Global Navigation Satellite System (GNSS)

Global Navigation Satellite System (GNSS) is a satellite system which is used as a timing interface. GNSS receiver receives signals from GNSS satellites and decodes the information from multiple satellites to determine its distance from each satellite. Based on this data, the GNSS receiver identifies the location of each satellite.

The chassis 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. The stratum-1 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 by using an onboard GPS chip.

To optimize the GNSS system, it requires all the systems to share a common time scale and coordinated system. If all the systems do not have a common time, the receiver sees a time offset and selects only one constellation having common time scale. More satellites should be added to increase the coverage of the constellation itself.

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

Cisco IOS XR routers now support onboard GNSS receiver to recover time.

Overview of GNSS Modules and Operations

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

The GNSS LED on the front panel of the RP indicates the status of the module. This table provides the different LED statuses.

LED Status	Description
Green	GNSS NormalState.Selfsurvey 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 We do not recommend that you configure both the front panel (10M, 1PPS and ToD) input configuration and the GNSS input configuration.

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

A GNSS module operates in one of these modes. Both modes acquire and provide timing signals to Cisco 8000 routers:

- **Self-survey mode** - When the router is reset, the GNSS module comes up in self-survey mode. It tries to lock on to a minimum of four different satellites and computes approximately 2000 different positions of the satellites to obtain a 3-D location (Latitude, Longitude, and Height) of its 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.
- **Over-determined clock mode** - The router switches to an over-determined (OD) mode when the self-survey mode is complete and the position information is stored in the 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. This tracking data is retained even after the router reload. 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 until one of the following conditions occur:

- When the position relocation of the antenna of more than 100 meters is detected. This detection causes an automatic restart of the self-survey mode.
- When the self-survey mode is restarted manually.
- When the stored reference position is deleted.
- When a worst-case recovery scenario is considered after a jamming-detection condition that cannot be resolved with other methods.

You can configure the GNSS module to automatically track any satellite or 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.

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 its pre-reloaded condition.

When the system restarts GNSS self-survey by using the default **gnss slot R0/R1** command in configuration mode, the 10MHz, 1PPS, and ToD signals are not changed and remain in the up state.

Prerequisites

- 1PPS, 10 MHz, and ToD must be configured for netsync and PTP.
- The antenna must have a clear view of the sky. For accurate timing, a minimum of four satellites should be locked.

Restrictions

- The GNSS module is not supported through SNMP; all configurations are performed through commands.
- The GNSS holdover performance is one microsecond in two hours of holdover after twelve hours of GNSS lock time.

PRTC Mode with GNSS

A Cisco 8000 router can act in Primary Reference Time Clock (PRTC) mode, when GNSS is locked and no telecom profiles are configured. In PRTC mode, the router provides ToD + 1PPS output with ToD in UBX format.

Once the router is in PRTC mode, ordinary clock and transparent clocks are not supported under LAN profiles. All boundary clocks under LAN profiles will be in GMC-BC mode, which fetches timestamps and grandmaster clock details as per the GNSS input.

The GMS-BC master clock provides these clock quality values.

```
Clock Quality:
    Class: 6                        //----GNSS CLASS
    Accuracy: Within 250ns          //----GNSS Accuracy
    Offset (log variance): 20061    //----GNSS Variance
```

PRTC mode is supported on PTP Default and Power profile. The conversion takes place automatically when GNSS moves to locked state.

Note GNSS cannot be configured when the one of the following is configured:

- 802.1AS
- PTP TC mode
- GMC-BC options

Class Support Matrix

This table provides information about the GNSS class supported on the Cisco 8000 series routers and line cards.

Table 1: GNSS Class Support Matrix

Hardware Module	Supported GNSS Class	Cisco IOS XR Release
8711-32FH-M router	PRTC-B	Release 24.3.1

Configure GNSS

You can configure any of the these constellation options for a router:

- GPS
- Galileo
- GLONASS
- BeiDou
- QZSS

Based on your configuration, the output displays the status of the GNSS receiver on the router models.

This section describes how you can configure GNSS for a router.

```
/* Enable the GNSS receiver and enter the gnss-receiver submode */

Router(config)# gnss-receiver 0 location 0/0/CPU0
Router(config-gnss)# frequency synchronization
Router(config-gnss-freqsync)# selection input
```

Optional Configuration

This is an optional configuration for GNSS.

```
Router(config)# gnss-receiver 0 location 0/0/CPU0
Router(config-gnss)# anti-jam disable
Router(config-gnss)# constellation GPS
Router(config-gnss)# snr threshold 10
Router(config-gnss)# frequency synchronization
Router(config-gnss-freqsync)# selection input
Router(config-gnss-freqsync)# priority 5
Router(config-gnss-freqsync)# wait-to-restore 0
```

Running Configuration

This example provides the running configuration for GNSS.

```
gnss-receiver 0 location 0/RP0/CPU0
frequency synchronization
  selection input
  priority 1
```

```
  wait-to-restore 0
  quality receive exact itu-t option 1 PRC
 !
!
```

Verification

These examples provide **show gnss-receiver** command output on the router models.

Example: 1

```
Router# show gnss-receiver
GNSS-receiver 0 location 0/RP0/CPU0
    Status: Available, Up
    Position: 741:12.12 N 4451:39.60 E 0.827km
    Time: 2019:01:17 14:43:08 (UTC offset: 18s)
    Firmware version: 1.4
    Lock Status: Phase Locked, Receiver Mode: 3D-fix
    Survey Progress: 100, Holdover Duration: 0
    Major Alarm: Not used
    Minor Alarm: Not used
    Anti-jam: Enabled, Cable-delay compensation: 0
    1PPS polarity: Positive
    PDOP: 6.000, HDOP: 0.000, VDOP: 0.000, TDOP: 1.000
    Constellation: GPS, Satellite Count: 10
```

Example: 2

```
Router# show gnss-receiver
Fri Jan 17 07:27:34.804 UTC
GNSS-receiver 0 location 0/RP0/CPU0
    Status: Available, Up
    Position: 12:56.18 N 77:41.77 E 0.823km
    Time: 2020:01:17 07:31:41 (UTC offset: 0s)
    Locked at: 2020:01:15 17:15:28
    Firmware version: TIM 1.10
    Lock Status: Phase Locked, Receiver Mode: Time fix only
    Survey Progress: 100, Holdover Duration: Unknown
    Major Alarms: Unknown
    Minor Alarms: Unknown
    Anti-jam: Enabled, Cable-delay compensation: 0
    1PPS polarity: Positive
    PDOP: 99.990, HDOP: 99.990, VDOP: 99.990, TDOP: 0.240
    Constellation: GPS, Satellite Count: 17
    Satellite Thresholds:
        SNR - 0 dB-Hz, Elevation - 0 degrees, PDOP - 0, TRAIM - 0 us
    Satellite Info:
        CHN: Channel, AQUN: Aquisition, EPH: Ephemeris
        PRN   CHN   AQUN   EPH    SV            Signal
        No.   No.   Flag   Flag   Type          Strength   Elevat'n   Azimuth
        ---   ---   ----   ----   -----------   --------   --------   --------
          1   n/a   On     On     GPS             44.000     19.000    220.000
          3   n/a   On     On     GPS             48.000     62.000    299.000
          4   n/a   On     On     GPS             46.000     30.000    338.000
          7   n/a   On     On     GPS             47.000      9.000    261.000
          8   n/a   On     On     GPS             41.000     17.000    172.000
          9   n/a   On     On     GPS             44.000      7.000    317.000
         11   n/a   On     On     GPS             42.000     10.000    202.000
         14   n/a   On     On     GPS             42.000     22.000     90.000
         16   n/a   On     On     GPS             46.000     66.000     59.000
         22   n/a   On     On     GPS             47.000     71.000    238.000
         23   n/a   On     On     GPS             46.000     27.000    332.000
         26   n/a   On     On     GPS             48.000     40.000     40.000
```