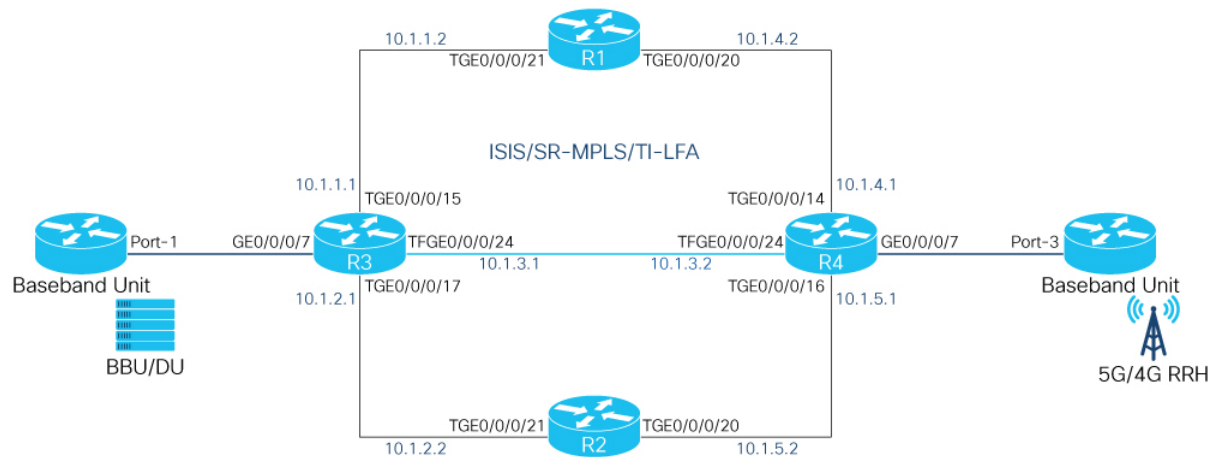




Overview

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.
 - [Prerequisites, on page 2](#)
 - [Connecting the Port to the Baseband Unit, on page 4](#)
 - [Connecting Port to Radio Unit, on page 6](#)
 - [Enabling EVPN, on page 7](#)
 - [Configuring PTP, on page 8](#)
 - [Configuring QoS, on page 10](#)
 - [Verifying the Fronthaul Configuration, on page 12](#)

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
!
interface Loopback0
 address-family ipv4 unicast
  prefix-sid index 1001
!
!
interface TenGigE0/0/0/15
 point-to-point
 address-family ipv4 unicast
  fast-reroute per-prefix
  fast-reroute per-prefix ti-lfa
!
!
interface TenGigE0/0/0/17
 point-to-point
 address-family ipv4 unicast
  fast-reroute per-prefix
  fast-reroute per-prefix ti-lfa
!
```

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
```

```

address-family ipv4 unicast
  prefix-sid index 1004
!
!
interface TenGigE0/0/0/14
  point-to-point
  address-family ipv4 unicast
    fast-reroute per-prefix
    fast-reroute per-prefix ti-lfa
!
!
interface TenGigE0/0/0/16
  point-to-point
  address-family ipv4 unicast
    fast-reroute per-prefix
    fast-reroute per-prefix ti-lfa
!

```

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
!
interface Loopback0
  address-family ipv4 unicast
    prefix-sid index 1002
!
!
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

```

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
!
!
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 `destmac` 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



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 (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 `destmac` matches the `srcmac` and the `srcmac` matches the `destmac` 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 l2vpn evpn
  !
  neighbor 44.44.44.44
    remote-as 108
    update-source Loopback0
    address-family l2vpn evpn
  !
```

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

```
router bgp 108
  bgp router-id 44.44.44.44
  address-family l2vpn evpn
  !
  neighbor 11.11.11.11
    remote-as 108
    update-source Loopback0
    address-family l2vpn 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 information 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
!
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
!
physical-layer-frequency
!
```

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
!
frequency synchronization
selection input
priority 1
wait-to-restore 0
ssm disable
quality receive exact itu-t option 1 PRC
!
!
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
!
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
  !
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.


```

-----
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.



Note 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
BB1            Te0/0/0/15        *PtoP*           Up    23   6d00h   Yes None None
BB2            Te0/0/0/17        *PtoP*           Up    21   5d23h   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
0      2      LSD(A)                               InUse Yes
0     13     LSD(A)                               InUse Yes
0    15000   LSD(A)                               InUse No
0    16000   ISIS(A):Core                         InUse No
0    24000   ISIS(A):Core                         InUse Yes
0    24001   ISIS(A):Core                         InUse Yes
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, TenGigE0/0/0/15, 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
BB2	Te0/0/0/16	*PtoP*	Up	21	5d23h	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
```

Label	Prefix/Interface
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
0	0	LSD(A)	InUse	Yes
0	1	LSD(A)	InUse	Yes
0	2	LSD(A)	InUse	Yes
0	13	LSD(A)	InUse	Yes
0	15000	LSD(A)	InUse	No
0	16000	ISIS(A):Core	InUse	No
0	24002	ISIS(A):Core	InUse	Yes
0	24003	ISIS(A):Core	InUse	Yes
0	24004	L2VPN(A)	InUse	Yes
0	24008	ISIS(A):Core	InUse	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 [11.11.11.11], Label: 17001
```

```
Prefix label: 17002
```

```

Backup-src: BB1.00
L2 33.33.33.33/32 [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 [11.11.11.11], 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 l2vpn 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 44.44.44.44, PW ID 2, state is up ( established )
PW class not set, XC ID 0xc0000002
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 l2vpn 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
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 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
MTB 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 l2vpn 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

```



```

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 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 controllers cpri 0/0/0/7
Mon Jan 20 17:42:45.369 UTC
Port CPRI0/0/0/7:
Admin State: In Service
Oper State: Up
Loopback Mode: None
Synchronization Mode: Slave
L1 startup timer: 0ms
Detected Alarms : LOF RAI
CPRI Datarate:
Rates:
  8110MB   10137MB  12165MB  24330MB
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
Persistent lost frames detected: False
Retimer Buffer Overrun Alarm: False
Retimer Buffer Underrun Alarm: False

```

```

RP/0/RP0/CPU0:R3# show controllers cpri 0/0/0/7 roe-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: 0ms
  Detected Alarms : LOF RAI
  CPRI Datarate:
  Rates:
    614MB      1228MB      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 controllers CPRI" counters never
ROE Status:
Is roe configured:      True
Idle frame TCA:         False
Persistent stray frames detected: False
Persistent lost frames detected: False
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: T0-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]              n/a                           SEC 255 Holdover
   CPRIoE0/0/0/7                      0/RP0/CPU0 ETH_RXMUX 3       PRC 100 Available
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    : T0-SEL-B 1588-SEL
    Chassis scoped: None
    Router scoped  : None
  Uses frequency selection
S  Input                               Last Selection Point          QL  Pri  Status

```

```

== =====
3  CPRIoE0/0/0/7          n/a          PRC 100 Available

RP/0/RP0/CPU0:R3# run
Mon Jan 20 17:20:01.237 UTC
[node0_RP0_CPU0:~]$
[node0_RP0_CPU0:~]$tmgctrl_client
tmgctrl>pll_rd 0x210
Read PLL reg 0x33f210 = 0x03
tmgctrl>pll_rd 0x120
Read PLL reg 0x33f120 = 0xf1
tmgctrl>
tmgctrl>exit
[node0_RP0_CPU0:~]$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:
    Up
  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: T0-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
      TenGigE0/0/0/16                     0/RP0/CPU0 ETH_RXMUX 2      PRC 100  Available
      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
  S  Input                               Last Selection Point          QL  Pri  Status
  == =====
  1  TenGigE0/0/0/14                     0/RP0/CPU0 ETH_RXMUX 1      PRC 100  Locked

```

```

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
S  Input                Last Selection Point      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 5d23h ago, and selection made 5d23h ago
Next selection points
  SPA scoped      : None
  Node scoped     : T0-SEL-B 1588-SEL
  Chassis scoped  : None
  Router scoped   : None
Uses frequency selection
S  Input                Last Selection Point      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:
    Up
    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:
    Up
    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
    
```

