Global Navigation Satellite System

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Global Navigation Satellite System

Industrial automation and control, utilities, and military networks require large numbers of devices in their networks to have an accurate and synchronized view of time. Some Cisco Catalyst IE9300 Rugged Series Switches switches have a built-in Global Navigation Satellite System (GNSS) receiver, which enables the switch to determine its own location and get an accurate time from a satellite constellation.

After the switch gets an accurate time, it can become the source (Grand Master Clock) for time distribution in the network. GNSS capability simplifies network synchronization planning and provides flexibility and resilience in resolving network synchronization issues in a hierarchical network.

Note Only IE9320 GE Fiber (IE-9320-22S2C4X-E and IE-9320-22S2C4X-A) switches have GNSS receiver.

The GNSS receiver is on the front of IE9320 GE Fiber switches, and it has LEDs that enable you to monitor the feature's status. For more information, see the section "GNSS Antenna" in the *Cisco Catalyst IE9300 Rugged Series Switch Hardware Installation Guide*.

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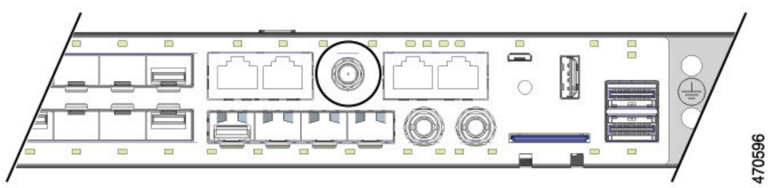
You configure the GNSS receiver by using the CLI. See the section Configure GNSS, on page 5 in this guide..

GNSS Hardware

Each IE9320 GE Fiber switch has receiver modules designed to provide a precise time pulse for the synchronization of 4G and 5G base stations. Each system has an SMA connector to attach an external GNSS antenna. It can provide current-limited power to power an active (amplified) antenna. For more information, see GNSS Signaling, on page 3 in this guide.

The following illustration shows the placement of the connector on the front panel of IE9320 GE Fiber switches. The receiver is circled in the illustration.

Figure 1: SMA connector for GNSS Antenna



The GNSS receiver supports multiple satellite constellations as shown in the following table.

Band	Frequency	Constellations
L1	1602MHz 1575.42 MHz	Auto, GPS, GLONASS, QZSS, Galileo
	1561.098 MHz	BeiDou
L5	1176.45 MHz	GPS, QZSS, Galileo, BeiDou, NavIC

LEDs above the connector enable you to monitor GNSS status.

LED	Color	System Status
GPS	Off	GNSS is not configured.
	Solid Green	Active with satellite fix.
	Blinking Green	Attempting to acquire satellite fix.
	Blinking Amber	Antenna Fault.

GNSS Software

The GNSS feature is available with the base license for IE9320 GE Fiber (IE-9320-22S2C4X-E and IE-9320-22S2C4X-A) switches. GNSS software performs the following functions:

- Configures the GNSS receiver.
- After the receiver has gained lock, performs the following functions once per second:
  - Reads the new time and date.

- Reads the corresponding PPS timestamp from the hardware.
- Feeds time/date and PPS timestamp into the Time Services SW Virtual Clock/Servo for GNSS.

  The GNSS SW Virtual Clock time can then be used to drive PTP output.

GNSS Signaling

There are two stages in the process for the GNSS receiver to acquire satellites and provide timing signals to the host system:

- **Self-Survey Mode:** On reset, the GNSS receiver comes up in self-survey mode and attempts to lock on to a minimum of four different satellites to obtain a 3-D fix on its current position. It computes nearly 2000 different positions for these satellites, which takes about 35 minutes. Also during this stage, the GNSS receiver is able to generate accurate timing signals and achieve "Normal (Locked to GPS)" state. Note that the timing signal obtained during self-survey mode can be off by 20 seconds; therefore, Cisco IOS collects PPS only during OD mode.

  After the self-survey is complete, the results are saved to the GNSS receiver flash, which speeds up the transition to OD mode the next time the self-survey runs. You can manually restart the self-survey process with the **gnss self-survey restart** Cisco IOS command. After self-survey mode completes again, the results in the GNSS receiver flash are overwritten with the updated results.

- **Over-determined (OD) clock mode:** The device transitions to OD mode when self-survey mode is completed and the position information is stored in non-volatile memory on the device. In this mode, the GNSS receiver outputs timing information based on satellite positions obtained in self-survey mode.

  The GNSS receiver remains in OD mode until there is a reason to leave it, such as:

  - Detection of a position relocation of the antenna of more than 100m, which triggers an automatic restart of the self-survey.
  - Manual restart of the self-survey using the **gnss self-survey restart** command.

After the GNSS receiver locks on to a satellite system, it sends a 10ms wide PPS pulse and the current time/date according to the satellite system to the Cisco IOS time service.

GNSS Antenna Requirements

GNSS RF Input

GNSS input requires a GPS/GNSS receive antenna with built-in low-noise amplifier (LNA) for optimal performance. The LNA amplifies the received satellite signals:

- To ccompensate for cable loss
- To increase the signal amplitude to a suitable range for the receiver front-end

  The amplification required is 22dB gain + cable loss + connector loss.

The recommended range of LNA gain (LNA gain minus all cable and connector losses) at the connector of the receiver input is 22dB to 30dB with a minimum of 20dB and a maximum of 35dB.

- The GPS/GNSS input on the switch provides 3.3 or 5VDC (software configurable) to the antenna through the same RF connector. The antenna should draw between 10 and 100mA. An antenna that draws less than 10mA may wrongly report and "Antenna Open" fault even though the antenna is operating properly.

Power Input

When deployed in a hazardous environment the antenna shall only use power provided by the RF input from a single switch. No additional power may be supplied to the antenna and associated equipment.

Caution Supplying additional power, such as with a powered splitter or amplified repeater, may provide enough energy to create an arc that could ignite the explosive atmosphere.

Surge Protection

The GNSS input has built-in ESD protection. If an outdoor antenna is being connected, additional surge protectionis required to meet the regulations and standards for lightning protection in the countries where the end product is installed.

The lightning protection must be mounted at the place where the antenna cable enters the building. The primary lightning protection must be certified for conducting all potentially dangerous electrical energy to PE (protective earth). Surge arrestors should support DC-pass and be suitable for the GPS/GNSS frequency range with low RF attenuation.

Caution The antenna terminal should be earthed at the building entrance in accordance with the ANSI/NFPA 70, the National Electrical Code (NEC), in particular Section 820.93, Grounding of Outer Conductive Shield of a Coaxial Cable.

Antenna Sky Visibility

GPS signals require a direct line of sight between antenna and satellite. The antenna should see as much of the sky as possible. Fixed installations require four satellites in view for an initial time fix, while subsequent updates may be possible with fewer satellites.

Guidelines and Limitations

The following are guidelines and limitations for GNSS on IE9320 GE Fiber (IE-9320-22S2C4X-E and IE-9320-22S2C4X-A) switches:

- GNSS is supported only on IE9320 GE Fiber switches; no other Cisco Catalyst IE9300 Rugged Series Switches support GNSS.
- GNSS is available as a timing source for PTP default and power profiles only.

- GNSS is available as a timing source for PTP only when PTP is in GMC-default mode.
- GNSS is disabled by default.
- Syslog messages are sent when the following GNSS events occur:
  - GNSS is in self-survey mode.
  - GNSS has completed self survey.
  - GNSS firmware upgrade is in progress, complete, or failed.
- If the switch is the PTP grandmaster clock and it loses the antenna signal, the clock quality will degrade, resulting in a grandmaster clock switchover.

  The GPS antenna alarm will not trigger an external relay alarm.

Configure GNSS

Complete the following steps to configure GNSS. To disable GNSS after it is enabled or to remove a GNSS parameter configuration, use the **no** form of the commands as shown in the following steps.

Note Configuring GNSS parameters is optional if you use the defaults, shown in the following table:

Parameter	Description	Default
cable-delay	Amount of time to compensate for cable delay in nanoseconds	0
constellation	Satellite constellation that GNSS detects GPS and locks to	auto

Before you begin

Refer to the documentation for your GNSS antenna to determine the antenna's power input voltage.

Step 1 Enter global configuration mode:

```
Switch# configure terminal
```

Step 2 Enable GNSS:

```
Switch(config)# gnss
```

Step 3 (Optional) Configure the GNSS constellation:

```
Switch(config-gnss)#[no] constellation {auto | beidou | galileo | glonass | gps}
```

- **auto**: Enables detection of the following constellations: GPS, GLONASS, QZSS.
- **beidou**: Enables detection and locking to the BeiDou constellation.

- **galileo**: Enables detection and locking to the Galileo constellation
- **glonass**: Enables detection and locking to the GLONASS constellation.
- **gps**: (Default) Enables detection and locking to the GPS constellation.

Note Only one constellation is active at any given time.

Step 4 (Optional) Restart the self-survey process:

```
Switch# gnss self-survey restart
```

This command deletes the stored reference position and restarts the self-survey process. After self-survey mode is complete, the new reference position is saved to the GNSS chip flash.

Use this command when the switch is moved to another location.

What to do next

Configure GNSS as the PTP Time Source

Complete the following steps to select the time source for PTP.

When the source is configured, the clock is active, and GNSS is in normal state, the GNSS PPS and timestamp string are used as input to PTP.

Before you begin

Ensure that the PTP clock is active and GNSS is enabled and in normal state. For more information about PTP configuration, see the chapter "Precision Time Protocol" in this guide.

Complete one of the following steps, depending on the profile.

Option	Description
If you choose...	Then...
Default profile	Enter the following command, as shown in the following example: `switch# ptp clock boundary domain 0 pr ofile default`
Power profile	Enter the following command, as shown in the following example: `switch# ptp clock boundary domain 0 profile power`

Verifying GNSS Configuration

This section lists CLI commands that you can use on a IE9320 GE Fiber (IE-9320-22S2C4X-E and IE-9320-22S2C4X-A) switch to verify the GNSS configuration. The section also provides examples of the command output.

Configuration Commands

Command	Purpose
`show gnss status`	Displays the GNSS status.
`show gnss satellite {all | satellite-number}`	Displays status of satellites tracked by GNSS. The signal strength is displayed in the form *carrier-to-noise density* (C/N0). The Signal Strength unit is dB-Hz and refers to the ratio of the carrier power and the noise power (dB) *per unit bandwidth* (Hz). Received satellite signal power varies with user antenna gain, satellite elevation angle, and satellite age. Typical C/N0 range is from 35–55 dB-Hz.
`show gnss time`	Displays GNSS time.
`show gnss location`	Displays GNSS location.
`show gnss device`	Displays the output of the GNSS receiver properties.

Configuration Command Examples

Command: `show gnss status`

The following example shows the `show gnss status` command and its output on a

```
Switch#show gnss status
GNSS status:
  GNSS status: Enable
  Clock Progress: Locked
  GNSS Fix Type: time only fix
  Receiver Status: OD
  Survey Progress: 100
  Constellation: AUTO
  Satellite count: 29
  PDOP: 1.18  TDOP: 1.00
  HDOP: 0.57  VDOP: 1.03
  Major Alarm: False
  Minor Alarm: False
```

Command: `show gnss satellite`

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

SV ID  Channel  Eph Flag  SV Used  CNR  Azimuth  Elevation  Health  Quality

-----------------------------------------------------------------------------------
```

```
 9    0    0  Used  15    0    0   -   -
 2    1    1  Used  45  102   28   -   -
19    2    1  Used  36  209   10   -   -
20    3    1  Used  30  354   29   -   -
27    4    0  Used  36    0    0   -   -
26    5    1  Used  42  354   38   -   -
18    6    1     -  44  346   34   -   -
 6    7    1  Used  39  101   32   -   -
12    8    0     -  29    0    0   -   -
 3    9    0  Used  42    0    0   -   -
 8   10    0  Used  14   38   14   -   -
 7   11    1  Used  46   62   64   -   -
33   12    0  Used  29    0    0   -   -
15   13    1     -  47   45   52   -   -
13   14    1  Used  43   65   37   -   -
24   15    1     -  45  128   23   -   -
32   16    0     -  44    0    0   -   -
25   17    1     -  43  194   20   -   -
21   18    1  Used  44  212   24   -   -
29   19    1     -  48  148   81   -   -
23   20    1     -  42  304   44   -   -
10   21    1     -  42  266   25   -   -
18   22    1  Used  43  120   19   -   -
 4   23    1  Used  27   22   19   -   -
26   24    0     -  37    0    0   -   -
 5   25    1  Used  49  352   67   -   -
15   26    0  Used  36    0    0   -   -
19   27    1  Used  38   77   46   -   -
 6   28    1  Used  37  225   37   -   -
```

Command: `show gnss time`

```
Switch#show gnss time
Current GNSS Time:
  Time: 2023/08/28  04:52:50 UTC
```

Command: `show gnss location`

```
Switch#show gnss location
Current GNSS Location:
  LOC: 0:13.547093 N  1:21.362719 E  827.67 m
```

Command: `show gnss device`

```
Switch#show gnss device
GNSS device:
  Model: RES SMT 720
  Hardware version: 0
  Protocol version: TSIP 1.0
  Firmware version: 1.0
  Unique Chip ID: 8FB67B12
  Major GNSS Satellites supported: GPS;GLO;GAL;BDS
```

Feature History for GNSS

The following table provides release and related information for the features that are documented in this guide. The features are available in all the releases after the one they were introduced in, unless noted otherwise.

Release	Feature	Feature Information
Cisco IOS XE Dublin 17.12.x	Global Navigation Satellite System (GNSS)	IE9320 GE Fiber switches have a built-in GNSS receiver. The receiver enables the switch to determine its own location and get an accurate time from a satellite constellation.