Configure the Global Navigation Satellite System

Effective Cisco IOS XR Release 7.5.1, GNSS is supported on the following router variants:

- N540-FH-CSR-SYS
- N540-FH-AGG-SYS

This chapter describes the Global Navigation Satellite System (GNSS) and how to configure it.

In typical telecom networks, network synchronization works in a hierarchal manner where the core network is connected to a stratum-1 clock. The timing from 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 the satellites by using an on-board GPS chip.

Router now uses a satellite receiver, also called the Global Navigation Satellite System (GNSS), as the new timing interface.

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

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Overview of GNSS

Effective Cisco IOS XR Release 7.1.1, the following Cisco NCS 540 variants support GNSS receiver:

- N540X-16Z4G8Q2C-A
- N540X-16Z4G8Q2C-D
- N540X-12Z16G-SYS-A
- N540X-12Z16G-SYS-D
- N540-24Z8Q2C-SYS
- N540-28Z4C-SYS

- N540-ACC-SYS
- N540X-ACC-SYS

Effective Cisco IOS XR Release 7.3.1, the following Cisco NCS 540 variants support GNSS receiver:

- N540-24Z8Q2C-SYS
- N540-28Z4C-SYS
- N540-ACC-SYS
- N540X-ACC-SYS

Effective Cisco IOS XR Release 7.4.1, the following Cisco NCS 540 variant supports GNSS receiver:

- N540-24Q8L2DD-SYS

No license is required to enable the GNSS module. The GNSS LED on the front panel indicates the status of the module. The following table describes the different status of GNSS LED:

LED Status	Description
Green	GNSS NormalState.Selfsurvey is complete.
Amber	GNSS not shut and not locked
OFF	If GNSS is not configured or is shut.

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 NCS540X 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.

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.

Operation of GNSS Module

Operation of GNSS Module on the N540-24Z8Q2C-SYS, N540-28Z4C-SYS, N540-ACC-SYS, and N540X-ACC-SYS Routers

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 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, the module is also 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.

The GNSS module stays in OD mode until 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 in only the OD mode.

Note GLONASS and BeiDou satellites cannot be enabled simultaneously.

When the router is reloaded, it always comes up in 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 meters from its pre-reloaded condition.

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

Operation of GNSS Module on the N540X-16Z4G8Q2C-A, N540X-16Z4G8Q2C-D, N540X-12Z16G-SYS-A, and N540X-12Z16G-SYS-D Routers, N540X-6Z18G-SYS-A, N540X-6Z18G-SYS-D, N540X-8Z16G-SYS - A, N540X-8Z16G-SYS - D

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

- Self-survey mode - Self-survey is the procedure that is performed prior to using time mode. It determines the position of a stationary receiver by building a weighted mean of all valid 3D position solutions.

  To stop self-survey mode, the following two requirements must be met:

  - The minimum observation time defines a minimum amount of observation time regardless of the actual number of valid fixes that are used for position calculation. Reasonable values range from one day for high accuracy position calculation to a few minutes for coarse position determination.

- The required 3D position standard deviation defines a limit on the spread of positions that contribute to the calculated mean. As the position error translates into a time error when using time mode, you should carefully evaluate the time accuracy requirements and choose an appropriate value.

Self-survey ends when both requirements are met. After self-survey is completed successfully, the receiver automatically enters time-fix mode.

Recommendations

- Self-survey must run for at least twenty-four hours because it is important to cover a full constellation run and a day-night cycle.
- CNO or signal strength for achieving time-fix during self-survey is 35dB.

- Time-fix mode - In order to use the time-fix mode, the exact position of the receiver must be known. The exact position of the receiver is determined by using self-survey. Errors in the fixed position translate into time errors depending on the satellite constellation.

  There is no minimum and maximum value (Time) in the self-survey process and the receiver makes the best effort to achieve the time-fix mode.

  For achieving the time-fix mode, a minimum of four satellites are required and it may take several days to get into the time-fix mode.

  If the position is already known, the module can achieve time-fix mode even if there is only one satellite received.

You can configure the GNSS module to automatically track any satellite or configure it to explicitly use a specific constellation.

When the router is reloaded, it always comes up in the time-fix mode unless the router is reloaded when the self-survey mode is in progress.

Prerequisites for GNSS

To use GNSS, the antenna must see as much as possible from the sky. For proper timing, a minimum of four satellites must be locked. For more information, see the *Cisco NCS 540 Series Router Hardware Installation Guide*.

Restrictions for GNSS

- 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.
- GNSS module is not supported in default profile mode.

Configure GNSS

Configuration Example

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/RP0/CPU0
Router(config-gnss)# no shutdown
Router(config-gnss)# frequency synchronization
Router(config-gnss-freqsync)# selection input
Router(config-gnss-freqsync)# commit
```

Optional Configuration Example

```
Router(config)# gnss-receiver 0 location 0/RP0/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  >>>Values can range from 1 (highest priority) to
 254 (lowest priority). The default value is 100.
Router(config-gnss-freqsync)# wait-to-restore 0
```

Running Configuration

```
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

The following is the output of the **show gnss-receiver** command on the router models.

The following is the output of the **show gnss-receiver** command on the router models - N540-24Z8Q2C-SYS, N540-28Z4C-SYS, N540-ACC-SYS, and N540X-ACC-SYS.

```
RP/0/RP0/CPU0:R6# 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
```

The following is the output of the **show gnss-receiver** command on the router models - N540X-16Z4G8Q2C-A, N540X-16Z4G8Q2C-D, N540X-12Z16G-SYS-A, N540X-12Z16G-SYS-D, N540X-6Z18G-SYS-A, N540X-6Z18G-SYS-D, N540X-8Z16G-SYS - A, N540X-8Z16G-SYS - D.

```
RP/0/RP0/CPU0:ios#show gnss-receiver
Sun Sep 29 09:25:29.477 UTC
GNSS-receiver 0 location 0/RP0/CPU0
    Status: Available, Up
    Position: 12:56.18 N 77:41.77 E 0.823km
    Time: 2019:10:24 11:32:21 (UTC offset: 0s)
    Locked at: 2019:09:29 09:19:20
    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: 0.450
    Constellation: Auto, Satellite Count: 5
    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     GLONASS         28.000     19.000    342.000
          7   n/a   On     On     GLONASS         25.000     30.000     91.000
          8   n/a   On     On     GLONASS         25.000     42.000     28.000
         10   n/a   On     On     GLONASS         33.000     54.000    211.000
         11   n/a   On     On     GLONASS         33.000     78.000    217.000
```