OUSTER LIDAR

Hardware integration guide

OXTS Survey

Overview

The Ouster OS1-64 is an all-purpose LiDAR that can be used for pointcloud creation in surveying applications or autonomous vehicle aiding. With 64 lasers this model is a mid-range Ouster LiDAR sensor. This guide will use the integration of an OS1-64 LiDAR with an xNAV650 INS as an example, but the principles are the same for all Ouster sensors and OxTS INS devices.

Requirements

For the LiDAR to function correctly with an Inertial Navigation System (INS), it needs to be receiving timing and synchronisation messages. To do this Precision Time Protocol (PTP) can be used to send these messages over ethernet. Alternatively, NMEA messages can be sent over ethernet or serial RS232 and time synchronisation can be done using pulse per second (PPS) signals.

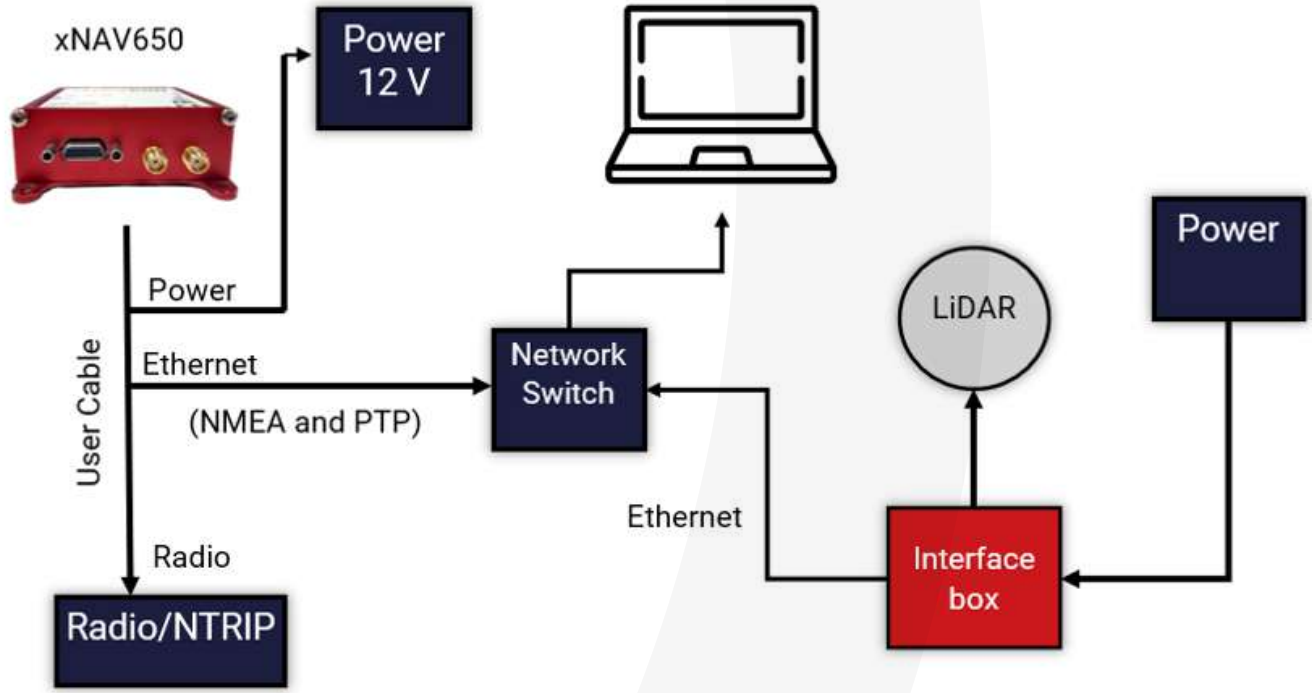
A way to record the LiDAR data must also be considered. The data can be streamed to a PC and recorded using software such as OusterStudio. OusterStudio is recommended as other data capturing software will not automatically piece the packets together.

Hardware

In order to fulfil the requirements above, a cable must be created to communicate between the two devices. The exact design of the cable will depend on your data capturing requirements. The simplest cable setup will be using PTP messages over ethernet. Wiring diagrams are included in the manuals of our INS devices and the Ouster OS1-64 manual to give you all the necessary information.

PTP Setup Diagram

An example setup using PTP:



PPS Setup

The following will use information about the xNAV650 user cable which is included towards the end of the xNAV650 user manual. Similarly, wiring information is included in the manuals of Ouster's products. NMEA and PPS messages must be sent from the INS to the LiDAR, PPS must be sent over the dedicated wire, and NMEA can be sent over serial or over ethernet.

Signal	xNAV650 Cable J1 Pin	xNAV650 Cable Wire Colour	Ouster Wire
RS232 RX	3	Red	(Not needed)
RS232 TX [SENDS NMEA]	4	Orange	Green, pin 1 [MULTIPURPOSE_IO]
Signal ground	11	White/Black	Black, pin 5 [GROUND]
PPS [SENDS PPS]	12	White/Brown	White, pin 9 [PPS_SLAVE]
Signal ground	13	White/Red	(Not needed)
I/O signal 2	9	Grey	(Not needed)
I/O signal 1	10	White	(Not needed)
Power +	2	Brown	Red, pin 10 [VCC_24]
Power -	1	White/Yellow	Black, pin 5 [GROUND]

Ouster units require a higher signal voltage (at least 3.3 V) for PPS and serial messages and therefore an adapter is needed between the INS, serial and PPS output and the Ouster interface box.

It is entirely possible to put a connector (eg M12) onto the INS user cable and to match this to a connector placed on the Ouster unit. NMEA, PPS and power can all be sent through this new connection and there is no need to use the interface box. Furthermore, if the unit is the OS1-16 then LiDAR data can be logged directly onto the INS but if it is a unit with more lasers, it will need to have an ethernet breakout to a separate logging device (eg PC). This is particularly useful on UAV applications so that only one power source connection is needed. When space is limited a Y cable can be used to deliver power from a source to both the INS and LiDAR.

To make a single connection and log data onto the INS you will need to match the ethernet output wires of the LiDAR to the ethernet input wires on the INS, in doing this you may want to also have a breakout cable to view data live on a PC.

Additional Notes

/ If you are using both the xNAV and LiDAR through an ethernet switch or into a PC through different ethernet connections, then the connections will have to be put onto the same IP range.

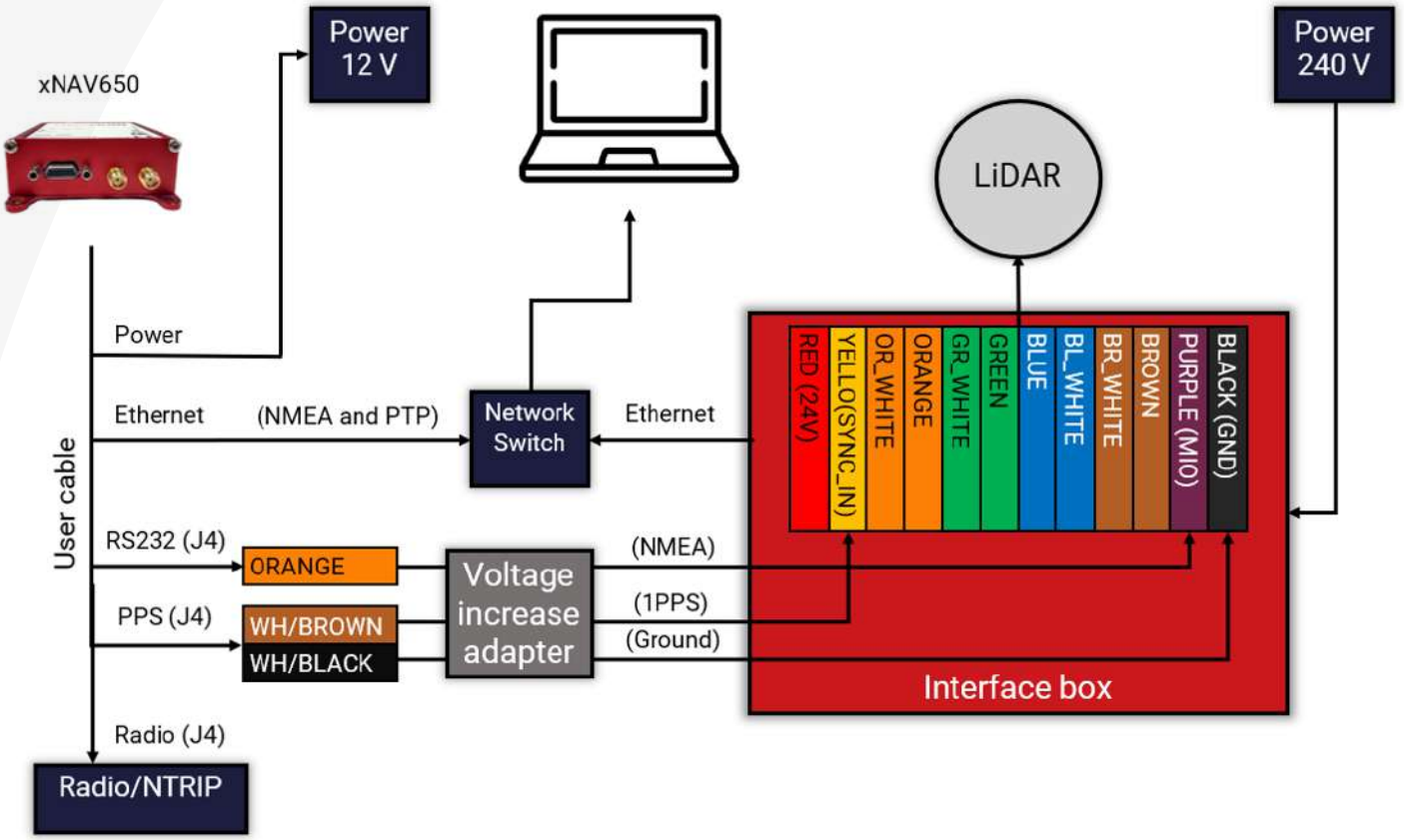
/ These PIN numbers apply to the xNAV650 device. The same principle applies to all OxTS INS devices, however the PIN numbers for the signals will depend on the INS in use due to the different connector types.

/ When working with high data rate LiDAR units it is often necessary to use a gigabit ethernet switch.

/ Check with Ouster whether removing the interface box will void the warranty. More information can be found in the LiDAR manual.

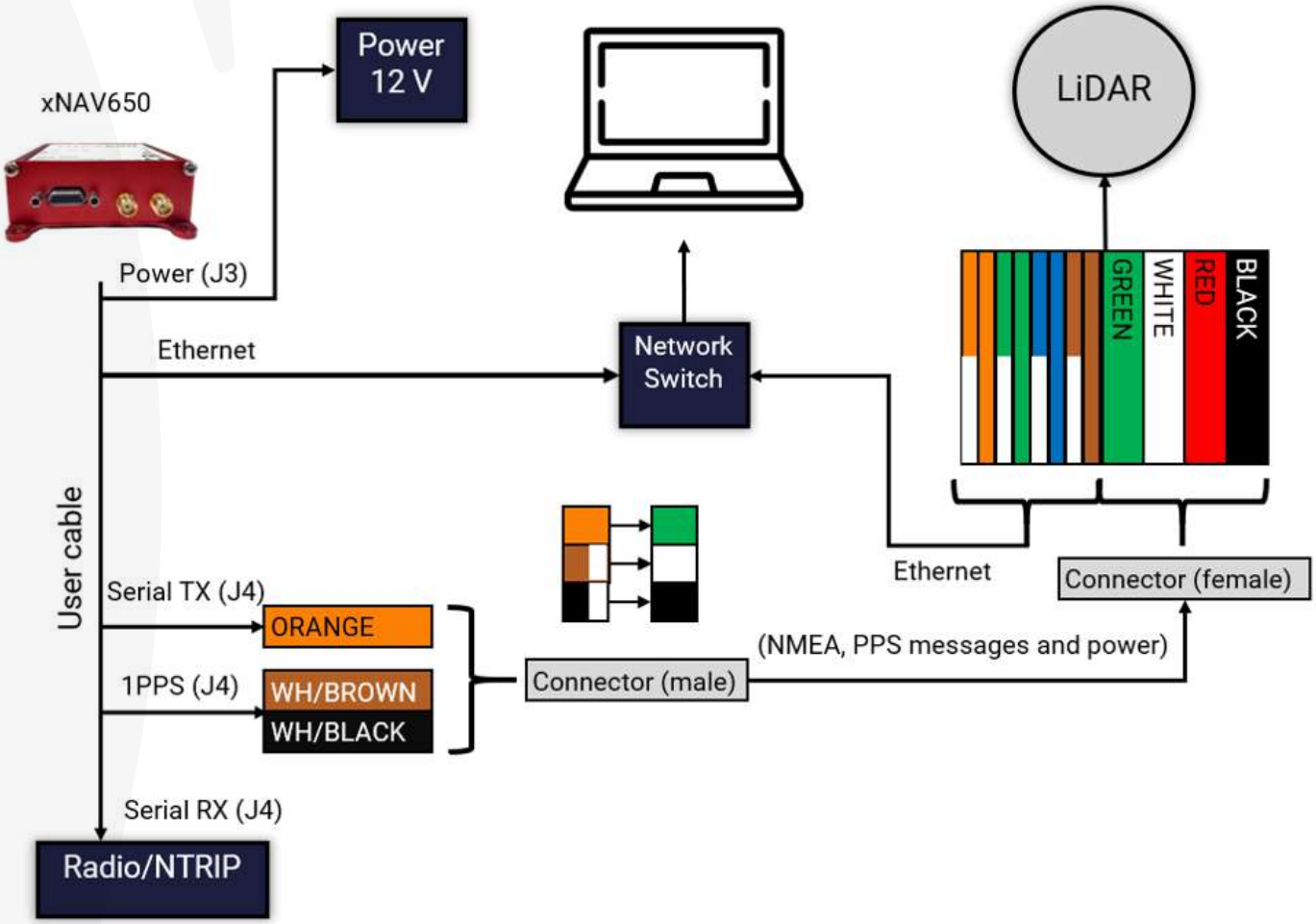
PPS Setup Diagram

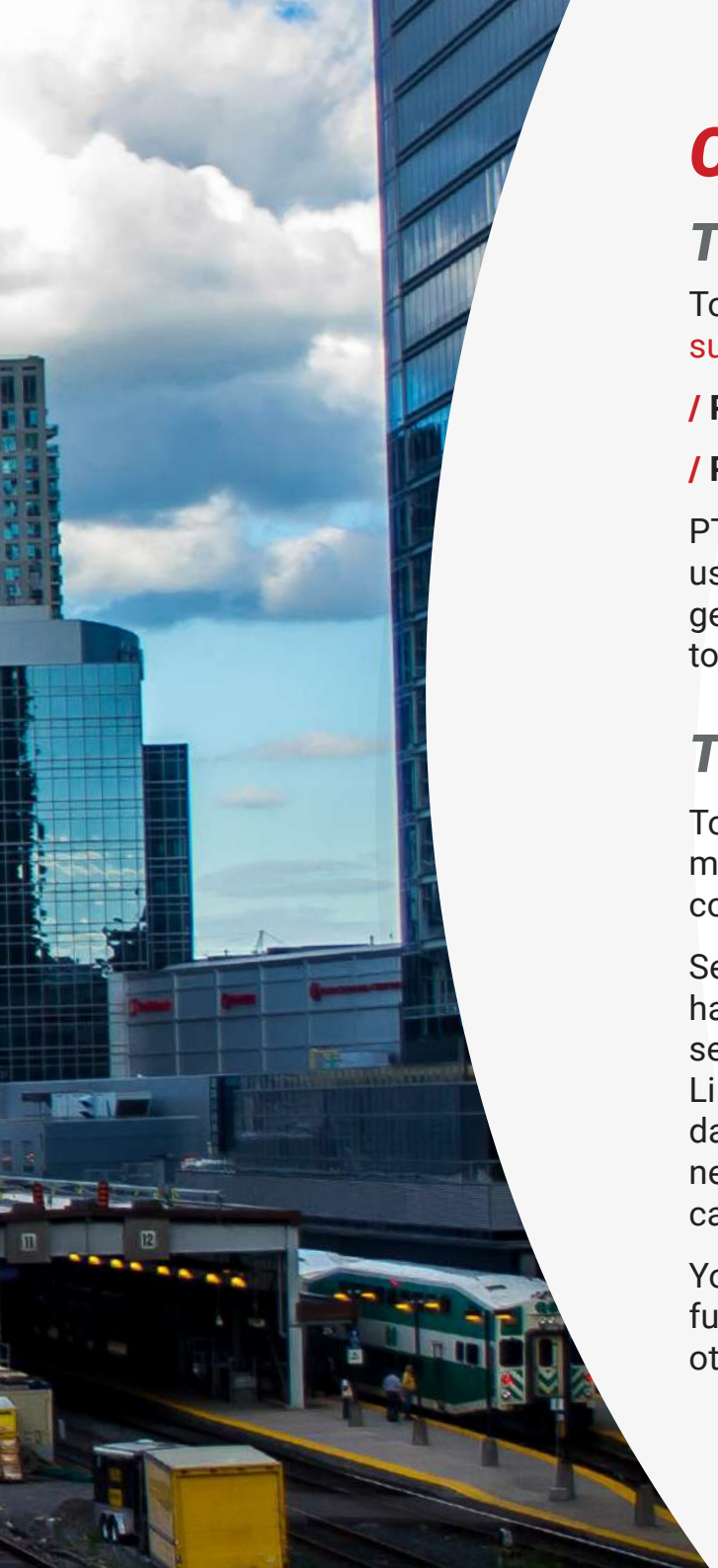
PPS and NMEA messages can be sent using a traditional PPS setup using the interface box:



Direct Connection Setup Diagram

PPS and NMEA messages can be sent using a direct connection:





Configuration

Time synchronisation using PTP

To help configure PTP several support articles are available on the OxTS support site support.oxts.com. These include:

/ **PTP quick start guide** - view article

/ **PTP time modes** - view article

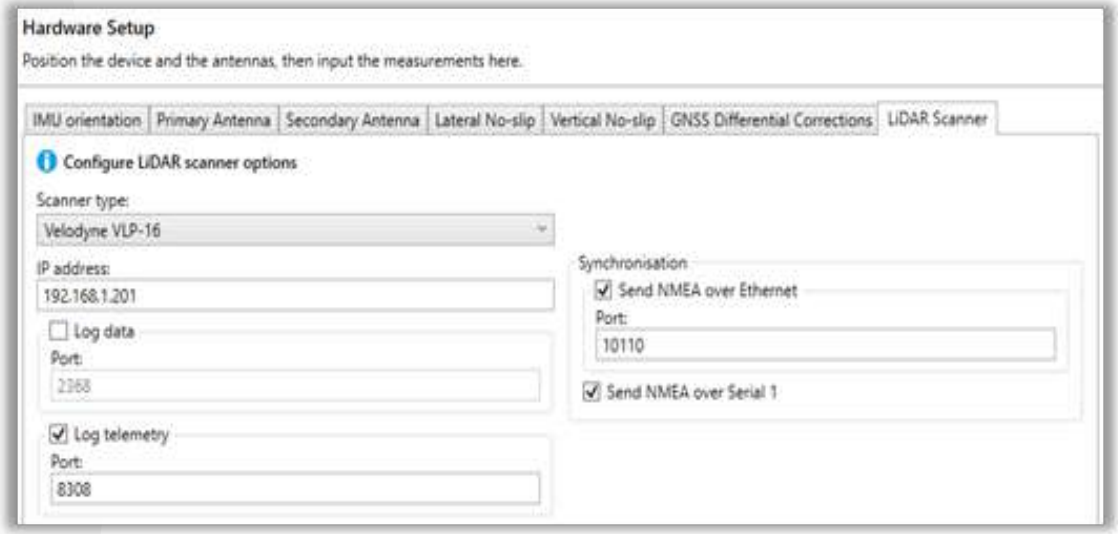
PTP can be configured with different time offsets for different time epochs, the Ouster uses Unix time. If you find you have the wrong time epoch and you are using OxTS' LiDAR georeferencing software, OxTS Georeferencer, a command can be added in post-processing to correct the timing.

Time synchronisation using PPS

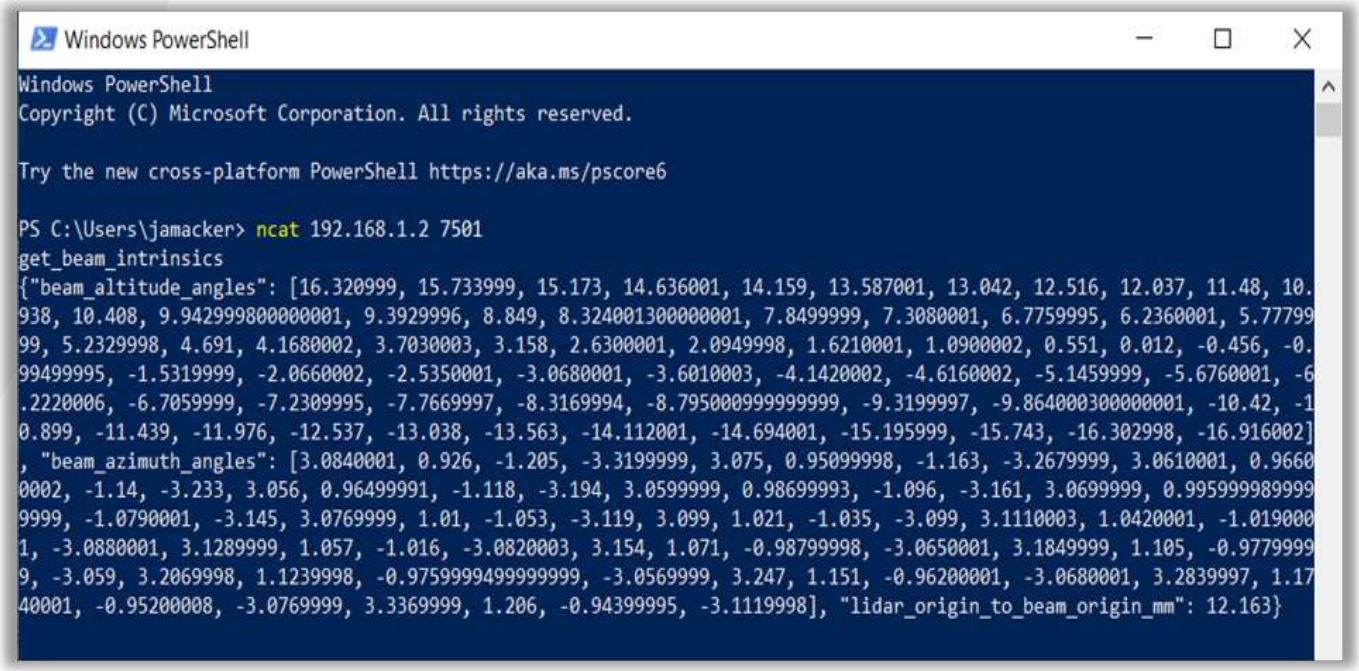
To configure your INS device to work with the required LiDAR, ensure that the correct messages are being sent. This can usually be done on the LiDAR Scanner tab of OxTS' complimentary INS device configuration software, NAVconfig.

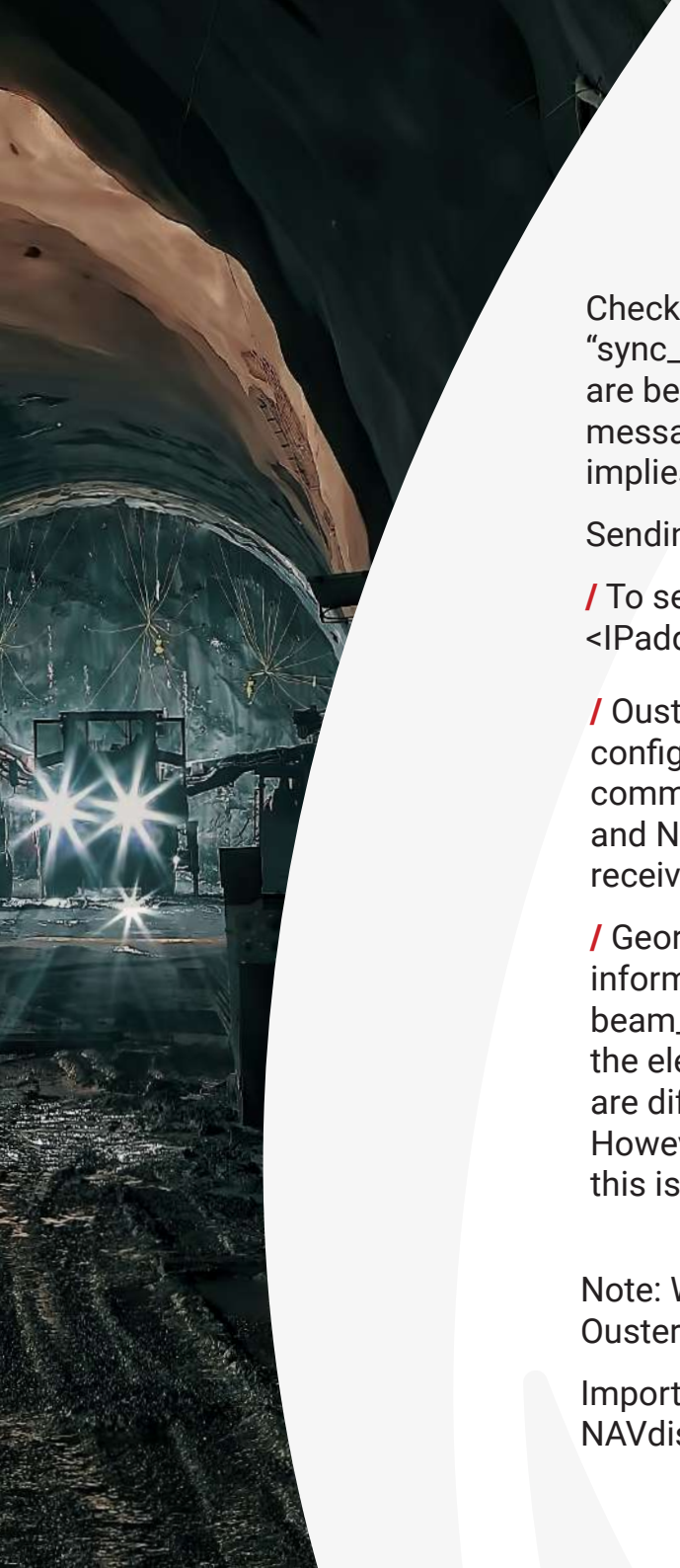
Select Velodyne VLP-16 (regardless of your Ouster LiDAR) from the drop-down. If your cable has been created to send NMEA over ethernet, check this box, if it has been created for serial NMEA then check that box. Data logging does not work between the INS and Ouster LiDAR due to the high data rate so make sure that the two boxes for losing telemetry and data are unchecked or the CPU can be overloaded. The IP address of the LiDAR unit is needed if you are sending NMEA over ethernet but a broadcast address of 255.255.255.0 can also be used.

You do not have to use the LiDAR Scanner tab, these settings can also be applied with further options in the Interfaces section of NAVconfig. A different type of NMEA message other than GPRMC can be selected here.



Before you begin collecting data, if you have an ethernet connection to the Ouster unit available then you can check the web interface to see that PPS or PTP time synchronisation messages are being received, NMEA messages have been received and the position coordinates are updating. To do this, Ouster requires a TCP command to be sent 'get_ time_info'. A message will appear looking like this:





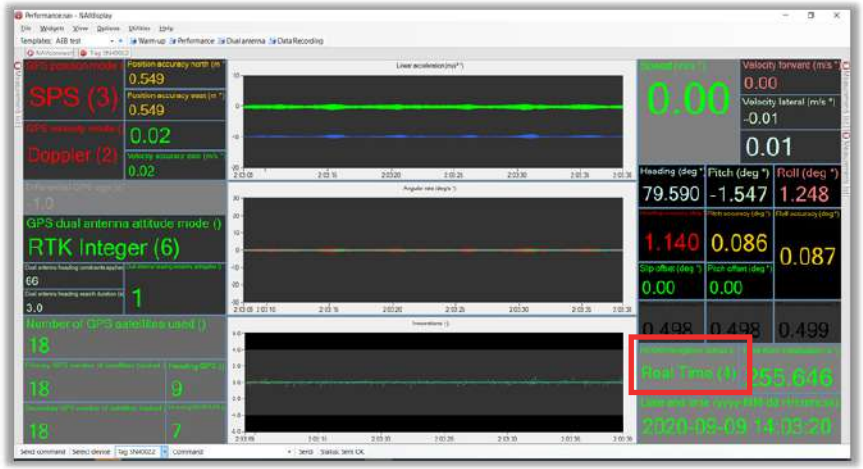
Check that after “NMEA” it says “‘locked”: 1’, this means NMEA is being received. Check after “sync_pulse_in” it says “‘locked”: 1’ if you are using PPS, this means that valid PPS messages are being received. Also, ensure that the Ouster is configured correctly to receive PPS or PTP messages. Seeing ‘{“timestamp”: {“time”: 3.714809032, “mode”: “TIME_FROM_SYNC_PULSE_IN”’ implies that PPS is being expected from outside.

Sending TCP commands:

/ To send TCP commands you can download ‘NMAP’ software and then in Powershell enter ‘ncat <IPaddress> <port-number>’ and then the commands that Ouster provide in their manual.

/ Ouster uses commands to configure the unit. A useful command for checking PPS and NMEA messages are being received is ‘get_time_info’.

/ Georeferencer requires the information from the ‘get_ beam_intrinsics’ command as the elevations and azimuths are different for each unit. However, an easier way to get this is through OusterStudio.



Note: When sending commands you cannot access the Ouster from another interface eg OusterStudio.

Important: The INS must be initialised to send valid NMEA messages. This can be checked in NAVdisplay.

Post processing

INS data is processed as normal using NAVsuite which is OxTS complimentary software suite that you can use to configure, monitor and post-process your data.

It is highly recommended that RTK base station corrections are used when processing in NAVsolve, OxTS' powerful post-processing tool, to get the best quality pointcloud.

OxTS Georeferencer and the boresight calibration solution are compatible with all generation two Ouster LiDAR models. These are listed on the OxTS Georeferencer web page - OxTS Georeferencer.

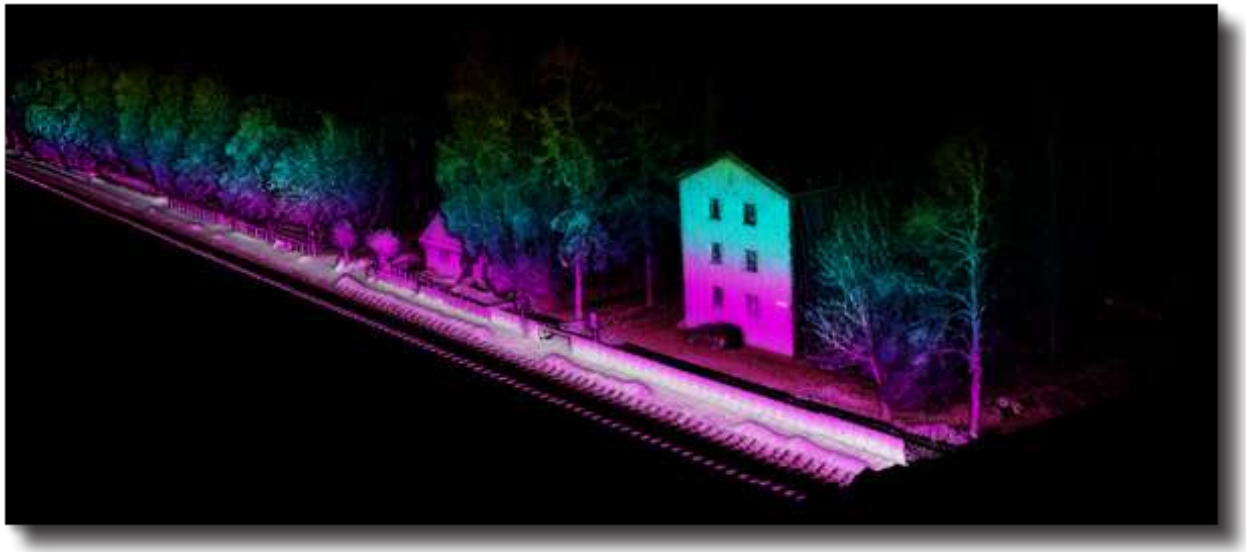
This will allow you to combine your INS data and your LiDAR PCAP to georeference a pointcloud quickly and efficiently.

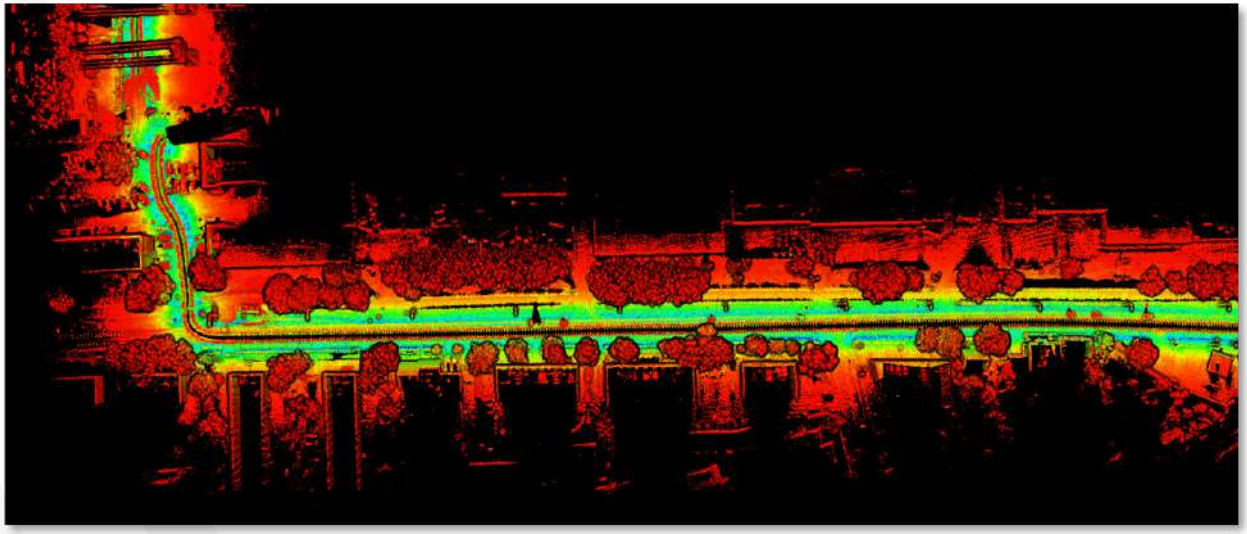
A guide for using OxTS Georeferencer can be found on the OxTS support site here - view article.

Ensure that you are using the latest version of Ouster firmware to use your LiDAR with OxTS Georeferencer. OxTS Georeferencer requires the JSON file of azimuths and elevations of the lasers that can be retrieved from the unit. This must be included in the same folder as the LiDAR PCAP and must have the same name.

Example data

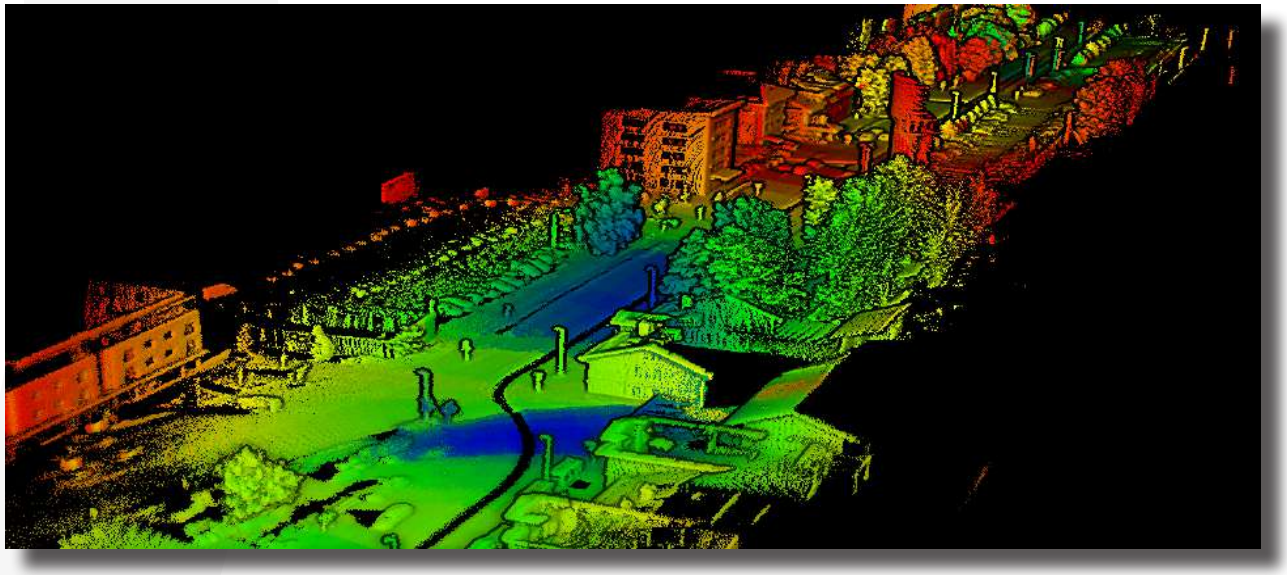
Below is an example road survey produced using an Ouster OS1-64 LiDAR sensor alongside an OxTS xNAV650 INS. The data was processed using OxTS Georeferencer.

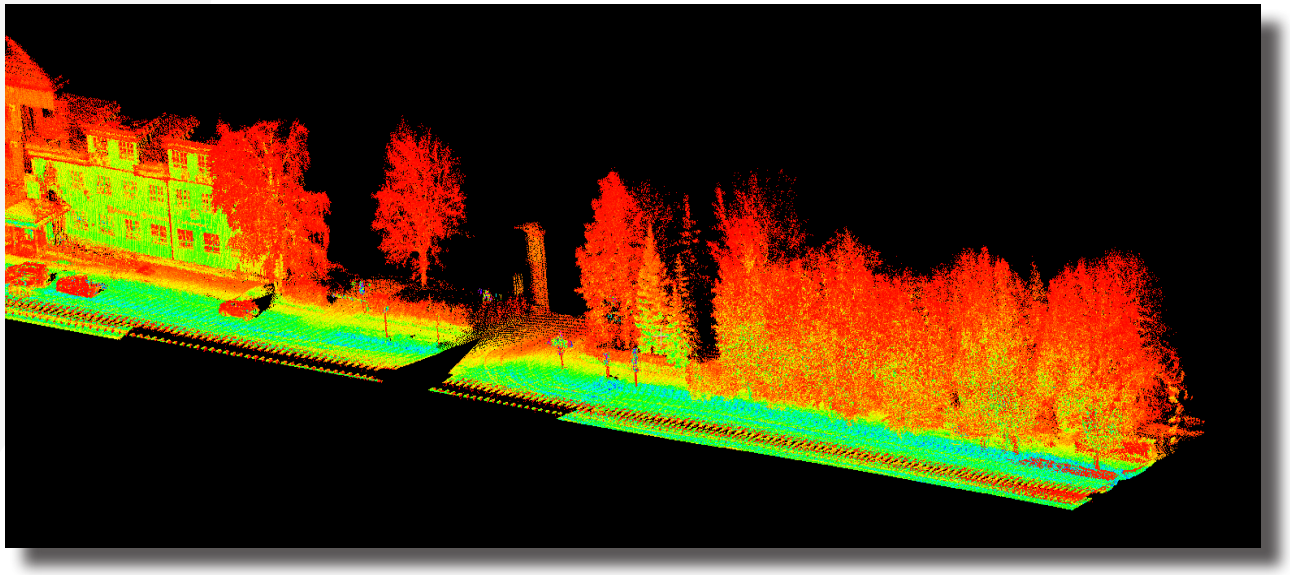




Example data (cont...)

The below data is the same road survey as depicted on the previous page. All pointclouds were produced using a land surveying vehicle, OxTS INS and Ouster LiDAR device.





Need further assistance?

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