



# NavView User Guide – 13 Timing

Document: 4DN\_NVUG\_S13\_01A

Release: 01

Revision: A

Released: 6/12/2024

4D Nav, LLC

REL	REV	ISSUE DESCRIPTION	PREPARED	REVIEWED	APPROVED	DATE
01	A	Initial release	SW	GAW	GAW	June 12, 2024

© Copyright 2024 4D Nav LLC

Unless explicitly stated otherwise, all rights including those in copyright in the content of this document are owned or controlled by 4D Nav LLC (4D Nav). Except as otherwise expressly permitted under copyright law or by 4D Nav, the content of this document may not be copied, reproduced, republished, downloaded, posted, broadcast, or transmitted in any way without the written permission of 4D Nav.

# Table of Contents

- 13. Timing.....1
- 13.1 Synchronization.....1
- 13.2 Configuring Time Synchronization.....1
- 13.2.1 Synchronize PC Time .....4
- 13.3 SNTP Server.....7
- 13.4 GNSS Time (GPS Leap Seconds) .....9
- 13.5 Monitoring Synchronization .....9
- 13.6 Data Time Stamping.....10

## 13. TIMING

NavView supports precise timing and time stamping of data using both absolute and relative timing. It utilizes the .NET Framework high resolution Stopwatch timer that enables NavView to measure the elapsed time since start-up with a precision of approximately 100 nanoseconds. This elapsed time since start-up is referred to as *system time*. The system time is converted to Universal Time Coordinated (UTC) by adding a UTC offset. If NavView is synchronized to an external UTC time source, this offset is determined using a synchronization algorithm. The conversion of system time to synchronized UTC is only performed at the presentation level, either to the user-interface or to an output (file, I/O, etc.).

If Roles and Privileges are enabled, the user must be logged in with Supervisor or Administrator privileges.

### 13.1 SYNCHRONIZATION

NavView supports the synchronization of system time to UTC time by computing the offset of the system time from an external UTC time reference using a robust filtering algorithm. The external time reference can be the local PC clock, a 1 PPS pulse and corresponding message, a device input message that contains UTC time (e.g., \$--ZDA) or the **4D Nav Network Services**.

If Network Time Protocol (NTP) or similar is used to synchronize the PC clock, NavView determines the offset from system time to the UTC reference by sampling the local clock and the system time. The difference between these two values is the filter input value.

If NavView is synchronized to 1PPS, each pulse is time stamped with system time and the associated UTC reference time is extracted from the corresponding input message. The difference between these two times is the filter input value.

If NavView is synchronized to an input message time, then each message is time stamped with system time and the UTC time reference value is extracted from the message. The difference between these two times is the filter input value.

If NavView is synchronized to the Network Services, then each network timing message is time stamped with system time and the UTC time reference value is extracted from the message. The difference between these two times is the filter input value. This option requires that one of the NavView clients on the network is synchronized using one of the above options.

### 13.2 CONFIGURING TIME SYNCHRONIZATION

1. Identify the method of synchronization to be used.
  - a. If synchronizing to a 1PPS input, add and configure the NMEA Input device accordingly. See the Devices Section and NMEA Input Device document for details

**Note:** The 1PPS input option is only available for NMEA Input devices using a serial port.

- b. If synchronizing to a message, e.g., NMEA ZDA, add and configure the NMEA Input device accordingly. See the Devices Section and NMEA Input Device document for details
  - c. If an NTP is in use, no device is required
  - d. If using Network Services, ensure Network Services are enabled and one of the NavView clients on the network are configured to Publish the time sync over the network
2. From the Configure section of the Setup tab ribbon, click the **Time Sync** button (see Figure 13-1). This will open the Time Synchronization Configuration dialog, see Figure 13-2. Time Sync can also be setup from the project Explorer, see Figure 13-3



FIGURE 13-1 TIMING – SETUP RIBBON – TIME SYNC BUTTON

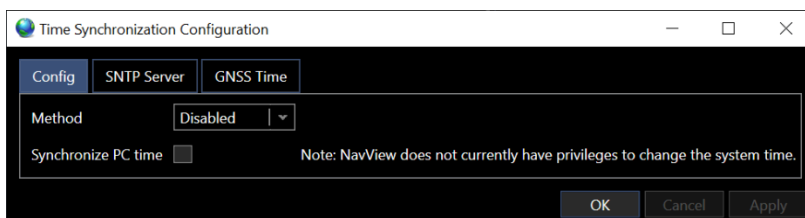


FIGURE 13-2 TIMING – TIME SYNCHRONIZATION CONFIGURATION DIALOG – SETUP RIBBON

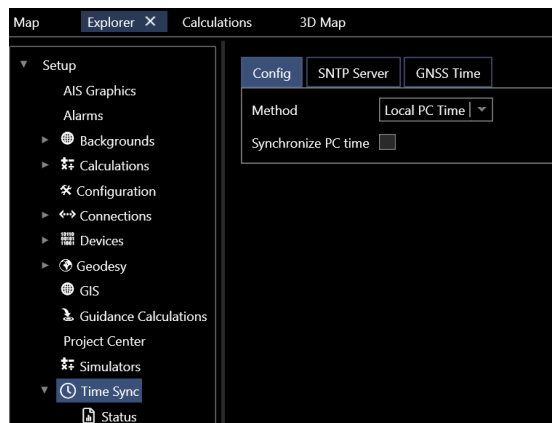


FIGURE 13-3 TIMING – TIME SYNCHRONIZATION CONFIGURATION DIALOG – EXPLORER

- 3. Select **Method** for time synchronization from the drop-down list.

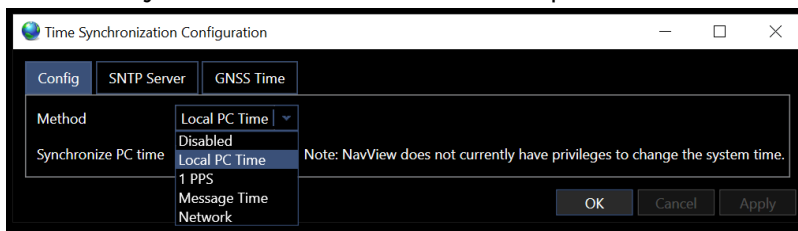


FIGURE 13-4 TIMING – AVAILABLE TIME SYNC METHODS

- a. **Disabled:** Select if NavView is not to be synchronized to a reference time

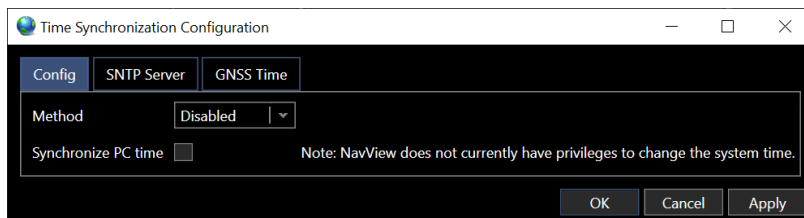


FIGURE 13-5 TIMING – TIME SYNC - DISABLED

- b. **Local PC Time:** Select if a NTP (PC clock synchronized over the internet) is in use and NavView is to be synchronized to the PC clock

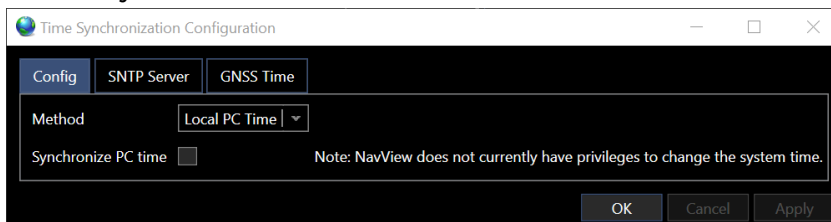


FIGURE 13-6 TIMING - TIME SYNC – LOCAL PC TIME

- c. **1 PPS:** NavView is to be synchronized to a 1 PPS input. From the drop-down list, select the device that is the source of the 1 PPS.

**Note:** This requires an NMEA Input device configured for 1PPS.

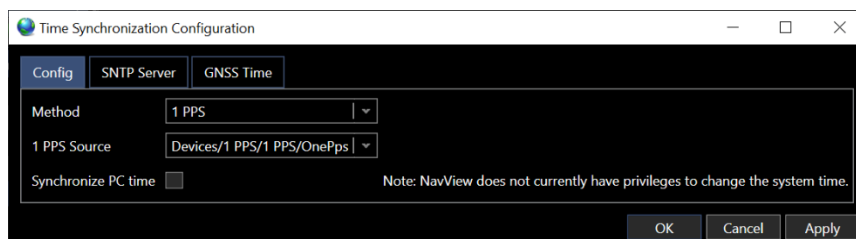


FIGURE 13-7 TIMING - TIME SYNC – 1 PPS

- d. **Message Time:** NavView is to be synchronized to a NMEA message time

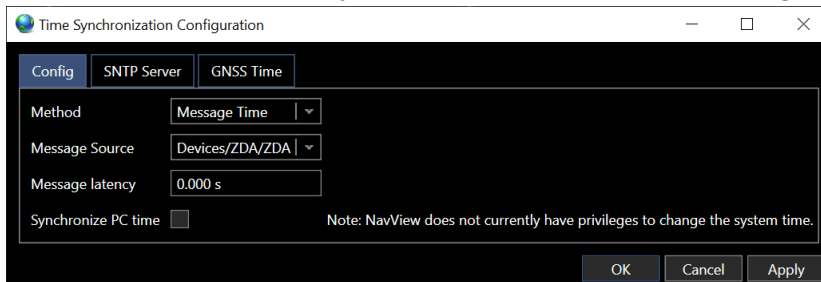


FIGURE 13-8 TIMING - TIME SYNC – MESSAGE TIME

- **Message Source:** From the drop-down list, select the device and message that is the source of the message to be used, e.g., ZDA
- **Latency:** Delay (seconds) from when the ZDA message leaves, in this example, the GPS receiver and arrives at the NavView PC. This would vary depending on mode of transmission

- e. **Network:** Select to receive time message published from a licensed NavView client on the network that is configured to provide time sync over the network using Network Services

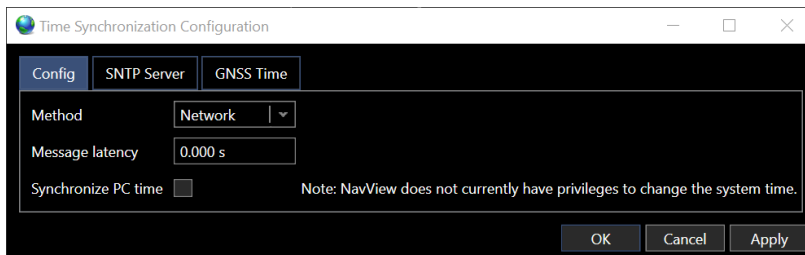


FIGURE 13-9 TIMING – TIME SYNC – NETWORK

- **Latency:** Delay (seconds) from when the time message leaves the NavView client publishing the time message and arrives at the NavView subscribing to message with Network Services.

### 13.2.1 SYNCHRONIZE PC TIME

NavView has the option of synchronizing the PC time using an external message such as ZDA when the PC is not connected to the internet to acquire a time sync from a NTP source. This is done by checking the **Synchronize PC time** box. In order for NavView to be able to set the PC time it needs to have SE\_SYSTEMTIME\_NAME privileges. This can be done by 1 of 2 methods:

1. Right click on the NavView shortcut icon then select “Run as administrator”, see Figure 13-10

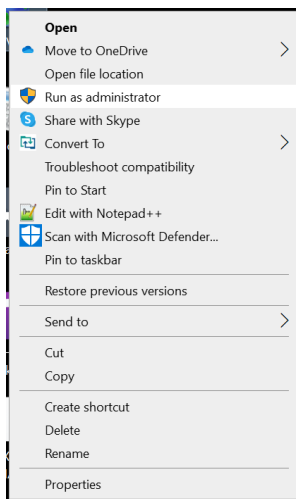


FIGURE 13-10 TIMING – SYNCHRONIZE PC TIME – RUN AS ADMINISTRATOR

Or..

2. Change SE\_SYSTEMTIME\_NAME privileges, by default only Windows Administrative users have that privilege.
  - a. Go to Local Security Policy > Local Policy > User Rights Assignment
  - b. Select Change the system time, see Figure 13-11

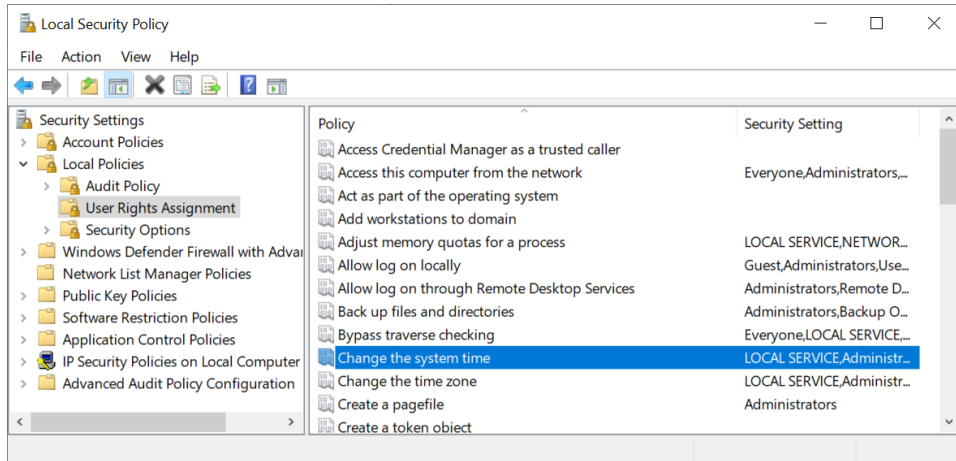


FIGURE 13-11 TIMING – SYNCHRONIZE PC TIME – LOCAL SECURITY POLICY

- c. Right click on Change the system time, select Properties, this opens the “Change the system time Properties” window

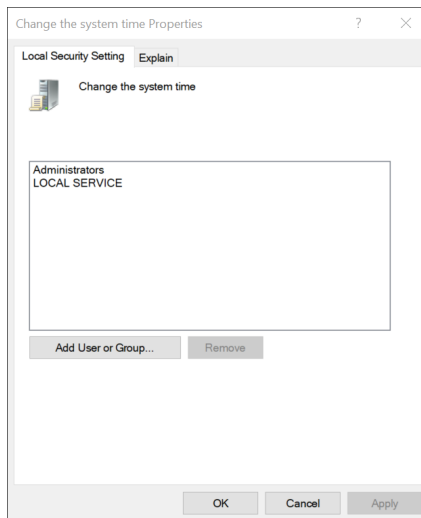


FIGURE 13-12 TIMING – SYNCHRONIZE PC TIME – CHANGE THE SYSTEM TIME PROPERTIES

- d. Click “Add User or Group”, this opens the “Select Users or Groups” window

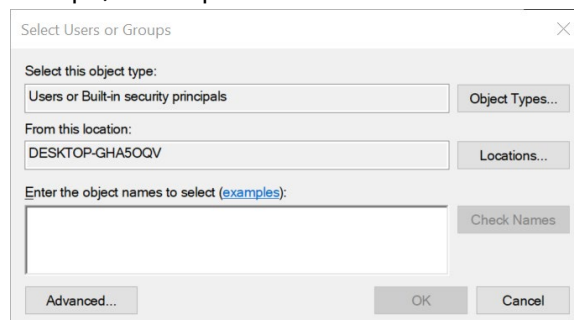


FIGURE 13-13 TIMING – SYNCHRONIZE PC TIME – SELECT USERS OR GROUPS

- e. Click “Advanced”

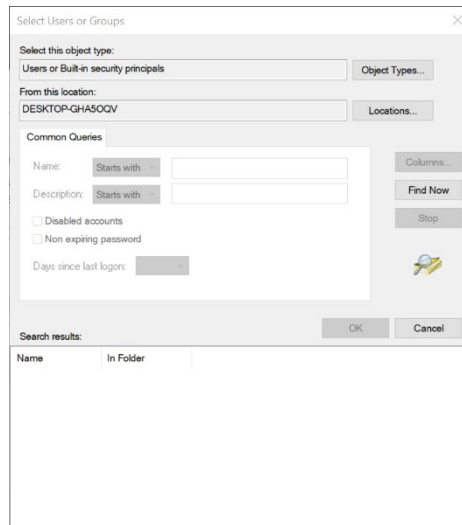


FIGURE 13-14 TIMING – SYNCHRONIZE PC TIME – SELECT USERS OR GROUPS – ADVANCED

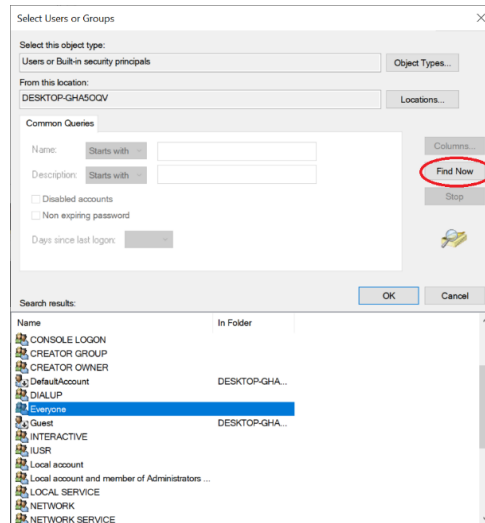


FIGURE 13-15 TIMING – SYNCHRONIZE PC TIME – SELECT USERS OR GROUPS – SELECT NAME

- f. In the Search results select the “Name” to assign the privilege to. In this example **Everyone** is selected. Click Okay, this closes the “Advanced” window. Everyone is visible in the object names panel.
- g. Click okay to close the “Select Users or Groups” window. Everyone is now in the ‘Local Security Setting list. To remove a privilege, select the name then click remove
- h. Click Okay
- i. Close “local Security Policy” window
- j. Restart PC for the change to be set
- k. NavView now has the privilege to Sync the PC time



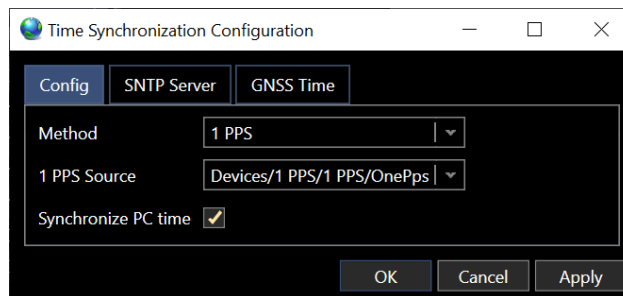


FIGURE 13-16 TIMING – SYNCHRONIZE PC TIME – NAVVIEW WITH SYNC PC TIME PRIVILEGE

### 13.3 SNTP SERVER

NavView has the ability to be used as a SNTP server to provide time synchronization over a network.

In the Config tab select the Method for time syncing the host NavView.

1. Select SNTP Server tab.

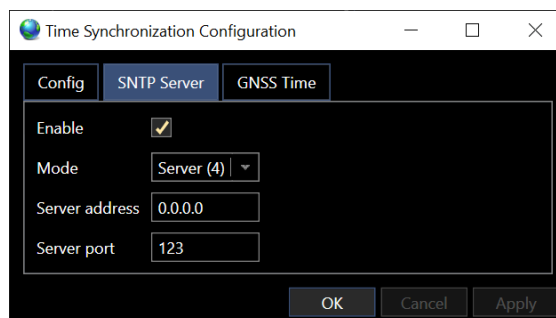


FIGURE 13-17 TIMING – SNTP SERVER CONFIGURATION DIALOG

2. **Enable:** Check box to enable SNTP Server.
3. **Mode:** From the drop-down list select how the NTP message is made available over a network.

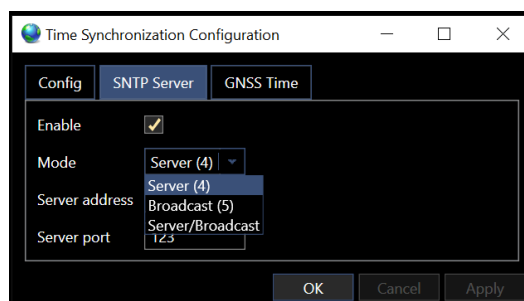


FIGURE 13-18 TIMING – SNTP SERVER – MODES

- a. **Server (4):** Normal NTP server operation mode 4 (server) where clients connect to the server

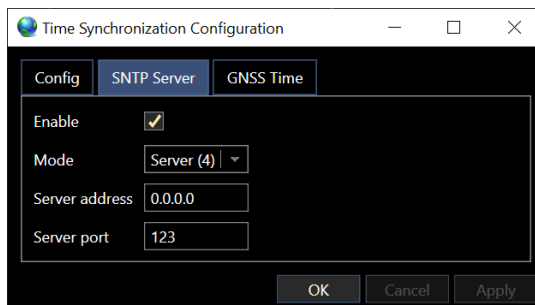


FIGURE 13-19 TIMING – SNTP SERVER – SERVER (4) MODE

- **Server address:** Default is 0.0.0.0, this tells the server to listen for and accept connections from any IP address
- **Server port:** This is the local UDP port the server is connected to. Default is 123

**Note:** Network to be on IPv4. If Firewall enabled, add incoming rule to allow for UDP port 123 traffic on the SNTP.

- b. **Broadcast (5):** Sends unsolicited NTP mode 5 (Broadcast) messages to the **Broadcast address** at the configured **Broadcast interval**

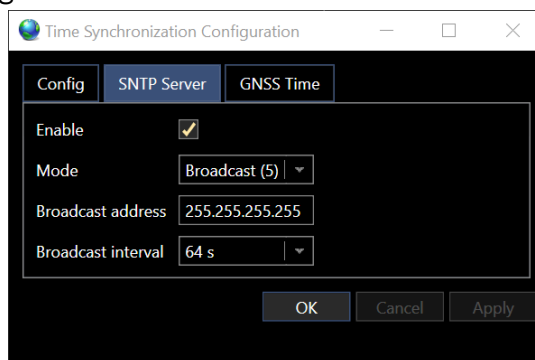


FIGURE 13-20 TIMING – SNTP SERVER – BROADCAST (5) MODE

- **Server address:** Destination broadcast address for unsolicited type 5 messages. This can be a broadcast or multicast address.
  - **Broadcast interval:** Select broadcast interval from drop-down list
- c. **Server/Broadcast:** Select use as Server (4) and Broadcast (5) mode. Configure as shown in Server (4) and Broadcast (5) modes

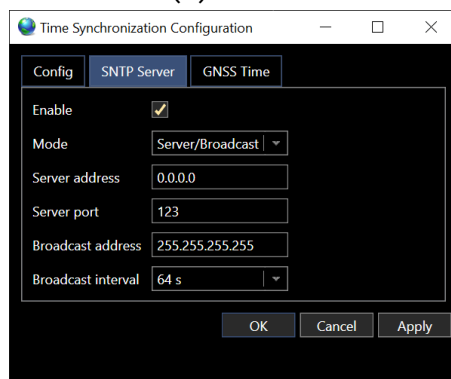


FIGURE 13-21 TIMING – SNTP SERVER – SERVER (4)/BROADCAST (5) MODE

### 13.4 GNSS TIME (GPS LEAP SECONDS)

Leap seconds is the difference between GPS Time and UTC Time (GPS time minus UTC Time). NavView identifies what messages are time stamped with UTC time therefore the leap seconds are ignored. Leap seconds would be applied if the message is time stamped with GPS time.

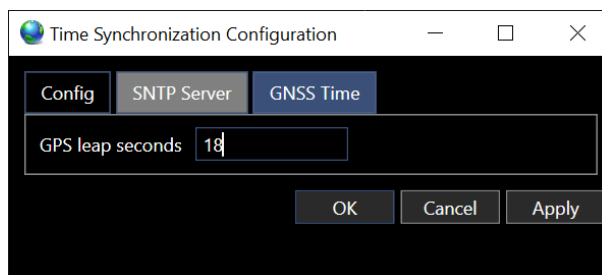


FIGURE 13-22 TIMING – GNSS TIME

- GPS leap seconds:** Enter the leap seconds, GPS minus UTC (default is the leap seconds at the time the respective NavView installation MSI was created).

### 13.5 MONITORING SYNCHRONIZATION

The synchronization is monitored with the Time Sync Status window. The key indicators are the Sync Status and Jitter.

- From the Windows section of the View tab ribbon, click the **Time Sync** button, see Figure 13-23 This will open the Time Sync window, see Figure 13-25. The Time Sync Status can also be viewed from the project Explorer, Time Sync > Status see Figure 13-24.

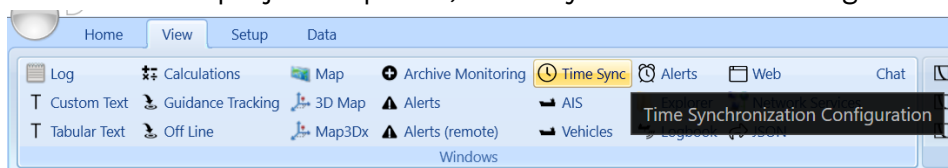


FIGURE 13-23 TIMING - VIEW RIBBON – TIME SYNC BUTTON

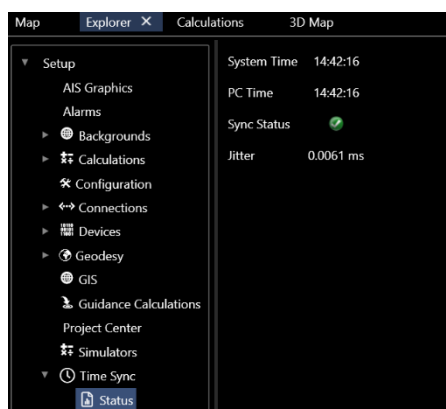


FIGURE 13-24 TIMING - EXPLORER – TIME SYNC STATUS

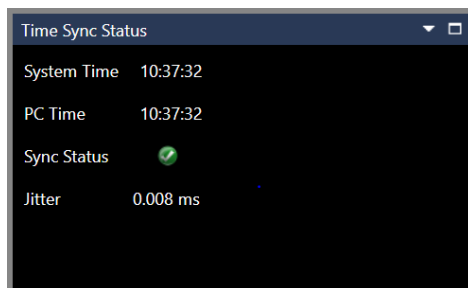




FIGURE 13-25 TIMING – VIEW RIBBON - TIME SYNC STATUS

- **System Time:** Displays NavView system time in Local or UTC as per the Preferences setting
- **PC Time:** Displays the PC time in Local or UTC as per the Preferences setting
- **Sync Status:** LED indicates the status of the data source and synchronization,  indicates the message associated with the configured Method is being received and successfully applied,  indicates it is not (this state is displayed if the synchronization is not enabled)
- **Jitter:** Displays the root mean square (RMS) of the synchronization jitter in seconds, i.e., the variation of the offset of the system time value from the external UTC time reference, cycle to cycle. This should be a small value, e.g., the jitter in Figure 13-25 is an example of synchronizing to a 1PPS signal from a GPS receiver where the jitter is 0.008 milliseconds.

## 13.6 DATA TIME STAMPING

All NavView data and observations are precisely time stamped with system time to an accuracy of 1ms. This includes the data received by a device as well as the observations resulting from a calculation. It is important to note that regardless of the time synchronization method in effect, the system time associated with data and observations is used for epoch matching, interpolation, etc., to ensure precise relative accuracy.

**Note:** In the case of a device, if NavView is synchronized to UTC using 1PPS and the source hardware providing data is also precisely synchronized to UTC and includes a time of data in the data message, it is recommended that the device configuration in NavView be set to use Message time.

The system time is also logged with the raw data. The offset between system time and UTC can be logged to a time file for future reference and post-processing.

When replaying logged raw sensor data, the system time logged with the raw data is used to ensure precise relative timing accuracy between the respective data inputs. The UTC time file is used to provide the respective UTC times.