Automatic Link Calibration

Automatic Link Calibration brings up your NCS 1000 optical line system. By identifying and addressing potential issues during the calibration process, ALC can enhance the overall reliability of the network, reducing downtime and ensuring consistent performance.

Automatic Link Calibration Overview

From Cisco IOS XR Release 7.11.1, NCS 1020 supports Automatic Link Calibration (ALC). ALC is an alternate to automatic link bring-up. When using ALC, the optical applications except APC remain idle when operating conditions change. After turning up the network, ALC saves optical parameters on all nodes as a baseline. ALC saves the following parameters as a baseline:

- Span loss data
- APC data
- C-band and OSC power measurements
- Link tuner data
- Gain estimator data
- OCM data

ALC is a link level application. ALC is initiated by the ALC manager which is the source OLT. The manager manages the downstream link. Similarly, the OLT at the other end of the link manages the upstream link.

ALC is a nework bring up operation. Link calibration is traffic impacting. When you are turning up a link

Prerequisites for ALC

- **OLT to OLT Topology**: OLT-OLT topology must be up and running from end to end. You should not have a Loss of Signal-Path (LOS-P) or a Loss of Channel (LOC) alarm on any node.
- **Channel Map Configuration**: You must configure channel maps on all nodes to align all nodes with the correct frequencies. Use **hw-module location 0/0/NXR0 grid-mode flex[inline-ampli |**

terminal-ampli] channel-id*id***centre-freq***frequency***width***width* command to configure the channel map for all 32 channels.

- **XC Creation**: You must create Optical Cross-Connects (OXCs) on OLT nodes. These OXCs should cover the entire spectrum to ensure the correct routing of optical signals.
- **Application Modes**: You must set all applications to either manual mode or disabled mode, except for Automatic Power Control (APC). We recommend, all control loop applications should be in manual mode.
- **Span-mode APC**: You must configure APC in span mode on all nodes.

Note If you use Cisco Optical Network Planner to design your network, the prerequisite configurations can be imported to the NCS 1020 nodes as an XML file. See Design and Analyze Networks for more information.

ALC Process

The following sequence of events takes palce when ALC is initiated.

1. The source Optical Line Terminal (OLT) starts the ALC procedure in the transmitting direction. The source OLT is the ALC manager for this direction. The ALC manager raises the **Automatic-link-calibration procedure is running** to indicate that the process is running.
2. The OLT drops all user channels and forces the ASE channels from the Noise Loader (NL). These ASE channels are used for the ALC calibration.

Note The Automatic Link Calibration (ALC) process needs a stable and reliable C-band source which covers entire spectrum. When the ALC process begins, it drops all active user channels and forces ASE noise channels from the noise loader. This is done to ensure that the calibration isn't affected by user traffic, which can fluctuate and cause inconsistencies. This allows the ALC process to accurately calibrate the power levels across the entire C-band spectrum, ensuring optimal performance of the optical network.

3. ALC initiates an OTDR scan on the receive (Rx) and transmit (Tx) interfaces in the downstream direction. After the scan is completed, the location of the sor file is saved.
4. ALC enables the Automatic Power Control (APC), Link Tuner, and Gain Estimator applications to run in parallel.
5. The Power Spectral Density (PSD) and gain are initially calculated using the Optical Supervisory Channel (OSC) span loss. This step is temporary and is used to bring the C-band up.
6. Once the C-band is up, the C-band based span loss is measured and the PSD and Gain are recalculated.
7. Using the PSD computed by the LinkTuner and the gain-range computed by the Gain Estimator, the APC regulates the channels. Once this is completed, the APC moves to the IDLE state.
8. After APC moves to the IDLE state on all nodes, ALC initiates the baseline.
9. After saving the optical parameters, ALC completes the procedure and the ALC status changes to IDLE.
10. The ALC Manager clears the **Automatic-link-calibration procedure is running**alarm.

11. The ALC manager rleases the ASE channels, and user channels become active.
12. ALC changes APC mode from Centralized-mode to Span-mode.

Restrictions for ALC

- ALC impacts network traffic, and the time it takes to converge depends on the number of nodes in the network.
- ALC does not support Raman networks.
- ALC saves baseline data only if the procedure completes successfully. If the ALC procedure fails due to network errors, the collected baseline data is not saved.
- Do not enable or disable any optical applications or initiate gain estimator after ALC is complete.
- Do not initiate ALC on a link without cross connect configuration across the entire spectrum.
- Baseline data is preserved across reloads.

Note To clear the baseline data, you must either perform a **commit replace** on the respective nodes or configure the **no** option of all the applications, for example, **no apc-span-mode RX** and **no apc-span-mode TX** to clear the APC baseline data on a node.

Configure Automatic Link Caliberation

Prerequisite configuration

The following commands are mandatory configurations for ALC onm an OLT node.

optical-line-control

controller Ots *R/S/I/P*

apc manual

gain-estimator manual

link-tuner manual

apc-span-mode RX

apc-span-mode TX

The following commands are mandatory configurations for ALC onm an ILA node.

optical-line-control

controller Ots0/0/0/0

gain-estimator manual

link-tuner manual

apc-span-mode TX

controller Ots0/0/0/2

gain-estimator manual

link-tuner manual

apc-span-mode TX

Configure APC in Span-mode

Use the following commands to configure APC in span-mode on an OLT node.

On an OLT node

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

apc-span-mode RX

apc-span-mode TX

commit

end

Use the following commands to configure APC in span-mode on an ILA node.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

apc-span-mode TX

commit

end

Note APC runs in centralized mode during Automatic Link Calibration. At the completion of ALC, ALC saves a baseline of the system. After saving the baseline, if the span-mode configurations are present, ALC changes APC mode to span-mode.

Pause Span-mode APC

Use the following commmands to pause span-mode APC

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

apc-span-mode-pause [TX | RX]

commit

end

The following is a sample configuration that pauses span-mode APC.

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#apc-span-mode-pause tx
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
Tue Apr 26 09:50:12.055 UTC
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

Turn Up a Link Using ALC

Perform the following steps to turn up a link using ALC.

1. Configure all nodes with base configurations and bring up the topology end to end. This involves setting up the basic configurations on all nodes in the network. These configurations include interface configurations, OSPF configurations, hostname, telemetry, and Cisco Optical Site Manager (COSM).
2. Import the XML file generated by Cisco Optical Network Planner (CONP) comprising required configurations for network turn up on all nodes. The CONP configuration file includes specific settings for the network, such as channel configuration, cross-connect (XC) configuration, optical application configuration in manual mode, and span mode Automatic Power Control (APC) configuration. Importing this file applies these settings to all nodes in the network.
3. Initiate the ALC procedure at the near-end Optical Line Terminal (OLT) using the exec command **olc alc-start controller ots 0/0/0/0**. The ALC status shows "IN-PROGRESS". The following sample shows the alc status after running the exec CLI.

   ```
   RP/0/RP0/CPU0:ios#olc alc-start controller ots 0/0/0/0
   RP/0/RP0/CPU0:ios#show olc alc status
   Tue Sep 26 16:54:57.934 IST

   Controller               : Ots0/0/0/0
   ALC Status               : IN-PROGRESS
   ALC-Procedure started at : 2023-09-26 16:04:07

   Node RID                 : 10.3.3.3
   ALC State                : IN-PROGRESS

   Node RID                 : 10.2.2.2
   ALC State                : IN-PROGRESS

   Node RID                 : 10.1.1.1
   ALC State                : IN-PROGRESS
   ```

4. After completing the ALC in one direction, initiate the ALC in the other direction. Exexcute the **olc alc-start controller ots 0/0/0/0** command on the far-end Optical Line Terminal (OLT), which acts as the ALC manager for the upstream direction.

Restriction Do not initiate ALC in a direction while ALC is in progress on the other direction. ALC procedure involves OTDR scans. NCS 1010 nodes perform OTDR scans in one direction at a time.

View Automatic Link Caliberation Status

Use the **show olc alc status** command to see the status of ALC. The following sample shows ALC status when ALC is in progress.

```
RP/0/RP0/CPU0:ios#show olc alc status
Tue Sep 26 16:54:57.934 IST

Controller               : Ots0/0/0/0
ALC Status               : IN-PROGRESS
ALC-Procedure started at : 2023-09-26 16:04:07

Node RID                 : 10.3.3.3
ALC State                : IN-PROGRESS

Node RID                 : 10.2.2.2
ALC State                : IN-PROGRESS

Node RID                 : 10.1.1.1
ALC State                : IN-PROGRESS
```

The following sample shows ALC status when ALC is IDLE after the completion of the ALC process.

```
RP/0/RP0/CPU0:ios#show olc alc status
Tue Sep 26 16:54:57.934 IST

Controller               : Ots0/0/0/0
ALC Status               : IDLE
ALC-Procedure started at : 2023-09-26 16:04:07

Node RID                 : 10.3.3.3
ALC State                : COMPLETE

Node RID                 : 10.2.2.2
ALC State                : COMPLETE

Node RID                 : 10.1.1.1
ALC State                : COMPLETE
```

Use the **show olc alc-local baseline controller ots** *R/S/I/P*command to view the saved baseline. The output of this command shows the baseline info saved for OTDR, Link Tuner, Gain Estimator, Span Loss, APC Regulation, and Power measurements. The following sample is a truncated output of the**show olc alc-local baseline** command.

```
RP/0/RP0/CPU0:ios#show olc alc-local baseline controller ots 0/0/0/0

OTDR
====
Controller   : Ots0/0/0/0
OTDR RX File : /harddisk:/otdr/PROD1_NCS1010_OTDR_Ots0_0_0_0_RX_20230926-192505.sor
OTDR TX File : /harddisk:/otdr/PROD1_NCS1010_OTDR_Ots0_0_0_0_TX_20230926-213923.sor

Link Tuner
==========
Controller          : Ots0/0/0/0
Config Mode         : Manual
Last PSD computation: 2023-09-26 16:11:40
Target PSD:
-------------------------------------------------------------------------
Setpoint            : Computed PSD
                      (dBm/12.5 GHz)
-------------------------------------------------------------------------
```

```
01                      -8.2
.
33                      -7.3

Gain Estimator
===============
Controller                          : Ots0/0/0/0
Config Mode                         : Manual
Ingress Estimated Gain              : 23.0 dB
Ingress Estimated Gain Mode         : Extended
Ingress Gain Estimation Timestamp   : 2023-09-26 13:59:44

Span Loss Computation
===============
Controller                                : Ots0/0/0/0
Neighbour RID                             : 10.2.2.2
Rx Span Loss                              : 16.8 dB
Rx Span Loss (with pumps off)             : NA
Estimated Rx Span Loss                    : NA
Tx Span Loss                              : 10.2 dB
Tx Span Loss (with pumps off)             : NA
Estimated Tx Span Loss                    : NA

APC Regulation Info
==================
Config Mode                               : Centralized APC
Controller                                : Ots0/0/0/0
Domain Manager                            : 10.3.3.3
Status                                    : IDLE
Direction                                 : Tx
PSD Minimum                               : -24.0 (dBm/12.5 GHz)
Gain Range                                : Normal
Last Correction                           : 2023-09-26 16:09:52
Residual Discrepancy from Previous Node   : NA
Residual Discrepancy Input Timestamp      : NA

  Device Parameters                       Min           Max           Configuration
    Operational
=============================================================================================

  Egress Ampli Gain (dB)           :      16.0          30.0          20.9
    20.9
  Egress Ampli Tilt (dB)           :      -5.0          2.5           -0.8
    -0.8
  Tx Ampli Power (dBm)             :       -            23.0           -
    22.8
  Tx VOA Attenuation (dB)          :      0.0           15.0          5.3
    5.3
  Egress WSS/DGE Attenuation (dB)  :      0.0           25.0           -
     -


  Channel Center    Channel     Channel     Channel     Spectrum      Ampli-Input
Target         Current        Discrepancy    Channel Slice
    Frequency        Width        ID        Source      Slice Num         PSD
PSD             PSD                          Attn Config
      (THz)          (GHz)                                        (dBm/12.5 GHz) (dBm/12.5
 GHz)   (dBm/12.5 GHz)         (dB)           (dB)
=============================================================================================

   191.412500       150.00        1          ASE          25             -23.4
-8.2            -8.1             -0.0          9.3
.
```

```
.
   196.062500       150.00        35         ASE           1513           -23.8
-7.4            -7.2             -0.0          9.5


Controller          : Ots0/0/0/0
Target PSD source   : Link Tuner
-------------------------------------------------------------------------------
Setpoint                Frequency                       Target PSD
                          (THz)                       (dBm/12.5 GHz)
-------------------------------------------------------------------------------
01                    191.375000                          -8.2
.
.
33                    196.175000                          -7.3


APC Regulation Info
==================
Config Mode                              : Centralized APC
Controller                               : Ots0/0/0/0
Domain Manager                           : 10.1.1.1
Status                                   : IDLE
Direction                                : Rx
PSD Minimum                              : -24.0 (dBm/12.5 GHz)
Gain Range                               : Extended
Last Correction                          : 2023-09-26 14:00:07
Residual Discrepancy from Previous Node  : NA
Residual Discrepancy Input Timestamp     : NA


  Device Parameters                          Min           Max           Configuration
     Operational
=============================================================================================


  Ingress Ampli Gain (dB)           :      20.0          38.0          22.2
     22.2
  Ingress Ampli Tilt (dB)           :      -5.0          5.0           0.9
     0.9
  Rx  Ampli Power (dBm)             :       -            25.0           -
     24.7
  Rx  VOA Attenuation (dB)          :      0.0           0.0           0.0
     0.0
  Ingress WSS/DGE Attenuation (dB)  :      0.0           25.0           -
      -


  Channel Center    Channel     Channel     Channel     Spectrum      Ampli-Input
Target         Current        Discrepancy    Channel Slice
    Frequency        Width        ID        Source      Slice Num         PSD
PSD             PSD                          Attn Config
      (THz)          (GHz)                                        (dBm/12.5 GHz) (dBm/12.5
 GHz)  (dBm/12.5 GHz)        (dB)            (dB)
=============================================================================================


   191.412500       150.00        1          ASE           25             -23.3
-8.0            -8.0             0.0           3.7
.
.
   196.062500       150.00        35         ASE           1513           -22.0
-8.0            -8.0             0.0           4.0
```

```
Power Measurements
==================

Controller                              : Ots0/0/0/0
C-Band Total Tx Power on Ots0/0/0/0     : 17.50 dBm
OSC Total Tx Power on Osc0/0/0/0        : 1.00 dBm
Measured at                             : 2023-09-26 16:13:47

 Spectrum Slices Spacing        :            3.125 Ghz
 Spectrum Slices Range          :            1 - 1548
 Slice Start Wavelength         :            1566.82 nm
 Slice Start Frequency          :            191337.50 GHz

 Spectrum power information :
 Tx power :
 ------------------------------------------------------------------------------------
 spectrum-slice num                       Ots0/0/0/0 Tx-power values (dBm)
 ------------------------------------------------------------------------------------
   1 - 12               -12.9  -10.7   -9.3   -8.5       -8.2   -8.2   -8.2   -8.2
-8.2   -8.1   -8.1   -8.1
.
.
 1537 - 1548             -28.6  -30.0  -31.0  -31.8      -32.4  -32.8  -33.2  -33.5
-33.7  -33.9  -34.1  -34.3

Controller                              : Ots0/0/0/0
C-Band Total Rx Power on Ots0/0/0/0     : 2.51 dBm
OSC Total Rx Power on Osc0/0/0/0        : -16.10 dBm
Measured at                             : 2023-09-26 14:01:51

 Spectrum Slices Spacing        :            3.125 Ghz
 Spectrum Slices Range          :            1 - 1548
 Slice Start Wavelength         :            1566.82 nm
 Slice Start Frequency          :            191337.50 GHz

 Spectrum power information :
 Rx power :
 ------------------------------------------------------------------------------------
 spectrum-slice num                       Ots0/0/0/0 Rx-power values (dBm)
 ------------------------------------------------------------------------------------
   1 - 12               -29.2  -26.4  -24.7  -23.7      -23.2  -23.2  -23.2  -23.3
-23.3  -23.3  -23.3  -23.3
.
.
 1537 - 1548             -42.6  -90.0  -90.0  -90.0      -90.0  -90.0  -90.0  -90.0
-90.0  -90.0  -90.0  -90.0
```