Level-2 adjacencies: System Id Interface SNPA State Hold Changed NSF IPv4 IPv6 BFD BFD BB1 Te0/0/0/14 *PtoP* Up 25 6d00h Yes None None *PtoP* 21 5d23h BB2 Te0/0/0/16 Up Yes None None Total adjacency count: 2 RP/0/RP0/CPU0:R4# show isis segment-routing label table Mon Jan 20 17:34:50.834 UTC IS-IS Core IS Label Table Prefix/Interface Label _____ _____ 17001 11.11.11.11/32 17002 22.22.22.22/32 17003 33.33.33.33/32 17004 Loopback0 RP/0/RP0/CPU0:R4# show mpls label table Mon Jan 20 17:34:56.081 UTC Table Label Owner State Rewrite ----- ----- ------_____ ____ ____ Ω Ο LSD(A) InUse Yes 0 1 LSD(A) InUse Yes 0 2 LSD(A) InUse Yes 13 0 LSD(A) InUse Yes LSD(A) 0 15000 InUse No 0 16000 InUse No ISIS(A):Core 24002 ISIS(A):Core 0 InUse Yes 0 24003 ISIS(A):Core InUse Yes 0 24004 L2VPN(A) InUse Yes 0 24008 ISIS(A):Core TnUse Yes 0 24009 ISIS(A):Core InUse Yes RP/0/RP0/CPU0:R4# show isis fast-reroute sr-only Mon Jan 20 17:35:00.055 UTC IS-IS Core IPv4 Unicast FRR backups Codes: L1 - level 1, L2 - level 2, ia - interarea (leaked into level 1) df - level 1 default (closest attached router), su - summary null C - connected, S - static, R - RIP, B - BGP, O - OSPF E - EIGRP, A - access/subscriber, M - mobile, a - application i - IS-IS (redistributed from another instance) D - Downstream, LC - Line card disjoint, NP - Node protecting P - Primary path, SRLG - SRLG disjoint, TM - Total metric via backup Maximum parallel path count: 8 L2 11.11.11.11/32 [30/115] via 10.1.4.2, TenGigE0/0/0/14, BB1, SRGB Base: 16000, Weight: 0 Backup path: LFA, via 10.1.5.2, TenGigE0/0/0/16, BB2, SRGB Base: 16000, Weight: 0, Metric: 30 via 10.1.5.2, TenGigE0/0/0/16, BB2, SRGB Base: 16000, Weight: 0 Backup path: LFA, via 10.1.4.2, TenGigE0/0/0/14, BB1, SRGB Base: 16000, Weight: 0, Metric: 30 L2 22.22.22.22/32 [20/115] via 10.1.4.2, TenGigE0/0/0/14, BB1, SRGB Base: 16000, Weight: 0 Backup path: TI-LFA (link), via 10.1.5.2, TenGigE0/0/0/16 BB2, SRGB Base: 16000, Weight: 0, Metric: 40 P node: R3.00 [11.11.11], Label: 17001 Prefix label: 17002

```
Backup-src: BB1.00

L2 33.33.33/32 [20/115]

via 10.1.5.2, TenGigE0/0/0/16, BB2, SRGB Base: 16000, Weight: 0

Backup path: TI-LFA (link), via 10.1.4.2, TenGigE0/0/0/14 BB1, SRGB Base: 16000,

Weight: 0, Metric: 40

P node: R3.00 [11.11.11.1], Label: 17001

Prefix label: 17003

Backup-src: BB2.00

RP/0/RP0/CPU0:R4#
```

Verifying Services (Xconnect, EVPN Status, Packets Received and Transmitted)

On R3:

```
RP/0/RP0/CPU0:R3# show 12vpn xconnect pw-id 2 detail
Mon Jan 20 17:39:41.124 UTC
Group 2, XC 2, state is up; Interworking none
 AC: CPRIoE0/0/0/7, state is up
   Type Ethernet
   MTU 9586; XC ID 0x1; interworking none
   Statistics:
     packets: received 61963291278, sent 61963291274
     bytes: received 160237071244908, sent 160237071234564
  PW: neighbor 44.44.44, PW ID 2, state is up ( established )
   PW class not set, XC ID 0xc000002
   Encapsulation MPLS, protocol LDP
   Source address 11.11.11.11
   PW type Ethernet, control word disabled, interworking none
   PW backup disable delay 0 sec
   Sequencing not set
   Ignore MTU mismatch: Disabled
   Transmit MTU zero: Disabled
   LSP : Up
   PW Status TLV in use
     MPLS Local
                                             Remote
     _____ ____
                        _____
     Label
               24005
                                              24004
     Group ID 0x3c040f8
                                              0x3c040f8
     Interface CPRIoE0/0/0/7
                                             CPRIOE0/0/0/7
     MTU
                9586
                                             9586
     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)
     _____ ____
   Incoming Status (PW Status TLV):
     Status code: 0x0 (Up) in Notification message
   Outgoing Status (PW Status TLV):
     Status code: 0x0 (Up) in Notification message
   MIB cpwVcIndex: 3221225474
   Create time: 14/01/2020 16:39:29 (6d01h ago)
   Last time status changed: 14/01/2020 17:07:32 (6d00h ago)
   Last time PW went down: 14/01/2020 17:07:17 (6d00h ago)
   Statistics:
     packets: received 61963291274, sent 61963291278
     bytes: received 160237071234564, sent 160237071244908
```

On R4:

```
RP/0/RP0/CPU0:R4# show 12vpn xconnect pw-id 2 detail
Mon Jan 20 17:38:33.349 UTC
Group 2, XC 2, state is up; Interworking none
 AC: CPRIoE0/0/0/7, state is up
   Type Ethernet
   MTU 9586; XC ID 0x1; interworking none
   Statistics:
     packets: received 62828756739, sent 62427728902
     bytes: received 162475164927054, sent 161438106940572
  PW: neighbor 11.11.11.11, PW ID 2, state is up ( established )
   PW class not set, XC ID 0xc000002
    Encapsulation MPLS, protocol LDP
   Source address 44.44.44.44
   PW type Ethernet, control word disabled, interworking none
   PW backup disable delay 0 sec
   Sequencing not set
    Ignore MTU mismatch: Disabled
    Transmit MTU zero: Disabled
   LSP : Up
    PW Status TLV in use
     MPLS Local
                                               Remote
      _____ ___
                         -----
                                                             _____
     Label
                24004
                                               24005
     Group ID 0x3c040f8
                                               0x3c040f8
     Interface CPRIoE0/0/0/7
                                               CPRIOE0/0/0/7
     MTU
                 9586
                                               9586
     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 expirv)
      _____
                                _____
   Incoming Status (PW Status TLV):
     Status code: 0x0 (Up) in Notification message
    Outgoing Status (PW Status TLV):
     Status code: 0x0 (Up) in Notification message
   MIB cpwVcIndex: 3221225474
   Create time: 14/01/2020 16:09:10 (6d01h ago)
   Last time status changed: 14/01/2020 17:05:36 (6d00h ago)
   Last time PW went down: 14/01/2020 17:05:36 (6d00h ago)
   Statistics:
     packets: received 62427728902, sent 62828756739
     bytes: received 161438106940572, sent 162475164927054
RP/0/RP0/CPU0:R4# show 12vpn xconnect pw-id 2 detail
Mon Jan 20 17:38:33.349 UTC
Group 2, XC 2, state is up; Interworking none
 AC: CPRIoE0/0/0/7, state is up
   Type Ethernet
   MTU 9586; XC ID 0x1; interworking none
   Statistics:
     packets: received 62828756739, sent 62427728902
     bytes: received 162475164927054, sent 161438106940572
  PW: neighbor 11.11.11.11, PW ID 2, state is up ( established )
   PW class not set, XC ID 0xc0000002
   Encapsulation MPLS, protocol LDP
   Source address 44.44.44.44
    PW type Ethernet, control word disabled, interworking none
   PW backup disable delay 0 sec
    Sequencing not set
   Ignore MTU mismatch: Disabled
   Transmit MTU zero: Disabled
   LSP : Up
```

L

```
PW Status TLV in use
                                           Remote
 MPLS Local
  _____ ____
            24004
 Label
                                           24005

        Group ID
        0x3c040f8

        Interface
        CPRIoE0/0/0/7

        MTU
        9586

                                           0x3c040f8
                                           CPRIoE0/0/0/7
                                           9586
 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)
  _____ ____
Incoming Status (PW Status TLV):
 Status code: 0x0 (Up) in Notification message
Outgoing Status (PW Status TLV):
 Status code: 0x0 (Up) in Notification message
MIB cpwVcIndex: 3221225474
Create time: 14/01/2020 16:09:10 (6d01h ago)
Last time status changed: 14/01/2020 17:05:36 (6d00h ago)
Last time PW went down: 14/01/2020 17:05:36 (6d00h ago)
Statistics:
 packets: received 62427728902, sent 62828756739
 bytes: received 161438106940572, sent 162475164927054
```

Verifying CPRI for Configured Rates

On R3:

| RP/0/RP0/CPU0:R3# show | controlle | ers cpri (|)/0/0/7 | | | | |
|-------------------------|------------|------------|---------------|--------|--------|--------|--------|
| Mon Jan 20 17:42:45.369 |) UTC | | | | | | |
| Port CPRI0/0/0/7: | | | | | | | |
| Admin State: In Servic | ce | | | | | | |
| Oper State: Up | | | | | | | |
| Loopback Mode: None | | | | | | | |
| Synchronization Mode: | Slave | | | | | | |
| L1 startup timer: Oms | | | | | | | |
| Detected Alarms : LOF | RAI | | | | | | |
| CPRI Datarate: | | | | | | | |
| Rates: | 614MB | 1228ME | 3 2457MB | 3072MB | 4915MB | 6144MB | 9830MB |
| 8110MB 10137MB | 12165MB | 24330MB | | | | | |
| Supported Rate List: | Y | Y | Y | Y | Y | Y | Y |
| – Y | - | - | | | | | |
| Configured Rate List: | - | - | Y | - | - | - | - |
| | - | - | | | | | |
| Negotiated Rate: | - | - | Y | - | - | - | - |
| | - | - | | | | | |
| Last clearing of "show | / controll | ers CPRI' | ' counters ne | ever | | | |
| ROE Status: | | | | | | | |
| Is roe configured: | | 1 | Irue | | | | |
| Idle frame TCA: | | E | False | | | | |
| Persistent stray frame | es detecte | ed: E | False | | | | |
| Persistent lost frames | detected | d: E | False | | | | |
| Retimer Buffer Overrun | n Alarm: | E | False | | | | |
| Retimer Buffer Underru | ın Alarm: | E | False | | | | |
| | | | | | | | |
| | | | | | | | |
| RP/0/RP0/CPU0:R3# show | controlle | ers cpRI (|)/0/0/7 roe-s | stats | | | |

Tue Jan 21 15:52:14.341 UTC ROE Statistics:

| Received Frames | | 19120060722 |
|--------------------------------|---|---------------|
| Received Good Frames | = | 19120060723 |
| Out of Seq Frames Detected | = | 0 |
| Dropped Frames | = | 0 |
| Stray Frames Detected | = | 0 |
| Errored Length Packets | = | 0 |
| Duplicate Frames Detected | = | 0 |
| Out of Seq Frames Dropped | = | 0 |
| | | |
| Output Frames | = | 19120060723 |
| Idle Frames Sent | = | 0 |
| | | |
| Retimer Buffer Overrrun Count | = | 0 |
| Retimer Buffer Underrrun Count | = | 0 |
| K Byte Mismatch | = | 0 |
| Packet Delay Variation : | | |
| max/min/avg | = | 441 / 75 / 77 |
| Idle Frame TCA | | 0 |
| Received RoE LCV count: | = | 0 |

On R4:

RP/0/RP0/CPU0:R4# show controllers cpri 0/0/0/7 Mon Jan 20 17:41:48.951 UTC Port CPRI0/0/0/7: Admin State: In Service Oper State: Up Loopback Mode: None Synchronization Mode: Master L1 startup timer: Oms Detected Alarms : LOF RAI CPRI Datarate: 614MB 1228MB 2457MB 3072MB 4915MB 9830MB Rates: 6144MB 8110MB 10137MB 12165MB 24330MB Y Supported Rate List: Y Y Y Y Y Y - Y ----Configured Rate List: Y _ _ _ _ _ _ - -Negotiated Rate: --Y _ _ _ _ _ --_ Last clearing of "show controllers CPRI" counters never ROE Status: Is roe configured: True Idle frame TCA: False Persistent stray frames detected: False False Persistent lost frames detected: Retimer Buffer Overrun Alarm: False Retimer Buffer Underrun Alarm: False

| RP/0/RP0/CPU0:R4# show controllers | cpRI 0/0/0/7 roe-stats |
|------------------------------------|------------------------|
| Tue Jan 21 15:49:10.895 UTC | |
| ROE Statistics: | |
| Received Frames | = 19515615537 |
| Received Good Frames | = 19515615539 |
| Out of Seq Frames Detected | = 0 |
| Dropped Frames | = 0 |
| Stray Frames Detected | = 0 |
| Errored Length Packets | = 0 |
| Duplicate Frames Detected | = 0 |
| Out of Seq Frames Dropped | = 0 |
| | |
| Output Frames | = 19515615539 |
| Idle Frames Sent | = 0 |
| | |

| Retimer Buffer Overrrun Count | = 0 |
|--------------------------------|-----------------|
| Retimer Buffer Underrrun Count | = 0 |
| K Byte Mismatch | = 0 |
| Packet Delay Variation : | |
| max/min/avg | = 437 / 72 / 73 |
| Idle Frame TCA | = 0 |
| Received RoE LCV count: | = 0 |
| RP/0/RP0/CPU0:R4# | |
| | |

Verifying PTP Configuration

On R3:

```
RP/0/RP0/CPU0:R3# show frequency synchronization selection
Mon Jan 20 17:17:14.283 UTC
Node 0/RP0/CPU0:
_____
Selection point: TO-SEL-B (2 inputs, 1 selected)
 Last programmed 6d00h ago, and selection made 02:54:01 ago
 Next selection points
   SPA scoped : None
   Node scoped : CHASSIS-TOD-SEL
   Chassis scoped: LC TX SELECT
   Router scoped : None
 Uses frequency selection
 Used for local line interface output
 S Input
          Last Selection Point
                                                  QL Pri Status
 __ _____ ___ ____ ____ _____
 1 Internal0 [0/RP0/CPU0] n/a
                                                   SEC 255 Holdover
    CPRIoE0/0/0/7
                          0/RP0/CPU0 ETH RXMUX 3
                                                   PRC 100 Available
Selection point: 1588-SEL (2 inputs, 1 selected)
 Last programmed 6d00h ago, and selection made 02:54:01 ago
 Next selection points
   SPA scoped : None
Node scoped : None
   Chassis scoped: None
   Router scoped : None
 Uses frequency selection
 S Input
                           Last Selection Point
                                                   QL Pri Status
  ______
 1 Internal0 [0/RP0/CPU0]
                                                   SEC 255 Holdover
                           n/a
                                                   PRC 100 Available
    CPRIoE0/0/0/7
                          0/RP0/CPU0 ETH RXMUX 3
Selection point: CHASSIS-TOD-SEL (1 inputs, 1 selected)
 Last programmed 02:54:12 ago, and selection made 02:54:12 ago
 Next selection points
   SPA scoped : None
Node scoped : None
   Chassis scoped: None
   Router scoped : None
 Uses time-of-day selection
 S Input
                          Last Selection Point Pri Time Status
 __ ____
                                                           _____
 1 Internal0 [0/RP0/CPU0]
                          0/RP0/CPU0 T0-SEL-B 1
                                                 255 No
                                                           Available
Selection point: ETH RXMUX (1 inputs, 1 selected)
 Last programmed 6d00h ago, and selection made 6d00h ago
 Next selection points
   SPA scoped : None
Node scoped : TO-SEL-B 1588-SEL
   Chassis scoped: None
   Router scoped : None
 Uses frequency selection
                          Last Selection Point QL Pri Status
 S Input
```

PRC 100 Available 3 CPRIoE0/0/0/7 n/a RP/0/RP0/CPU0:R3# run Mon Jan 20 17:20:01.237 UTC [node0 RP0 CPU0:~]\$ [node0 RP0 CPU0:~]\$tmgctrl client tmgctrl>pll rd 0x210 Read PLL reg 0x33f210 = 0x03tmgctrl>pll_rd 0x120 Read PLL reg 0x33f120 = 0xf1tmgctrl> tmgctrl>exit [node0 RP0 CPU0:~]\$exit logout RP/0/RP0/CPU0:JAG1# RP/0/RP0/CPU0:JAG1#show frequency synchronization interfaces Mon Jan 20 17:21:41.994 UTC Interface CPRIoE0/0/0/7 (up) Assigned as input for selection Wait-to-restore time 0 minutes SSM Disabled Input: αU Configured QL: Opt-I/PRC Effective QL: Opt-I/PRC, Priority: 100, Time-of-day Priority 100 Supports frequency Output: Selected source: Internal0 [0/RP0/CPU0] Selected source QL: Opt-I/SEC Next selection points: ETH RXMUX On R4: RP/0/RP0/CPU0:R4# show frequency synchronization selection Mon Jan 20 17:22:55.884 UTC Node 0/RP0/CPU0: _____ Selection point: TO-SEL-B (3 inputs, 1 selected) Last programmed 5d23h ago, and selection made 03:01:38 ago Next selection points SPA scoped : None Node scoped : CHASSIS-TOD-SEL Chassis scoped: LC TX SELECT Router scoped : None Uses frequency selection Used for local line interface output S Input Last Selection Point QL Pri Status __ _____ ____ ____ _____ ______ 1 TenGigE0/0/0/14 0/RP0/CPU0 ETH_RXMUX 1 PRC 100 Locked 0/RP0/CPU0 ETH_RXMUX 2 PRC 100 Available TenGigE0/0/0/16 Internal0 [0/RP0/CPU0] n/a SEC 255 Available Selection point: 1588-SEL (3 inputs, 1 selected) Last programmed 5d23h ago, and selection made 03:01:38 ago Next selection points SPA scoped : None Node scoped : None Chassis scoped: None Router scoped : None Uses frequency selection

__ _____ ___ ____


```
TenGigE0/0/0/16
                             0/RP0/CPU0 ETH RXMUX 2
                                                      PRC 100 Available
    Internal0 [0/RP0/CPU0] n/a
                                                       SEC 255 Available
Selection point: CHASSIS-TOD-SEL (1 inputs, 1 selected)
 Last programmed 6d01h ago, and selection made 6d01h ago
 Next selection points
   SPA scoped : None
Node scoped : None
   Chassis scoped: None
   Router scoped : None
 Uses time-of-day selection
                            Last Selection Point
  S Input
                                                   Pri Time Status
  __ _____
                            _____
                                                    ____ ____
                                                               _____
 1 TenGigE0/0/0/14
                            0/RP0/CPU0 T0-SEL-B 1 100 No
                                                               Available
Selection point: ETH RXMUX (2 inputs, 2 selected)
 Last programmed 5d\overline{2}3h ago, and selection made 5d23h ago
 Next selection points
   SPA scoped : None
   Node scoped : TO-SEL-B 1588-SEL
   Chassis scoped: None
   Router scoped : None
 Uses frequency selection
                            Last Selection Point
 S Input
                                                    QL Pri Status
 -- ----- ---- ----- ----- -----
 1 TenGigE0/0/0/14 n/a
                                                      PRC 100 Available
 2 TenGigE0/0/0/16
                            n/a
                                                      PRC 100 Available
RP/0/RP0/CPU0:R4# show frequency synchronization interfaces
Mon Jan 20 17:23:29.828 UTC
Interface TenGigE0/0/0/14 (up)
 Assigned as input for selection
 Wait-to-restore time 0 minutes
 SSM Disabled
 Input:
   Uр
   Configured QL: Opt-I/PRC
   Effective QL: Opt-I/PRC, Priority: 100, Time-of-day Priority 100
   Supports frequency
  Output:
   Selected source: TenGigE0/0/0/14
   Selected source QL: Opt-I/PRC
   Output is squelched
 Next selection points: ETH_RXMUX
Interface TenGigE0/0/0/16 (up)
  Assigned as input for selection
 Wait-to-restore time 0 minutes
 SSM Disabled
 Input:
   Uр
   Configured QL: Opt-I/PRC
   Effective QL: Opt-I/PRC, Priority: 100, Time-of-day Priority 100
   Supports frequency
  Output:
   Selected source: TenGigE0/0/0/14
   Selected source QL: Opt-I/PRC
  Next selection points: ETH RXMUX
```