Configuring GMPLS UNI

The primary function of Generalized Multiprotocol Label Switching (GMPLS) User Network Interface (UNI) is to create circuit connection between two clients (UNI-C) of an optical network. This is achieved by signaling exchanges between UNI Client (UNI-C) and UNI Network (UNI-N) nodes. NCS 1002 node acts as UNI-C and NCS 2000 series node acts as UNI-N in GMPLS-UNI reference model.

The user can create a GMPLS optical channel trail (OCH Trail) in a network where the NCS 1002 node is connected to a NCS 2000 series node. The OCH trail circuit originates from a NCS 1002 trunk interface (UNI-C) on the source NCS 1002 node and terminates on the NCS 2000 series interface (UNI-N) on the destination NCS 2000 series node to create an optical connection. The prerequisite for the OCH trail circuit is to create a Link Management Protocol (LMP) link between the optical channel Add/Drop NCS 2000 series interface on the NCS 2000 series node and the NCS 1002 interface on the NCS 1002 node.

GMPLS UNI is supported only on the 100G and 200G trunk ports of the NCS 1002 node until R6.2.1. GMPLS UNI is supported on the 250G trunk port of the NCS 1002 node from R6.3.2.

Channel Spacing

DWDM grid (C-band: 1530 nm to 1569 nm) in optical spectrum can be divided into multiple channels so that each channel can carry data traffic independently. These channels can be separated with available slot widths called channel spacing.

GMPLS has two types of channel spacing.

- Fixed Grid channel spacing - The channel spacing is fixed to either 100 GHz, 50 GHz, or 12.5 GHz. NCS 1002 supports 50 GHz channel spacing.
- Flexible Grid channel spacing - The channels are divided in finer slices. The flexibility in channel spacing allows to transmit mixed bit-rate or mixed modulation data in a grid with different channel widths. It also helps in effective usage of DWDM grid with minimal wastage of spectral bandwidth. NCS 1002 supports 6.25 GHz channel spacing.

GMPLS UNI is supported only for fixed grid until R6.2.1. Hence, 250G channels from NCS 1002 node cannot pass through the NCS 2000 series node because of spectral issues of 50 GHz spacing. GMPLS UNI flexible grid is suported from R6.3.2 that suports 250G channels.

Prerequisites

- NCS 1002 node must have both the MPLS and MPLS-TE packages.
- NCS 2000 series node must have a valid license for ROADM and WSON support.

- The management IPs of NCS 1002 and NCS 2000 series nodes on both the source and destination must be reachable.

Limitations of GMPLS Flexible Grid

Flexible grid interoperability between R6.3.2 of NCS 1002 and R10.8 of NCS 2000 works for LMP discovery, flexible grid based wavelength assignment, and E2E tunnels.

However, there are interoperability issues with NCS 2000 at the following UNI revert and restoration scenarios.

- UNI-revert does not work for tunnels with XRO configurations.
- Restoration does not work due to wrong carrier allocation.

Configure GMPLS UNI

Configuring GMPLS UNI involves the following tasks:

The following configurations must be performed on the NCS 2000 series node.

1. Configure LMP and Alien Wavelength in NCS 2000 Series Node, on page 4
2. Retrieve Ifindex from NCS 2000 Series Node, on page 5

The following configurations must be performed on the NCS 1002 node.

1. Configure LMP in Cisco NCS 1002, on page 6
2. Configure RSVP in NCS 1002, on page 6
3. Configure MPLS Tunnel in NCS 1002, on page 7

GMPLS UNI Command Reference

For detailed command information about GMPLS UNI commands, see Cisco IOS XR MPLS Command Reference.

Debuggability

For any software issues, it is recommended to collect the output of show tech of (mpls, mpls-te, rsvp, cf-mgr, sysdb, ncs1k) for head node and tail node.

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3. Configure MPLS Tunnel in NCS 1002, on page 7

GMPLS UNI Command Reference

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Debuggability

For any software issues, it is recommended to collect the output of show tech of (mpls, mpls-te, rsvp, cf-mgr, sysdb, ncs1k) for head node and tail node.

Configure LMP and Alien Wavelength in NCS 2000 Series Node

This procedure creates a static LMP link between a NCS 2000 series node and NCS 1002 node. Unnumbered LMP can be configured only through TL1. Numbered LMP can be configured through both CTC and TL1.

In unnumbered LMP, the tunnel is terminated in any of the links reaching the peer NCS 1002 node. The numbered LMP is recommended because NCS 1002 trunk connections must be symmetric.

The alien wavelength must be configured for the NCS 2000 series interface (UNI-N) before creating the MPLS tunnel from NCS 1002 node (UNI-C). As CTC does not manage the NCS 1002 node, the alien wavelength must be separately configured in the Add Drop ports of NCS 2000 series node.

Procedure

See DLP-G800 Create an LMP Link Using CTC to configure LMP and alien wavelength in NCS 2000 series node.

Configure Unnumbered LMP in NCS 2000 Series Node

In unnumbered LMP, the tunnel is terminated in any of the links reaching the peer NCS 1002 node. The numbered LMP is recommended because NCS 1002 trunk connections must be symmetric.

Use the following command to configure the unnumbered LMP from the TL1 interface.

```
ENT-UNICFG:[<TID>]:<src>:<CTAG>::<rvrsaid>,<rsysip>,<rifcip>,<mstpip>,
<commip>,[<remoteifinfo>]:[VALMODE=<optval>],[VALZONE=<oprzone>],[ADMINSTATE=<adminstate>],
[RESTTYPE=<resttype>],[CKTLABEL=<cktlabel>],[USPWROFS=<upstrmpwr>],
[DSPWROFS=<dnstrmpwr>],[ALLOWREGEN=<allowregen>],
[UNICTRLMODE=<unictrlmode>],[REVERTMODE=<revertmode>],
[SOAK=<HH-MM-SS>],[RESTVALMODE=<restvalmode>,[RESTVALZONE=<restvalzone>],
[TERMINTFDX=<termintfdx>],[DIVERSITY=<diversity>],[DIVERSITYTYPE=<diversitytype>],
[ISLOOSE=<isloose>],[UNIMODE=<unimode>],[DESCR=<descr>],[ALIENID=<alienid>],
[FECMODE=<fecmode>],[TRUNKMODE=<trunkmode>],[OPTENDPOINT=<optendpoint>],
[PAIREDOPTENDPOINT=<pairedoptendpoint>],[REMOTEIFINFOLIST=<remoteifinfolist>],
[LMPTYPE=<lmptype>][:];
```

rvrsaid is the destination AID. *rsysip* is the remote system IP address. *rifcip* is the remote interface IP address and enter 0.0.0.0 for unnumbered LMP. *mstpip* is the MSTP interface IP address and enter 0.0.0.0 for unnumbered LMP. *commip* is the destination IP address.

Example

```
ENT-UNICFG::PLINE-20-5-RX:111::PLINE-20-5-TX,10.58.229.22,10.22.22.5,10.90.90.5,10.58.229.22,
"Unnumb":VALMODE=FULL,VALZONE=RED,DESCR=90_Porta5_int27_Rosco22_250_20%,ADMINSTATE=UP,RESTTYPE=NONE,
UNICTRLMODE=CLIENT,RESTVALMODE=NONE,UNIMODE=GMPLS,ALIENID=NCS1K,
FECMODE=SD-20,TRUNKMODE=250G,LMPTYPE=SIGNALED;
```

Retrieve Ifindex from NCS 2000 Series Node

The Ifindex of all the LMP ports of NCS 2000 series node can be retrieved using CTC or TL1.

Using CTC

The Ifindex of all the LMP ports of NCS 2000 series node in decimal format can be retrieved using CTC from the **Originating Interface Index** column under the **Provisioning** > **LMP** tabs.

Using TL1

1. Log in to the TL1 interface and issue the following command.
2. **rtrv-unicfg ::all:1;**

This command retrieves the Ifindex of all the LMP ports of NCS 2000 series node in hexadecimal. This must be converted to decimal and used in remote Ifindex of NCS 1002 node during the LMP configuration.

TL1 Output

```
PSLINE-81-1-9-RX:PSLINE-81-1-9-TX,10.77.142.92,10.3.3.4,10.3.3.3,0.0.0.0,VALMODE=NONE,ADMINSTATE=UP,
RESTTYPE=REVERT,USPWROFS=0.0,
DSPWROFS=0.0,ALLOWREGEN=NO,UNICTRLMODE=CLIENT,REVERTMODE=MANUAL,SOAK=00-01-00,
RESTVALMODE=NONE,TERMINTFDX=0,ORIGINTFIDX=7f000d12,NUMBERED=TRUE,UNIMODE=GMPLS
```

```
PSLINE-81-1-10-RX:PSLINE-81-1-10-TX,10.77.142.92,10.4.4.4,10.4.4.3,0.0.0.0,VALMODE=NONE,ADMINSTATE=UP,
RESTTYPE=REVERT,USPWROFS=0.0,DSPWROFS=0.0,ALLOWREGEN=NO,UNICTRLMODE=CLIENT,
REVERTMODE=MANUAL,SOAK=00-01-00,RESTVALMODE=NONE,TERMINTFDX=0,
ORIGINTFIDX=7f000d14,NUMBERED=TRUE,UNIMODE=GMPLS
```

The Ifindex of Port 81-1-9 is 7f000d12 (in hexadecimal) and 2130709778 (in decimal). The Ifindex of Port 81-1-10 is 7f000d14 (in hexadecimal) and 2130709780 (in decimal).

Configure LMP in Cisco NCS 1002

Link Management Protocol (LMP) is a logical link that must be created on the trunk optics controller on the source and destination NCS 1002 nodes of the tunnel. Only static LMP is supported.

As CTC does not manage the NCS 1002 node, the Ifindex of Add Drop ports of NCS 2000 series node must be manually retrieved through TL1 or CTC LMP panel and used in LMP configuration in NCS 1002. See Retrieve Ifindex from NCS 2000 Series Node, on page 5 to retrieve the Ifindex. This Ifindex must be converted to decimal and used in the **neighbor interface-id unnumbered** command node during the LMP configuration.

Numbered trail creation requires the management IP address, link IP address (IP address of the optics controller), and the interface index. Unnumbered trail creation requires the management IP address and the interface index.

link-id ipv4 unicast IP address is the IP address of the optics controller. **neighbor link-id ipv4 unicast** IP address is the IP address of the MSTP interface. **neighbor flexi-grid-capable** enables GMPLS UNI flexible grid channel spacing.

The following is a sample of configuring the LMP on the source NCS 1002 node.

show running-config lmp

```
lmp
gmpls optical-uni
  controller Optics0/0/0/13
   neighbor NCS1K
   neighbor link-id ipv4 unicast 192.0.2.3
   neighbor flexi-grid-capable
   neighbor interface-id unnumbered 19
   link-id ipv4 unicast 192.0.2.4
  !
  neighbor NCS1K
   ipcc routed
   router-id ipv4 unicast 192.0.2.1
  !
  router-id ipv4 unicast 192.0.2.2
!
!
```

Configure RSVP in NCS 1002

Resource Reservation Protocol (RSVP) configuration with appropriate timeout for optical network must be performed on the source and destination NCS 1002 nodes of the tunnel. The following is a sample of configuring RSVP on the source NCS 1002 node.

```
controller optics 0/0/0/6
```

```
 signalling refresh out-of-band interval 3600
 signalling refresh out-of-band missed 24
```

Configure MPLS Tunnel in NCS 1002

MPLS tunnels can be configured only from the 100G and 200G trunk ports of the NCS 1002 node. The trunk optics controller must be in **no shut** state.

The following is a sample of configuring the MPLS tunnel on the source NCS 1002 node.

```
mpls traffic-eng
    gmpls optical-uni
        controller optics 0/0/0/6
           tunnel-properties
              tunnel-id 100
              destination ipv4 unicast 10.20.20.20
              path-option 10 no-ero lockdown
```

Explicit Route Object (ERO) - Includes the route(s) to be used through a list of specified nodes for a tunnel.

Exclude Route Object (XRO) - Excludes the route(s) to be used through a list of specified nodes for a tunnel.

The following is a sample to enable the controller to participate in the MPLS tunnel on the destination NCS 1002 node.

```
mpls traffic-eng
    gmpls optical-uni
        controller optics 0/0/0/6
```

Headless Mode and GMPLS UNI

NCS 1002 can carry traffic with a non-functional CPU (headless mode) for up to 72 hours. The existing GMPLS UNI tunnels are not affected by headless events such as system reload and CPU OIR operation on NCS 1002 node. However, the existing GMPLS UNI tunnels are affected if changes to the tunnel are triggered by the peer device when NCS 1002 node operates in headless mode.

Display GMPLS UNI Tunnel, RSVP, and LMP Information

show mpls traffic-eng link-management optical-uni controller optics *0/0/0/13*

```
Mon Sep 25 10:58:02.018 UTC
Optical interface: Optics0/0/0/13
  Overview:
    IM state: Up
    Child interface: : IM state Unknown
    OLM/LMP state: Up
    Optical tunnel state: up
  Connection:
    Tunnel role: Head
    Tunnel-id: 32, LSP-id 144, Extended tunnel-id 10.77.142.93
    Tunnel source: 10.77.142.93, destination: 10.6.1.1
    Optical router-ids: Local: 10.77.142.93, Remote: 10.77.142.94
    Label source: UNI-N
```

```
  Upstream label:
    Optical label:
    Grid                : DWDM
    Channel spacing     : 6.25 GHz
    Identifier          : 0
    Channel Number      : 88
  Downstream label:
    Optical label:
    Grid                : DWDM
    Channel spacing     : 6.25 GHz
    Identifier          : 0
    Channel Number      : 88
  SRLG discovery: Disabled
  SRLG announcement: None
Admission Control:
  Upstream: Admitted (LSP ID: 144)
  Downstream: Admitted (LSP ID: 144)
OLM/LMP adjacency information:
  Adjacency status: Up
  Local:
    node ID: 10.77.142.93
    link interface ID: 19
    link ID: 10.5.1.1
  Neighbor:
    node ID: 10.77.142.94 (38-SIT3)
    link interface ID: 2130709792
    link ID: 10.5.1.2
    IPCC: Routed to 10.77.142.94
Optical capabilities:
  Controller type: DWDM
  Channel spacing: 6.25 GHz
  Default channel: 88
  776 supported channels:
    -295, -294, -293, -292, -291, -290, -289, -288
    -287, -286, -285, -284, -283, -282, -281, -280
    -279, -278, -277, -276, -275, -274, -273, -272
    -271, -270, -269, -268, -267, -266, -265, -264
    -263, -262, -261, -260, -259, -258, -257, -256
    -255, -254, -253, -252, -251, -250, -249, -248
    -247, -246, -245, -244, -243, -242, -241, -240
    -239, -238, -237, -236, -235, -234, -233, -232
    -231, -230, -229, -228, -227, -226, -225, -224
    -223, -222, -221, -220, -219, -218, -217, -216
    -215, -214, -213, -212, -211, -210, -209, -208
    -207, -206, -205, -204, -203, -202, -201, -200
    -199, -198, -197, -196, -195, -194, -193, -192
    -191, -190, -189, -188, -187, -186, -185, -184
    -183, -182, -181, -180, -179, -178, -177, -176
    -175, -174, -173, -172, -171, -170, -169, -168
    -167, -166, -165, -164, -163, -162, -161, -160
    -159, -158, -157, -156, -155, -154, -153, -152
    -151, -150, -149, -148, -147, -146, -145, -144
    -143, -142, -141, -140, -139, -138, -137, -136
    -135, -134, -133, -132, -131, -130, -129, -128
    -127, -126, -125, -124, -123, -122, -121, -120
    -119, -118, -117, -116, -115, -114, -113, -112
    -111, -110, -109, -108, -107, -106, -105, -104
    -103, -102, -101, -100, -99, -98, -97, -96
    -95, -94, -93, -92, -91, -90, -89, -88
    -87, -86, -85, -84, -83, -82, -81, -80
    -79, -78, -77, -76, -75, -74, -73, -72
    -71, -70, -69, -68, -67, -66, -65, -64
    -63, -62, -61, -60, -59, -58, -57, -56
    -55, -54, -53, -52, -51, -50, -49, -48
```

```
 -47, -46, -45, -44, -43, -42, -41, -40
 -39, -38, -37, -36, -35, -34, -33, -32
 -31, -30, -29, -28, -27, -26, -25, -24
 -23, -22, -21, -20, -19, -18, -17, -16
 -15, -14, -13, -12, -11, -10, -9, -8
 -7, -6, -5, -4, -3, -2, -1, 0
 1, 2, 3, 4, 5, 6, 7, 8
 9, 10, 11, 12, 13, 14, 15, 16
 17, 18, 19, 20, 21, 22, 23, 24
 25, 26, 27, 28, 29, 30, 31, 32
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 49, 50, 51, 52, 53, 54, 55, 56
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 65, 66, 67, 68, 69, 70, 71, 72
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 81, 82, 83, 84, 85, 86, 87, 88
 89, 90, 91, 92, 93, 94, 95, 96
 97, 98, 99, 100, 101, 102, 103, 104
 105, 106, 107, 108, 109, 110, 111, 112
 113, 114, 115, 116, 117, 118, 119, 120
 121, 122, 123, 124, 125, 126, 127, 128
 129, 130, 131, 132, 133, 134, 135, 136
 137, 138, 139, 140, 141, 142, 143, 144
 145, 146, 147, 148, 149, 150, 151, 152
 153, 154, 155, 156, 157, 158, 159, 160
 161, 162, 163, 164, 165, 166, 167, 168
 169, 170, 171, 172, 173, 174, 175, 176
 177, 178, 179, 180, 181, 182, 183, 184
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 193, 194, 195, 196, 197, 198, 199, 200
201, 202, 203, 204, 205, 206, 207, 208
 209, 210, 211, 212, 213, 214, 215, 216
 217, 218, 219, 220, 221, 222, 223, 224
 225, 226, 227, 228, 229, 230, 231, 232
 233, 234, 235, 236, 237, 238, 239, 240
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 249, 250, 251, 252, 253, 254, 255, 256
 257, 258, 259, 260, 261, 262, 263, 264
 265, 266, 267, 268, 269, 270, 271, 272
 273, 274, 275, 276, 277, 278, 279, 280
 281, 282, 283, 284, 285, 286, 287, 288
 289, 290, 291, 292, 293, 294, 295, 296
 297, 298, 299, 300, 301, 302, 303, 304
 305, 306, 307, 308, 309, 310, 311, 312
 313, 314, 315, 316, 317, 318, 319, 320
 321, 322, 323, 324, 325, 326, 327, 328
 329, 330, 331, 332, 333, 334, 335, 336
 337, 338, 339, 340, 341, 342, 343, 344
 345, 346, 347, 348, 349, 350, 351, 352
 353, 354, 355, 356, 357, 358, 359, 360
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 369, 370, 371, 372, 373, 374, 375, 376
 377, 378, 379, 380, 381, 382, 383, 384
 385, 386, 387, 388, 389, 390, 391, 392
 393, 394, 395, 396, 397, 398, 399, 400
 401, 402, 403, 404, 405, 406, 407, 408
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 425, 426, 427, 428, 429, 430, 431, 432
 433, 434, 435, 436, 437, 438, 439, 440
 441, 442, 443, 444, 445, 446, 447, 448
 449, 450, 451, 452, 453, 454, 455, 456
 457, 458, 459, 460, 461, 462, 463, 464
```

```
    465, 466, 467, 468, 469, 470, 471, 472
    473, 474, 475, 476, 477, 478, 479, 480
  Controller SRLGs
    None
```

show mpls traffic-eng link-management optical-uni

Displays the summary of the GMPLS UNI tunnel state. MPLS tunnels are not created when the optics controller is in shutdown state. IM state is shown as "Admin down". Issue the **no shutdown** command under the controller interface to initiate the tunnel creation.

```
Mon Jan 11 04:57:46.220 UTC

System Information:
Optical Links Count: 1 (Maximum Links Supported 100)

Optical interface: Optics0/0/0/13
Overview:
IM state: Up
Child interface: : IM state Unknown
OLM/LMP state: Up
Optical tunnel state: up
Connection:
Tunnel role: Tail
Tunnel-id: 1, LSP-id 2, Extended tunnel-id 10.77.132.158
Tunnel source: 10.77.132.158, destination: 10.1.1.1
Optical router-ids: Local: 10.77.132.156, Remote: 10.77.132.158
Label source: UNI-N
Upstream label:
Optical label:
Grid : DWDM
Channel spacing : 50 GHz
Identifier : 0
Channel Number : -8
Downstream label:
Optical label:
Grid : DWDM
Channel spacing : 50 GHz
Identifier : 0
Channel Number : -8
SRLG discovery: Disabled
SRLG announcement: None
Admission Control:
Upstream: Admitted (LSP ID: 2)
Downstream: Admitted (LSP ID: 2)
OLM/LMP adjacency information:
Adjacency status: Up
Local:
node ID: 10.77.132.156
link interface ID: 6
link ID: 10.1.1.1
Neighbor:
node ID: 10.77.132.158 (RDT_2)
link interface ID: 19
link ID: 10.1.1.2
IPCC: Routed to 10.77.132.158
Optical capabilities:
Controller type: DWDM
Channel spacing: 50 GHz
Default channel: -7
97 supported channels:
-36, -35, -34, -33, -32, -31, -30, -29
-28, -27, -26, -25, -24, -23, -22, -21
```

```
-20, -19, -18, -17, -16, -15, -14, -13
-12, -11, -10, -9, -8, -7, -6, -5
-4, -3, -2, -1, 0, 1, 2, 3
4, 5, 6, 7, 8, 9, 10, 11
12, 13, 14, 15, 16, 17, 18, 19
20, 21, 22, 23, 24, 25, 26, 27
28, 29, 30, 31, 32, 33, 34, 35
36, 37, 38, 39, 40, 41, 42, 43
44, 45, 46, 47, 48, 49, 50, 51
52, 53, 54, 55, 56, 57, 58, 59
60
Controller SRLGs
None
```

show mpls traffic-eng link-management optical-uni tabular

Displays the summary of the GMPLS UNI tunnel state in tabular format.

```
Mon Jan 11 05:27:06.407 UTC

System Information:
Optical Links Count: 1 (Maximum Links Supported 100)

State LMP GMPLS tunnel
Interface       Admin    Oper       adjacency     role     tun-id  state
-------------------------------------------------------------------------------
Op0/0/0/13       up       up           up         Tail       1      up
```

show mpls traffic-eng tunnels

Displays information about tunnels.

```
Mon Jan 11 05:30:44.501 UTC

LSP Tunnel 10.77.132.158 1 [8] is signalled, Signaling State: up
Tunnel Name: ios_ot1_10.1.1.1 Tunnel Role: Tail
Upstream label:
Optical label:
Grid : DWDM
Channel spacing : 50 GHz
Identifier : 0
Channel Number : -8
Downstream label:
Optical label:
Grid : DWDM
Channel spacing : 50 GHz
Identifier : 0
Channel Number : -8
Signalling Info:
Src 10.77.132.158 Dst 10.1.1.1, Tun ID 1, Tun Inst 8, Ext ID 10.77.132.158
Router-IDs: upstream 10.77.132.158
local 10.77.132.156
Priority: 7 7
SRLGs: not collected
Path Info:
Incoming Address: 10.1.1.2
Incoming:
Explicit Route:
No ERO

Route Exclusions:
No XRO
Record Route: Disabled
Tspec: avg rate=4294967033 kbits, burst=1000 bytes, peak rate=4294967033 kbits
```

```
Session Attributes: Local Prot: Not Set, Node Prot: Not Set, BW Prot: Not Set
Resv Info: None
Record Route: Disabled
Fspec: avg rate=4294967033 kbits, burst=1000 bytes, peak rate=4294967033 kbits
Displayed 0 (of 0) heads, 0 (of 0) midpoints, 1 (of 1) tails
Displayed 0 up, 0 down, 0 recovering, 0 recovered heads
```

show rsvp neighbors

Displays information about RSVP neighbors.

```
Mon Jan 11 05:33:21.483 UTC
Global Neighbor: 10.77.132.158
Interface       Neighbor Interface
------------------- ---------------
10.77.132.158   MgmtEth0/RP0/CPU0/0
```

show lmp gmpls optical-uni

Verifies LMP configuration and state.

```
GMPLS Optical-UNI LMP Router ID: 10.77.132.156

LMP Neighbor
Name: RDT_2, IP: 10.77.132.158, Owner: GMPLS Optical-UNI
IPCC ID: 1, State Up
Known via : Configuration
Type : Routed
Destination IP : 10.77.132.158
Source IP : 10.77.132.156

Interface I/F | Lcl Interface ID | Lcl Link ID | Interface LMP state
----------------------+-------------------+----------------+-----------------------
Optics0/0/0/13     6                10.1.1.1           Up
```

Example of MPLS Tunnel Creation Without ERO

On the source NCS 1002 node:

```
lmp
gmpls optical-uni
controller Optics0/0/0/5
neighbor HUB-1
neighbor link-id ipv4 unicast 10.4.4.2
neighbor interface-id unnumbered 2130709780
link-id ipv4 unicast 10.4.4.1
neighbor HUB-1
ipcc routed
router-id ipv4 unicast 10.77.142.94
router-id ipv4 unicast 10.77.142.93
mpls traffic-eng
gmpls optical-uni
controller Optics0/0/0/5
tunnel-properties
tunnel-id 10
destination ipv4 unicast 10.4.4.4
path-option 10 no-ero lockdown
rsvp
controller Optics0/0/0/5
```

```
signalling refresh out-of-band interval 3600
signalling refresh out-of-band missed 24
```

On the destination NCS 1002 node:

```
lmp
gmpls optical-uni
controller Optics0/0/0/5
neighbor HUB-2
neighbor link-id ipv4 unicast 10.4.4.3
neighbor interface-id unnumbered 2130709780
link-id ipv4 unicast 10.4.4.4
neighbor HUB-2
ipcc routed
router-id ipv4 unicast 10.77.142.46
router-id ipv4 unicast 10.77.142.92
mpls traffic-eng
gmpls optical-uni
controller Optics0/0/0/5
rsvp
controller Optics0/0/0/6
signalling refresh out-of-band interval 3600
signalling refresh out-of-band missed 24
```

The following is the output of the **show mpls traffic-eng tunnels 10** command on the source NCS 1002 node.

```
Name: GMPLS-UNI-Optics0/0/0/5  Destination: 10.4.4.4
  Signalled-Name: HEADNODE_ot10_10.4.4.4
GMPLS UNI tunnel controlling link Optics0/0/0/5, tunnel-id: 10
  Status:
    Admin:    up Oper:   up   Path:  valid   Signalling: connected

    path option 10, (LOCKDOWN) type no-ero  (Basis for Setup)
    Last Signalled Error : Tue Feb 14 02:19:01 2017
      Info: [11] PathErr(24,6)-(routing, unacceptable label object) at 10.4.4.2
    G-PID: 0x0800 (derived from egress interface properties)
    Creation Time: Tue Jan 10 15:07:11 2017 (4w6d ago)
  Config Parameters:
    Priority:  7  7 Affinity: 0x0/0xffff
    Path Protection: Not Enabled
    BFD Fast Detection: Disabled
    Reoptimization after affinity failure: Enabled
    SRLG discovery: Disabled
  History:
    Tunnel has been up for: 00:00:33 (since Tue Feb 14 02:19:02 IST 2017)
    Current LSP:
      Uptime: 00:00:33 (since Tue Feb 14 02:19:02 IST 2017)
Displayed 1 (of 4) heads, 0 (of 0) midpoints, 0 (of 0) tails
Displayed 1 up, 0 down, 0 recovering, 0 recovered heads
```

Example of MPLS Tunnel Creation with ERO

On the source NCS 1002 node:

```
mpls traffic-eng
      gmpls optical-uni
          controller Optics0/0/0/5
              tunnel-properties
                  tunnel-id 10
```

```
                destination ipv4 unicast 10.4.4.4
                path-option 10 explicit name ero-1 lockdown verbatim

explicit-path name ero-1
     index 10 next-address strict ipv4 unicast 10.4.4.2
     index 20 next-address strict ipv4 unicast 10.77.142.66
```

The following is the output of the **show mpls traffic-eng tunnels 10** command on the source NCS 1002 node.

```
Name: GMPLS-UNI-Optics0/0/0/5  Destination: 10.4.4.4
  Signalled-Name: HEADNODE_ot10_10.4.4.4
GMPLS UNI tunnel controlling link Optics0/0/0/5, tunnel-id: 10
  Status:
    Admin:    up Oper:   up   Path:  valid   Signalling: connected

    path option 10, (LOCKDOWN verbatim) type explicit ero-1 (Basis for Setup)
    Last Signalled Error : Tue Feb 14 01:57:02 2017
      Info: [7] PathErr(24,6)-(routing, unacceptable label object) at 10.4.4.2
    G-PID: 0x0800 (derived from egress interface properties)
    Creation Time: Tue Jan 10 15:07:11 2017 (4w6d ago)
  Config Parameters:
    Priority:  7  7 Affinity: 0x0/0xffff
    Path Protection: Not Enabled
    BFD Fast Detection: Disabled
    Reoptimization after affinity failure: Enabled
    SRLG discovery: Disabled
  History:
    Tunnel has been up for: 00:09:19 (since Tue Feb 14 01:57:02 IST 2017)
    Current LSP:
      Uptime: 00:09:19 (since Tue Feb 14 01:57:02 IST 2017)

  Path info (No IGP):
  Hop0: 10.4.4.2
  Hop1: 10.77.142.66
Displayed 1 (of 4) heads, 0 (of 0) midpoints, 0 (of 0) tails
Displayed 1 up, 0 down, 0 recovering, 0 recovered heads
```

Example of MPLS Tunnel Creation with XRO

On the source NCS 1002 node:

```
mpls traffic-eng
      attribute-set xro xro-1
           exclude strict lsp source 10.77.132.93 destination 10.3.3.4 tunnel-id 22
extended-tunnel-id 10.77.132.93
           exclude strict srlg value 123123
      gmpls optical-uni
          controller Optics0/0/0/5
             tunnel-properties
                tunnel-id 10
                destination ipv4 unicast 10.4.4.4
                path-option 10 no-ero xro-attribute-set xro-1 lockdown
          controller Optics0/0/0/6
             tunnel-properties
                tunnel-id 22
                destination ipv4 unicast 10.3.3.4
                path-option 12 no-ero lockdown
```

The following is the output of the **show mpls traffic-eng tunnels 10** command on the source NCS 1002 node.

```
Name: GMPLS-UNI-Optics0/0/0/5  Destination: 10.4.4.4
  Signalled-Name: HEADNODE_ot10_10.4.4.4
GMPLS UNI tunnel controlling link Optics0/0/0/5, tunnel-id: 10
  Status:
    Admin:    up Oper:   up   Path:  valid   Signalling: connected

    path option 10, (LOCKDOWN) type no-ero  (Basis for Setup)
      XRO attribute-set: xro-1
        Strict, SRLG id 123123
        Strict, P2P LSP, tun-id 22 lsp-id 0,Mutual-Div-flag 0 LSP-id ignored
          src 10.77.132.93, dest 10.3.3.4, ext-id 10.77.132.93
    Last Signalled Error : Tue Feb 14 02:09:13 2017
      Info: [8] PathErr(24,6)-(routing, unacceptable label object) at 10.4.4.2
    G-PID: 0x0800 (derived from egress interface properties)
    Creation Time: Tue Jan 10 15:07:11 2017 (4w6d ago)
  Config Parameters:
    Priority:  7  7 Affinity: 0x0/0xffff
    Path Protection: Not Enabled
    BFD Fast Detection: Disabled
    Reoptimization after affinity failure: Enabled
    SRLG discovery: Disabled
  History:
    Tunnel has been up for: 00:01:41 (since Tue Feb 14 02:09:13 IST 2017)
    Current LSP:
      Uptime: 00:01:41 (since Tue Feb 14 02:09:13 IST 2017)
Displayed 1 (of 4) heads, 0 (of 0) midpoints, 0 (of 0) tails
Displayed 1 up, 0 down, 0 recovering, 0 recovered heads
```

Example of MPLS Tunnel Creation with Explicit Signaled Wavelength

On the source NCS 1002 node:

```
gmpls optical-uni
     controller Optics0/0/0/5
         tunnel-properties
             tunnel-id 10
             destination ipv4 unicast 10.4.4.4
             path-option 10 no-ero signaled-label dwdm wavelength 22 lockdown
```

Validate GMPLS Assigned Channel Number (6.25 Ghz) over Coherent DSP

This procedure allows you to validate whether the channel number assigned through GMPLS is programmed in optics controller.

Procedure

Step 1 **show mpls traffic-eng link-management optical-uni controller optics** *0/0/0/13*

This command provides the channel number assigned (say 88) and channel spacing (say 6.25 Ghz).

```
Mon Sep 25 10:58:02.018 UTC

Optical interface: Optics0/0/0/13
  Overview:
    IM state: Up
    Child interface: : IM state Unknown
    OLM/LMP state: Up
    Optical tunnel state: up
  Connection:
    Tunnel role: Head
    Tunnel-id: 32, LSP-id 144, Extended tunnel-id 10.77.142.93
    Tunnel source: 10.77.142.93, destination: 10.6.1.1
    Optical router-ids: Local: 10.77.142.93, Remote: 10.77.142.94
    Label source: UNI-N
    Upstream label:
      Optical label:
      Grid                : DWDM
      Channel spacing     : 6.25 GHz
      Identifier          : 0
      Channel Number      : 88
    Downstream label:
      Optical label:
      Grid                : DWDM
      Channel spacing     : 6.25 GHz
      Identifier          : 0
      Channel Number      : 88
    SRLG discovery: Disabled
    SRLG announcement: None
```

Step 2 **show controllers optics** *0/0/0/13* **dwdm-carrrier-map flexi-grid**

This command provides the mapping for the channel number (say 88) to respective frequency (say 193.65000) and wavelength (say 1548.115).

```
DWDM Carrier Band:: OPTICS_C_BAND
MSA ITU channel range supported: 1~97

DWDM Carrier Map table
-----------------------------------------------------
Channel     G.694.1     Frequency     Wavelength
index      Ch Num        (THz)          (nm)
-----------------------------------------------------
   393        88        193.65000      1548.115
```

Step 3 **show controllers optics** *0/0/0/13* **| inc Wavelength**

This command provides the wavelength present in optics controller for the specific trunk port.

```
Tue Nov  7 04:05:09.148 UTC
Wavelength= 1548.115
```

Step 4 **show hw-module slice 1 coherentDSP 13 config hardware | inc Frequency**

This command verifes the frequency obtained in step 3 with the frequency programmed in coherent DSP.

```
Tue Nov  7 04:07:35.449 UTC

**********COHERENT DSP 13**********
Device Configuration:
-Traffic mode: 16-QAM 250G 20%-FEC (0)
-Power Mode: High Power (1)
```

```
-Near End Loop: disabled (0)
-Far End Loop: disabled (0)
-Caui Bitrate: Ethernet (1)
-Caui Mode: 0x0006
-TX Laser Frequency:  193.65000
-TX Optical Output Power SetPoint: -1.50 dBm
-TX Caui Ports enabled: 0x00000007
-TX Output Power: enabled
-TX Differential Encoder: enabled
-Tx LsWavalm ConsAction: disabled
-RX Laser Frequency:  193.65000
-RX Caui Ports enabled: 0x00000007
-RX CD Start Value: -70000 ps/nm
-RX CD Stop Value: 70000 ps/nm
-RX PreFec Ber Raise Threhold: 1065353216.000000
-RX PreFec Ber Cease Threhold: 1065353216.000000
-RX Preemphasis: P: 0 R: 0 T: 0 Q: 0 S: 0 U: 0
-RX Differential Decoder: enabled
-RX SD-FEC Decoder: enabled
-RX Lock to Hold-On Clock: disabled
-RX Enable POWALM cons action: disabled
-TX MCLK: disabled
-Tx MCLK Rate: 1/32 of symbolrate (0)
-RX MCLK: disabled
-Rx MCLK Rate: 1/32 of symbolrate (0)
-RX PreFec Ber Raise Time Interval: 1.00 s
-RX PreFec Ber Cease Time Interval: 1.00 s
-TX Mapper: A: PortP_L1, B: PortP_L2, C: PortR_L1, D: PortR_L2, E: PortT_L1
-RX Demapper: A: PortP_L1, B: PortP_L2, C: PortR_L1, D: PortR_L2, E: PortT_L1
-TX Laser Fine Tuning: 0.0 GHz
-RX Laser Fine Tuning: 0.0 GHz
```