

Configuring the Global Navigation Satellite System

Effective Cisco IOS-XE Release 3.17, the Cisco ASR 903 (with RSP3 module) and Cisco ASR 907 router uses a satellite receiver, also called the global navigation satellite system (GNSS), as a new timing interface.

In typical telecom networks, synchronization works in a hierarchal manner where the core network is connected to a stratum-1 clock and this clock is then distributed along the network in a tree-like structure. However, with a GNSS receiver, clocking is changed to a flat architecture where access networks can directly take clock from satellites in sky using an on-board GPS chips.

This capability simplifies network synchronization planning, provides flexibility and resilience in resolving network synchronization issues in the hierarchical network.

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Information About the GNSS

Overview of the GNSS Module

The GNSS module is present on the front panel of the RSP3 module and can be ordered separately with PID=. However, there is no license required to enable the GNSS module.

The GNSS LED on the RSP3 front panel indicates the status of the module. The following table explains the different LED status.

LED Status	Description
Green	GNSS Normal State. Self survey is complete.

LED Status	Description
Amber	All other states

When connected to an external antenna, the module can acquire satellite signals and track up to 32 GNSS satellites, and compute location, speed, heading, and time. GNSS provides an accurate one pulse-per-second (PPS), a stable 10 MHz frequency output to synchronize broadband wireless, aggregation and pre-aggregation routers, and an accurate time-of-day (ToD).



Note The RSP3 module can also receive 1PPS, 10 MHz, and ToD signals from an external clocking and timing source. However, the timing signals from the GNSS module (when enabled) take precedence over those of the external source.

By default, anti-jamming is enabled on the GNSS module.

Operation of the GNSS Module

The GNSS module has the following stages of acquiring and providing timing signals to the Cisco router:

- Self-Survey Mode—When the router is reset, the GNSS module comes up in self-survey mode. It tries to lock on to minimum four different satellites and computes approximately 2000 different positions of the satellites to obtain a 3-D location (Latitude, Longitude, and Height) of it current position. This operation takes about 35-to-40 minutes. During this stage also, the module is able to generate accurate timing signals and achieve a *Normal* or *Phase-locked* state.

When GNSS moves into *Normal* state, you can start using the 1PPS, 10 MHz, and ToD inputs from GNSS. The quality of the signal in Self-Survey mode with *Normal* state is considered good enough to lock to GNSS.

- Over determined clock mode—The router switches to over determined (OD) mode when the self-survey mode is complete and the position information is stored in non-volatile memory on the router. In this mode, the module only processes the timing information based on satellite positions captured in self-survey mode.

The router saves the tracking data, which is retained even when the router is reloaded. If you want to change the tracking data, use the **no shutdown** command to set the GNSS interface to its default value.

The GNSS module stays in the OD mode unless one of the following conditions occur:

- A position relocation of the antenna of more than 100 meters is detected. This detection causes an automatic restart of the self-survey mode.
- A manual restart of the self-survey mode or when the stored reference position is deleted.
- A worst-case recovery option after a jamming-detection condition that cannot be resolved with other methods.

You can configure the GNSS module to automatically track any satellite or configure it to explicitly use a specific constellation. However, the module uses configured satellites only in the OD mode.

Note GLONASS and BeiDou satellites cannot be enabled simultaneously. GALILEO is not supported.

When the router is reloaded, it always comes up in the OD mode unless:

- the router is reloaded when the Self-Survey mode is in progress
- the physical location of the router is changed to more than 100 m from it's pre-reloaded condition.

When the GNSS self-survey is restarted using the default **gnss slot R0/R1** command in config mode, the 10MHz, 1PPS, and ToD signals are not changed and remain up.

High Availability for GNSS

The Cisco ASR 903 and Cisco ASR 907 routers have two GNSS modules, one each on the active and standby RSP3 modules. Each GNSS module must have a separate connection to the antenna in case of an RSP3 switchover.

Firmware Upgrade

GNSS firmware is integrated into the Cisco IOS XE Everest 16.5.1 image. When you load this image, the GNSS firmware is copied to the `/usr/binos/bin/` directory.

If the version of the firmware in the software image is greater than the current running verison, firmware is automatically upgraded.

Points to Note During Upgrade

- During firmware upgrade, the GNSS module status is displayed as *not detected* and lock status as *disabled*.
- SSO during firmware upgrade on standby does not impact firmware upgrade.
- After firmware upgrade is complete or if firmware upgrade is not required, firmware upgrade progress in the show command is displayed as *NA (Not-Applicable)*.
- Syslog messages are displayed to indicate the firmware upgrade start, cancel, and finish states.
- While firmware upgrade is in progress, GNSS configuration is not allowed on both, active or standby modules.
- To display the status of the firmware ugrade or downgrade, use the **show platform hardware slot** *R0/R1* **network-clock | sec GNSS** or the **show gnss status** commands.

Note The **show gnss status** command is not applicable on the standby.

Prerequisites for GNSS

To use GNSS:

- 1PPS, 10 MHz, and ToD must be configured for netsync and PTP. For more information see the Configuring Clocking and Timing chapter in the *Cisco ASR 903 Router Chassis Software Configuration Guide* .
- The antenna must have a clear view of the sky. For proper timing, minimum of four satellites should be locked. For information, see the *Cisco ASR 903 Series Aggregation Services Router Hardware Installation Guide* .

Restrictions for GNSS

- The GNSS module is not supported through SNMP; all configurations are performed through commands.
- On HA system, the traps from the standby system are logged to the console as the SNMP infra does not get enabled on standby RSP module.
- GNSS objects or performance counters are updated every 5 seconds locally and acknowledge the MIB object request accordingly.
- GNSS traps generation is delayed for 300 seconds for the first time after system startes to avoid any drop of GNSS traps.

GNSS MIB

The MIB file, CISCO-GNSS-MIB, has the following objects:

- **cGnssModuleLockStatus**: This object specifies the lock status of GNSS module. If the GNSS module is able to acquire and lock a set of satellites and provide a valid 10 M and 1 pps signal to the system, it indicates that the GNSS module is locked and its status is Up.

  Similarly, if it is not able to acquire or lock to the satellites or is unable to provide valid signals to the router where it is inserted, it indicates that the GNSS module is not locked and its status is Down.

GNSS Lock Status	Value
Down	1
Up	2

- **cGnssModulePresenceStatus**:

  This object specifies the presence of the GNSS module on system. Hence, if the GNSS module is present or inserted and if it is not present or removed from the router, the status is updated as Present or Absent.

GNSS Module	Value
Absent	1
Present	2

- **cGnssModuleSlotInfo**: This object specifies slot information where the GNSS module is inserted. It can be Slot-0 or Slot-1 for Cisco RSP3 Module and is Slot-0 for Cisco ASR-920-12SZ-IM and ASR-920U-12SZ-IM and Cisco ASR-920-12SZ-A and Cisco ASR-920-12SZ-D.
- **cGnssModuleSlotState**:

This object specifies state of the RSP (active or standby) where the GNSS module is inserted.

- **cGnssSatelliteVisibilityStatus**:

  This object specifies the status of the GNSS satellite visibility (good or bad). If the tracking is minimum 3 satellites with more than 30 dBm, then GNSS satellite visibility is good, otherwise bad.

GNSS Module Satellite Visibility	Value
Bad	1
Good	2

- **cGnssModuleSatelliteCount**:

  This object specifies the total number of satellites tracked by GNSS module at that particular time.

- **cGnssModuleSvIdSNR**:

  This object specifies the SNR value and the satellite ID for each visible satellite. Satellite ID and SNR of satellites are formatted in a string as show below:

  "<SvID1:SNR SvID2:SNR …. SvID32:SNR>"

- **cGnssAntennaShortAlarmStatus**:

  This object specifies GNSS module antenna short alarm status. It is used as the antenna short alarm status identifier of the GNSS module. Notification generated for the antenna short alarm is Raise or Clear status.

Antenna Short Status	Value
Raise	1
Clear	2

- **cGnssAntennaOpenAlarmStatus**:

  This object specifies GNSS module antenna open alarm status. It is used as the antenna open alarm status identifier of the GNSS module. Notification generated for the antenna open alarm is Raise or Clear status.

Antenna Open Status	Value
Raise	1
Clear	2

Telemetry for GNSS Module

Table 1: Feature History

Feature Name	Release Information	Description
Telemetry for GNSS Module	Cisco IOS XE Amsterdam 17.3.1	This feature provides externalization of operational data using Network Configuration Protocol (NETCONF) or Yet Another Next Generation (YANG) data modeling language. Prior to this release, the traditional show commands were available to only view the GNSS statistic data. But, you could not use these show command outputs to manage network devices as demanded by centralized orchestration application such as Cisco Digital Network Architecture Center (DNAC). The introduction of this feature provides externalization of operational data using Network Configuration Protocol (NETCONF) or Yet Another Next Generation (YANG) data modeling language to bring more visibility in the timing services operations. This feature is supported on Cisco ASR 900 RSP3 module.

Any deployed network requires constant monitoring and troubleshooting facilities to spot issues and trends, and to resolve them. Thus, the network devices must expose the operational state and important events to provide network assurance. The GNSS module has various statistic data like module lock status, satellite count, survey progress, alarm status, and so on. Prior to Cisco IOS XE Amsterdam 17.3.x, you could only use the traditional show commands to view these statistic data. But, you could not use these show command outputs to manage network devices as demanded by centralized orchestration application such as Cisco Digital Network Architecture Center (DNAC).

Effective Cisco IOS XE Amsterdam 17.3.x, the telemetry feature for GNSS module is introduced that provides externalization of operational data using Network Configuration Protocol (NETCONF) or Yet Another Next Generation (YANG) data modeling language. This feature helps to bring more visibility in the timing services operations.

For more information on the Telemetry feature, see the Programmability Configuration Guide, Cisco IOS XE Amsterdam 17.1.x.

Restrictions

You cannot obtain the GNSS data from the standby RSP device for Cisco ASR900 RSP3 Module HA system.

GNSS Traps

- **GNSS Antenna Short Alarm Trap**:

  Once the GNSS module is inserted or powered on to the router and configured, the module detects if there is any antenna short present according to the power drawn from the module. If the power drawn is above the threshold level, it is notified as an antenna short alarm.

  A trap is generated when the GNSS module detects an antenna short alarm. Similarly, the trap is cleared when the antenna short alarm is cleared. This trap and its clearance are generated based on the antenna short alarm status reading from the GNSS module.

- **GNSS Antenna Open Alarm Trap**:

  Once the GNSS module is inserted or powered on to the router and configured, the module detects if there is any antenna open present according to the power drawn from the module. If the power drawn is below the threshold level, it is notified as an antenna open alarm.

  A trap is generated when the GNSS module detects an antenna open alarm. Similarly, the trap is cleared when the antenna open alarm is cleared. This trap and its clearance are generated based on the antenna open alarm status reading from the GNSS module.

- **GNSS Satellite Visibility Trap**:

  Once the GNSS module is inserted or powered on to the router and configured, it gets locked onto a set of satellites and provides valid 10 M and 1 pps signals to the system.

  Based on the following conditions, the satellite visibility condition is decided:

  - Number of satellites tracked is less than three
  - Signal strength of the tracked satellites is less than 30 dBm

  So, if more than 3 satellites are visible with more than 30 dBm, then it indicates the signal strength is good, else its bad. Traps are generated accordingly when the signal strength status changes between good and bad. This trap and its clearance are generated based on the signal strength status reading from the GNSS module.

Trap OID

When a trap is generated, it contains a unique OID for each trap that acts as primary key to identify a trap.

The following tables show the mapping of trap and clearance names to its OIDs:

Trap Name	OID
ciscoGnssModuleLockStatus	1.3.6.1.4.1.9.9.862.0.1
ciscoGnssModuleLockClear	1.3.6.1.4.1.9.9.862.0.2
ciscoGnssModulePresenceStatus	1.3.6.1.4.1.9.9.862.0.3

Trap Name	OID
ciscoGnssModulePresenceClear	1.3.6.1.4.1.9.9.862.0.4
ciscoGnssAntennaShortAlarmStatus	1.3.6.1.4.1.9.9.862.0.5
ciscoGnssAntennaShortAlarmClear	1.3.6.1.4.1.9.9.862.0.6
ciscoGnssAntennaOpenAlarmStatus	1.3.6.1.4.1.9.9.862.0.7
ciscoGnssAntennaOpenAlarmClear	1.3.6.1.4.1.9.9.862.0.8
ciscoGnssSatelliteVisibilityStatus	1.3.6.1.4.1.9.9.862.0.9
ciscoGnssSatelliteVisibilityClear	1.3.6.1.4.1.9.9.862.0.10

Objects/Performance Counters	
cGnssModuleLockStatus	1.3.6.1.4.1.9.9.862.1.1
cGnssModulePresenceStatus	1.3.6.1.4.1.9.9.862.1.2
cGnssModuleSlotInfo	1.3.6.1.4.1.9.9.862.1.3
cGnssModuleSlotState	1.3.6.1.4.1.9.9.862.1.4
cGnssSatelliteVisibilityStatus	1.3.6.1.4.1.9.9.862.1.5
cGnssModuleSatelliteCount	1.3.6.1.4.1.9.9.862.1.6
cGnssModuleSvIdSNR	1.3.6.1.4.1.9.9.862.1.7
cGnssAntennaShortAlarmStatus	1.3.6.1.4.1.9.9.862.1.8
cGnssAntennaOpenAlarmStatus	1.3.6.1.4.1.9.9.862.1.9

How to Configure the GNSS

Note To know more about the commands referenced in this document, see the Cisco IOS Master Command List .

Enabling the GNSS on the Cisco Router

```
enable
configure terminal
gnss slot r0
no shutdown
exit
```

Note After the GNSS module is enabled, GNSS will be the source for 1PPS, ToD, and 10MHz clocking functions.

Configuring the Satellite Constellation for GNSS

```
enable
configure terminal
gnss slot r0
constellation [auto | gps | galelio | beidou | qzss
exit
```

Configuring Pulse Polarity

```
enable
configure terminal
gnss slot r0
1pps polarity negative
exit
```

Note The **no 1pps polarity negative** command returns the GNSS to default mode (positive is the default value).

Configuring Cable Delay

```
enable
configure terminal
gnss slot r0
1pps offset 5
exit
```

Note It is recommended to compensate 5 nanosecond per meter of the cable.

The **no 1pps offset** command sets cable delay offset to zero.

Disabling Anti-Jam Configuration

```
enable
configure terminal
gnss slot

ro
anti-jam disable
exit
```

Verifying the Configuration of the GNSS

Use the **show gnss status** command to display status of GNSS.

```
Router# show gnss status
GNSS status:

  GNSS device: detected
  Lock status: Normal
  Receiver Status: Auto
  Clock Progress: Phase Locking
  Survey progress: 100
  Satellite count: 22
  Holdover Duration: 0
  PDOP: 1.04   TDOP: 1.00
  HDOP: 0.73   VDOP: 0.74
  Minor Alarm: NONE
  Major Alarm: None
```

Use the **show gnss satellite** command to display the status of all satellite vehicles that are tracked by the GNSS module.

```
Router# show gnss satellite all
All Satellites Info:

SV PRN No   Channel No       Acq Flg    Ephemeris Flg     SV Type     Sig Strength
-------------------------------------------------------------------------------
14          0                     1                1           0               47
21          2                     1                1           0               47
22          3                     1                1           0               46
18          4                     1                1           0               47
27          6                     1                1           0               44
31          8                     1                1           0               49
24          10                    1                1           0               42
79          12                    0                1           1               18
78          13                    1                1           1               26

Router# show gnss satellite 21
Selected Satellite Info:

  SV PRN No: 21
  Channel No: 2
  Acquisition Flag: 1
 Ephemeris Flag: 1
  SV Type: 0
  Signal Strength: 47
```

Use the **show gnss time** and **show gnss location** to display the time and location of the Cisco ASR 902 or Cisco ASR907 router.

```
Router# show gnss time

Current GNSS Time:

  Time: 2015/10/14  12:31:01 UTC Offset: 17

Router# show gnss location
Current GNSS Location:

  LOC: 12:56.184000 N  77:41.768000 E 814.20 m
```

Use the **show gnss device** to displays the hardware information of the active GNSS module.

```
Router# show gnss device
GNSS device:

  Serial number: FOC2130ND5X
  Firmware version: 1.4
  Firmware update progress: NA
  Authentication: Passed
```

Swapping the GNSS Module

Hot swap is supported on the RSP3 module of the GNSS.

1. Remove the standby RSP module.
2. Replace the GNSS module on the standby RSP slot.
3. Reinsert the RSP into the chassis and wait for the RSP to boot with standby ready.
4. Check for GNSS Lock Status of the standby RSP. Use command **show platform hardware slot** <*R0/R1*> [**network-clocks** | **sec GNSS**] to verify.
5. Trigger SSO after the GNSS on standby RSP is locked.
6. Repeat steps 1–3 for the other RSP.

Configuring Telemetry for GNSS module

The following example shows the configuration example of telemetry for GNSS module:

```
configure terminal
telemetry ietf subscription 1
encoding encode-tdl
filter tdl-uri /services;serviceName=ios_emul_oper/gnss_data
source-vrf Mgmt-intf
stream native
update-policy periodic 1000
receiver ip address 7.0.1.112 45000 protocol native
```

Configuration Example For Configuring GNSS

```
gnss slot R0
no shutdown
anti-jam disable
constellation glonass
1pps polarity negative
1pps offset 1000 negative
operating-mode high-accuracy
```

Verification of Telemetry for GNSS Module Configuration

Use the **show gnss status** command to display the GNSS module status configured in the device.

```
#show gnss status
GNSS status:

  GNSS device: detected
  Lock status: Normal
  Receiver Status: OD
  Clock Progress: Phase Locking
  Survey progress: 100
  Satellite count: 12
  Holdover Duration: 0
  PDOP: 0.00   TDOP: 1.00
  HDOP: 0.00   VDOP: 0.00
  Minor Alarm: NONE
  Major Alarm: None
  High Accuracy Mode: OFF, Bandwidth : 1.7Hz
```

Use the **show gnss satellite all** command to display the information of all visible satellite at a particular time.

```
#show gnss satellite all
All Satellites Info:

SV PRN No Channel No Acq Flg  Ephemeris Flg SV Type Sig Strength Elevation Azimuth
-------------------------------------------------------------------------------------------------------------
193         0           1           1           5         37         15       138
22          1           1           1           0         47         41       192
9           2           1           1           0         48         32       335
16          3           1           1           0         46         31        31
8           4           1           1           0         47         43       145
3           5           1           1           0         49         54       217
194         6           1           1           5         40         22        52
7           7           1           1           0         44         20       298
195         8           1           1           5         40         21        80
23          9           1           1           0         45         58       359
11          10          1           1           0         43         14       182
27          11          1           1           0         46         40        95
73          12          1           1           1         24         29       273
```

The following example shows the sample output of telemetry configuration:

```
"op": "GREEN_RECORD_UPDATE",
                    "len": 498,
                    "entry_data": {
                        "gnss_data": {
                            "slot": 1,
                            "slot_state": "TDL_RSP_STANDBY",
                            "presence_status": "TDL_GNSS_MODULE_STATUS_PRESENT",
                            "lock_status": "TDL_GNSS_MODULE_LOCK_STATUS_UP",
                            "survey_progress_status": 100,
                            "satellite_tracking_status": "TDL_GNSS_SV_SNR_STATUS_GOOD",
                            "gnss_antenna_open_alarm_status": "TDL_GNSS_ALARM_ENABLE",
                            "gnss_antenna_short_alarm_status": "TDL_GNSS_ALARM_DISABLE",
                            "satellite_cnt": 9,
                            "s_cnt": 9,
                            "satellite_info": [
                                {
                                    "sv_prn": 5,
                                    "channel": 2,
                                    "acq_flag": "TDL_ACQUIRED",
                                    "eph_flag": 1,
                                    "signal_level": 46,
                                    "sv_type": "TDL_GNSS_SV_TYPE_GPS",
                                    "elevation": 62,
                                    "azimuth": 35
                                },
```

```
{
    "sv_prn": 29,
    "channel": 0,
    "acq_flag": "TDL_ACQUIRED",
    "eph_flag": 1,
    "signal_level": 44,
    "sv_type": "TDL_GNSS_SV_TYPE_GPS",
    "elevation": 18,
    "azimuth": 328
```


Additional References

Standards

Standard	Title
—	There are no associated standards for this feature,

MIBs

MIB	MIBs Link
• There are no MIBs for this feature.	To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFC	Title
—	There are no associated RFCs for this feature.