# Configuring Ethernet Interfaces

This module describes the configuration of Ethernet interfaces.

*Table 1: Feature History Table*

| Feature Name | Release | Description |
|---|---|---|
| OTN Support for NC55-MPA-12T-S MPA on Cisco NCS 5500 Series Routers. | Release 7.5.1 | This release introduces support for Optical Network Transport (OTN) on NC55-MPA-12T-S Modular Port Adapter (MPA) on the following Cisco NCS 5500 Series Line cards:<br>• NCS-55A2-MOD-S<br>• NCS-55A2-MOD-SE-S<br>• NCS-55A2-MOD-HX-S<br>• NCS-55A2-MOD-SE-H-S<br>• NCS-55A2-MOD-HD-S<br>OTN is a superior technology that bridges the gap between next-generation IP and legacy time-division multiplexing (TDM) networks by acting as a converged transport layer for newer packet-based and existing TDM services. OTN provides robust transport services that leverage many benefits of SONET/SDH, such as resiliency and performance monitoring, while adding enhanced multi-rate capabilities in packet traffic.<br>The Cisco NCS 5500 Series Routers support Ethernet, SONET/SDH, and OTN client interfaces with data rates from 1 to 10 Gigabits per second.<br>To enable OTN, use the **pm otn report enable** command in the otu2e or odu2e mode. |

The following distributed ethernet architecture delivers network scalability and performance, while enabling service providers to offer high-density, high-bandwidth networking solutions.

- 10-Gigabit
- 40-Gigabit
- 100-Gigabit

**Tip** You can programmatically configure and manage the Ethernet interfaces using `openconfig-ethernet-if.yang` and `openconfig-interfaces.yang` OpenConfig data models. To get started with using data models, see the *Programmability Configuration Guide for Cisco NCS 5500 Series Routers*.

These solutions are designed to interconnect the router with other systems in point-of-presence (POP)s, including core and edge routers and Layer 2 and Layer 3 switches.

### Restrictions for Configuring Ethernet Interfaces

- Router does not support configuration of the static mac address.
- As per design, traffic logs for incoming CRC error packets don't display packets per second (PPS) and other packet-specific information, as highlighted below.

```
Router# show interface tenGigE 0/0/0/10 | include packets

5 minute input rate 541242000 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
   0 packets input, 7718374402816 bytes, 0 total input drops
   Received 0 broadcast packets, 0 multicast packets
   2952 packets output, 389664 bytes, 0 total output drops
   Output 0 broadcast packets, 2952 multicast packets
```

- To save power consumption, the router shuts down the ethernet interfaces with no configuration other than **no shutdown** after a graceful line card or system reload. To avoid ethernet interfaces going down in such scenarios, you must provide a description and the **no shutdown** configuration under the interface. You can use the **description (interface)** to add a description to an interface.
- The router doesn't support connecting a 1Gig copper cable to a 25GbE or higher speed QSFP ports.
- For 1Gig fibre cable, the router doesn't support auto-negotiation for 25GbE or higher speed QSFP ports.


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# Configuring Gigabit Ethernet Interfaces

### Restrictions and Important Guidelines

- NC55-MPA-12T-S supports 1G optics in eight ports. The ports are 0 to 3 and 8 to 11.
- NC55-MPA-12T-S supports 10G optics in ports 4 to 7.

Use this procedure to create a basic Ethernet interface configuration.

### SUMMARY STEPS

1. **show version**
2. **show interfaces** [**GigE** | **TenGigE** | | | **HundredGigE**] *interface-path-id*
3. **configure**
4. **interface** [**GigE** | **TenGigE** | | | **HundredGigE**] *interface-path-id*
5. **ipv4 address** *ip-address mask*
6. **mtu** *bytes*
7. **no shutdown**
8. **end** or **commit**
9. **show interfaces** [**GigE TenGigE HundredGigE** ] *interface-path-id*

### DETAILED STEPS

### Procedure

**Step 1** **show version**

**Example:**

```
RP/0/RP0/CPU0:router# show version
```

(Optional) Displays the current software version, and can also be used to confirm that the router recognizes the line card.

**Step 2** **show interfaces** [**GigE** | **TenGigE** | | | **HundredGigE**] *interface-path-id*

**Example:**

```
RP/0/RP0/CPU0:router# show interface HundredGigE 0/1/0/1
```

(Optional) Displays the configured interface and checks the status of each interface port.

**Step 3** **configure**

**Example:**

```
RP/0/RP0/CPU0:router# configure terminal
```

Enters global configuration mode.

**Step 4** **interface** [**GigE** | **TenGigE** | | | **HundredGigE**] *interface-path-id*

**Example:**

```
RP/0/RP0/CPU0:router(config)# interface HundredGigE 0/1/0/1
```

Enters interface configuration mode and specifies the Ethernet interface name and notation *rack/slot/module/port*. Possible interface types for this procedure are:

- GigE
- 10GigE
- 100GigE

**Note**
- The example indicates a 100-Gigabit Ethernet interface in the  line card in slot 1.

**Step 5** **ipv4 address** *ip-address mask*

**Example:**

```
RP/0/RP0/CPU0:router(config-if)# ipv4 address 172.18.189.38 255.255.255.224
```

Assigns an IP address and subnet mask to the interface.

- Replace *ip-address* with the primary IPv4 address for the interface.
- Replace *mask* with the mask for the associated IP subnet. The network mask can be specified in either of two ways:
- The network mask can be a four-part dotted decimal address. For example, 255.0.0.0 indicates that each bit equal to 1 means that the corresponding address bit belongs to the network address.
- The network mask can be indicated as a slash (/) and number. For example, /8 indicates that the first 8 bits of the mask are ones, and the corresponding bits of the address are network address.

**Step 6** **mtu** *bytes*

**Example:**

```
RP/0/RP0/CPU0:router(config-if)# mtu 2000
```

(Optional) Sets the MTU value for the interface.

- The configurable range for MTU values is 1514 bytes to 9646 bytes.
- The default is 1514 bytes for normal frames and 1518 bytes for 802.1Q tagged frames.

**Step 7** **no shutdown**

**Example:**

```
RP/0/RP0/CPU0:router(config-if)# no shutdown
```

Removes the shutdown configuration, which forces an interface administratively down.

**Step 8** **end** or **commit**

**Example:**

```
RP/0/RP0/CPU0:router(config-if)# end
```

or

```
RP/0/RP0/CPU0:router(config-if)# commit
```

Saves configuration changes.

- When you issue the **end** command, the system prompts you to commit changes:

```
Uncommitted changes found, commit them before exiting(yes/no/cancel)?
[cancel]:
```

- Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
- Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
- Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.
- Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

**Step 9** **show interfaces** [**GigE TenGigE HundredGigE** ] *interface-path-id*

**Example:**

```
RP/0/RP0/CPU0:router# show interfaces HundredGigE 0/1/0/1
```

(Optional) Displays statistics for interfaces on the router.

### Example

This example shows how to configure an interface for a 100-Gigabit Ethernet line card:

```
RP/0/RP0/CPU0:router# configure
RP/0/RP0/CPU0:router(config)# interface HundredGigE 0/1/0/1
RP/0/RP0/CPU0:router(config-if)# ipv4 address 172.18.189.38 255.255.255.224

RP/0/RP0/CPU0:router(config-if)# mtu 2000

RP/0/RP0/CPU0:router(config-if)# no shutdown
RP/0/RP0/CPU0:router(config-if)# end
Uncommitted changes found, commit them? [yes]: yes


RP/0/RP0/CPU0:router# show interfaces HundredGigE 0/5/0/24
HundredGigE0/5/0/24 is up, line protocol is up
  Interface state transitions: 1
  Hardware is HundredGigE, address is 6219.8864.e330 (bia 6219.8864.e330)
  Internet address is 3.24.1.1/24
  MTU 9216 bytes, BW 100000000 Kbit (Max: 100000000 Kbit)
     reliability 255/255, txload 3/255, rxload 3/255
  Encapsulation ARPA,
  Full-duplex, 100000Mb/s, link type is force-up
  output flow control is off, input flow control is off
  Carrier delay (up) is 10 msec
  loopback not set,
  Last link flapped 10:05:07
  ARP type ARPA, ARP timeout 04:00:00
  Last input 00:08:56, output 00:00:00
  Last clearing of "show interface" counters never
  5 minute input rate 1258567000 bits/sec, 1484160 packets/sec
  5 minute output rate 1258584000 bits/sec, 1484160 packets/sec
     228290765840 packets input, 27293508436038 bytes, 0 total input drops
     0 drops for unrecognized upper-level protocol
```

```
     Received 15 broadcast packets, 45 multicast packets
              0 runts, 0 giants, 0 throttles, 0 parity
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     212467849449 packets output, 25733664696650 bytes, 0 total output drops
     Output 23 broadcast packets, 15732 multicast packets
     39 output errors, 0 underruns, 0 applique, 0 resets
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions
```

```
RP/0/RP0/CPU0:router# show running-config interface HundredGigE 0/5/0/24

interface HundredGigE 0/5/0/24
 mtu 9216
 service-policy input linerate
 service-policy output elinerate
 ipv4 address 3.24.1.1 255.255.255.0
 ipv6 address 3:24:1::1/64
 flow ipv4 monitor perfv4 sampler fsm ingress
!
```

# Information About Configuring Ethernet

This section provides the following information sections:

## Default Configuration Values for 100-Gigabit Ethernet

This table describes the default interface configuration parameters that are present when an interface is enabled on a 100-Gigabit Ethernet line card.

**Note** You must use the **shutdown** command to bring an interface administratively down. The interface default is **no shutdown**. When a line card is first inserted into the router, if there is no established preconfiguration for it, the configuration manager adds a shutdown item to its configuration. This shutdown can be removed only be entering the **no shutdown** command.

***Table 2: 100-Gigabit Ethernet line card Default Configuration Values***

| Parameter | Configuration File Entry | Default Value |
|---|---|---|
| MTU | **mtu** | • 1514 bytes for normal frames<br>• 1518 bytes for 802.1Q tagged frames.<br>• 1522 bytes for Q-in-Q frames. |
| MAC address | **mac address** | Hardware burned-in address (BIA) |

# Network Interface Speed

1Gig interfaces connected through copper or fiber cable can have interface speed of either 100 Mbps or 1000 Mbps. This is applicable on 1Gig interface with a 1000Base-T module (GLC-TE). By default 1G interface has following capabilities:

- Speed—1000 Mbps for fiber cable and autonegotiate for copper cable
- Duplex—Full
- Pause—Receive Part (RX) and Transmit Part (TX)

The copper and fiber cables have same default values as mentioned above but autonegotiation is default for copper cable.

The speed can either configured or set to autonegotiate with remote end interface. When in autonegotiation mode, an interface is capable of negotiating the speed of 100 Mbps or 1000 Mbps depending on the speed at the remote end interface; and other parameters such as full duplex and pause are also autonegotiated.

Autonegotiation is an optional function of the Fast Ethernet standard that enables devices to automatically exchange information over a link about speed and duplex abilities. Autonegotiation is very useful for ports where devices with different capabilities are connected and disconnected on a regular basis.

**Note** Autonegotiation is disabled by default, but it's mandatory on QSFP-100G-CUxM link. You must enable autonegotiation manually when you use 100GBASE-CR4 DAC cable.

**Note** Starting with IOS-XR software release 24.1.1, the default value for Forward Error Correction (FEC) is set to disabled for 25G 1M and 2M copper optics.

# Configuring Network Interface Speed

You can configure the network interface speed by using one of the following methods:

- Using the **speed** command
- Using the **negotiation auto** command
- Using both **speed** and **negotiation auto** command

**Note** Cisco recommends configuring network interface speed in autonegotiation mode.

## Using the speed command

When you configure the speed of the network interface (1G) using the **speed** command, the interface speed is forced to the configured speed by limiting the speed value of the auto negotiated parameter to the configured speed.

This sample configuration forces the Gig interface speed to 100Mbps.

**Note** The interface speed at remote end is also set to 100Mbps.

```
#configuration
 (config)#interface GigabitEthernet 0/0/0/31
 (config-if)#speed 100
 (config-if)#commit
 (config-if)#end
```

Use the **show controller GigE** and **show interface GigE** commands to verify if the speed is configured to 100Mbps and autonegotiation is disabled:

```
#show controllers GigabitEthernet 0/0/0/31
Operational data for interface GigabitEthernet0/0/0/31:
State:
    Administrative state: enabled
    Operational state: Up
    LED state: Green On
Phy:
    Media type: Four-pair Category 5 UTP PHY, full duplex
    Optics:
        Vendor: CISCO
        Part number: SBCU-5740ARZ-CS1
        Serial number: AVC194525HW
        Wavelength: 0 nm
    Digital Optical Monitoring:
        Transceiver Temp: 0.000 C
        Transceiver Voltage: 0.000 V

        Alarms key: (H) Alarm high, (h) Warning high
                    (L) Alarm low, (l) Warning low
           Wavelength    Tx Power          Rx Power      Laser Bias
        Lane  (nm)     (dBm)     (mW)      (dBm)     (mW)       (mA)
        --   -----    ------    ------     ------    ------     ------
        0     n/a     0.0   1.0000     0.0   1.0000     0.000

        DOM alarms:
            No alarms

        Alarm                     Alarm    Warning   Warning    Alarm
        Thresholds                High      High       Low       Low
                                 -------   -------   -------   -------
        Transceiver Temp (C):      0.000     0.000     0.000     0.000
        Transceiver Voltage (V):   0.000     0.000     0.000     0.000
        Laser Bias (mA):           0.000     0.000     0.000     0.000
        Transmit Power (mW):       1.000     1.000     1.000     1.000
        Transmit Power (dBm):      0.000     0.000     0.000     0.000
        Receive Power (mW):        1.000     1.000     1.000     1.000
        Receive Power (dBm):       0.000     0.000     0.000     0.000
    Statistics:
        FEC:
            Corrected Codeword Count: 0
            Uncorrected Codeword Count: 0

MAC address information:
    Operational address: 0035.1a00.e67c
    Burnt-in address: 0035.1a00.e62c
Autonegotiation disabled.

Operational values:
```

```
    Speed: 100Mbps       /*Gig interface speed is set to 100Mbps */
    Duplex: Full Duplex
    Flowcontrol: None
    Loopback: None (or external)
    MTU: 1514
    MRU: 1514
    Forward error correction: Disabled
```

```
#show interfaces GigabitEthernet 0/0/0/31
GigabitEthernet0/0/0/31 is up, line protocol is up
  Interface state transitions: 7
  Hardware is GigabitEthernet, address is 0035.1a00.e62c (bia 0035.1a00.e62c)
  Internet address is Unknown
  MTU 1514 bytes, BW 100000 Kbit (Max: 100000 Kbit)
     reliability 255/255, txload 0/255, rxload 0/255
  Encapsulation ARPA,
  Full-duplex, 100Mb/s, TFD, link type is force-up
  output flow control is off, input flow control is off
  Carrier delay (up) is 10 msec
  loopback not set,
  Last link flapped 00:00:30
  Last input 00:00:00, output 00:00:00
  Last clearing of "show interface" counters never
  30 second input rate 1000 bits/sec, 1 packets/sec
  30 second output rate 0 bits/sec, 1 packets/sec
     90943 packets input, 11680016 bytes, 0 total input drops
     0 drops for unrecognized upper-level protocol
     Received 0 broadcast packets, 90943 multicast packets
              0 runts, 0 giants, 0 throttles, 0 parity
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     61279 packets output, 4347618 bytes, 0 total output drops
     Output 0 broadcast packets, 8656 multicast packets
     0 output errors, 0 underruns, 0 applique, 0 resets
     0 output buffer failures, 0 output buffers swapped out
8 carrier transitions
```

In the above show output you will observe that the state of the GigabitEthernet0/0/0/31 is up, and line protocol is up. This is because the speed at both ends is 100Mbps.

## Using the negotiation auto command

When you configure the network interface speed using **negotiation auto** command, the speed is autonegotiated with the remote end interface. This command enhances the speed capability to 100M or 1G to be negotiated with the peer.

This sample configuration sets the interface speed to autonegotiate:

**Note** The interface speed at remote end is set to 100Mbps.

**Note** Before Cisco IOS XR Software Release 7.3.2, the default setting for autonegotiation varied with different platforms under the NCS 5500 family. On NCS 540 and NCS 55A2, 100G autonegotiation was enabled by default.

From Cisco IOS XR Software Release 7.3.2 onwards, autonegotiation is not enabled by default. Use the **negotiation auto** command to enable autonegotiation.

```
#configuration
 (config)#interface GigabitEthernet 0/0/0/31
 (config-if)#negotiation auto
 (config-if)#commit
 (config-if)#end
```

Use the **show controller GigE** and **show interface GigE** commands to verify if the speed is autonegotiated:

```
#show interfaces GigabitEthernet 0/0/0/31
GigabitEthernet0/0/0/31 is up, line protocol is up
  Interface state transitions: 10
  Hardware is GigabitEthernet, address is 0035.1a00.e62c (bia 0035.1a00.e62c)
  Internet address is Unknown
  MTU 1514 bytes, BW 100000 Kbit (Max: 100000 Kbit)
     reliability 255/255, txload 0/255, rxload 0/255
  Encapsulation ARPA,
  Full-duplex, 100Mb/s, TFD, link type is autonegotiation
  output flow control is off, input flow control is off
  Carrier delay (up) is 10 msec
  loopback not set,
  Last link flapped 00:00:01
  Last input 00:00:00, output 00:00:00
  Last clearing of "show interface" counters never
  30 second input rate 1000 bits/sec, 1 packets/sec
  30 second output rate 0 bits/sec, 0 packets/sec
     91005 packets input, 11687850 bytes, 0 total input drops
     0 drops for unrecognized upper-level protocol
     Received 0 broadcast packets, 91005 multicast packets
              0 runts, 0 giants, 0 throttles, 0 parity
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     61307 packets output, 4350024 bytes, 0 total output drops
     Output 0 broadcast packets, 8668 multicast packets
     0 output errors, 0 underruns, 0 applique, 0 resets
     0 output buffer failures, 0 output buffers swapped out
     15 carrier transitions
```

In the above show output you see that GigabitEthernet0/0/0/31 is up, and line protocol is up.

```
 #show controllers GigabitEthernet 0/0/0/31
Operational data for interface GigabitEthernet0/0/0/31:

State:
    Administrative state: enabled
    Operational state: Up
    LED state: Green On

Phy:
    Media type: Four-pair Category 5 UTP PHY, full duplex
    Optics:
        Vendor: CISCO
        Part number: SBCU-5740ARZ-CS1
        Serial number: AVC194525HW
        Wavelength: 0 nm
```

```
    Digital Optical Monitoring:
        Transceiver Temp: 0.000 C
        Transceiver Voltage: 0.000 V

        Alarms key: (H) Alarm high, (h) Warning high
                    (L) Alarm low, (l) Warning low
           Wavelength    Tx Power          Rx Power      Laser Bias
        Lane  (nm)     (dBm)     (mW)      (dBm)      (mW)       (mA)
        --   -----    ------   ------     ------   ------     ------
        0     n/a     0.0   1.0000     0.0   1.0000     0.000

        DOM alarms:
            No alarms

        Alarm                     Alarm    Warning   Warning    Alarm
        Thresholds                High      High       Low       Low
                                 -------   -------   -------   -------
        Transceiver Temp (C):      0.000     0.000     0.000     0.000
        Transceiver Voltage (V):   0.000     0.000     0.000     0.000
        Laser Bias (mA):           0.000     0.000     0.000     0.000
        Transmit Power (mW):       1.000     1.000     1.000     1.000
        Transmit Power (dBm):      0.000     0.000     0.000     0.000
        Receive Power (mW):        1.000     1.000     1.000     1.000
        Receive Power (dBm):       0.000     0.000     0.000     0.000
    Statistics:
        FEC:
            Corrected Codeword Count: 0
            Uncorrected Codeword Count: 0

MAC address information:
    Operational address: 0035.1a00.e67c
    Burnt-in address: 0035.1a00.e62c

Autonegotiation enabled:
    No restricted parameters

Operational values:
    Speed: 100Mbps
    Duplex: Full Duplex
    Flowcontrol: None
    Loopback: None (or external)
    MTU: 1514
    MRU: 1514
    Forward error correction: Disabled
```

## Using speed and negotiation auto command

When you configure the speed of the network interface (1G) using the **speed** and **negotiation auto** command, the interface autonegotiates all the paramets (full-duplex and pause) except speed. The speed is forced to the configured value.

This sample shows how to configures Gig interface speed to 100Mbps and autonegotiate other parameters:

**Note** The interface speed at remote end is set to 100Mbps.

```
#configuration
(config)#interface GigabitEthernet 0/0/0/31
(config-if)#negotiation auto
(config-if)#speed 100
```

```
 (config-if)#end
```

Use the **show controller GigE** and **show interface GigE** command to verify if the link is up, speed is forced to 100Mbps and autonegotiation is enabled:

```
#show interfaces GigabitEthernet 0/0/0/31
GigabitEthernet0/0/0/31 is up, line protocol is up
  Interface state transitions: 9
  Hardware is GigabitEthernet, address is 0035.1a00.e62c (bia 0035.1a00.e62c)
  Internet address is Unknown
  MTU 1514 bytes, BW 100000 Kbit (Max: 100000 Kbit)
     reliability 255/255, txload 0/255, rxload 0/255
  Encapsulation ARPA,
  Full-duplex, 100Mb/s, TFD, link type is autonegotiation
  output flow control is off, input flow control is off
  Carrier delay (up) is 10 msec
  loopback not set,
  Last link flapped 00:00:03
  Last input 00:00:00, output 00:00:00
  Last clearing of "show interface" counters never
  30 second input rate 0 bits/sec, 1 packets/sec
  30 second output rate 0 bits/sec, 0 packets/sec
     90968 packets input, 11683189 bytes, 0 total input drops
     0 drops for unrecognized upper-level protocol
     Received 0 broadcast packets, 90968 multicast packets
              0 runts, 0 giants, 0 throttles, 0 parity
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     61287 packets output, 4348541 bytes, 0 total output drops
     Output 0 broadcast packets, 8664 multicast packets
     0 output errors, 0 underruns, 0 applique, 0 resets
     0 output buffer failures, 0 output buffers swapped out
     12 carrier transitions
```

In the above show output you will observe that the GigabitEthernet0/0/0/31 is up, and line protocol is up This is because the speed at both ends is 100Mbps.

```
#show controllers GigabitEthernet 0/0/0/31
Operational data for interface GigabitEthernet0/0/0/31:

State:
    Administrative state: enabled
    Operational state: Up
    LED state: Green On

Phy:
    Media type: Four-pair Category 5 UTP PHY, full duplex
    Optics:
        Vendor: CISCO
        Part number: SBCU-5740ARZ-CS1
        Serial number: AVC194525HW
        Wavelength: 0 nm
    Digital Optical Monitoring:
        Transceiver Temp: 0.000 C
        Transceiver Voltage: 0.000 V

        Alarms key: (H) Alarm high, (h) Warning high
                    (L) Alarm low, (l) Warning low
           Wavelength    Tx Power          Rx Power      Laser Bias
        Lane  (nm)     (dBm)     (mW)      (dBm)      (mW)       (mA)
        --   -----    ------    ------     ------    ------     ------
        0     n/a      0.0   1.0000     0.0   1.0000     0.000
```

```
        DOM alarms:
            No alarms

        Alarm                      Alarm    Warning   Warning    Alarm
        Thresholds                 High      High       Low       Low
                                  -------   -------   -------   -------
        Transceiver Temp (C):       0.000     0.000     0.000     0.000
        Transceiver Voltage (V):    0.000     0.000     0.000     0.000
        Laser Bias (mA):            0.000     0.000     0.000     0.000
        Transmit Power (mW):        1.000     1.000     1.000     1.000
        Transmit Power (dBm):       0.000     0.000     0.000     0.000
        Receive Power (mW):         1.000     1.000     1.000     1.000
        Receive Power (dBm):        0.000     0.000     0.000     0.000
    Statistics:
        FEC:
            Corrected Codeword Count: 0
            Uncorrected Codeword Count: 0

MAC address information:
    Operational address: 0035.1a00.e67c
    Burnt-in address: 0035.1a00.e62c

Autonegotiation enabled:
    Speed restricted to: 100Mbps  /* autonegotiation is enabled and speed is forced to
100Mbps*/

Operational values:
    Speed: 100Mbps
    Duplex: Full Duplex
    Flowcontrol: None
    Loopback: None (or external)
    MTU: 1514
    MRU: 1514
    Forward error correction: Disabled
```

# Ethernet MTU

The Ethernet maximum transmission unit (MTU) is the size of the largest frame, minus the 4-byte frame check sequence (FCS), that can be transmitted on the Ethernet network. Every physical network along the destination of a packet can have a different MTU.

Cisco IOS XR software supports two types of frame forwarding processes:

- Fragmentation for IPV4 packets–In this process, IPv4 packets are fragmented as necessary to fit within the MTU of the next-hop physical network.

**Note** IPv6 does not support fragmentation.

- MTU discovery process determines largest packet size–This process is available for all IPV6 devices, and for originating IPv4 devices. In this process, the originating IP device determines the size of the largest IPv6 or IPV4 packet that can be sent without being fragmented. The largest packet is equal to the smallest MTU of any network between the IP source and the IP destination devices. If a packet is larger than the smallest MTU of all the networks in its path, that packet will be fragmented as necessary. This process ensures that the originating device does not send an IP packet that is too large.

**Note** To enable hashing for L3 header only when the majority of traffic is fragmented, use the **hw-module profile load-balance algorithm L3-Only** command.

Jumbo frame support is automatically enable for frames that exceed the standard frame size. The default value is 1514 for standard frames and 1518 for 802.1Q tagged frames. These numbers exclude the 4-byte frame check sequence (FCS).

Following are the supported MTU properties on devices containing NC55 first generation line cards, NCS 5501, NCS5501-SE cards:

- Each physical port can have a different MTU.
- Main interface of each bundle can have one MTU value.
- L3 sub-interface (bundle or physical) shares MTU profiles and can have a maximum of 3 unique configured MTUs per NPU.

**Note** L2 sub-interface MTU is not supported.

Following are the supported MTU profiles on devices containing NC55 second generation line cards. Each profile has a limit of 7 configured MTUs per NPU.

- Port MTU profile: This is shared by bundle main interfaces and physical main interfaces.
- RIF MTU profile: This is used by the L3 sub-interface (bundle or physical) on the device.

**Note** L2 sub-interface MTU is not supported.

For more information about the architecture, refer to the NCS 5500 and NCS 5700 Fixed Platform Architecture white paper.

# Link Layer Discovery Protocol (LLDP)

Cisco Discovery Protocol (CDP) is a device discovery protocol that runs over Layer 2. Layer 2 is also known as the data link layer that runs on all Cisco-manufactured devices, such as routers, bridges, access servers, and switches. CDP allows the network management applications to automatically discover and learn about other Cisco devices that connect to the network.

To support non-Cisco devices and to allow for interoperability between other devices, it also supports the IEEE 802.1AB LLDP. LLDP is also a neighbor discovery protocol that is used for network devices to advertise information about themselves to other devices on the network. This protocol runs over the data link layer, which allows two systems running different network layer protocols to learn about each other.

With LLDP, you can also access the information about a particular physical network connection. If you use a non-Cisco monitoring tool (via SNMP,) LLDP helps you identify the Object Identifiers (OIDs) that the system supports. The following are the supported OIDs:

- 1.0.8802.1.1.2.1.4.1.1.4
- 1.0.8802.1.1.2.1.4.1.1.5
- 1.0.8802.1.1.2.1.4.1.1.6
- 1.0.8802.1.1.2.1.4.1.1.7
- 1.0.8802.1.1.2.1.4.1.1.8
- 1.0.8802.1.1.2.1.4.1.1.9
- 1.0.8802.1.1.2.1.4.1.1.10
- 1.0.8802.1.1.2.1.4.1.1.11
- 1.0.8802.1.1.2.1.4.1.1.12

# Enabling LLDP Globally

To run LLDP on the router, you must enable it globally. When you enable LLDP globally, all interfaces that support LLDP are automatically enabled for both transmit and receive operations.

You can override this default operation at the interface to disable receive or transmit operations.

The following table describes the global attributes that you can configure:

| Attribute | Default | Range | Description |
|---|---|---|---|
| Holdtime | 120 | 0-65535 | Specifies the holdtime (in sec) that are sent in packets |
| Reinit | 2 | 2-5 | Delay (in sec) for LLDP initialization on any interface |
| Timer | 30 | 5-65534 | Specifies the rate at which LLDP packets are sent (in sec) |

To enable LLDP globally, complete the following steps:

1. `RP/0/RSP0/CPU0:router # configure`
2. `RP/0/RSP0/CPU0:router(config) #lldp`
3. `end or commit`

### Running configuration

```
RP/0/RP0/CPU0:router-5#show run lldp
Fri Dec 15 20:36:49.132 UTC
lldp
!

RP/0/RP0/CPU0:router#show lldp neighbors
Fri Dec 15 20:29:53.763 UTC
Capability codes:
```

```
        (R) Router, (B) Bridge, (T) Telephone, (C) DOCSIS Cable Device
        (W) WLAN Access Point, (P) Repeater, (S) Station, (O) Other

Device ID       Local Intf          Hold-time  Capability     Port ID
SW-NOSTG-I11-PUB.cis Mg0/RP0/CPU0/0      120        N/A             Fa0/28

Total entries displayed: 1

RP/0/RP0/CPU0:router#show lldp neighbors mgmtEth 0/RP0/CPU0/0
Fri Dec 15 20:30:54.736 UTC
Capability codes:
        (R) Router, (B) Bridge, (T) Telephone, (C) DOCSIS Cable Device
        (W) WLAN Access Point, (P) Repeater, (S) Station, (O) Other

Device ID       Local Intf          Hold-time  Capability     Port ID
SW-NOSTG-I11-PUB.cis Mg0/RP0/CPU0/0      120        N/A             Fa0/28

Total entries displayed: 1
```

# Enabling LLDP Per Interface

When you enable LLDP globally, all interfaces that support LLDP are automatically enabled for both transmit and receive operations. However, if you want to enable LLDP per interface, perform the following configuration steps:

1. `RP/0/RSP0/CPU0:router(config)# int gigabitEthernet 0/2/0/0`
2. `RP/0/RSP0/CPU0:router(config-if)# no sh`
3. `RP/0/RSP0/CPU0:router(config-if)#commit`
4. `RP/0/RSP0/CPU0:router(config-if)#lldp ?`
5. `RP/0/RSP0/CPU0:router(config-if)#lldp enable`
6. `RP/0/RSP0/CPU0:router(config-if)#commit`

### Running configuration

```
RP/0/RSP0/CPU0:router#sh running-config
Wed Jun 27 12:40:21.274 IST
Building configuration...
!! IOS XR Configuration 0.0.0
!! Last configuration change at Wed Jun 27 00:59:29 2018 by UNKNOWN
!
interface GigabitEthernet0/1/0/0
 shutdown
!
interface GigabitEthernet0/1/0/1
 shutdown
!
interface GigabitEthernet0/1/0/2
 shutdown
!
interface GigabitEthernet0/2/0/0
 Shutdown
!
interface GigabitEthernet0/2/0/1
 shutdown
!
interface GigabitEthernet0/2/0/2
 shutdown
```

```
!
end
```

### Verification

```
Verifying the config
==================
RP/0/RSP0/CPU0:router#sh lldp interface <===== LLDP enabled only on GigEth0/2/0/0
Wed Jun 27 12:43:26.252 IST


GigabitEthernet0/2/0/0:
        Tx: enabled
        Rx: enabled
        Tx state: IDLE
        Rx state: WAIT FOR FRAME
RP/0/RSP0/CPU0:router#

RP/0/RSP0/CPU0:router# show lldp neighbors
Wed Jun 27 12:44:38.977 IST
Capability codes:
        (R) Router, (B) Bridge, (T) Telephone, (C) DOCSIS Cable Device
        (W) WLAN Access Point, (P) Repeater, (S) Station, (O) Other

Device ID       Local Intf          Hold-time  Capability     Port ID
ios             Gi0/2/0/0           120        R              Gi0/2/0/0       <====== LLDP
 enabled only on GigEth0/2/0/0 and neighborship seen for the same.

Total entries displayed: 1

RP/0/RSP0/CPU0:router#
```

# Dense Wavelength Division Multiplexing Tunable Optics

The Dense Wavelength-Division Multiplexing (DWDM) wavelengths of the DWDM-SFP10G-C module on the Cisco NCS 5500 Series Aggregation Services Routers is tunable. You can configure the DWDM ITU wavelengths by using the itu channel command in the interface configuration mode. The itu channel command ensures that the traffic continues to flow.

The following table contains the wavelength mapping information for the DWDM module:

| Channel | Frequency (THz) | Wavelength (nm) |
|---|---|---|
| 1 | 191.35 | 1566.723 |
| 2 | 191.40 | 1566.314 |
| 3 | 191.45 | 1565.905 |
| 4 | 191.50 | 1565.496 |
| 5 | 191.55 | 1565.087 |
| 6 | 191.60 | 1564.679 |
| 7 | 191.65 | 1564.271 |
| 8 | 191.70 | 1563.863 |

| Channel | Frequency (THz) | Wavelength (nm) |
|---|---|---|
| 9 | 191.75 | 1563.455 |
| 10 | 191.80 | 1563.047 |
| 11 | 191.85 | 1562.640 |
| 12 | 191.90 | 1562.233 |
| 13 | 191.95 | 1561.826 |
| 14 | 192.00 | 1561.419 |
| 15 | 192.05 | 1561.013 |
| 16 | 192.10 | 1560.606 |
| 17 | 192.15 | 1560.200 |
| 18 | 192.20 | 1559.794 |
| 19 | 192.25 | 1559.389 |
| 20 | 192.30 | 1558.983 |
| 21 | 192.35 | 1558.578 |
| 22 | 192.40 | 1558.173 |
| 23 | 192.45 | 1557.768 |
| 24 | 192.50 | 1557.363 |
| 25 | 192.55 | 1556.959 |
| 26 | 192.60 | 1556.555 |
| 27 | 192.65 | 1556.151 |
| 28 | 192.70 | 1555.747 |
| 29 | 192.75 | 1555.343 |
| 30 | 192.80 | 1554.940 |
| 31 | 192.85 | 1554.537 |
| 32 | 192.90 | 1554.134 |
| 33 | 192.95 | 1553.731 |
| 34 | 193.00 | 1553.329 |
| 35 | 193.05 | 1552.926 |
| 36 | 193.10 | 1552.524 |

| Channel | Frequency (THz) | Wavelength (nm) |
|---|---|---|
| 37 | 193.15 | 1552.122 |
| 38 | 193.20 | 1551.721 |
| 39 | 193.25 | 1551.319 |
| 40 | 193.30 | 1550.918 |
| 41 | 193.35 | 1550.517 |
| 42 | 193.40 | 1550.116 |
| 43 | 193.45 | 1549.715 |
| 44 | 193.50 | 1549.315 |
| 45 | 193.55 | 1548.915 |
| 46 | 193.60 | 1548.515 |
| 47 | 193.65 | 1548.115 |
| 48 | 193.70 | 1547.715 |
| 49 | 193.75 | 1547.316 |
| 50 | 193.80 | 1546.917 |
| 51 | 193.85 | 1546.518 |
| 52 | 193.90 | 1546.119 |
| 53 | 193.95 | 1545.720 |
| 54 | 194.00 | 1545.322 |
| 55 | 194.05 | 1544.924 |
| 56 | 194.10 | 1544.526 |
| 57 | 194.15 | 1544.128 |
| 58 | 194.20 | 1543.730 |
| 59 | 194.25 | 1543.333 |
| 60 | 194.30 | 1542.936 |
| 61 | 194.35 | 1542.539 |
| 62 | 194.40 | 1542.142 |
| 63 | 194.45 | 1541.746 |
| 64 | 194.50 | 1541.349 |

| Channel | Frequency (THz) | Wavelength (nm) |
|---|---|---|
| 65 | 194.55 | 1540.953 |
| 66 | 194.60 | 1540.557 |
| 67 | 194.65 | 1540.162 |
| 68 | 194.70 | 1539.766 |
| 69 | 194.75 | 1539.371 |
| 70 | 194.80 | 1538.976 |
| 71 | 194.85 | 1538.581 |
| 72 | 194.90 | 1538.186 |
| 73 | 194.95 | 1537.792 |
| 74 | 195.00 | 1537.397 |
| 75 | 195.05 | 1537.003 |
| 76 | 195.10 | 1536.609 |
| 77 | 195.15 | 1536.216 |
| 78 | 195.20 | 1535.822 |
| 79 | 195.25 | 1535.429 |
| 80 | 195.30 | 1535.036 |
| 81 | 195.35 | 1534.643 |
| 82 | 195.40 | 1534.250 |
| 83 | 195.45 | 1533.858 |
| 84 | 195.50 | 1533.465 |
| 85 | 195.55 | 1533.073 |
| 86 | 195.60 | 1532.681 |
| 87 | 195.65 | 1532.290 |
| 88 | 195.70 | 1531.898 |
| 89 | 195.75 | 1531.507 |
| 90 | 195.80 | 1531.116 |
| 91 | 195.85 | 1530.725 |
| 92 | 195.90 | 1530.334 |

| Channel | Frequency (THz) | Wavelength (nm) |
|---|---|---|
| 93 | 195.95 | 1529.944 |
| 94 | 196.00 | 1529.553 |
| 95 | 196.05 | 1529.163 |
| 96 | 196.10 | 1528.773 |

**Note** For more information on limitations of this feature and details about optical parameters, see https://www.cisco.com/c/en/us/products/collateral/interfaces-modules/dwdm-transceiver-modules/data_sheet_c78-711186.html.

# Configuring the DWDM Tunable Optics

Perform the following procedure to configure the DWDM Tunable Optics module:

1. `Router# enable //Enables the privileged EXEC mode. If prompted, enter your password.`
2. `Router# configure terminal`
3. `Router(config)# interface tengigabitethernet 4/11 // Specifies the 10-Gigabit Ethernet interface to be configured. slot/port—Specifies the location of the interface.`
4. `Router(config-if)# itu channel 28 //Sets the ITU channel. number specifies the ITU channel number. The acceptable values are from 1-96.`

### Verifying the ITU Configuration

The following example shows how to use the show controller optics command to check an ITU configuration:

```
RP/0/RP0/CPU0:ios#show controllers optics 0/0/0/16
Tue Sep  5 08:25:54.127 UTC

 Controller State: Up

 Transport Admin State: In Service

 Laser State: Off

 LED State: Off

 Optics Status

         Optics Type:  SFP+ 10G DWDM Tunable
         DWDM carrier Info: C BAND, MSA ITU Channel=49, Frequency=193.75THz,
         Wavelength=1547.316nm

         Alarm Status:
         -------------
         Detected Alarms:
                 LOW-RX0-PWR

         LOS/LOL/Fault Status:
```

```
        Laser Bias Current = 0.0 mA
        Actual TX Power = 0.00 dBm
        RX Power = 0.00 dBm

        Performance Monitoring: Enable

        THRESHOLD VALUES
        ----------------

        Parameter                 High Alarm  Low Alarm  High Warning  Low Warning
        ------------------------  ----------  ---------  ------------  -----------
        Rx Power Threshold(dBm)         -2.9      -30.9          -7.0        -26.9
        Tx Power Threshold(dBm)          5.9       -5.0           2.9         -1.0
        LBC Threshold(mA)              75.00      25.00         70.00        30.00
        Temp. Threshold(celsius)       75.00      -5.00         70.00         0.00
        Voltage Threshold(volt)         3.63       2.97          3.46         3.13

        Polarization parameters not supported by optics

        Temperature = 38.00 Celsius
        Voltage = 3.28 V

 Transceiver Vendor Details

       Form Factor : SFP+
       Vendor Info
       -----------
        Optics type    : SFP+ 10G DWDM Tunable
        Name           : CISCO-OCLARO
        OUI Number     : 00.0b.40
        Part Number    : TRS7080FNCCA033
        Rev Number     : 0000
        Serial Number  : ONT2038009B
        PID            : DWDM-SFP10G-C
        VID            : V01


// DWDM Channel to Frequency/Wavelength Mapping
RP/0/RP0/CPU0:ios#show controllers optics 0/0/0/16 dwdm-carrrier-map
Tue Sep  5 08:26:31.175 UTC
DWDM Carrier Band:: (null)
MSA ITU channel range supported: 1~96

DWDM Carrier Map table
-----------------------------------------------------
ITU Ch   G.694.1         Frequency       Wavelength
 Num     Ch Num           (THz)            (nm)
-----------------------------------------------------
     1   -35             191.35          1566.723
-----------------------------------------------------
     2   -34             191.40          1566.314
-----------------------------------------------------
     3   -33             191.45          1565.905
-----------------------------------------------------
     4   -32             191.50          1565.496
-----------------------------------------------------
     5   -31             191.55          1565.087
-----------------------------------------------------
     6   -30             191.60          1564.679
-----------------------------------------------------
     7   -29             191.65          1564.271
-----------------------------------------------------
     8   -28             191.70          1563.863
```

| | | | |
|---|---|---|---|
| 9 | -27 | 191.75 | 1563.455 |
| 10 | -26 | 191.80 | 1563.047 |
| 11 | -25 | 191.85 | 1562.640 |
| 12 | -24 | 191.90 | 1562.233 |
| 13 | -23 | 191.95 | 1561.826 |
| 14 | -22 | 192.00 | 1561.419 |
| 15 | -21 | 192.05 | 1561.013 |
| 16 | -20 | 192.10 | 1560.606 |
| 17 | -19 | 192.15 | 1560.200 |
| 18 | -18 | 192.20 | 1559.794 |
| 19 | -17 | 192.25 | 1559.389 |
| 20 | -16 | 192.30 | 1558.983 |
| 21 | -15 | 192.35 | 1558.578 |
| 22 | -14 | 192.40 | 1558.173 |
| 23 | -13 | 192.45 | 1557.768 |
| 24 | -12 | 192.50 | 1557.363 |
| 25 | -11 | 192.55 | 1556.959 |
| 26 | -10 | 192.60 | 1556.555 |
| 27 | -9 | 192.65 | 1556.151 |
| 28 | -8 | 192.70 | 1555.747 |
| 29 | -7 | 192.75 | 1555.343 |
| 30 | -6 | 192.80 | 1554.940 |
| 31 | -5 | 192.85 | 1554.537 |
| 32 | -4 | 192.90 | 1554.134 |
| 33 | -3 | 192.95 | 1553.731 |
| 34 | -2 | 193.00 | 1553.329 |
| 35 | -1 | 193.05 | 1552.926 |
| 36 | 0 | 193.10 | 1552.524 |
| 37 | 1 | 193.15 | 1552.122 |
| 38 | 2 | 193.20 | 1551.721 |
| 39 | 3 | 193.25 | 1551.319 |
| 40 | 4 | 193.30 | 1550.918 |

| | | | |
|---|---|---|---|
| 41 | 5 | 193.35 | 1550.517 |
| 42 | 6 | 193.40 | 1550.116 |
| 43 | 7 | 193.45 | 1549.715 |
| 44 | 8 | 193.50 | 1549.315 |
| 45 | 9 | 193.55 | 1548.915 |
| 46 | 10 | 193.60 | 1548.515 |
| 47 | 11 | 193.65 | 1548.115 |
| 48 | 12 | 193.70 | 1547.715 |
| 49 | 13 | 193.75 | 1547.316 |
| 50 | 14 | 193.80 | 1546.917 |
| 51 | 15 | 193.85 | 1546.518 |
| 52 | 16 | 193.90 | 1546.119 |
| 53 | 17 | 193.95 | 1545.720 |
| 54 | 18 | 194.00 | 1545.322 |
| 55 | 19 | 194.05 | 1544.924 |
| 56 | 20 | 194.10 | 1544.526 |
| 57 | 21 | 194.15 | 1544.128 |
| 58 | 22 | 194.20 | 1543.730 |
| 59 | 23 | 194.25 | 1543.333 |
| 60 | 24 | 194.30 | 1542.936 |
| 61 | 25 | 194.35 | 1542.539 |
| 62 | 26 | 194.40 | 1542.142 |
| 63 | 27 | 194.45 | 1541.746 |
| 64 | 28 | 194.50 | 1541.349 |
| 65 | 29 | 194.55 | 1540.953 |
| 66 | 30 | 194.60 | 1540.557 |
| 67 | 31 | 194.65 | 1540.162 |
| 68 | 32 | 194.70 | 1539.766 |
| 69 | 33 | 194.75 | 1539.371 |
| 70 | 34 | 194.80 | 1538.976 |
| 71 | 35 | 194.85 | 1538.581 |
| 72 | 36 | 194.90 | 1538.186 |

```
-----------------------------------------------------
    73    37             194.95          1537.792
-----------------------------------------------------
    74    38             195.00          1537.397
-----------------------------------------------------
    75    39             195.05          1537.003
-----------------------------------------------------
    76    40             195.10          1536.609
-----------------------------------------------------
    77    41             195.15          1536.216
-----------------------------------------------------
    78    42             195.20          1535.822
-----------------------------------------------------
    79    43             195.25          1535.429
-----------------------------------------------------
    80    44             195.30          1535.036
-----------------------------------------------------
    81    45             195.35          1534.643
-----------------------------------------------------
    82    46             195.40          1534.250
-----------------------------------------------------
    83    47             195.45          1533.858
-----------------------------------------------------
    84    48             195.50          1533.465
-----------------------------------------------------
    85    49             195.55          1533.073
-----------------------------------------------------
    86    50             195.60          1532.681
-----------------------------------------------------
    87    51             195.65          1532.290
-----------------------------------------------------
    88    52             195.70          1531.898
-----------------------------------------------------
    89    53             195.75          1531.507
-----------------------------------------------------
    90    54             195.80          1531.116
-----------------------------------------------------
    91    55             195.85          1530.725
-----------------------------------------------------
    92    56             195.90          1530.334
-----------------------------------------------------
    93    57             195.95          1529.944
-----------------------------------------------------
    94    58             196.00          1529.553
-----------------------------------------------------
    95    59             196.05          1529.163
-----------------------------------------------------
96    60             196.10          1528.773

// Change Frequency

RP/0/RP0/CPU0:ios#conf t
Tue Sep  5 08:34:14.312 UTC
RP/0/RP0/CPU0:ios(config)#controller optics 0/0/0/16
RP/0/RP0/CPU0:ios(config-Optics)#shutdown
RP/0/RP0/CPU0:ios(config-Optics)#dwdm-carrier 50GHz-grid frequency 19335
RP/0/RP0/CPU0:ios(config-Optics)#commit
Tue Sep  5 08:34:39.943 UTC
RP/0/RP0/CPU0:ios(config-Optics)#end
RP/0/RP0/CPU0:ios#show controllers optics 0/0/0/16
Tue Sep  5 08:34:42.824 UTC

 Controller State: Administratively Down
```

```
Transport Admin State: Out Of Service

Laser State: Off

LED State: Off

Optics Status

        Optics Type:  SFP+ 10G DWDM Tunable
        DWDM carrier Info: C BAND, MSA ITU Channel=41, Frequency=193.35THz,
        Wavelength=1550.517nm

        Alarm Status:
        -------------
        Detected Alarms:
                LOW-RX0-PWR

        LOS/LOL/Fault Status:

        Laser Bias Current = 0.0 mA
        Actual TX Power = 0.00 dBm
        RX Power = 0.00 dBm

        Performance Monitoring: Enable

        THRESHOLD VALUES
        ----------------

        Parameter                 High Alarm  Low Alarm  High Warning  Low Warning
        ------------------------  ----------  ---------  ------------  -----------
        Rx Power Threshold(dBm)         -2.9      -30.9          -7.0        -26.9
        Tx Power Threshold(dBm)          5.9       -5.0           2.9         -1.0
        LBC Threshold(mA)              75.00      25.00         70.00        30.00
        Temp. Threshold(celsius)       75.00      -5.00         70.00         0.00
        Voltage Threshold(volt)         3.63       2.97          3.46         3.13

        Polarization parameters not supported by optics

        Temperature = 39.00 Celsius
        Voltage = 3.28 V

Transceiver Vendor Details

       Form Factor : SFP+
       Vendor Info
       -----------
        Optics type    : SFP+ 10G DWDM Tunable
        Name           : CISCO-OCLARO
        OUI Number     : 00.0b.40
        Part Number    : TRS7080FNCCA033
        Rev Number     : 0000
        Serial Number  : ONT2038009B
        PID            : DWDM-SFP10G-C
        VID            : V01

// Change Wavelength

RP/0/RP0/CPU0:ios#conf t
Tue Sep  5 11:27:21.614 UTC
RP/0/RP0/CPU0:ios(config)#controller optics 0/0/0/16
RP/0/RP0/CPU0:ios(config-Optics)#shutdown
RP/0/RP0/CPU0:ios(config-Optics)#dwdm-carrier 50GHz-grid wavelength 1539766
RP/0/RP0/CPU0:ios(config-Optics)#commit
Tue Sep  5 11:28:14.547 UTC
```

```
RP/0/RP0/CPU0:ios(config-Optics)#end
RP/0/RP0/CPU0:ios#show controllers optics 0/0/0/16
Tue Sep  5 11:28:30.934 UTC

 Controller State: Administratively Down

 Transport Admin State: Out Of Service

 Laser State: Off

 LED State: Off

 Optics Status

         Optics Type:  SFP+ 10G DWDM Tunable
         DWDM carrier Info: C BAND, MSA ITU Channel=68, Frequency=194.70THz,
         Wavelength=1539.766nm

         Alarm Status:
         -------------
         Detected Alarms:
                 LOW-RX0-PWR

         LOS/LOL/Fault Status:

         Laser Bias Current = 0.0 mA
         Actual TX Power = 0.00 dBm
         RX Power = 0.00 dBm

         Performance Monitoring: Enable

         THRESHOLD VALUES
         ----------------

         Parameter                 High Alarm  Low Alarm  High Warning  Low Warning
         ------------------------  ----------  ---------  ------------  -----------
         Rx Power Threshold(dBm)         -2.9      -30.9          -7.0        -26.9
         Tx Power Threshold(dBm)          5.9       -5.0           2.9         -1.0
         LBC Threshold(mA)              75.00      25.00         70.00        30.00
         Temp. Threshold(celsius)       75.00      -5.00         70.00         0.00
         Voltage Threshold(volt)         3.63       2.97          3.46         3.13

         Polarization parameters not supported by optics

         Temperature = 38.00 Celsius
         Voltage = 3.28 V

 Transceiver Vendor Details

        Form Factor : SFP+
        Vendor Info
        -----------
         Optics type    : SFP+ 10G DWDM Tunable
         Name           : CISCO-OCLARO
         OUI Number     : 00.0b.40
         Part Number    : TRS7080FNCCA033
         Rev Number     : 0000
         Serial Number  : ONT2038009B
         PID            : DWDM-SFP10G-C
         VID            : V01
// Change Channel
RP/0/RP0/CPU0:ios#conf t
Tue Sep  5 08:29:03.648 UTC
RP/0/RP0/CPU0:ios(config)#controller optics 0/0/0/16
```

```
RP/0/RP0/CPU0:ios(config-Optics)#shutdown
RP/0/RP0/CPU0:ios(config-Optics)#dwdm-carrier 50GHz-grid ?
  frequency   Configure Frequency and Map to ITU Channel
  itu-ch      Configure the ITU 50GHz Grid ITU Channel
  wavelength  Configure Wavelength and Map to ITU Channel
RP/0/RP0/CPU0:ios(config-Optics)#dwdm-carrier 50GHz-grid itu-ch 84
RP/0/RP0/CPU0:ios(config-Optics)#commit


RP/0/RP0/CPU0:ios#show controllers optics 0/0/0/16
Tue Sep  5 08:29:54.851 UTC

 Controller State: Administratively Down

 Transport Admin State: Out Of Service

 Laser State: Off

 LED State: Off

 Optics Status

         Optics Type:  SFP+ 10G DWDM Tunable
         DWDM carrier Info: C BAND, MSA ITU Channel=84, Frequency=195.50THz,
         Wavelength=1533.465nm

         Alarm Status:
         -------------
         Detected Alarms:
                 LOW-RX0-PWR

         LOS/LOL/Fault Status:

         Laser Bias Current = 0.0 mA
         Actual TX Power = 0.00 dBm
         RX Power = 0.00 dBm

         Performance Monitoring: Enable

         THRESHOLD VALUES
         ----------------

         Parameter                 High Alarm  Low Alarm  High Warning  Low Warning
         ------------------------  ----------  ---------  ------------  -----------
         Rx Power Threshold(dBm)         -2.9      -30.9          -7.0        -26.9
         Tx Power Threshold(dBm)          5.9       -5.0           2.9         -1.0
         LBC Threshold(mA)              75.00      25.00         70.00        30.00
         Temp. Threshold(celsius)       75.00      -5.00         70.00         0.00
         Voltage Threshold(volt)         3.63       2.97          3.46         3.13

         Polarization parameters not supported by optics

         Temperature = 38.00 Celsius
         Voltage = 3.28 V

 Transceiver Vendor Details

        Form Factor : SFP+
        Vendor Info
        -----------
         Optics type    : SFP+ 10G DWDM Tunable
         Name           : CISCO-OCLARO
         OUI Number     : 00.0b.40
         Part Number    : TRS7080FNCCA033
```

```
Rev Number     : 0000
Serial Number  : ONT2038009B
PID            : DWDM-SFP10G-C
VID            : V01
```

# Priority Flow Control (PFC)

Priority flow control (PFC; IEEE 802.1Qbb), which is also referred to as Class-based Flow Control (CBFC) or Per Priority Pause (PPP), is a mechanism that prevents frame loss that is due to congestion. PFC is similar to 802.3x Flow Control (pause frames) or link-level flow control (LLFC). However, PFC functions on a per class-of-service (CoS) basis.

During congestion, PFC sends a pause frame that indicates which CoS value needs to be paused. A PFC pause frame contains a 2-octet timer value for each CoS that indicates the length of time that the traffic needs to be paused. The unit of time for the timer is specified in pause quanta. A quanta is the time that is required for transmitting 512 bits at the speed of the port. The range is from 0 to 65535.

**Note** The router sends out the required amount of pause frames or pause-threshold (x-off ) messages to achieve lossless queues. It also sends out resume-threshold (x-on) messages.

PFC asks the peer to stop sending frames of a particular CoS value by sending a pause frame to a well-known multicast address. This pause frame is a one-hop frame that is not forwarded when received by the peer. When the congestion is mitigated, the router stops sending the PFC frames to the upstream node.

**Note**

- PFC Rx traffic processing is enabled only if `hw-module profile priority-flow-control` command is enabled on the line card.
- `CISCO-PFC-EXT-MIB` is supported.

The PFC feature is only supported on the following line card or fixed chassis PIDs of the NCS5500 Series:

- NC55-36X100G
- NC55-18H18F
- NC55-24X100G-SE
- NC55-36X100G-S
- NC55-24H12F-SE
- NC55-36X100G-A-SE
- NCS-55A1-36H-SE-S
- NCS-55A1-36H-S
- NCS-55A1-24H
- NCS-55A1-48Q6H

# Restrictions for PFC

PFC has the following restrictions:

- PFC for transmit is not supported for internal traffic (recycle / loopback) and non-unicast traffic (broadcast / multicast).
- PFC for receive impacts all traffic meant to go out of the port. This may cause unintended drops to both unicast and non-unicast traffic because non-unicast traffic may consume buffer descriptors, thus starving unicast traffic. Hence, PFC is incompatible with sustained high rate non-unicast traffic in the system.
- PFC configuration will enable or disable both PFC transmit and receive functionalities. There is no support to enable only transmit or receive functions.
- PFC is only supported in the non-HQoS profile. For more details on this QoS prerequisite and configuration examples, please refer to *Modular QoS Configuration Guide for Cisco NCS 5500 Series Routers*.
- Link level flow control and PFC are not supported on the same interface simultaneously.
- PFC is only qualified on 40G and 100G physical interface types. PFC is not supported on breakout ports for these interface types and is not qualified on other interface types.
- Being an Ethernet feature, PFC has to be individually configured on the member interfaces of a bundle instead of the bundle interface. The user is expected to either enable or disable PFC on all members of the bundle, as a mix isn't supported.
- Pause frames are not counted in the interface's statistical information, and the **show interfaces** command displays this counter as 0. Use the **show controllers** *Ethernet-interface-type interface-path-id* command to retrieve the PFC statistics.

# Configuring Priority Flow Control

Use the following steps to configure Priority Flow Control:

**Configuration:**

```
RP/0/RP0/CPU0:router# configure
RP/0/RP0/CPU0:router(configure)#interface HundredGigE0/0/0/0
RP/0/RP0/CPU0:router(config)# priority-flow-control mode on
```

**Running configuration:**

```
*Interface Level*
interface HundredGigE0/0/0/0
priority-flow-control mode on
```

**Verification:**

Sample output for `show controllers hundredGigE 0/0/0/0 priority-flow-control` command is:

```
RP/0/RP1/CPU0:router#show controllers hundredGigE 0/0/0/0 priority-flow-control
Mon Oct 12 12:20:53.520 UTC

Priority flow control information for interface HundredGigE0/0/0/0:

Priority Flow Control:
    Total Rx PFC Frames: 0
    Total Tx PFC Frames: 1764273
    Rx Data Frames Dropped: 0
    CoS  Status  Rx Frames   Tx Frames
```

```
---  ------  ----------  ----------
  0  off              0           0
  1  off              0           0
  2  off              0           0
  3  on               0      882032
  4  on               0      882241
  5  off              0           0
  6  off              0           0
  7  off              0           0


Priority flow control watchdog configuration:
(D) : Default value
U : Unconfigured
------------------------------------------------------------------------------
       Configuration Item           Global  Interface Effective
------------------------------------------------------------------------------
    PFC watchdog state           :        U        U  Enabled(D)
    Poll interval                :        U        U      100(D)
    Shutdown multiplier          :        U        U        1(D)
    Auto-restore multiplier      :        U        U       10(D)


Priority flow control watchdog statistics:
SAR: Auto restore and shutdown
-------------------------------------------------------------------------------------------------------
Traffic Class            :       0        1        2        3        4        5        6
      7
-------------------------------------------------------------------------------------------------------
Watchdog Events          :       0        0        0        0        0        0        0
      0
Shutdown Events          :       0        0        0        0        0        0        0
      0
Auto Restore Events      :       0        0        0        0        0        0        0
      0
SAR Events               :       0        0        0        0        0        0        0
      0
SAR Instantaneous Events :       0        0        0        0        0        0        0
      0
Total Dropped Packets    :       0        0        0        0        0        0        0
      0
Dropped Packets          :       0        0        0        0        0        0        0
      0


Priority flow control watchdog state machine state:
D - Disabled
M - Monitoring
S - Waiting For Shutdown
R - Waiting to Restore
---------------------------------------------------------------
PFC Watchdog      : Enabled
Watchdog SM state :  Traffic Class
                     7 6 5 4 3 2 1 0
                     - - - D D - - -
RP/0/RP1/CPU0:router#
```

Sample output for `show controllers hundredGigE 0/0/0/0 priority-flow-control statistics` command is:

```
RP/0/RP1/CPU0:router#show controllers hundredGigE 0/0/0/0 priority-flow-control statistics

Mon Oct 12 12:22:39.362 UTC

Priority flow control information for interface HundredGigE0/0/0/0:
```

```
Priority Flow Control:
    Total Rx PFC Frames: 0
    Total Tx PFC Frames: 1764273
    Rx Data Frames Dropped: 0
    CoS  Status  Rx Frames   Tx Frames
    ---  ------  ----------  ----------
      0  off              0           0
      1  off              0           0
      2  off              0           0
      3  on               0      882032
      4  on               0      882241
      5  off              0           0
      6  off              0           0
      7  off              0           0
```

Sample output for `clear controller hundredGigE 0/0/0/0 priority-flow-control statistics [traffic-class <0-7>]` is:

```
RP/0/RP1/CPU0:router#clear controller hundredGigE 0/0/0/0 priority-flow-control statistics
 traffic-class 3
Mon Oct 12 12:22:48.778 UTC
RP/0/RP1/CPU0:router#show controllers hundredGigE 0/0/0/0  priority-flow-control statistics

Mon Oct 12 12:22:51.097 UTC

Priority flow control information for interface HundredGigE0/0/0/0:

Priority Flow Control:
    Total Rx PFC Frames: 0
    Total Tx PFC Frames: 882241
    Rx Data Frames Dropped: 0
    CoS  Status  Rx Frames   Tx Frames
    ---  ------  ----------  ----------
      0  off              0           0
      1  off              0           0
      2  off              0           0
      3  on               0           0
      4  on               0      882241
      5  off              0           0
      6  off              0           0
      7  off              0           0
RP/0/RP1/CPU0:router#
```

# Optical Transport Networks

Optical Transport Network (OTN) encapsulates frames of data that allows the system to send multiple data sources on the same channel.

OTN can carry any kind of traffic and removes the restriction of the different physical network dependencies. These physical networks offer different types of services, such as Ethernet, SDH, SONET, Fiber Channel, and so on.

OTN comprises of the following switching layers:

- Time Division Multiplexing (TDM)
- Wavelength Switched Optical Network (WSON)

OTN uses the following information structures to encapsulate data:

- OTUk – where k=1/2/2e/3/3e2/4, is an information structure into which the system maps another information structure called ODUk (k=1/2/2e/3/3e2/4). The ODUk signal is the server layer signal for client signals.
- OTU2e (Data rate 11.09Gb/s) transports a 10 Gigabit Ethernet LAN PHY coming from IP/Ethernet switches and routers at full line rate (10.3 Gbit/s), as specified in G.Sup43

# Restrictions and Important Guidelines

The following are some of the important guidelines and restrictions related to OTN:

- OTN is only supported on the NC55-MPA-12T-S line card.
- NC55-MPA-12T-S is supported on the following 2RU Cisco NCS 5500 Series Routers:
  - NCS-55A2-MOD-S
  - NCS-55A2-MOD-SE-S
  - NCS-55A2-MOD-HX-S
  - NCS-55A2-MOD-SE-H-S
  - NCS-55A2-MOD-HD-S
- NC55-MPA-12T-S is supported in the following Modular Line cards:
  - NC55-MOD-A-S
  - NC55-MOD-A-SE-S
- OTN isn't supported on SF_BER and SD_BER.
- OTN converts 10GE LAN PHY signal (host side) into OTU1e/OTU2e signal (line side).
- Supports 10G mapping modes
- OTU2e signal operates at 11.096 Gbps, which carries 10GE LAN PHY signal. Also known as the BMP mapping
- OTU1e signal operates at 11.049 Gbps, which carries 10GE LAN PHY signal. Also known as the BMP mapping
- Supports FEC functionality in the following modes:
  - GFEC = ITU-T G.709 / G.975, OH 7%
  - EFEC = ITU-T G.975.1 (1.4), OH 7%
  - UFEC = ITU-T G.975.1 (1.7), OH 7%
- FEC EC/UNC alarms aren't reported on NC55-MPA-12T-S.

# OTN Architecture

*Figure 1: OTN Architecture*

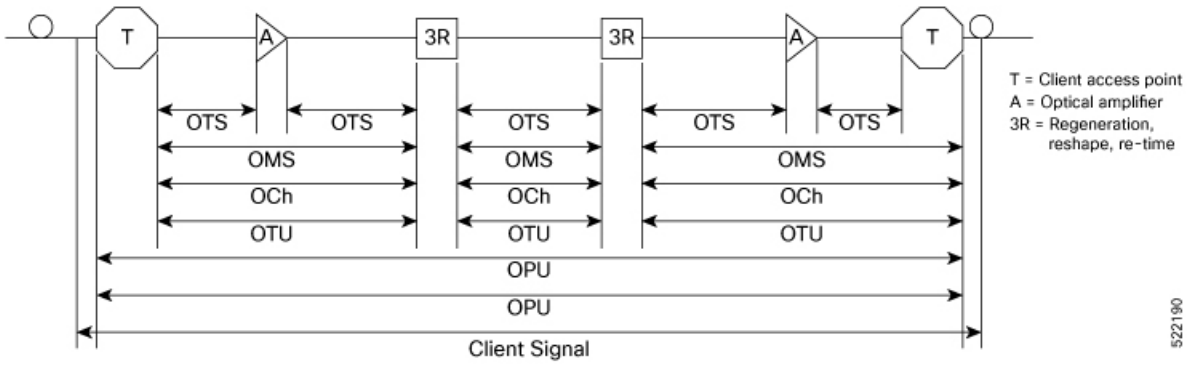
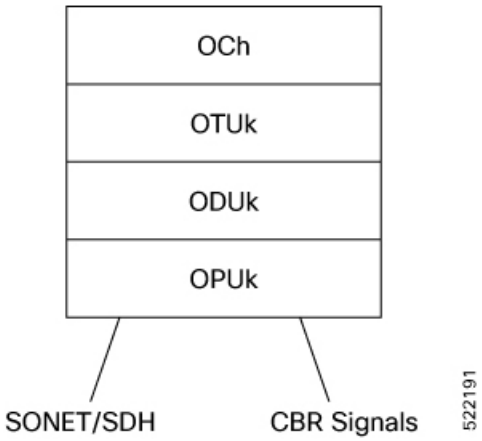



*Figure 2: OTN Layers*




### OTN Layers and their Functions

| Layer | Function | Ternimated On |
|---|---|---|
| Optical Transport Section (OTS) | Optical transmission. Includes fiber and optical amplifier. | Optical Amplifier |
| Optical Multiplex Section (OMS) | Optical multiplexing. Lambda multiplexing. | MUX/DEMUX |
| Optical Channel (OCh) | Client Optical Adaptation | Regenators |
| Optical Transport Unit (OTU) | Section Monitoring, FEC | Regenerators, Client Access Point, OTN Switch |
| Optical Data Unit (ODU) | Path Monitoring, Tandem Connection Monitoring | Client Access Point |
| Optical Channel Payload Unit (OPU) | Client Signal Adaptation | Client Access Point |

# Configuring OTN Interface

This section describes how you can configure OTN on an interface.

```
/* Configure “port-mode Otn framing opu2e” under controller optics of the interface. */

controller Optics0/2/1/0
port-mode Otn framing opu2e
!
```

### Running Configuration

```
controller Optics0/2/1/0
port-mode Otn framing opu2e
!
```

### Verification

```
RP/0/RP1/CPU0:ios#show portmode all
Sat Nov 20 21:37:01.717 UTC
Portmode Information
-------------------------------------------------
Port Name Portmode Type Framing Mapping PT type
Rate
Optics0_2_1_0 OTN OPU2e framing type None mapping type NA
None
Optics0_2_1_11 OTN OPU2e framing type None mapping type NA
None
RP/0/RP1/CPU0:ios#
```

```
RP/0/RP1/CPU0:ios#show controllers otu2e 0/2/1/0
Sat Nov 20 21:38:17.853 UTC
Port : OTU2E 0/2/1/0
Controller State : Up
Inherited Secondary State : Normal
Configured Secondary State : Normal
Derived State : In Service
Loopback mode : None
BER Thresholds : SF = 1.0E-6 SD = 1.0E-7
Performance Monitoring : Enable
Alarm Information:
LOS = 0 LOF = 0 LOM = 0
OOF = 0 OOM = 0 AIS = 0
IAE = 1 BIAE = 0 SF_BER = 0
SD_BER = 0 BDI = 0 TIM = 0
FECMISMATCH = 0 FEC-UNC = 0 FLEXO_GIDM = 0
FLEXO-MM = 0 FLEXO-LOM = 0 FLEXO-RDI = 0
FLEXO-LOF = 0
Detected Alarms : None
OTU TTI Received
FEC mode : STANDARD
```

```
RP/0/RP1/CPU0:ios#show controllers odu2e 0/2/1/0
Sat Nov 20 21:39:06.792 UTC
Port : ODU2E 0/2/1/0
Controller State : Up
Inherited Secondary state : Normal
Configured Secondary state : Maintenance
Derived State : Maintenance
Loopback mode : None
BER Thresholds : SF = 1.0E-6 SD = 1.0E-7
Performance Monitoring : Enable
Path Monitoring Mode : Non-Intrusive Monitor
PM TIM-CA state : Disable
```

```
Alarm Information:
AIS = 0 IAE = 0 BIAE = 0
SF_BER = 0 SD_BER = 0 BDI = 0
OCI = 0 LCK = 0 PTIM = 0
TIM = 0 CSF = 0 GFP LFD = 0
GFP LOCS = 0 GFP LOCCS = 0 GFP UPM = 0
Detected Alarms : None
ODU TTI Sent
ODU TTI Received
ODU TTI Expected
Owner : All
Resource State : ODU Resource Free
Private Line Emulation(PLE) supported : No
```

### Supported Alarms

This table lists the supported OTN alarms:

| ODU Alarms | OUT Alarms |
|---|---|
| AIS | OOF |
| OCI | AIS |
| LCK | LOF |
| BDI | LOM |
| | OOM |
| | BDI |
| | BIAE |
| | IAE |

The following are the supported OTN PM counters:

- BIP
- BEI

# How to Configure Interfaces in Breakout Mode

***Table 3: Feature History Table***

| Feature name | Release Information | Feature Description |
|---|---|---|
| 2x50GbE Breakout Ports on Cisco NCS-55A1-24H Routers | Release 7.5.2 | You can now configure 2x50GbE breakout ports on all QSFP28 ports of the Cisco NCS-55A1-24H fixed port router. |

# Information About Breakout

The router supports transmission of traffic in the breakout mode. The breakout mode enables a 40GbE, 100GbE, or 400GbE port to be split into multiple GbE ports.

Breakout Mode options:

- 4x10GbE
- 4x25GbE
- 2x50GbE
- 8x50GbE
- 4x100GbE
- 3x100GbE
- 2x100GbE
- 1x100GbE

**Note**

- The supported breakout mode is dependent on the port and optic transceiver.

# Configure Breakout in a Port

**Note** For the N540-24Q8L2DD-SYS router , before proceeding with the breakout configuration, ensure that you configure the port mode speed under the optics controller. This step is crucial to ensure that the optics controller operates at the desired speed and can properly handle the breakout settings.

For port mode speed configuration steps, refer to Configure Port Mode Speed.

This example shows how to configuring a 4x10GbE breakout in a port:

```
RP/0/RP0/CPU0:Router# configure
RP/0/RP0/CPU0:Router(config)# controller optics 0/1/0/28
RP/0/RP0/CPU0:Router(config-Optics)# breakout 4x10
RP/0/RP0/CPU0:Router(config-Optics)# commit
RP/0/RP0/CPU0:Router(config-Optics)# end
RP/0/RP0/CPU0:Router#
```

# Remove the Breakout Configuration

Removing the breakout configuration:

```
RP/0/RP0/CPU0:Router# configure
RP/0/RP0/CPU0:Router(config)# controller optics 0/1/0/28
RP/0/RP0/CPU0:Router(config-Optics)# no breakout 4x10
RP/0/RP0/CPU0:Router(config-Optics)# commit
RP/0/RP0/CPU0:uut(config-Optics)# end
```

## Verify a Breakout Configuration

Verifying a breakout configuration:

```
RP/0/RP0/CPU0:Router# show running-config controller optics 0/1/0/28
controller Optics0/1/0/28
breakout 4x10
!

RP/0/RP0/CPU0:Router# show int br location 0/1/CPU0 | i Te0/1/0/28
       Te0/1/0/27/0          up          up               ARPA 10000   10000000
       Te0/1/0/27/1          up          up               ARPA 10000   10000000
       Te0/1/0/27/2          up          up               ARPA 10000   10000000
       Te0/1/0/27/3          up          up               ARPA 10000   10000000
       Te0/1/0/28/0          up          up               ARPA 10000   10000000
       Te0/1/0/28/1          up          up               ARPA 10000   10000000
       Te0/1/0/28/2          up          up               ARPA 10000   10000000
       Te0/1/0/28/3          up          up               ARPA 10000   10000000
```

# How to Configure Interfaces in Breakout Mode

## Information About Breakout

The router supports transmission of traffic in the breakout mode. The breakout mode enables a 40GbE, 100GbE, or 400GbE port to be split into multiple GbE ports.

Breakout Mode options:

- 4x10GbE
- 4x25GbE
- 2x50GbE
- 8x50GbE
- 4x100GbE
- 3x100GbE
- 2x100GbE
- 1x100GbE

**Note**

- The supported breakout mode is dependent on the port and optic transceiver.

# Configure Breakout in a Port

**Note** For the N540-24Q8L2DD-SYS router , before proceeding with the breakout configuration, ensure that you configure the port mode speed under the optics controller. This step is crucial to ensure that the optics controller operates at the desired speed and can properly handle the breakout settings.

For port mode speed configuration steps, refer to Configure Port Mode Speed.

This example shows how to configuring a 4x10GbE breakout in a port:

```
RP/0/RP0/CPU0:Router# configure
RP/0/RP0/CPU0:Router(config)# controller optics 0/1/0/28
RP/0/RP0/CPU0:Router(config-Optics)# breakout 4x10
RP/0/RP0/CPU0:Router(config-Optics)# commit
RP/0/RP0/CPU0:Router(config-Optics)# end
RP/0/RP0/CPU0:Router#
```

# Remove the Breakout Configuration

Removing the breakout configuration:

```
RP/0/RP0/CPU0:Router# configure
RP/0/RP0/CPU0:Router(config)# controller optics 0/1/0/28
RP/0/RP0/CPU0:Router(config-Optics)# no breakout 4x10
RP/0/RP0/CPU0:Router(config-Optics)# commit
RP/0/RP0/CPU0:uut(config-Optics)# end
```

# Verify a Breakout Configuration

Verifying a breakout configuration:

```
RP/0/RP0/CPU0:Router# show running-config controller optics 0/1/0/28
controller Optics0/1/0/28
breakout 4x10
!

RP/0/RP0/CPU0:Router# show int br location 0/1/CPU0 | i Te0/1/0/28
       Te0/1/0/27/0          up          up               ARPA 10000   10000000
       Te0/1/0/27/1          up          up               ARPA 10000   10000000
       Te0/1/0/27/2          up          up               ARPA 10000   10000000
       Te0/1/0/27/3          up          up               ARPA 10000   10000000
       Te0/1/0/28/0          up          up               ARPA 10000   10000000
       Te0/1/0/28/1          up          up               ARPA 10000   10000000
       Te0/1/0/28/2          up          up               ARPA 10000   10000000
       Te0/1/0/28/3          up          up               ARPA 10000   10000000
```