Falcon K1 LiDAR

User Manual

Preface

Product

Falcon K1 LiDAR

Manufacturer

SEYOND

Legal Disclaimer

Overview

This manual provides instructions for the installation, usage, maintenance, and diagnostic evaluation of Falcon K1 LiDAR (hereinafter referred to as "Falcon" or "LiDAR"). The contents of the manual are based on the different phases of the LiDAR life cycle, including the installation, configuration, and maintenance of the LiDAR.

The intended users of this manual include project developers (R&D personnel and designers), installers, electrical professionals, safety professionals, and service personnel.

Original document

This document is the original document owned by Seyond.

Manual description

Although this document covers instructions to handle frequent problems, it is still not guaranteed to fully resolve all problems. If you encounter other issues not covered in the manual, please contact Seyond staff in time. This manual will be updated when new information becomes available.

Tel : (650)963-9573
E-mail: info@ seyond.com

Precautions

This user manual provides descriptions of Falcon K1 LiDAR introduction, installation, transferring, usage, maintenance, diagnostic evaluation, disposal, etc., and software instructions.

Considering this is a laser product (1550 nm), please thoroughly read and comprehend all information within this manual before the operation and consider the precautions to avoid danger. Please strictly follow the instructions and steps described in the manual during operation.

Safety notices

Before using the product, please read this manual carefully and strictly follow the relevant instructions.

Please contact Seyond staff to obtain detailed specifications.

To reduce the risk of electric shock and avoid violating the warranty, please do not disassemble or modify the LiDAR without permission. This product does not contain the user's serviceable parts. Please consult Seyond's certified service personnel for maintenance and repair.

Service procedures where the laser is energized, is only intended to be performed by Seyond service personnel or persons trained by Seyond to perform such service.

⚠ Caution

Use of controls, adjustments, or performance of procedures other than those specified for this product may result in hazardous radiation leakage.

⚠ Caution

➤ Class 1 laser product.

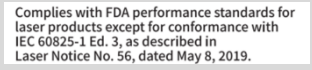
➤ Failure to use, control, adjust or operate LiDAR as specified herein may result in serious radiation hazards.

➤ The product incorporates a Class 4 fiber laser system which, by itself, may be hazardous. This device incorporates a protective housing and a scan failure safeguard in the machine design such that there is no exposure or human access to laser radiation generated by the fiber laser during operation or maintenance.

➤ UNDER NO CIRCUMSTANCE shall attempts be made to operate the laser with protective housing removed or the scan failure safeguards overridden.

➤When the laser is powered up, service procedures are only intended to be operated by Seyond service personnel or persons trained and certified by Seyond.

⚠ Caution



This product meets the following standards:

IEC 60825-1

21 CFR 1040.10 and 1040.11, except for the deviation of Laser Notice No.50 issued on June 24, 2007.

Device maintenance

This product is made of metal, glass, plastic, and contains sensitive electronic components.

- Do not misuse the product by dropping, burning, piercing, bumping, squeezing, etc.
- Shut off the product immediately once it is hit or dropped. Please contact Seyond staff for technical support.
- If there is any possibility that the product may have been damaged, please stop using it immediately to prevent personnel injury.
- Do not touch the LiDAR window with your hands in case of performance degradation.
- If the LiDAR window is stained, please clean the product as described in the *Cleaning* section of this manual.
- It is strictly forbidden for users to disassemble or convert the device without permission. Dismantling this product may result in product damage, loss of waterproof performance, or personal injury.

Electrical safety

- Always use the connecting cable and power adapter provided or specified by Seyond.
- Using damaged cables or adapters in a humid environment may lead to fire, electric shock, personal injury, product damage, or other property losses.
- Voltage surges due to lightning may lead to the degeneration of electrical systems over an extended period.

Heat dissipation

- Long-time contact with the hot surface of the product may cause personal discomfort or injury.
- To avoid heat accumulation, please ensure the device is in well-ventilated environment.
- LiDAR may generate a high amount of heat after prolonged operations. It is recommended to shut off the power for a few minutes before touching it.

Operating environment

- Do not subject the product to intense vibration.
- Do not look directly at the transmitting laser through a magnifying device (such as a microscope and magnifying glass).
- Do not look directly at the transmitting laser through an electronic device.
- Do not place this product near flammable and explosive materials.
- Do not expose this product to areas with explosive air, such as areas with a high concentration of flammable chemicals or saturated vapor.
- Do not expose this product to an environment with high-density industrial chemicals, such as easily vaporized liquefied gas (e.g., helium), to avoid performance degradation.

Radio frequency interference

Before the operation, please read the product label's certification and safety information. Although the product's design, testing, and manufacturing comply with the relevant provisions of RF energy radiation, the radiation from the product may still lead to the failure of other electronic equipment.

Medical device interference

Some components and radio devices contained in this product will emit electromagnetic fields that may interfere with medical equipment, such as cochlear implants, pacemakers, and defibrillators. Consult your doctor and medical equipment manufacturer for specific information, e.g., whether you need to keep a safe distance from this product. If there's any possibility that this product is interfering with your medical equipment, please stop using it immediately.

1 Product description

1.1 Product introduction

Product Overview

Falcon K1 (hereinafter referred to as "Falcon" or "LiDAR") is an industry-leading automotive-grade LiDAR developed by Seyond through forward engineering. It can detect objects as far as 500 meters, and dark objects with 10% reflectivity up to 250 meters. Falcon can maximize point density in region of interest (ROI) which is adjustable to focus where it matters most to better track objects on the road. High performance LiDAR with strong environmental adaptability like Falcon is key to safe autonomy and smart transportation.

Product features

- 500m ultra-long detection range, image-grade ultra-high resolution
- Flexible and adjustable ROI
- 1550nm laser wavelength enables better eye-safety
- Greater environmental adaptability and longer product life
- Mass production of automotive-grade robust products is ready

1.2 Time of flight

LiDAR performs based on the time-of-flight (ToF) methodology.

1. The LiDAR emits a light pulse of short duration and narrow divergence.
2. Upon hitting an object, the emitted light will undergo scattered reflection.
3. Some of the reflected light will return to the unit and be detected by the LiDAR's optical sensor.
4. The object's distance is calculated by measuring the time between the emission of the light pulse and the detection of the reflected light. The object's location is known since the angular direction of the emitted light pulse is known.
5. The LiDAR emits light pulses in multiple directions sequentially, thereby constructing a 3-dimensional map of the system's surroundings.

The distance is expressed as:

$$d = \frac{ct}{2}$$

d: distance c: speed of flight t: flight time of the laser pulse

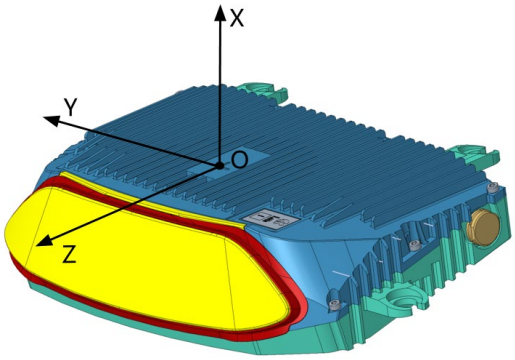
1.3 LiDAR laser and coordinate system

Falcon is a semi-solid-state LiDAR with a laser light source wavelength of 1550nm.

The three-dimensional coordinate system is defined as follows.

- X-axis is perpendicular to the ground, pointing up.

- Y-axis is parallel to the ground, pointing right.
- Z-axis is parallel to the ground, pointing forward.
- The origin in this coordinate is the optical origin and can be used for calibration reference.



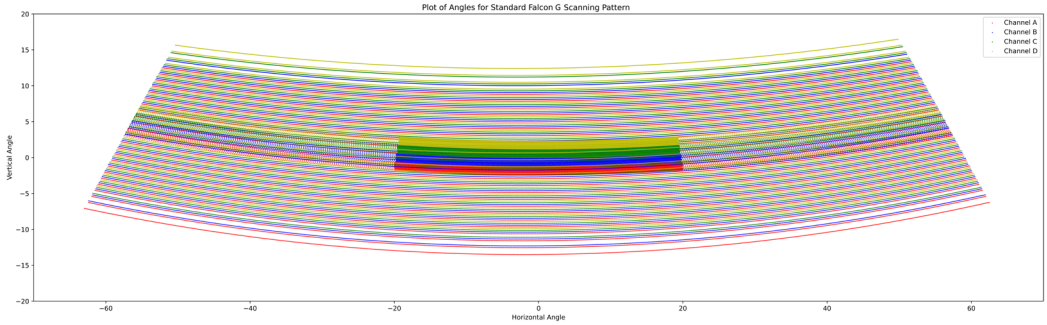
1.4 Scanning pattern

Falcon is designed with a dual-dimensional scanning pattern.

The Field of View (FOV) is the angle through which the LiDAR is sensitive to the electromagnetic radiation. FOV (H × V): 120°×25°. Angular resolution (H × V): 0.18°×0.24°.

The Region of Interest (ROI) is the angle with high point cloud density, which is about six times higher than the non-ROI in LiDAR. FOV in ROI (H × V): 40°×4.8°. Angular resolution in ROI (H × V): 0.09°×0.08°.

The position of ROI center can be adjusted in real-time within the entire FOV through the computer commands sent to LiDAR.



1.5 Specifications

Table 1 Specifications

OPTICAL PERFORMANCE	
Range (Maximum)	500 m
Range (Minimum)	1.5 m
Detection Range (10% Lambertian reflectivity @ 10 Hz)	250 m@100 klx sunlight, POD>90%
Detection Range Accuracy	± 5 cm for Lambertian targets

	± 10 cm for retroreflectors
Detection Range Precision (10% Lambertian reflectivity)	2 cm (50 m@1sigma)
Detection Range Resolution	0.5 cm
Vertical Scanning Lines	1520 lines/sec
FOV in non-ROI (H×V)	120°×25°
FOV in ROI (H×V)	40°×4.8°
Angular Resolution in non-ROI (H×V)	0.18°×0.24°
Angular Resolution in ROI (H×V)	0.09°×0.08°
Angular Accuracy	± 0.1°
Frame Rate	10 FPS (configurable: 5 to 20 FPS)
False Positive Rate	<0.01% @ 100 klx sunlight
# of Returns	Up to 2 returns
LASER	
Laser Safety Class	Class 1 (IEC 60825-1)
Laser Wavelength	1550 nm
Beam Divergence (Full Angle)	0.1°
LIDAR OUTPUT	
Data transmission	1000Base-T1 Ethernet (UDP, TCP)
Points Per Second	900,000 Points/sec
Data Rate (Megabits Per Second)	7.385MB/S@1 return 10.965MB/S@2 return
CONTROL INTERFACE	
Interface	TCP and HTTP APIs
Time Synchronization	• IEEE1588 (PTP) • IEEE 802.1as(gPTP)
MECHANICAL/ELECTRICAL	
Power	12V/30W
Operating Voltage	9 to 34V DC
Connector	Proprietary pluggable connector (Power + Automotive Ethernet + CAN)
Dimensions (H×W×D)	58.9mm×228mm×149.6mm
Weight	1.75 kg
Mounting	4×M4×18 screws, located in bushings
OPERATIONAL	
Operating Temperature	-40 °C to +85 °C
Storage Temperature	-40 °C to +105 °C
Ingress Protection	IP67(body) IP69K(window)
Shock	IEC 60068-2-27

Vibration	IEC 60068-2-64
Compliance	IEC60825-1 Class 1 eye-safe, RoHS, CE 
ACCESSORIES	
Optional Wire Harness	5m cable (power & Ethernet)
Optional Converter	Metadaptor
Optional Mount	Metal bracket
SOFTWARE	
Available Drivers	ROS/ROS2

Note

Specifications are subject to change without notice.

2 Getting started

This chapter provides the procedure to test and verify that your LiDAR is operating properly.

2.1 Delivery list

It is highly recommended to check if there are any loss or damage of the components according to the delivery list before installation.

Table 2 Standard delivery list

No.	Name	No.	Name
1	LiDAR	2	Standard cable

You can select the optional components to customize your delivery list on demand. The list of the optional components is shown below. For more information, please contact Seyond staff for support.

Table 3 Optional delivery list

No.	Name	No.	Name
3	LiDAR connector	4	Metadaptor
5	Metadaptor charger		

Note

The delivery list is subject to your individual order, this section is for reference only.

2.2 Verification

Note

It is recommended to check out a new LiDAR's functionality and start processing the LiDAR before mounting.

1. Unpack the LiDAR and the accessories on a workbench or desk. About the component list, see *2.1 Delivery list.*
2. Connect the LiDAR to the power supply and startup the LiDAR. About the connection method, see *2.2.1 LiDAR connection*. About the LiDAR startup, see *2.2.2 Start the LiDAR*.
3. Connect the LiDAR to a test computer. Change the computer IP address to the same subnet with the LiDAR. About the connection method, see *2.2.1 LiDAR connection*.

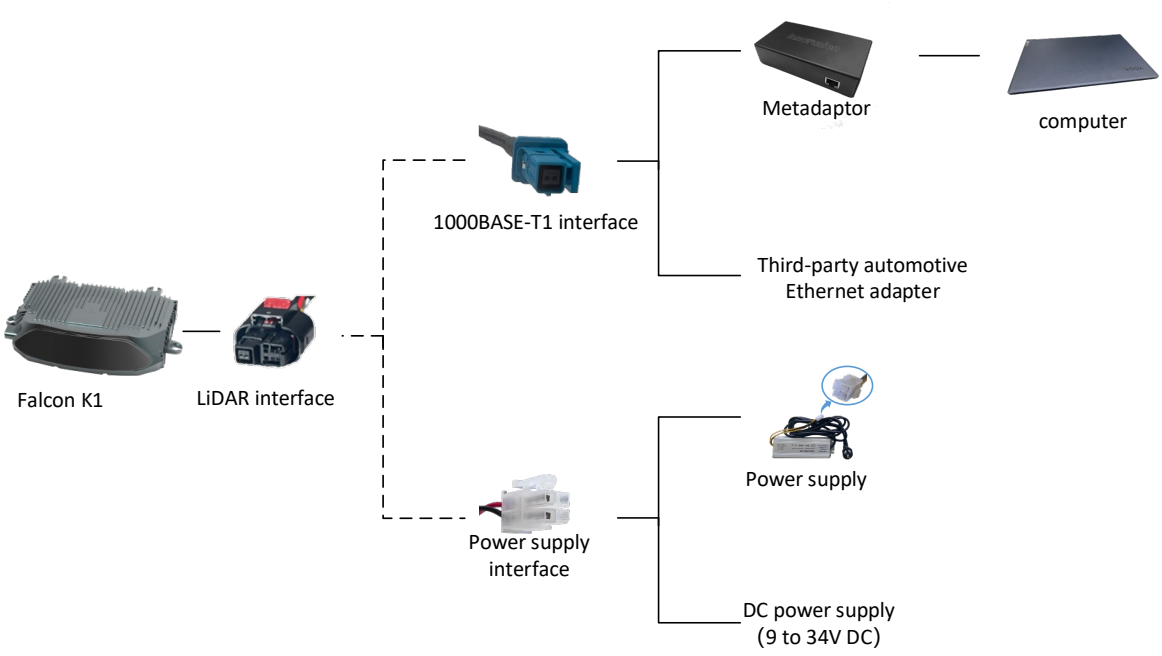
   About how to change the computer IP address on Windows, see *2.2.3.1 Change the computer IP address on Linux.* About how to change the computer IP address on Windows, see *2.2.3.2 Change the computer IP address on Windows.*
4. View the point cloud status to verify the connection and the function. You could choose one of the following methods according to your actual situation.

   About how to view the point cloud via ILA, see *2.2.4 View the point cloud status on ILA.*

   About how to view the point cloud in ROS, see *2.2.5 (Optional) View the point cloud status in ROS*.

5. About how to view the point cloud via MetaView, see *2.2.6 (Optional) View the point cloud status via MetaView.*

2.2.1 LiDAR connection



2.2.2 Start the LiDAR

1. Connect the power supply to start the LiDAR.
2. The LiDAR completes initialization and generates data after powering on for 11 to 18 seconds.

Note

The LiDAR does not have a power switch. It will become operational when power is applied.

2.2.3 Change the computer IP address

You need to change the computer IP address to the same subnet with the LiDAR before viewing the point cloud status. The method of changing the IP address may vary with the operating system.

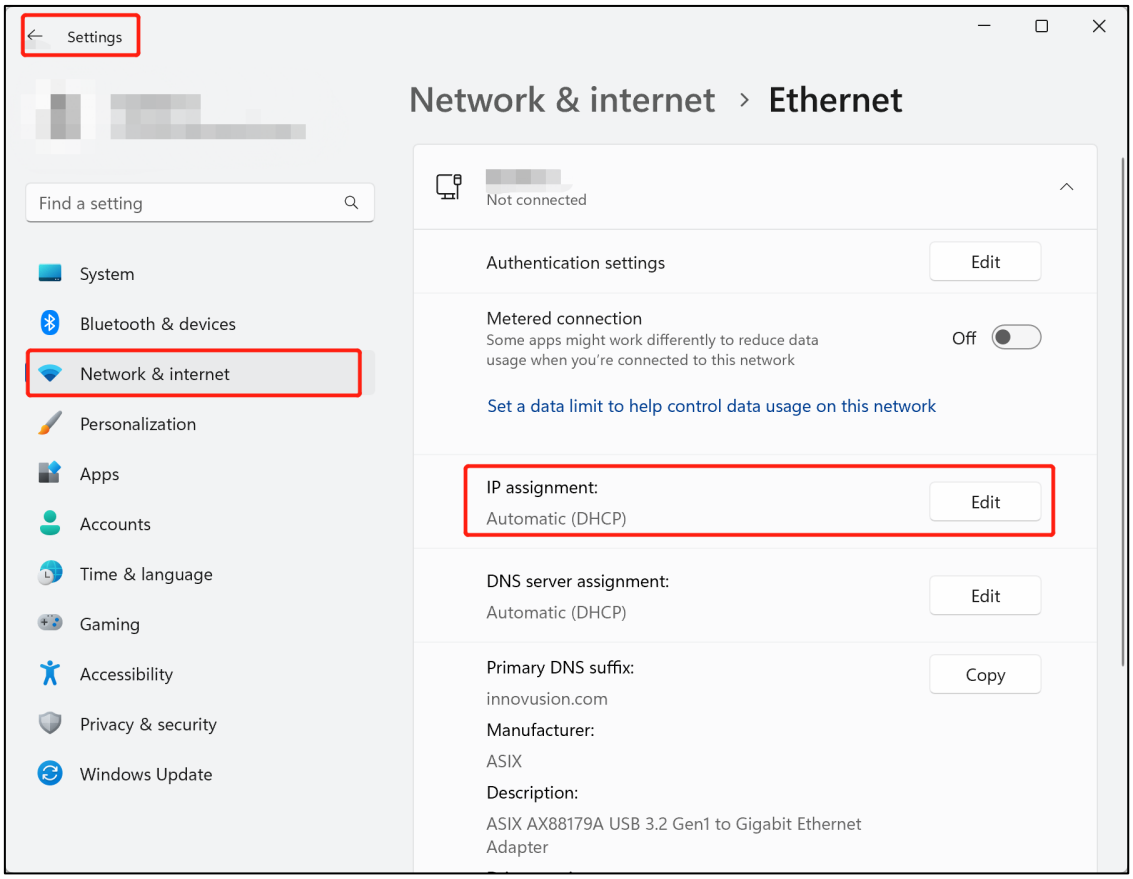
2.2.3.1 Change the computer IP address on Linux

1. Connect the computer to LiDAR and ensure the Ethernet connection.
2. Select **Settings** > **Network**.
3. Select **IPv4**. Click **Manual** to change the computer IP to the same subnet with the LiDAR.
4. Click **Apply**.

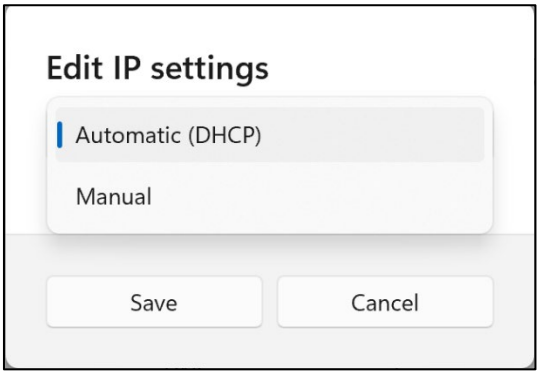
2.2.3.2 Change the computer IP address on Windows

1. Connect the computer to LiDAR and ensure the Ethernet connection.

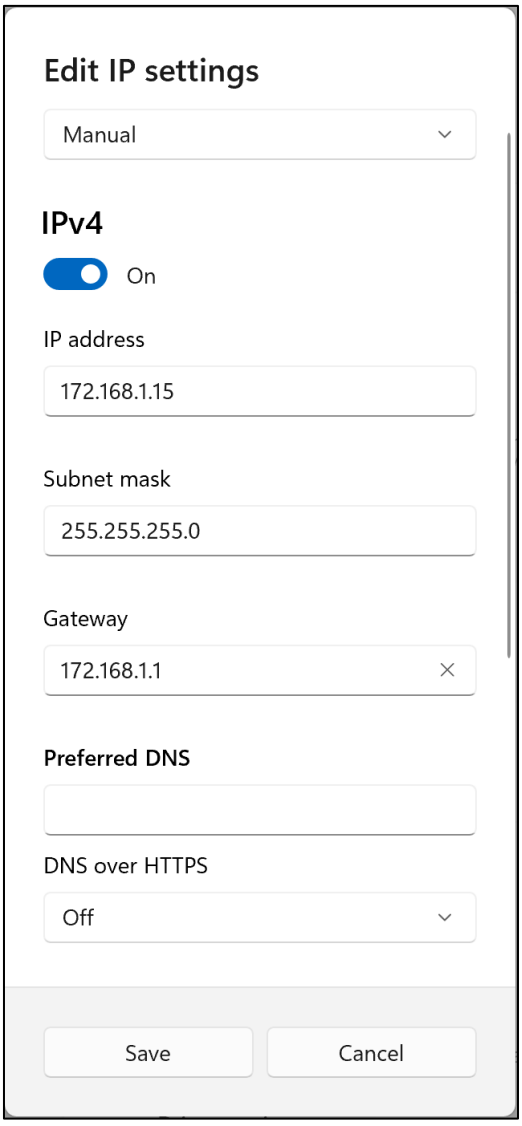
2. Select **Settings** > **Network & internet** > **Ethernet**.
3. Click **Edit** on the **IP assignment** bar.



4. Select **Manual** in the **Edit IP settings** dialog box.

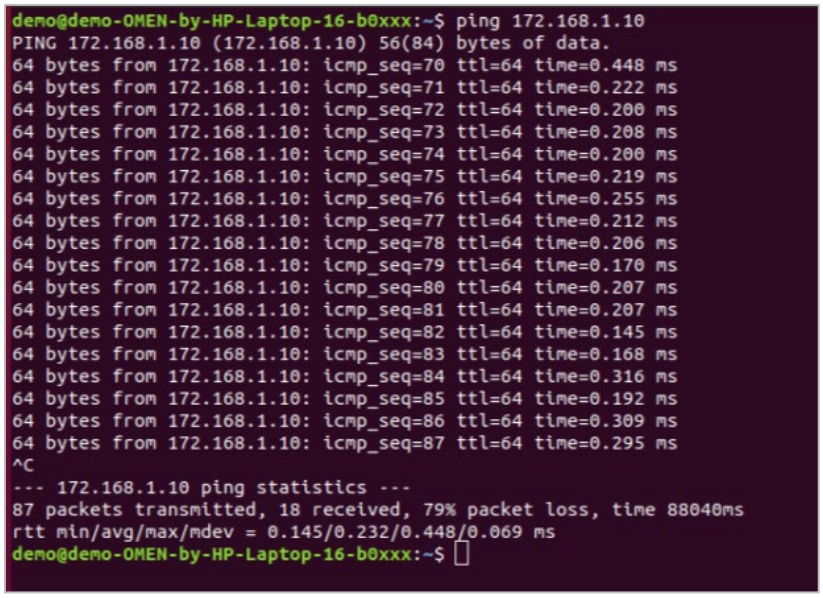


5. Toggle on **IPv4**. Enter the **IP address**, **Subnet mask** and **Gateway** to make the computer with the same subnet to the LiDAR. See below for example of the settings for a default factory LiDAR. Click **Save** to save the settings.



6. (Optional) Verify the connection.

   It is recommended to check the access to the LiDAR IP address by using the ping command. The return value is shown in the figure below. The default factory LiDAR will usually have an IP address of 172.168.1.10.



2.2.4 View the point cloud status on ILA

1. Open the browser. Enter the LiDAR IP address and port number in the address bar `<IP Address>:<PORT>` to access the ILA.

Note

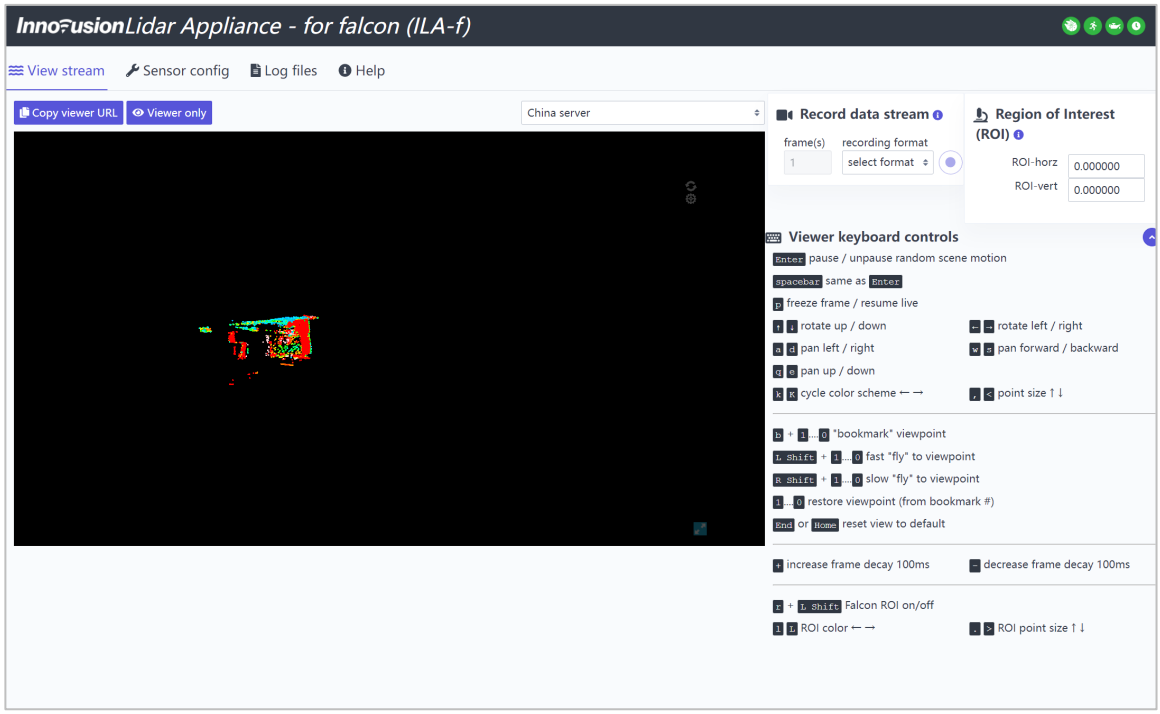
The default LiDAR IP address is 172.168.1.10. By default, the ILA port number is 8675. The default ILA login address is 172.168.1.10:8675.

It is recommended to use the Google Chrome browser to log in to the ILA.

2. You can directly view the status of the LiDAR point cloud in real-time on the **View Stream**.
3. (Optional) Change the point of view and distance in which the point cloud data is displayed using the keyboard shortcuts and mouse.

   The available keyboard shortcuts are listed on the **View Stream**.
4. (Optional) Click **Viewer Only** to launch the point cloud viewer and view the live point cloud in a new tab.

   From the new tab, it is possible to maximize the display into full-screen mode.



2.2.5 (Optional) View the point cloud status in ROS

2.2.5.1 View the point cloud status in ROS1

1. View the system details and obtain the corresponding driver. Copy the driver to the root directory of the system. Execute the following command to install the driver.

```
sudo dpkg -i <package.deb>
```

Note

package.deb is the driver's name of the LiDAR. Obtain the latest driver version based on the actual conditions.

2. Start ROS. The return value is shown in the figure below.

```
roscore
```

3. Obtain the point cloud data of the LiDAR. The return value is shown in the figure below.

- Obtain the point cloud data via the TCP port.

```
source /opt/ros/melodic/setup.bash
roslaunch innovusion_pointcloud innovusion_points.launch device_ip:= <device_ip> port:=<TCP_port > processed:= <Processed_number>
```

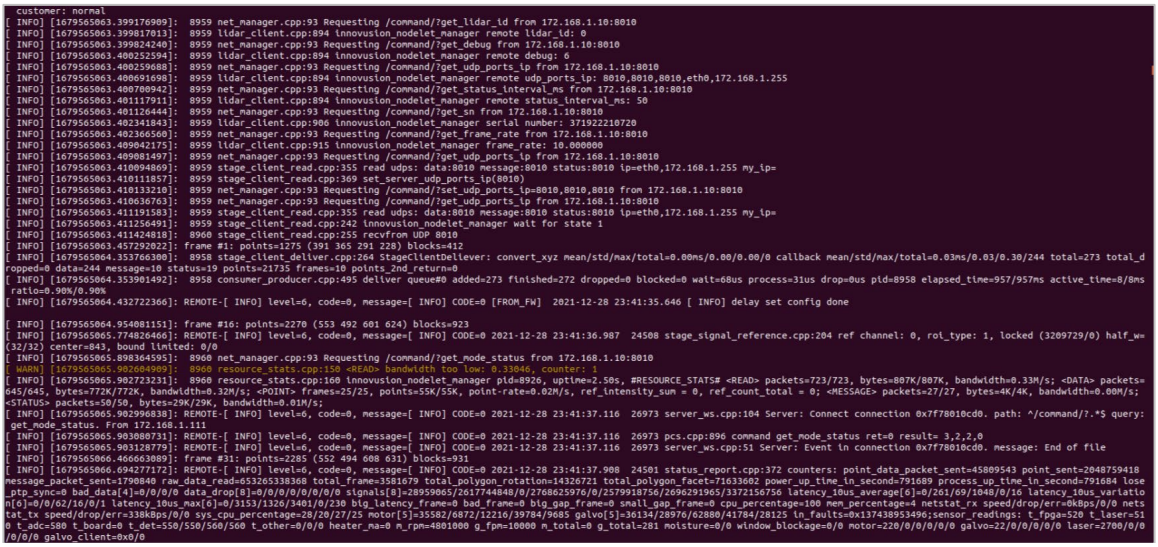
- Obtain the point cloud data via the UDP port.

```
source /opt/ros/melodic/setup.bash
roslaunch innovusion_pointcloud innovusion_points.launch device_ip:= <device_ip> udp_port:=<UDP_port> processed:= <Processed_number>
```

Note

The default value of device_ip is 172.168.1.10. By default, the UDP port number is 8010.

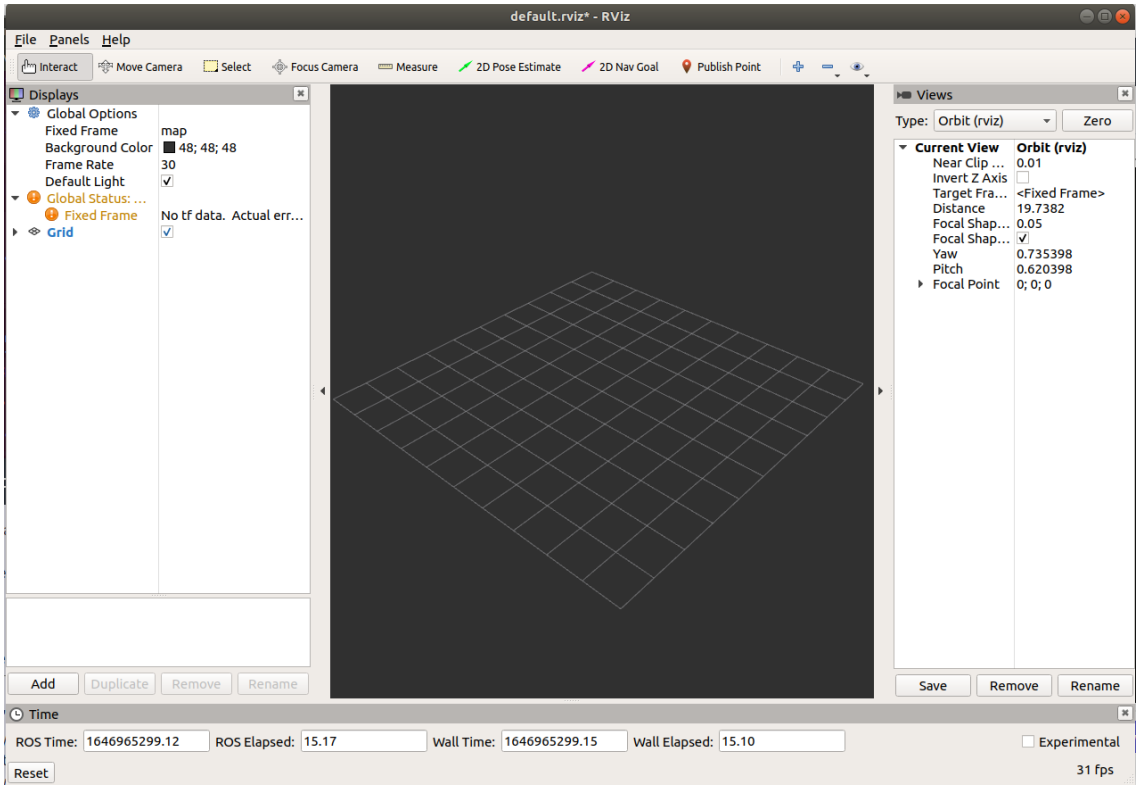
The value of processed_number can be 0 or 1. When the process_number is set to 1, the point cloud data is obtained from ROS client. When the process_number is set to 0, the point cloud data is obtained from external PCS.



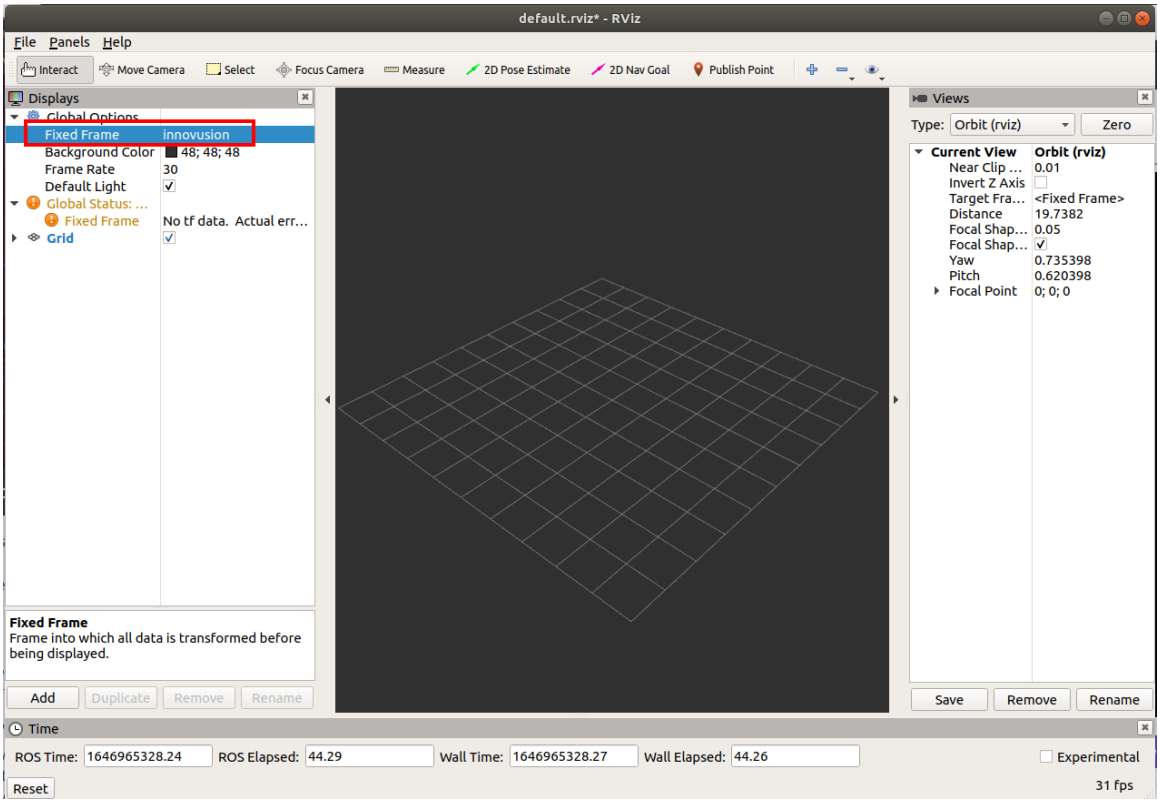
4. Start the graphical tool **rviz**. The return value and **rviz** interface are shown below.

```
rviz
```

```
demo@demo-OMEN-by-HP-Laptop-16-b0xxx:~$ rviz rviz
[ INFO] [1646808931.535449917]: rviz version 1.13.21
[ INFO] [1646808931.535492615]: compiled against Qt version 5.9.5
[ INFO] [1646808931.535502544]: compiled against OGRE version 1.9.0 (Ghadamon)
[ INFO] [1646808931.539157206]: Forcing OpenGl version 0.
[ INFO] [1646808932.122437501]: Stereo is NOT SUPPORTED
[ INFO] [1646808932.122552411]: OpenGL device: NVIDIA GeForce RTX 3060 Laptop GPU/PCIe/SSE2
[ INFO] [1646808932.122633840]: OpenGl version: 4.6 (GLSL 4.6).
QObject::connect: Cannot queue arguments of type 'QVector<int>'
(Make sure 'QVector<int>' is registered using qRegisterMetaType().)
QObject::connect: Cannot queue arguments of type 'QVector<int>'
(Make sure 'QVector<int>' is registered using qRegisterMetaType().)
```



5. Select **Global Options** > **Fixed Frames**. Set the Fixed Frames value to **innovusion**.

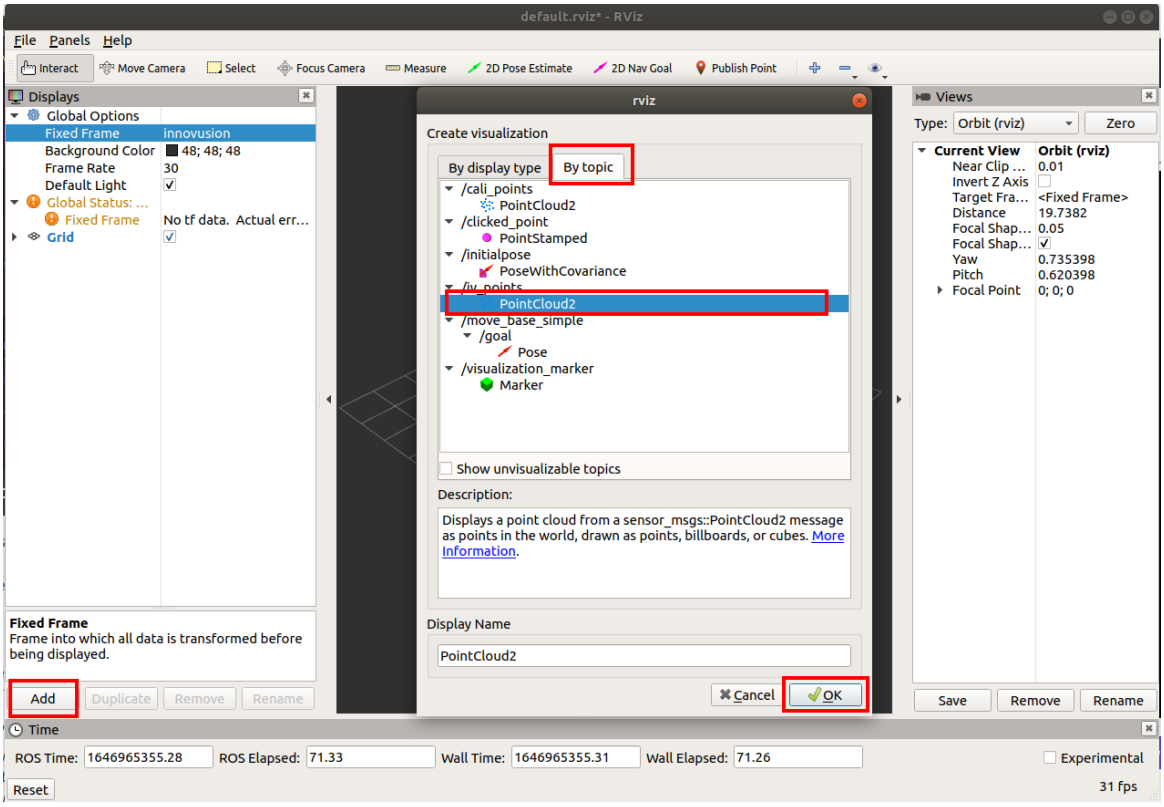


i. Add PointCloud2 to Displays.

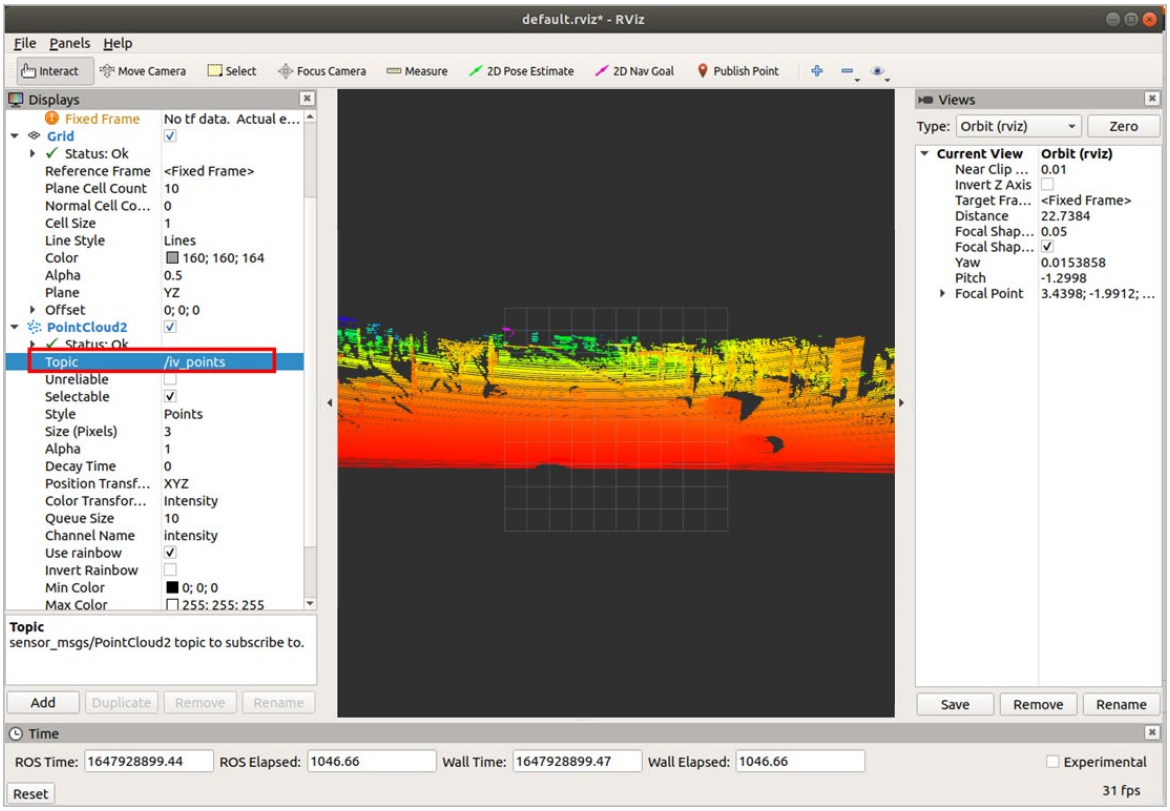
a. Click **Add.**

b. Select By topic > iv_points > PointCloud2.

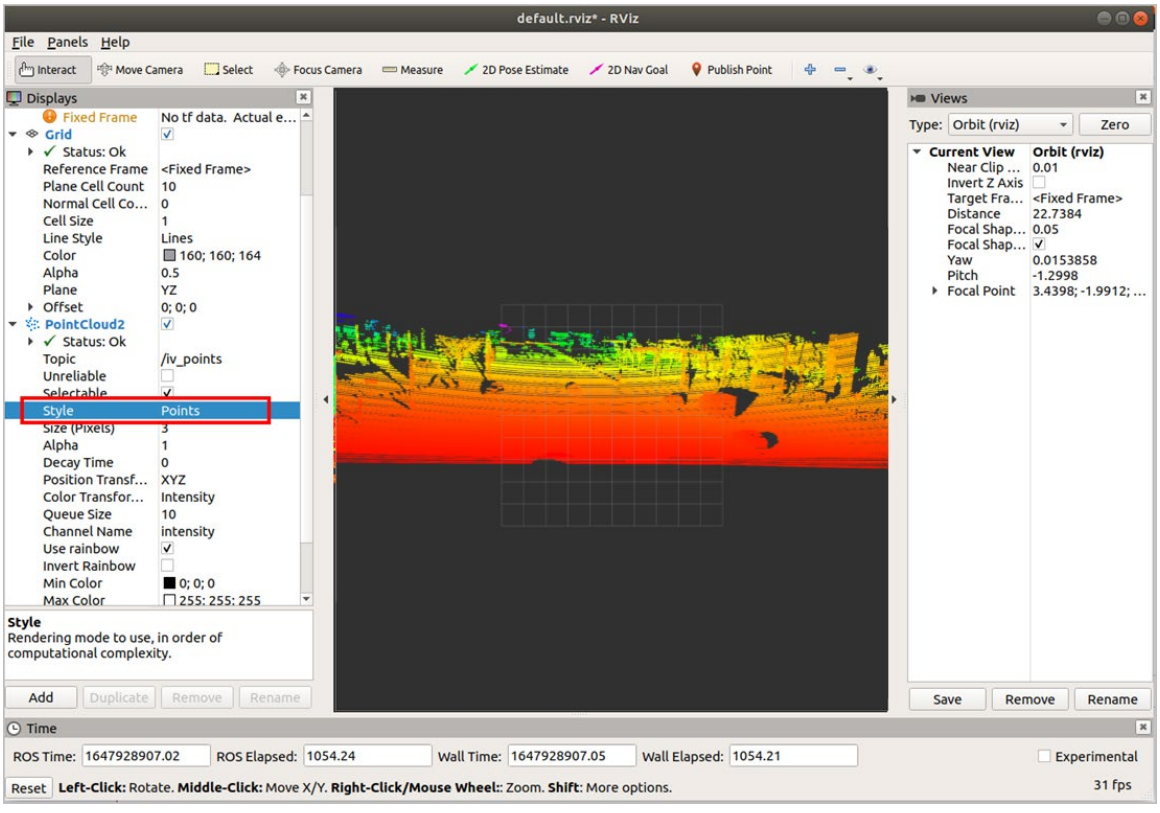
c. Click **OK**.



ii. Select **PointCloud2** > **Topic**. Set the Topic value to **/iv_points**.



iii. Select **PointCloud2** > **Style**. Set the Style value to **Points**.



2.2.5.2 View the point cloud status in ROS2

1. View the system details and obtain the corresponding driver. Copy the driver to the root directory of the system. Execute the following command to install the driver.

```
sudo dpkg -i <package.deb>
```

Note

package.deb is the driver's name of the LiDAR. Obtain the latest driver version based on the actual conditions.

Table 4 Available system

ROS2 version	System Version	CPU
Foxy, Galactic	Ubuntu 20.04	ARM
		X86
Humble	Ubuntu 22.04	ARM
		X86

2. You could obtain the point cloud data of the LiDAR via TCP or UDP.

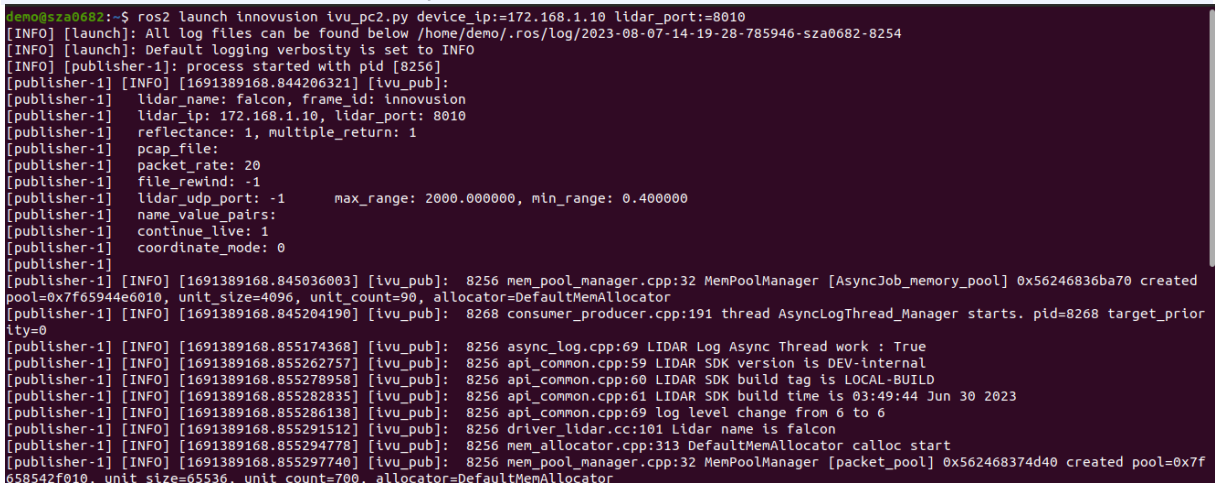
Note

Execute the following command and re-run the obtain command and if the point cloud data was obtained correctly.

```
source /opt/ros/foxy/setup.bash
```

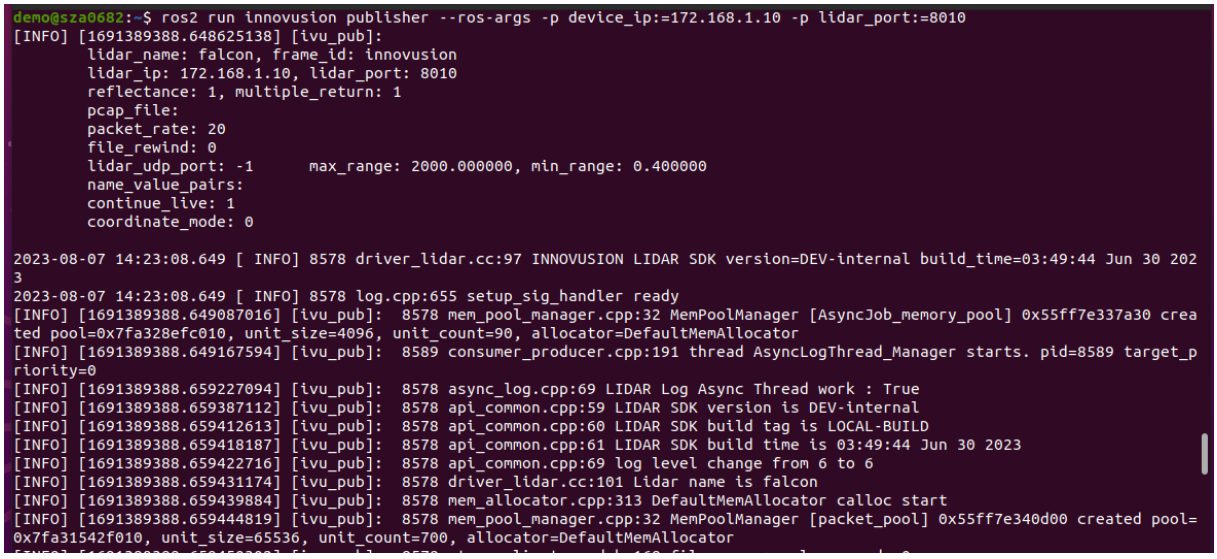
- Obtain the point cloud data via TCP.
  - Method 1

```
ros2 launch innovusion ivu_pc2.py device_ip:=<device_ip> lidar_port:=<TCP_port>
```



  - Method 2

```
ros2 run innovusion publisher --ros-args -p device_ip:=<device_ip> -p lidar_port:=<TCP_port>
```



Note

The default value of device_ip is 172.168.1.10. By default, the TCP port number is 8010. You can run the `ros2 launch innovusion ivu_pc2.py` or `ros2 run innovusion publisher` directly to obtain the point cloud data with the default settings.

- Obtain the point cloud data via UDP.
  - Method 1

```
ros2 launch innovusion ivu_pc2.py device_ip:=<device_ip> udp_port:=<UDP_port>
```

  - Method 2

```
ros2 run innovusion publisher --ros-args -p device_ip:=<device_ip> -p udp_port:=<UDP_port>
```

Note

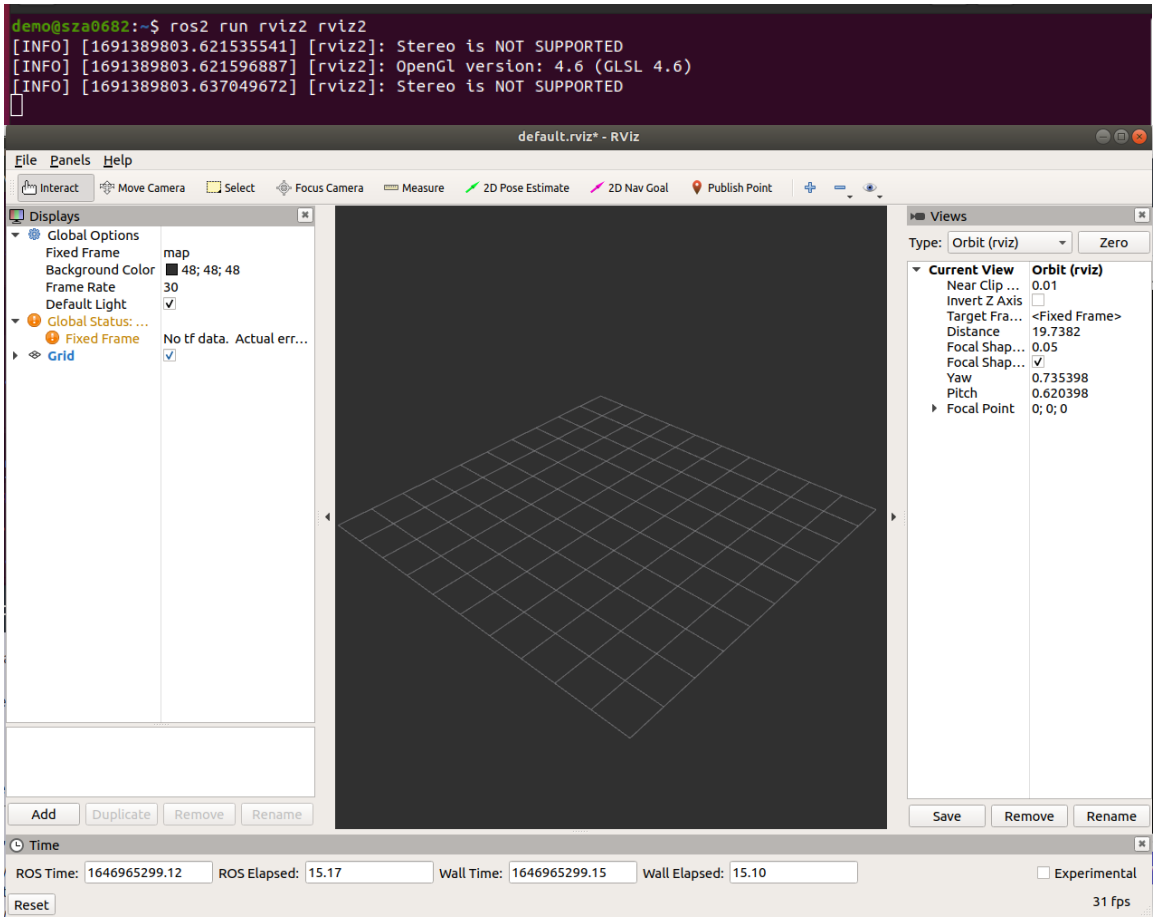
The default value of device_ip is 172.168.1.10. Please notice that the LiDAR transmits the data via TCP by default.

3. Open a new terminal and execute the command to source the setup file.

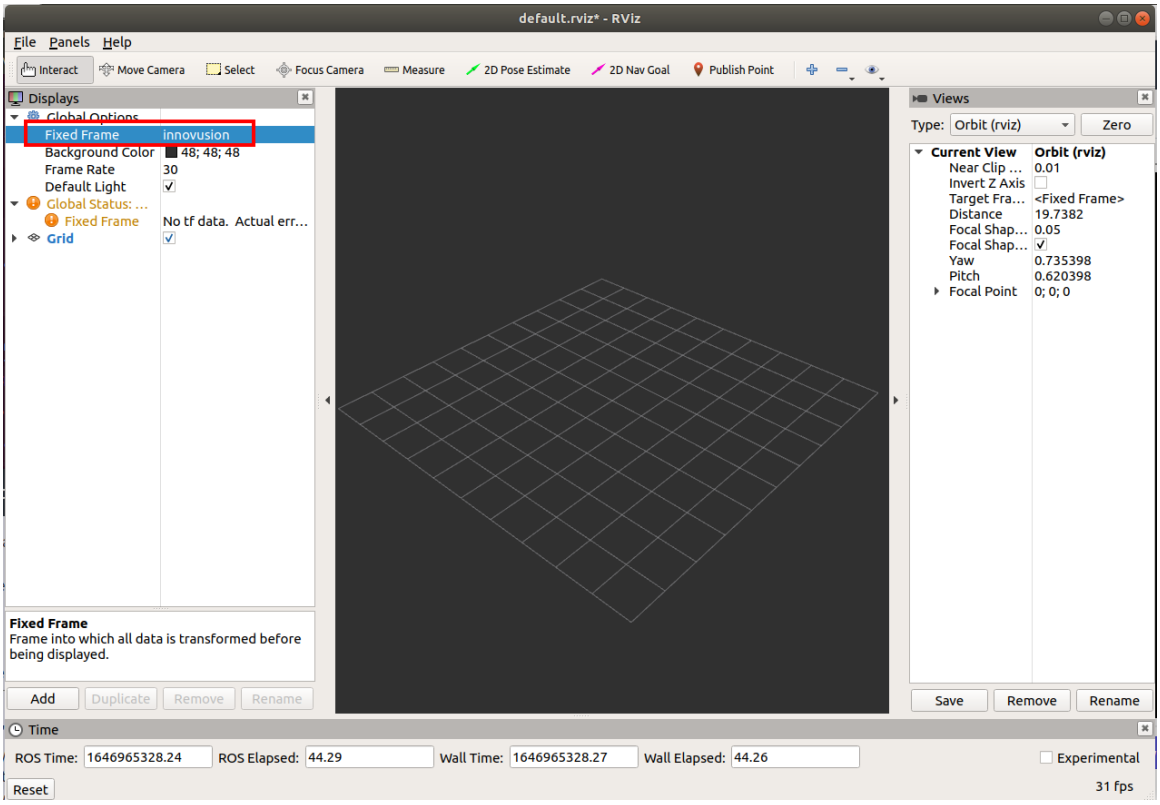
```
source /opt/ros/foxy/setup.bash
```

4. Start the graphical tool **rviz**. The return value and **rviz** interface are shown below.

```
ros2 run rviz2 rviz2
```



5. Select **Global Options** > **Fixed Frames**. Set the Fixed Frames value to **innovusion**.



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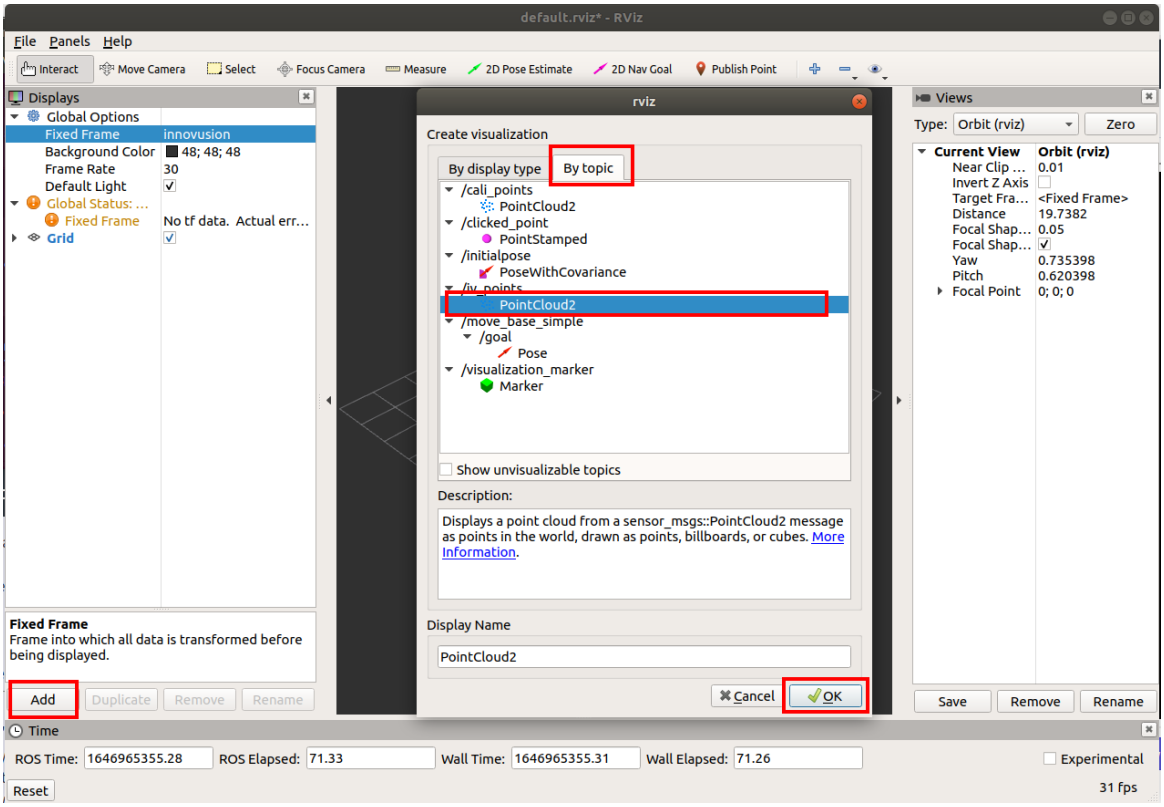
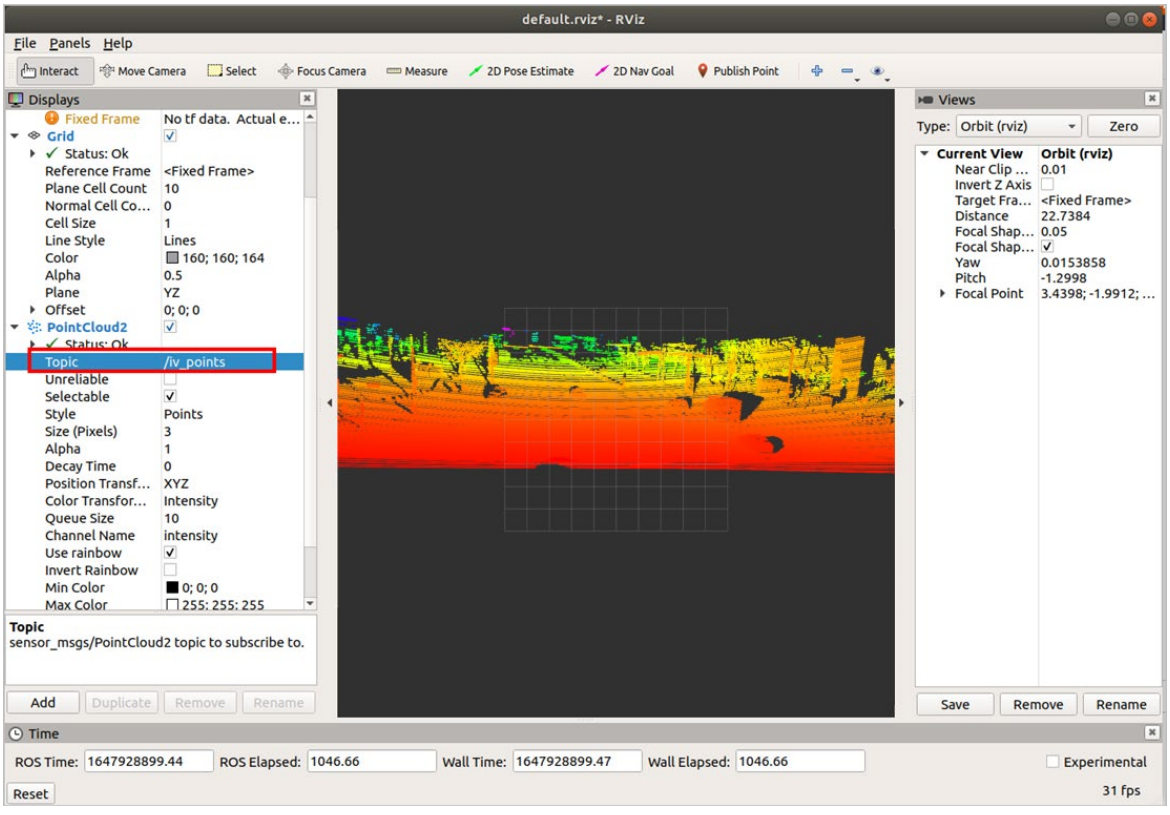
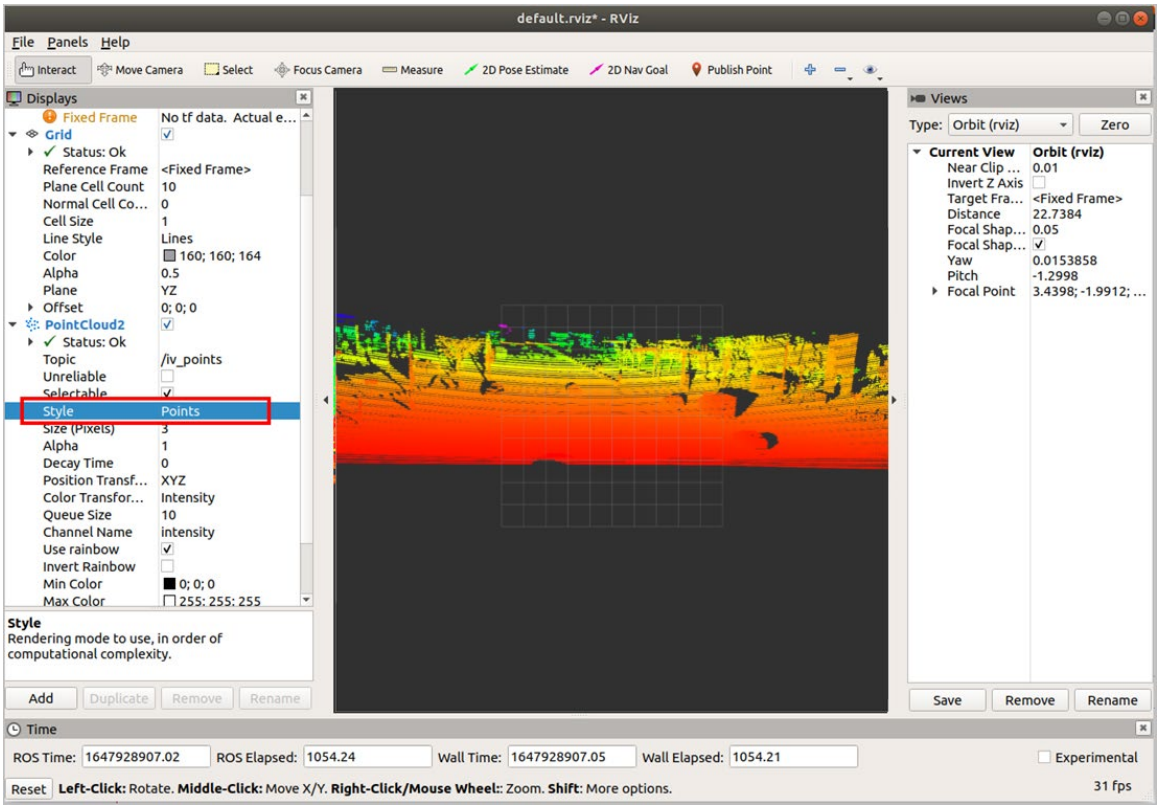


ii. Select **PointCloud2** > **Topic**. Set the Topic value to **/iv_points**.



iii. Select **PointCloud2** > **Style**. Set the Style value to **Points**.



2.2.6 (Optional) View the point cloud status via MetaView

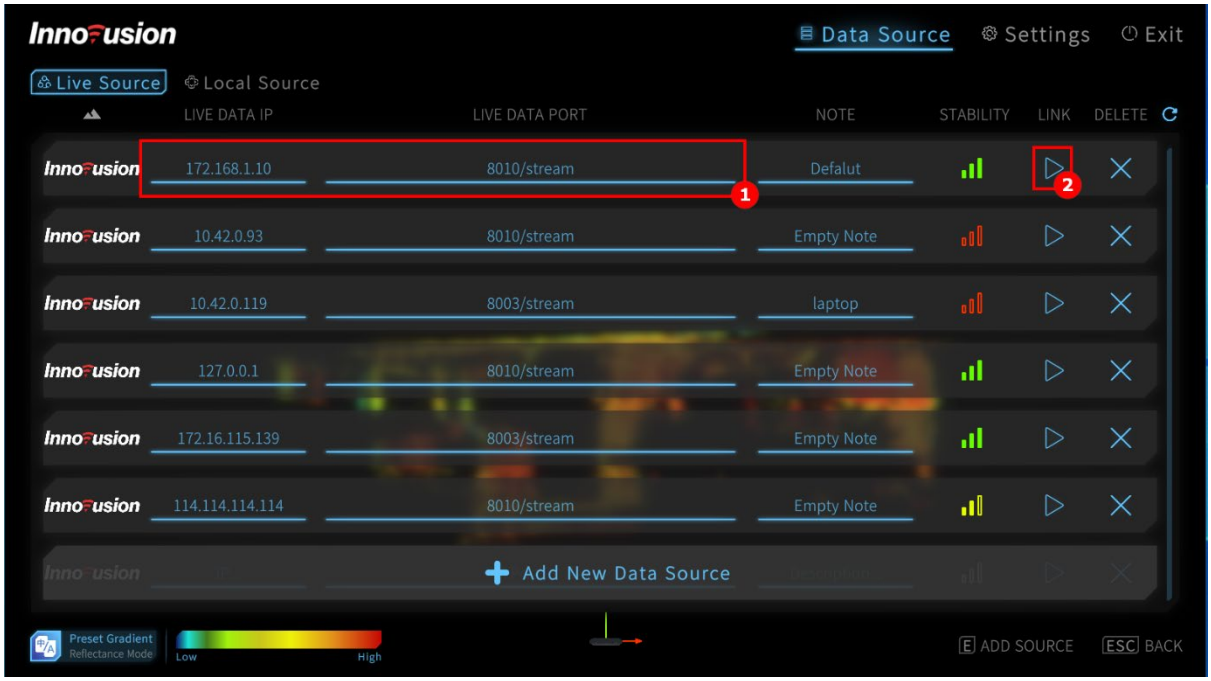
1. Double-click to open MetaView.exe.

Note

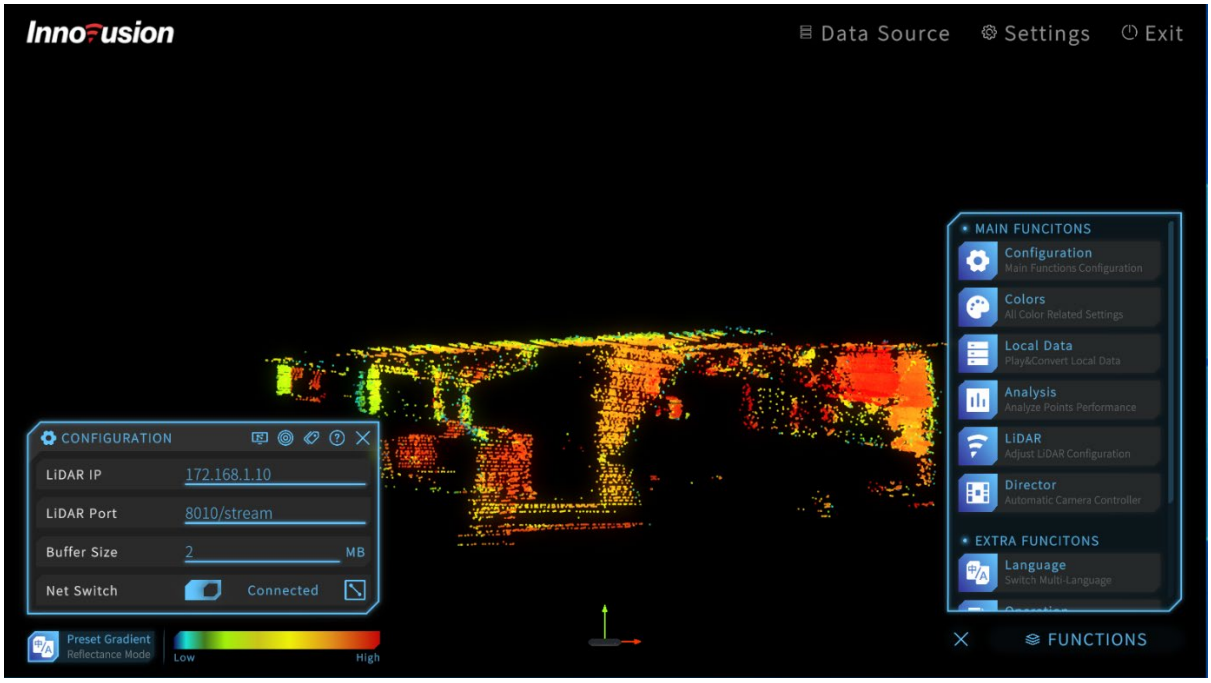
You can download the latest MetaView at the Seyond Resource Hub at https://hub.seyond.com/.

2. Go to **Data Source** > **Live Source**. Click **Add New Data Source**.

3. Enter LiDAR IP address and port number. Click  to connect the LiDAR. The default LiDAR IP address is 172.168.1.10 and the default port number is 8010.



4. You could check the point cloud status after adding the LiDAR.



3 Installation

3.1 Precautions

Falcon is generally intended to be mounted on vehicles. Please follow the instructions during the installation process.

Personnel Requirements

The device is only intended to be installed by Seyond service personnel or persons trained by Seyond.

Installation

- If components are damaged or lost before installation, please contact Seyond staff for support.
- It is recommended to connect the ground to the vehicle chassis to improve the Falcon's immunity to emissions.
- It is recommended to install the device on the center of the vehicle top.
- Make sure the LiDAR installation is flat and the tilt angle should be less than 3.5°. If there are specific tilt angle requirements, please contact Seyond staff for support.
- It is recommended that the mounting surface should be made of aluminum alloy to facilitate the heat dissipation of the LiDAR.
- Make sure that the LiDAR cable keeps a certain degree of slackness.
- A space of 8 cm should be reserved at the outlet of the LiDAR to facilitate cabling.
- Before installation, please ensure there is no obstruction in the FOV (field of view) of the LiDAR. The vertical FOV of the LiDAR is between -13 ° to +12°, and the horizontal FOV of the LiDAR is between -60 ° to +60°. The specific FOV is shown in the figures below. It is recommended to keep a vertical FOV of -16 degrees to 15 degrees free of obstructions to allow for variations in mounting angle tolerance.

Storage

- The storage environment should be dry and well-ventilated. The recommended storage temperature is between -40°C and +85°C. The recommended storage humidity is lower than 85%.
- Without the official consent of Seyond, do not continuously immerse the product in water.
- Avoid exposing the product to an environment exceeding the ingress protection rating.

Transportation

- The equipment should be packed in a packing box filled with cushioning materials to avoid product damage during transportation.
- Please handle the device with care. Impact to the device can damage or decrease performance of optical components in the device.
- Consider the space and location during transportation to minimize the handling distance. Utilize

auxiliary tools or assistants if needed.

- Please do not place the device in an unstable position or handle it in an incorrect posture in case of device damage and personal injury.

Disposal of packaging materials

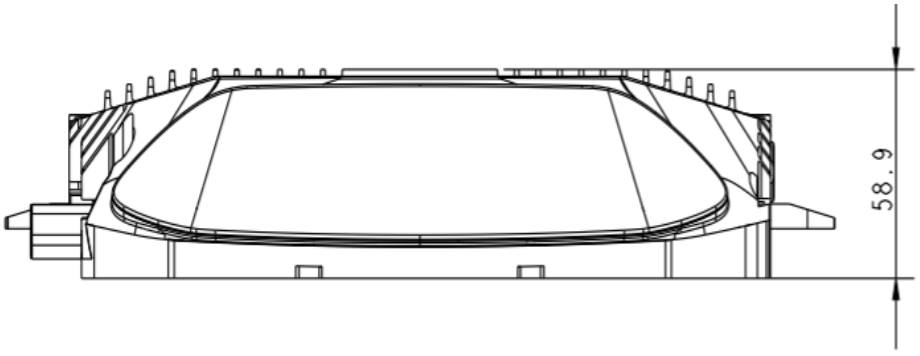
- Packaging materials are recyclable. Please dispose of them correctly when discarding.
- Packaging bags, cartons, or plastic films should be kept out of reach of infants and children to avoid injury or suffocation.

3.2 LiDAR installation

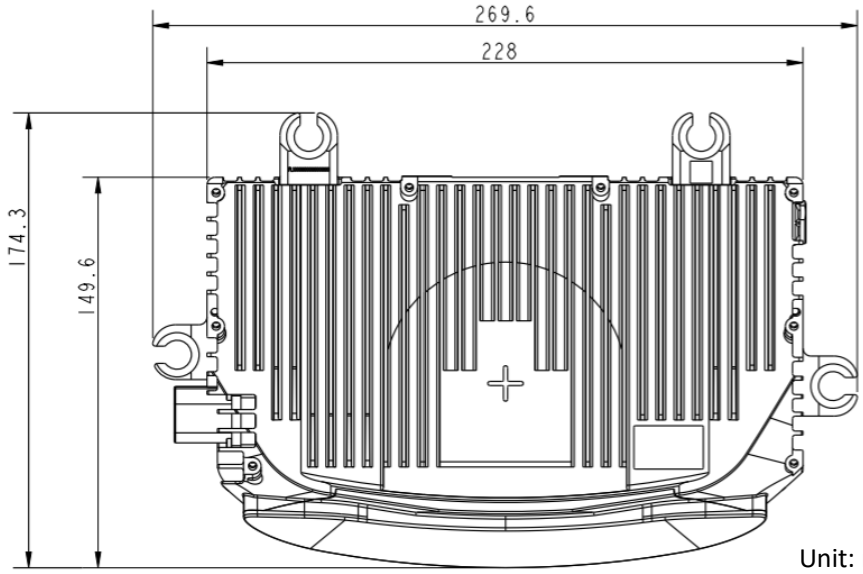
3.2.1 Power description

The operating voltage range of Falcon is 9 to 34 VDC. It is recommended to use standard 12 VDC for the power supply. The power consumption of LiDAR is about 30W during regular operating. The peak power when the LiDAR is activated is about 50W and lasts less than 1 second. The peak power should be considered when choosing the power supply.

3.2.2 Dimensions



Front View Unit: mm



Unit: mm

Top view

3.3 Cable description

Please notice that if the Falcon must connect to industrial Ethernet with an RJ45 connector, it is necessary to adopt a media converter for the switch from the 1000Base-T1 interface to an RJ45 interface.

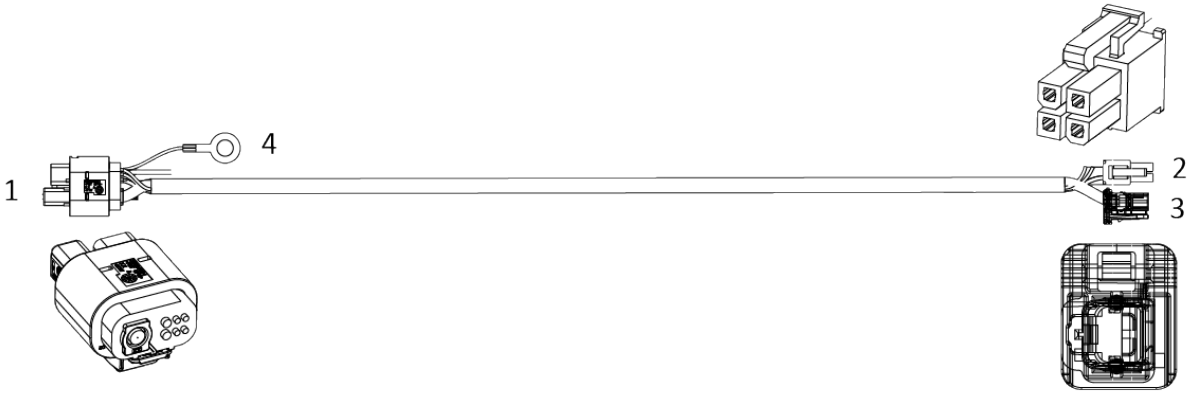
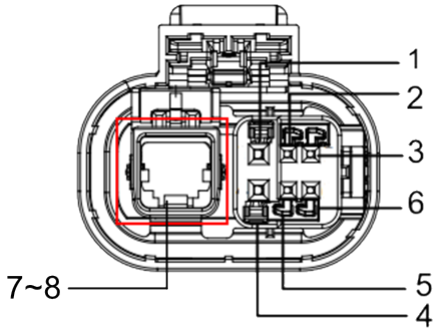
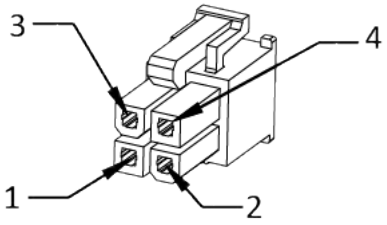
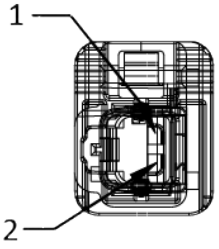
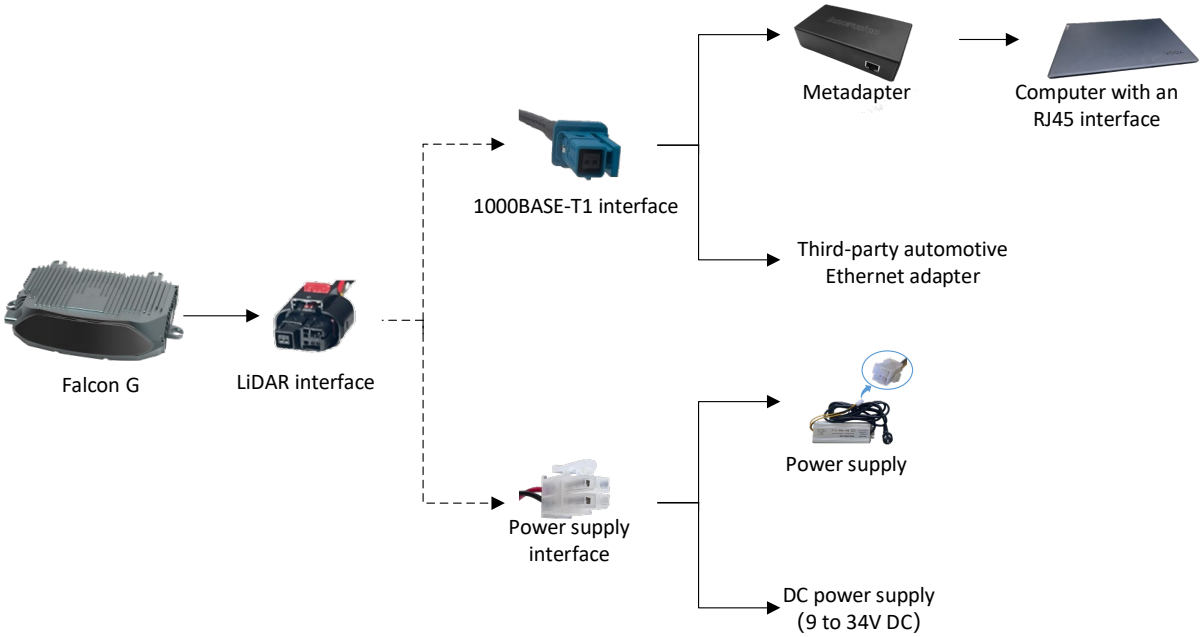


Table 5 Interface description

NO.	Name	Description
1	LiDAR interface	8-pin interface. Pins are defined as follows.

		 [1]: Grounding [2]: Empty pin [3]: Shield grounding [4]: Power supply [5]: CAN high [6]: CAN low [7] and [8]: Gigabit Ethernet
2	Power supply	4-pin interface. Pins are defined as follows.  [1]: Power supply- [2]: Empty pin [3]: Power supply+ [4]: Empty pin
3	1000Base-T1 automotive Ethernet	1000Base-T1 automotive Ethernet. Pins are defined as follows.  [1]: Ethernet D+ [2]: Ethernet D-
4	Grounding	Shield grounding

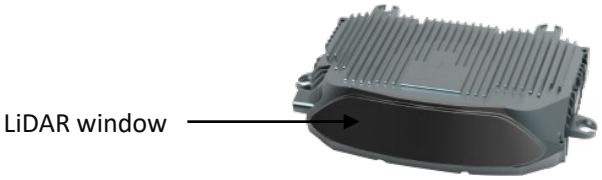
3.4 LiDAR connection



3.5 Cleaning

For optimal performance of LiDAR, please keep the front window of the sensor clean and free of dirt, bugs, and other debris. The steps to clean the optical window are as follows.

1. Prepare a lint-free cloth, soak it in the alcohol, and wring it out.
2. Loose the debris from the LiDAR window with the lint-free cloth for 1 minute. Do not wipe dirt directly off the LiDAR window glass without loosening it sufficiently.



3. Please wait 1 minute, gently wipe the window with the clean microfiber cloth and dry it.
4. Wipe the window with a new, dry lint-free cloth. Do not apply excessive force to avoid damaging the optical coating.

Note

Please wash your hands or wear PVC powder-free clean gloves before touching the product.

Do not use solvents since they may damage the window coating.

Please use a new dust-free wiper to wipe the LiDAR window.

The LiDAR window is made of special plastic material. Please pay attention to the following items when cleaning: Avoid direct skin contact with the optical window. Do not use corrosive cleaners and solvents.

Do not use paper towels or similar materials to clean the window to avoid scratches.

4 Software operation

You can operate the LiDAR on the following platforms. For how to operate LiDAR using SDK tools, please refer to *5 SDK configuration.* If you want to get more information, please contact Seyond staff to obtain related manuals.

Table 6 platform instructions

NO.	Software Interface	Description
1	ILA	ILA is the quickest way to view live point clouds and record data. The ILA GUI can be accessed through a web browser (preferably Chrome) and does not require any SW installation. Running on Linux, Windows, or Mac OS, and does not require any SW installation. ILA does not support the replaying of recorded data.
2	ROS	ROS (ROS1) drivers are available for Kinetic, Melodic and Noetic. Please notice that drivers for ROS Kinetic will be discontinued soon. ROS2 drivers are also available for Foxy Fitzroy, Galactic Geochelone, and Humble Hawksbill.
3	MetaView	The MetaView can be run from any Linux or Windows OS computer. It allows viewing of the live point cloud, data recording, and replaying recorded data. For the operations on MetaView, please see the user manuals related to MetaView.
4	Docker	Docker drivers are available for users to view and replay data. It also provides a convenient way for calibration and troubleshooting.

4.1 Operate on ILA

The ILA operations in this chapter are based on the 4385 version of the firmware.

4.1.1 Start the LiDAR

1. Connect the power supply to start the LiDAR.
2. The LiDAR completes initialization and generates data after powering on for 11 to 18 seconds.

Note

The LiDAR does not have a power switch. It will become operational when power is applied.

4.1.2 Login

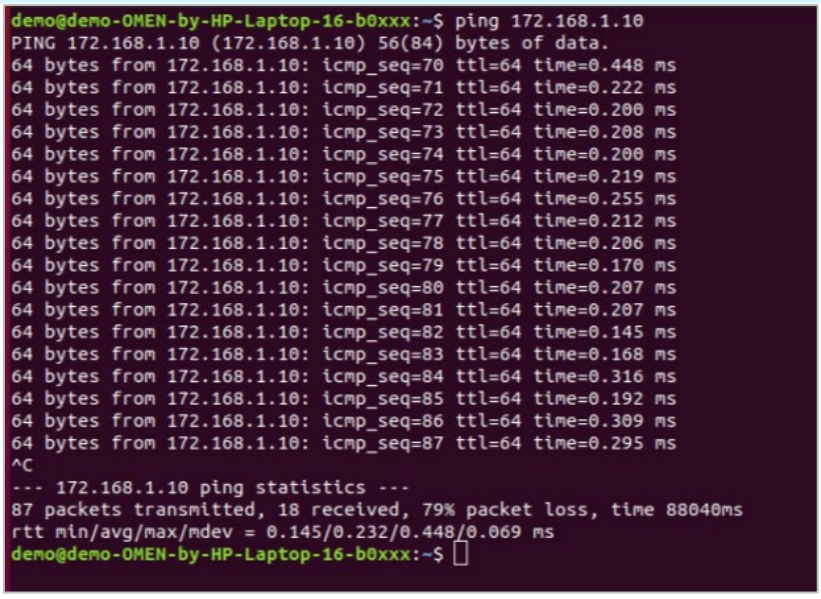
1. Connect the computer to LiDAR and ensure the Ethernet connection.
2. Change the computer IP address to the same subnet with the LiDAR.
3. Open the web browser. Enter the LiDAR IP address and port number in the address bar `<IP Address>: <PORT>` to access the ILA.

Note

The default LiDAR IP address is 172.168.1.10. By default, the ILA port number is 8675. The default ILA login address is 172.168.1.10:8675.

It is recommended to check the access to the LiDAR IP address by using the ping command. The return value is shown in the figure below.

It is recommended to use the Google Chrome browser to log in to the ILA.



4.1.3 View the point cloud status of the LiDAR

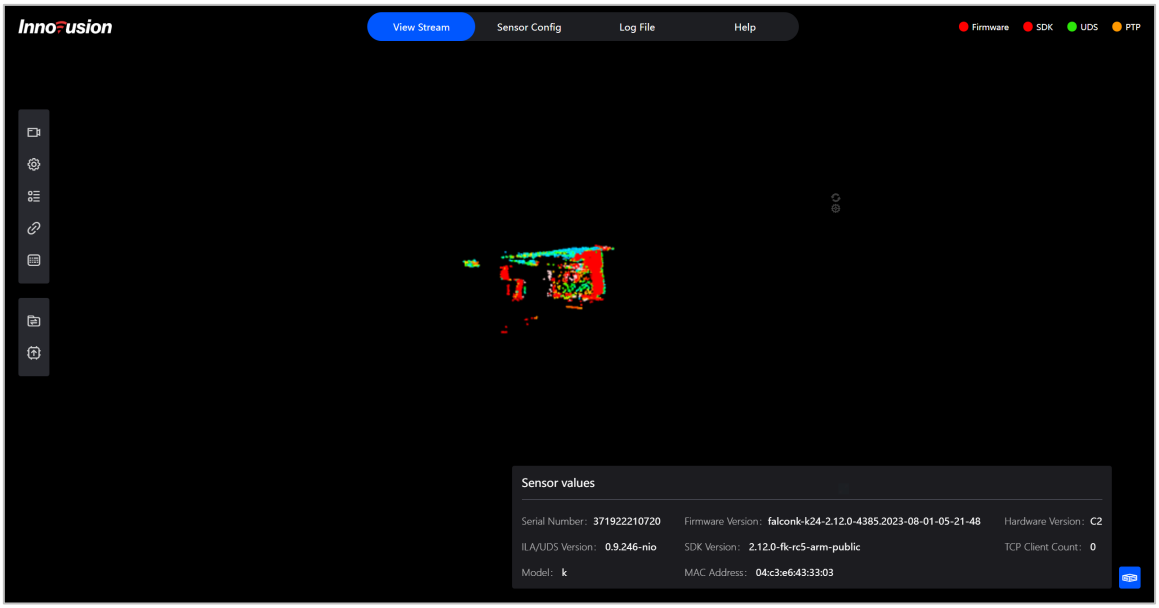
Note

Ensure the internal point cloud service (PCS) runs on the **Sensor config**. If PCS is running, the green Run button should be greyed out.

Before viewing the point cloud status, please ensure the computer can access to the Internet. While the latest ILA has a built-in WebGL viewer, a more feature-rich viewer is available with an Internet connection.

1. You can directly view the status of the LiDAR point cloud in real-time on the **View Stream**.
2. (Optional) Change the point of view and distance in which the point cloud data is displayed using the keyboard shortcuts and mouse.

   You could click  to check the available keyboard shortcuts.

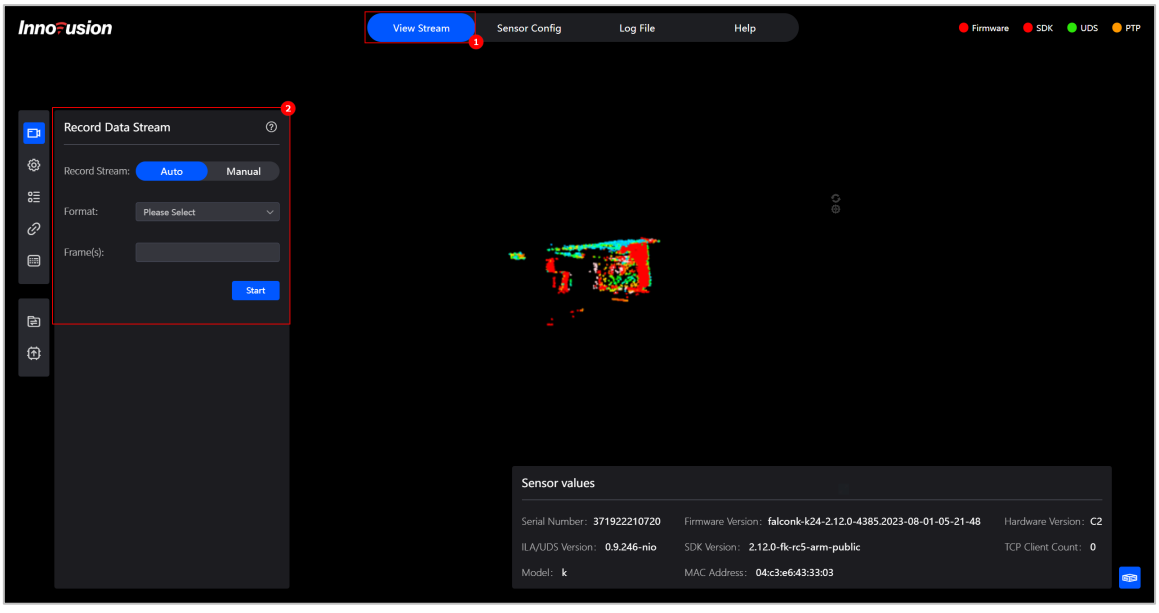


4.1.4 Record LiDAR point cloud data

You can record LiDAR point cloud data in different formats.

1. Go to **View stream** > **Record data stream**.
2. Select the way to record the point cloud file.

   If you select **Auto**, you need to specify the size of file before recording. If you select **Manual**, you need to click **Stop** to stop recording the file.



3. Select the file format and size of the data to be recorded.

   - Record a file in pcd format.

Select **Pointcloud snapshot (.pcd)** in **Format**. Enter the number of frames to be recorded in **frame (s)**. The range is from 0 to 20.

- Record a file in inno_pc format.
  Select **Inno-pointcloud (.inno_pc)** in **Format**. Enter the number of frames to be recorded in **frame (s)**.
  inno_pc is a proprietary format of Seyond point cloud files and cannot be read by 3rd party software. The points in inno_pc files are in spherical coordinates. inno_pc is in the optimum compression.
- Record a file in inno_pc_xyz format.
  Select Cartesian **coordinates Pointcloud (.inno_pc_xyz)** in **Format**. Enter the number of frames to be recorded in **frame(s)**. The range is from 0 to 10.
  inno_pc_xyz is a proprietary format of Seyond point cloud files and cannot be read by 3rd party software. The points in inno_pc_xyz files are in Cartesian coordinates. inno_pc_xyz is in the less optimum compression compared to inno_pc.
- Record a file in png format.
  Select **Portable Network Graphic (.png)** in **Format**.
- Record a file in csv format.
  Select **Comma-separated value (.csv)** in **Format**. Enter the number of frames to be recorded in **frame (s)**. The range is from 0 to 20.

4. Click **Start** to record the file. If you select **Manual**, you need to click **Stop** to stop recording the file.

Note

Point cloud data recording starts immediately by default.

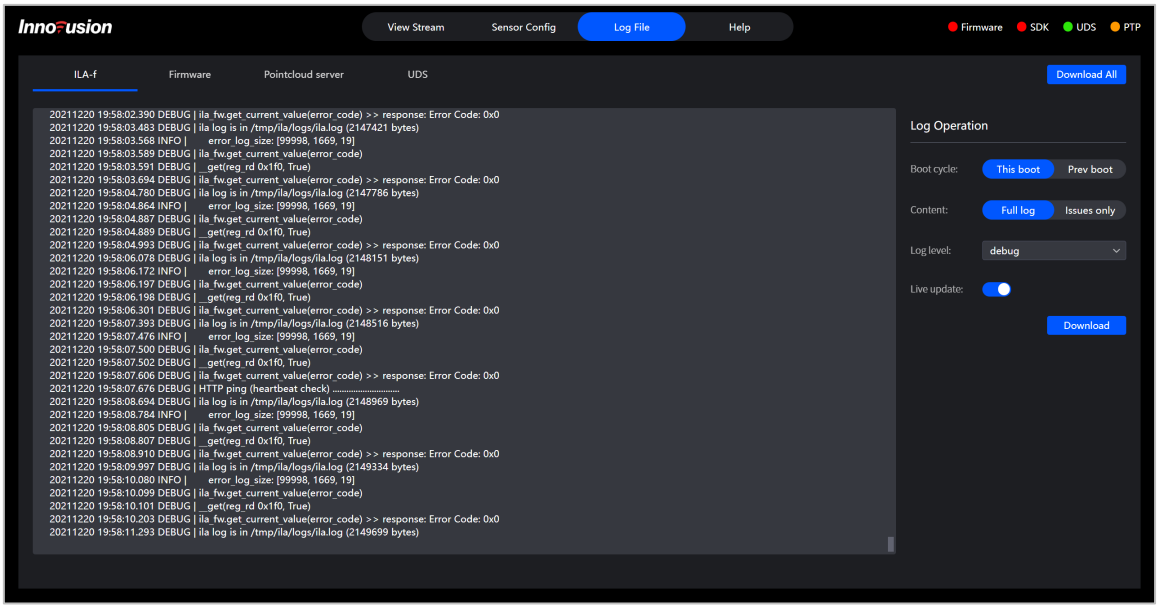
The recorded data file is in the **Download** folder on the computer.

The limitation of the file size is subject to change according to the file format.

4.1.5 View/download logs

You can view and download logs related to different components to confirm operations and alarm information.

1. Go to **Log File**.
2. Select the log type. You can select four types of logs: **ILA-f (related to the webpage)**, **Firmware**, **Pointcloud server,** and **UDS**.



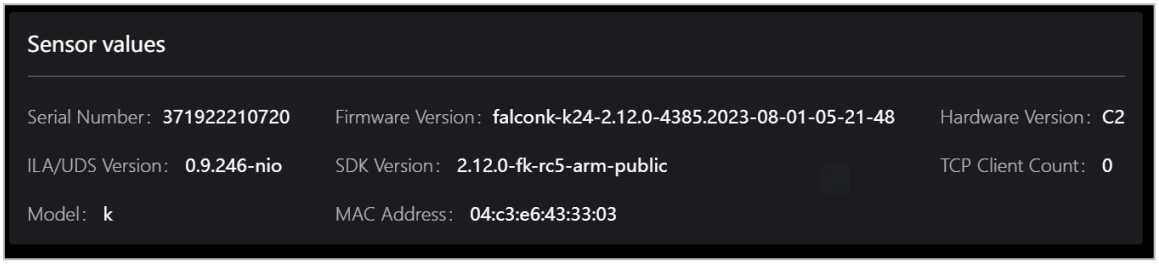
3. (Optional) Set the filtering criteria of the logs.

   - Time range: Select **Prev boot** or **This boot** to choose whether to display the last 100 log messages generated before this boot or those generated after this boot.
   - Type of log: Select **Issues only** or **Full log** to choose whether to display only the problem or all logs.
   - Log level: Click **Log level** and select the log level to be displayed. The log level is described in the following table.

4. You can view logs on the left panel. You can also click **Download** to download the corresponding logs.

4.1.6 View version information

You can check the device serial number, hardware version, and SDK version information in the **View Stream** > **Sensor values**.



4.1.7 Shut down the LiDAR

Disconnect the power supply to shut down the LiDAR.

4.2 Operate in ROS

4.2.1 Operate in ROS1 environment

The operations in this chapter are based on the Ubuntu 18.04. The version of ROS is melodic.

4.2.1.1 Start the LiDAR

1. Connect the power supply to start the LiDAR.
2. The LiDAR completes initialization and generates data after powering on for 11 to 18 seconds.

Note

The LiDAR does not have a power switch. It will become operational when power is applied.

4.2.1.2 Obtain point cloud data

Note

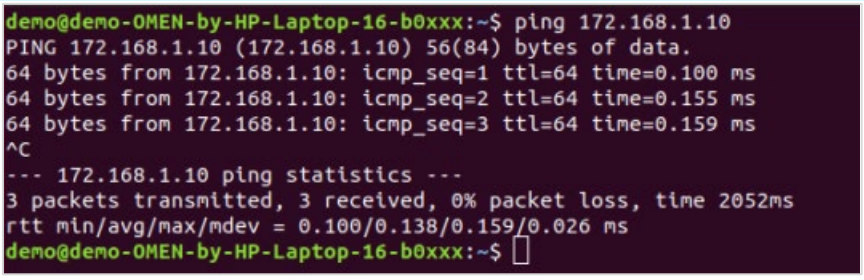
- The ROS driver needs to be restarted after the LiDAR is shut down or the software is restarted.
- For the installation method of ROS, please refer to http://wiki.ros.org/.

1. Connect the computer to the LiDAR.
2. Change the computer IP address to the same subnet with the LiDAR.

Note

The default LiDAR IP address is 172.168.1.10.

It is recommended to check the access to the LiDAR IP address via the ping command. The return value is shown in the figure below.



3. View the system details and obtain the corresponding driver. Copy the driver to the root directory of the system. Execute the following command to install the driver.

```
sudo dpkg -i <package.deb>
```

Note

package.deb is the driver's name of the LiDAR. Obtain the latest driver version based on the actual conditions.

Table 7 Available system

System Version	CPU
Ubuntu 16.0.4	ARM
	X86

System Version	CPU
Ubuntu 18.0.4	ARM
	X86
Ubuntu 20.0.4	ARM
	X86

4. Start ROS. The return value is shown in the figure below.

```
roscore
```

5. Obtain the point cloud data of the LiDAR. The return value is shown in the figure below.

- Obtain the point cloud data via the TCP port.

```
source /opt/ros/melodic/setup.bash
roslaunch innovusion_pointcloud innovusion_points.launch device_ip:= <device_ip> port:=<
TCP_port > processed:= <Processed_number>
```

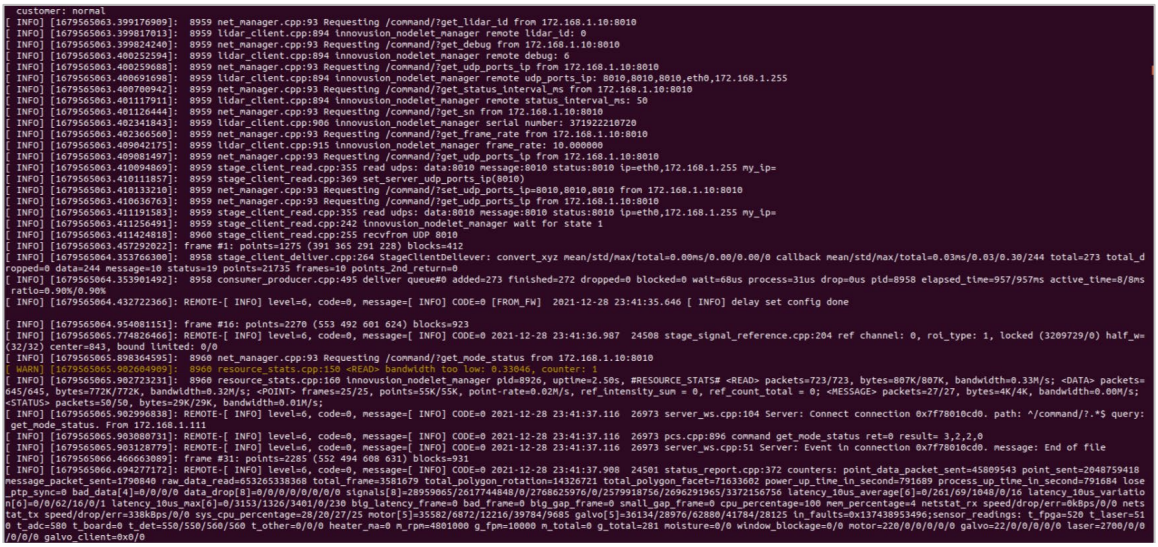
- Obtain the point cloud data via the UDP port.

```
source /opt/ros/melodic/setup.bash
roslaunch innovusion_pointcloud innovusion_points.launch device_ip:= <device_ip> udp_port:=
<UDP_port> processed:= <Processed_number>
```

Note

The default value of device_ip is 172.168.1.10. By default, the UDP port number is 8010.

The value of processed_number can be 0 or 1. When the process_number is set to 1, the point cloud data is obtained from ROS client. When the process_number is set to 0, the point cloud data is obtained from external PCS.



4.2.1.3 View LiDAR point cloud data

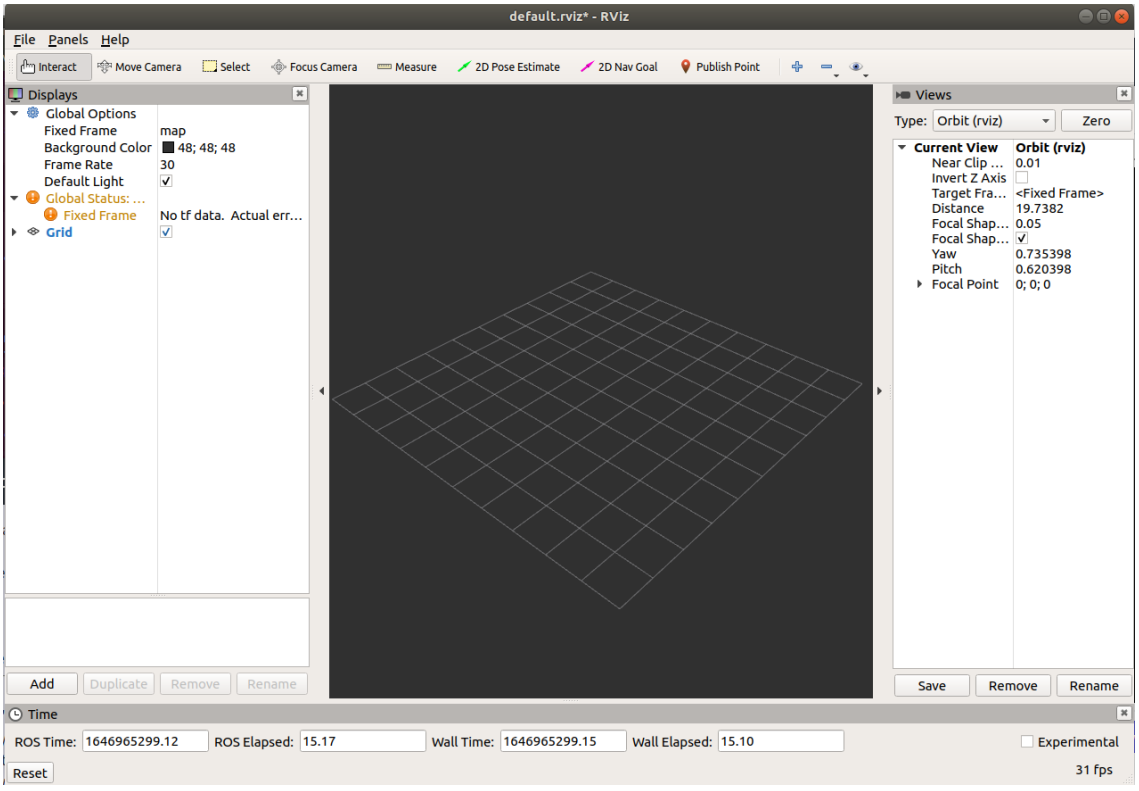
Note

Before viewing the point cloud data, please confirm that the point cloud data has been obtained.

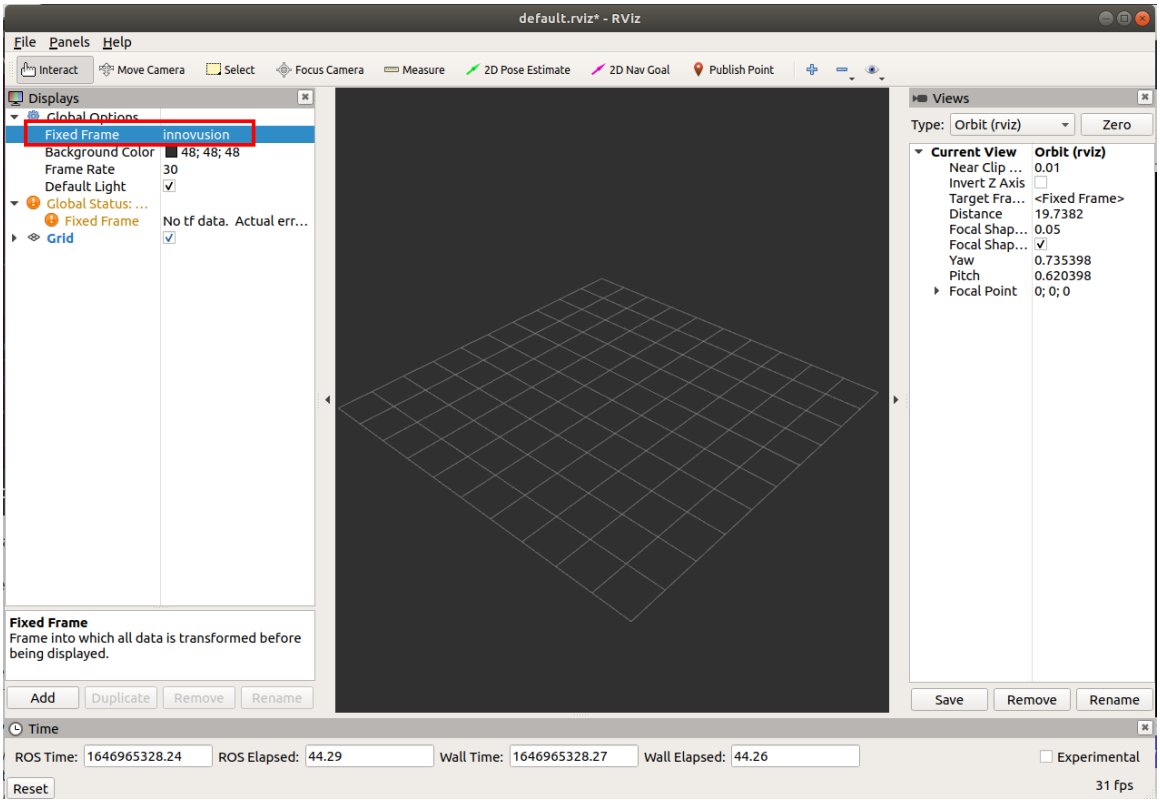
1. Start the graphical tool **rviz**. The return value and **rviz** interface are shown below.

```
rviz
```

```
demo@demo-OMEN-by-HP-Laptop-16-b0xxx:~$ rviz rviz
[ INFO] [1646808931.535449917]: rviz version 1.13.21
[ INFO] [1646808931.535492615]: compiled against Qt version 5.9.5
[ INFO] [1646808931.535502544]: compiled against OGRE version 1.9.0 (Ghadamon)
[ INFO] [1646808931.539157206]: Forcing OpenGl version 0.
[ INFO] [1646808932.122437501]: Stereo is NOT SUPPORTED
[ INFO] [1646808932.122552411]: OpenGL device: NVIDIA GeForce RTX 3060 Laptop GPU/PCIe/SSE2
[ INFO] [1646808932.122633840]: OpenGl version: 4.6 (GLSL 4.6).
QObject::connect: Cannot queue arguments of type 'QVector<int>'
(Make sure 'QVector<int>' is registered using qRegisterMetaType().)
QObject::connect: Cannot queue arguments of type 'QVector<int>'
(Make sure 'QVector<int>' is registered using qRegisterMetaType().)
```



2. Select **Global Options** > **Fixed Frames**. Set the Fixed Frames value to **innovusion**.

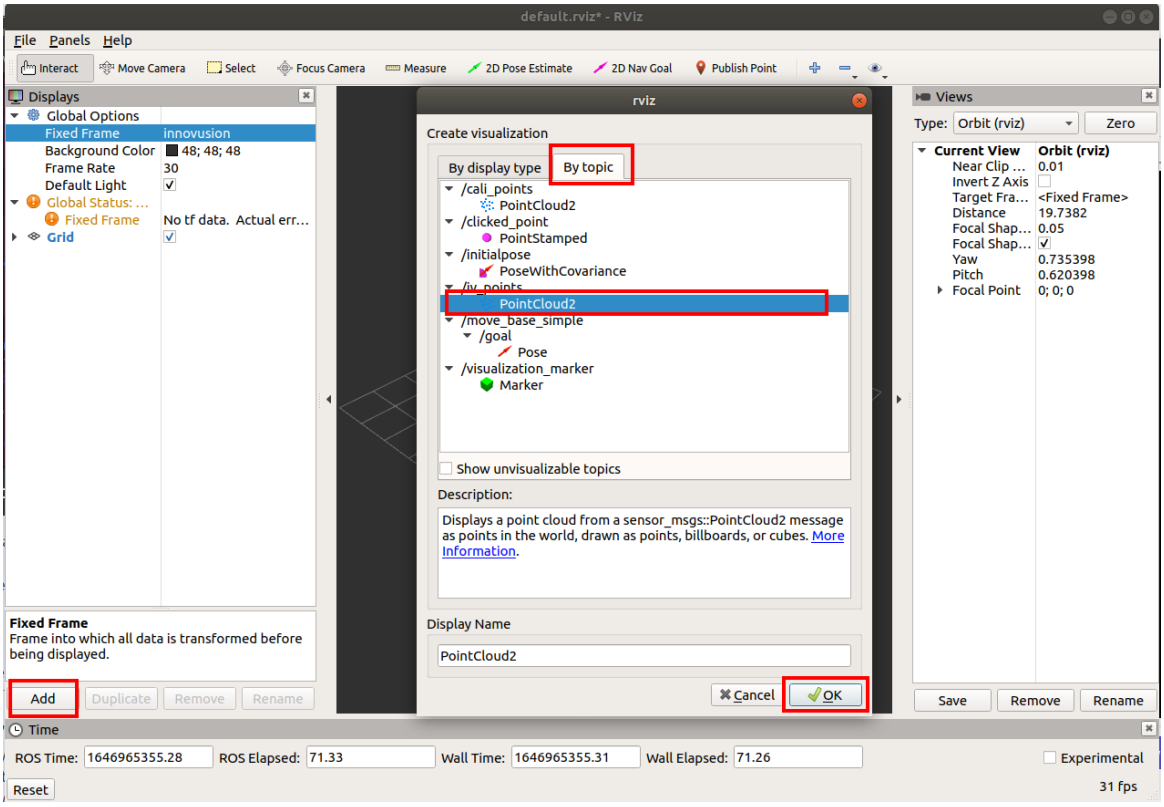


i. Add PointCloud2 to Displays.

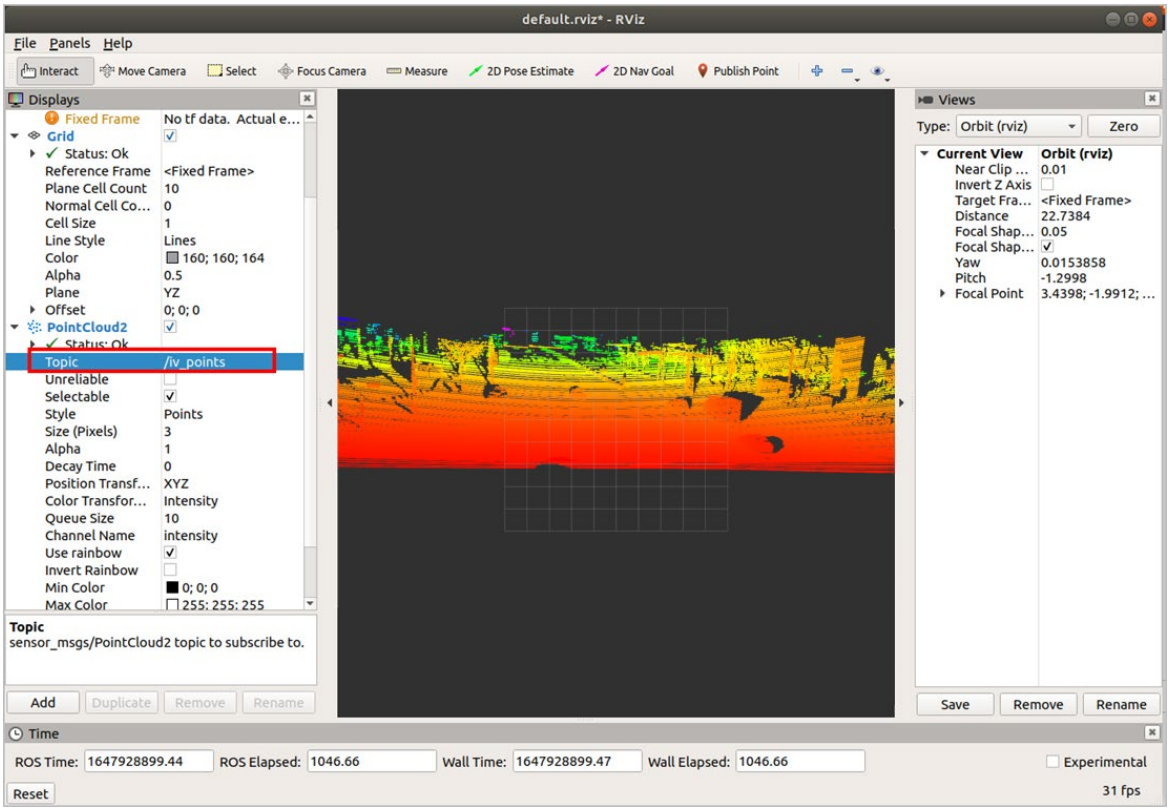
a. Click **Add.**

b. Select By topic > iv_points > PointCloud2.

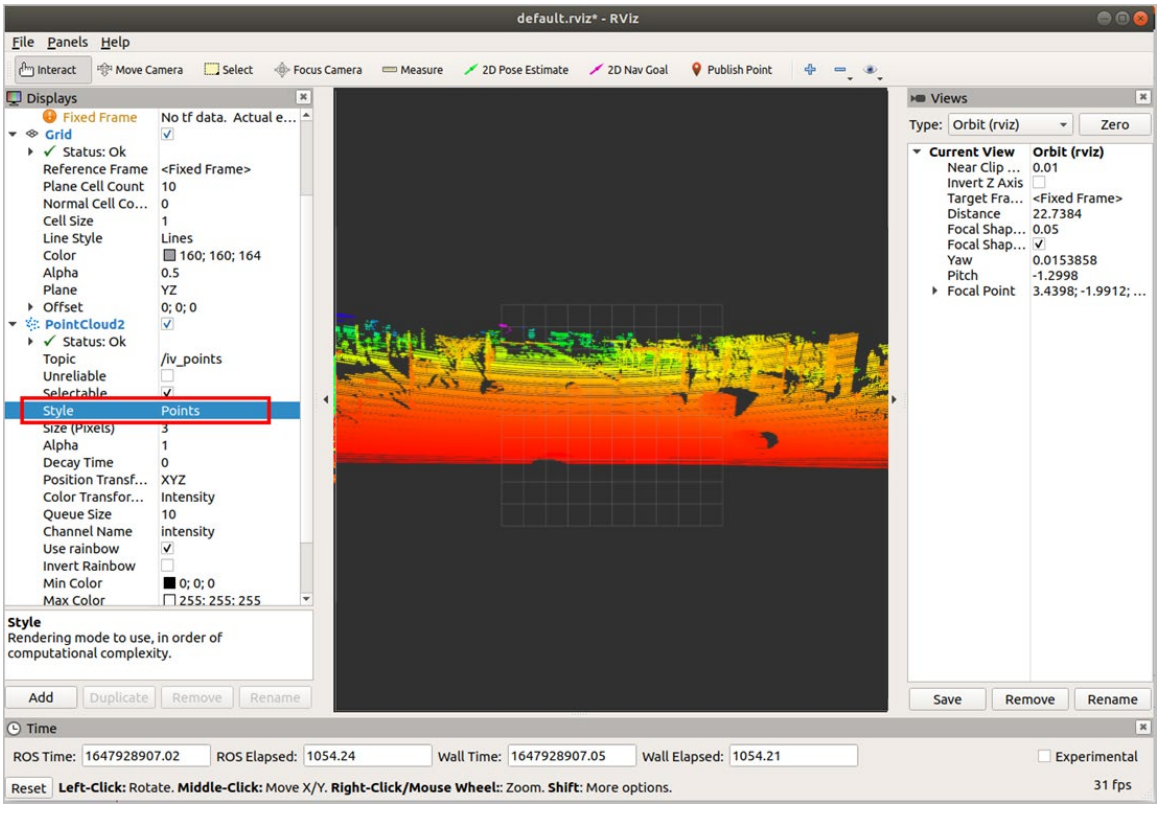
c. Click **OK**.



ii. Select **PointCloud2** > **Topic**. Set the Topic value to **/iv_points**.



iii. Select **PointCloud2** > **Style**. Set the Style value to **Points**.

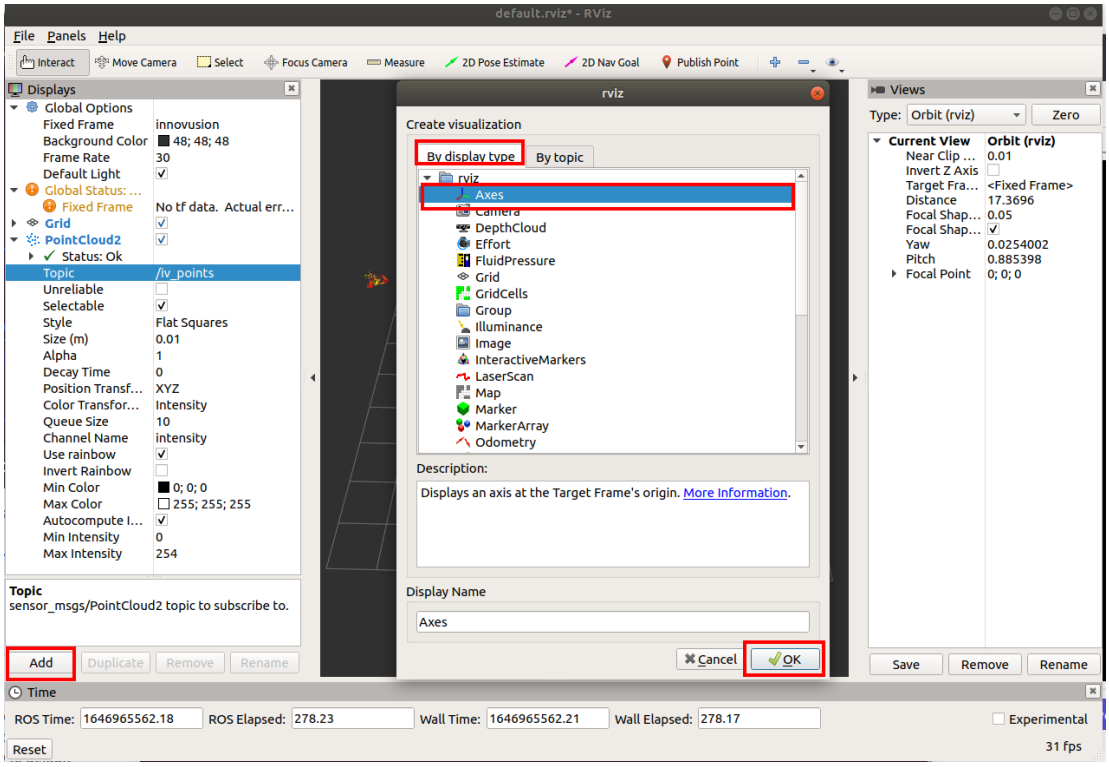


3. (Optional) You can change the angle and distance of the real-time point cloud status and get more information as needed.

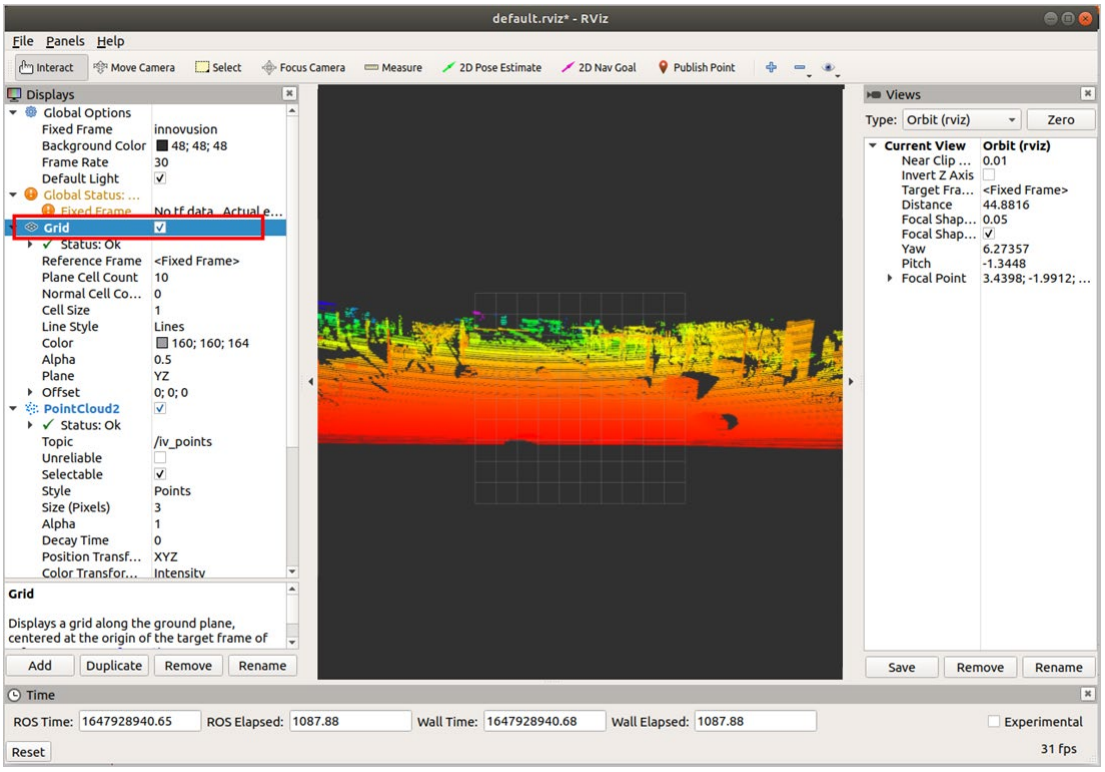
- You can select **Axes** to add the coordinate system to the diagram as a reference.

  a. Select Add > By display type > Axes.

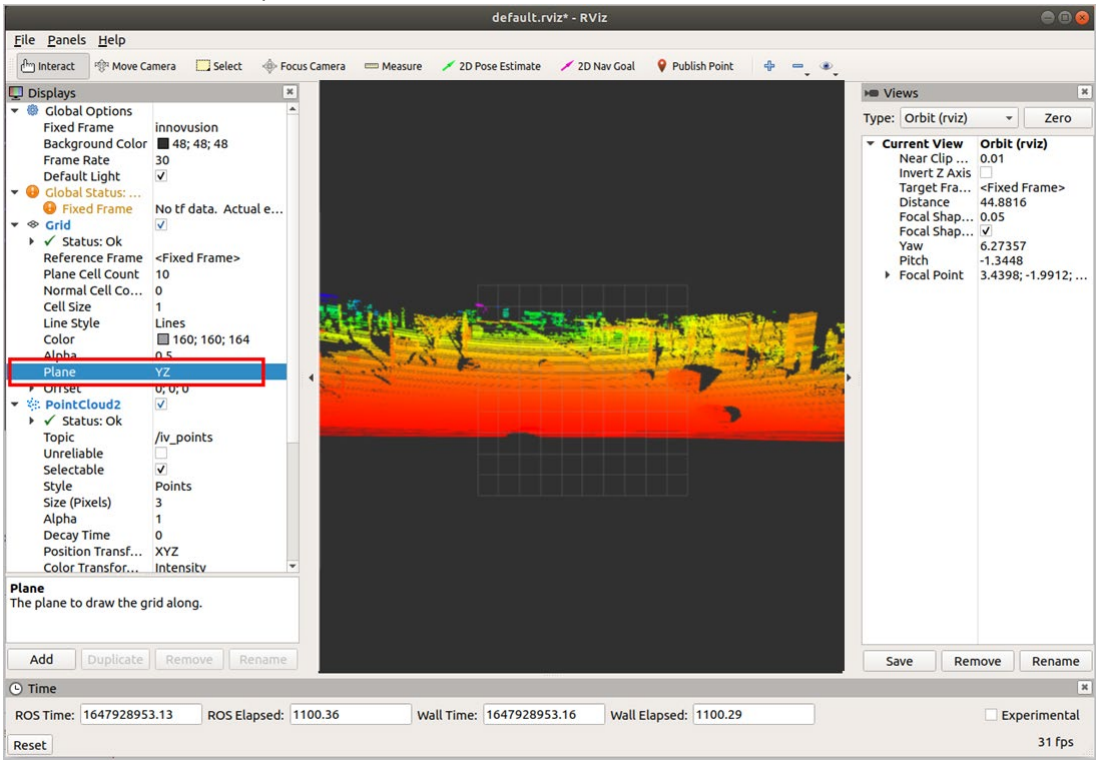
  b. Click **OK**.



- Select **Grid** to add the grid to the diagram as a reference. Grid is enabled by default when rviz is started.



- Set the **plane** value to view the point cloud status under different coordinate systems. There are three options: **XY**, **XZ**, and **YZ**.



4.2.1.4 Record LiDAR point cloud data

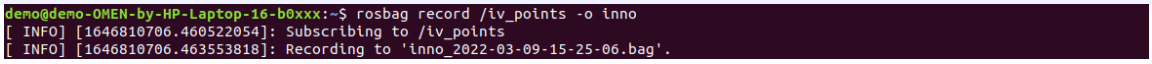
You can record the point cloud data of the LiDAR in bag format in ROS.

Note

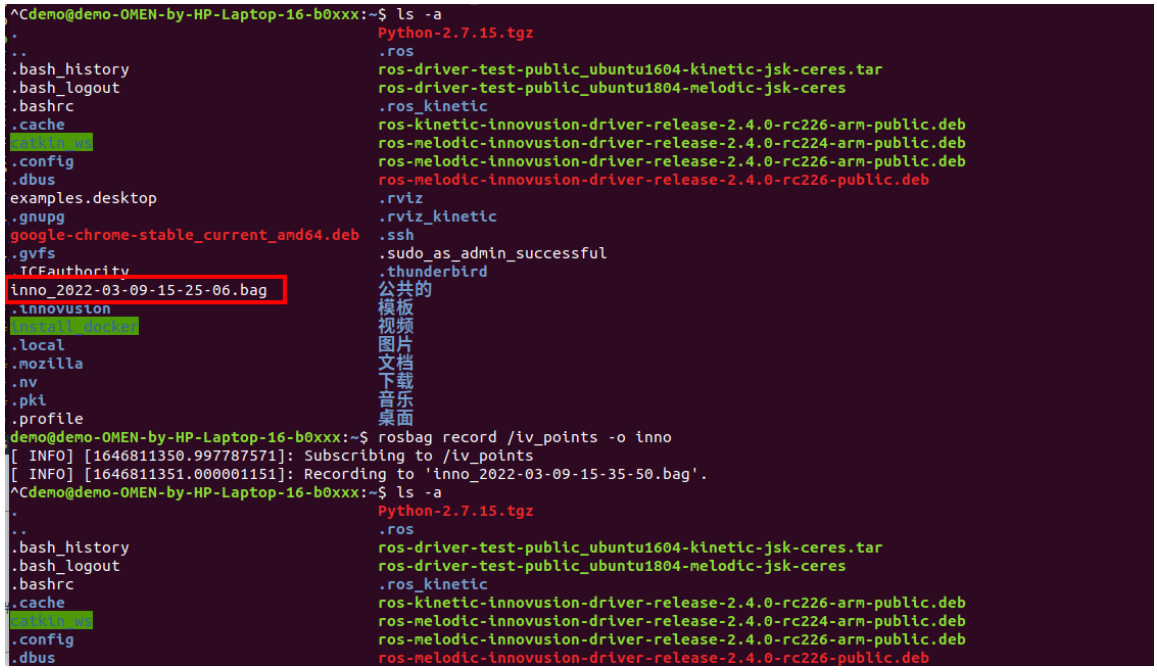
Before recording the point cloud data of the LiDAR, please confirm that the point cloud data has been obtained correctly in ROS. For information on how to get the point cloud data, see *4.2.1.2 Obtain point cloud data*.

1. Record point cloud data in bag format. Recording starts at the execution time.

```
rosbag record /iv_points -o inno //Start to record the point cloud data in bag format. The file is saved in the current path and the file name is “inno-Year-Mon-Day-Hr-Min.bag”
```



2. Press **Ctrl+C** to stop recording point cloud data.
3. (Optional) Execute ls - a command to check the directory of recorded point cloud data.



4.2.1.5 Replay LiDAR point cloud data

You can replay the point cloud data in bag format in ROS environment.

Note

Before replaying LiDAR point cloud data, please confirm that the recorded point cloud data file has been obtained.

1. Run ROS. The return value is shown in the figure.

```
roscore
```

```
demo@demo-OMEN-by-HP-Laptop-16-b0xxx:~$ roscore
... logging to /home/demo/.ros/log/a09b36de-9f71-11ec-874a-c85acfaa1d16/roslaunch-demo-OMEN-by-HP-Laptop-16-b0xxx-9812.log
Checking log directory for disk usage. This may take a while.
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.

started roslaunch server http://demo-OMEN-by-HP-Laptop-16-b0xxx:42677/
ros_comm version 1.14.12


SUMMARY
========

PARAMETERS
 * /rosdistro: melodic
 * /rosversion: 1.14.12

NODES

auto-starting new master
process[master]: started with pid [9822]
ROS_MASTER_URI=http://demo-OMEN-by-HP-Laptop-16-b0xxx:11311/

setting /run_id to a09b36de-9f71-11ec-874a-c85acfaa1d16
process[rosout-1]: started with pid [9833]
started core service [/rosout]
```

2. Start the graphical tool **rviz**. The return value and **rviz** interface are shown below.

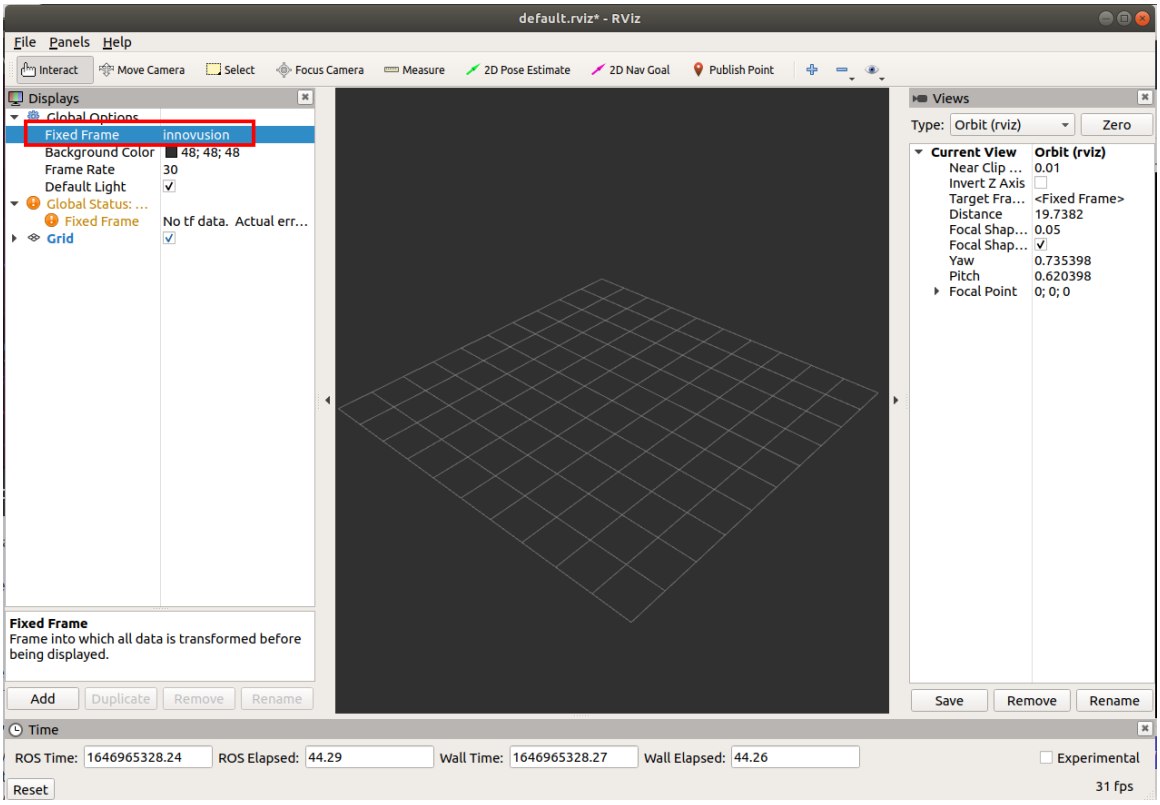
```
rviz
```

```
demo@demo-OMEN-by-HP-Laptop-16-b0xxx:~$ rviz rviz
[ INFO] [1646808931.535449917]: rviz version 1.13.21
[ INFO] [1646808931.535492615]: compiled against Qt version 5.9.5
[ INFO] [1646808931.535502544]: compiled against OGRE version 1.9.0 (Ghadamon)
[ INFO] [1646808931.539157206]: Forcing OpenGl version 0.
[ INFO] [1646808932.122437501]: Stereo is NOT SUPPORTED
[ INFO] [1646808932.122552411]: OpenGL device: NVIDIA GeForce RTX 3060 Laptop GP
U/PCIe/SSE2
[ INFO] [1646808932.122633840]: OpenGl version: 4.6 (GLSL 4.6).
QObject::connect: Cannot queue arguments of type 'QVector<int>'
(Make sure 'QVector<int>' is registered using qRegisterMetaType().)
QObject::connect: Cannot queue arguments of type 'QVector<int>'
(Make sure 'QVector<int>' is registered using qRegisterMetaType().)
```

3. Replay LiDAR point cloud data in **rviz**.

```
rosbag play <filename.bag>
```

4. Select **Global Options** > **Fixed Frames**. Set the **Fixed Frames** value to **innovusion**.



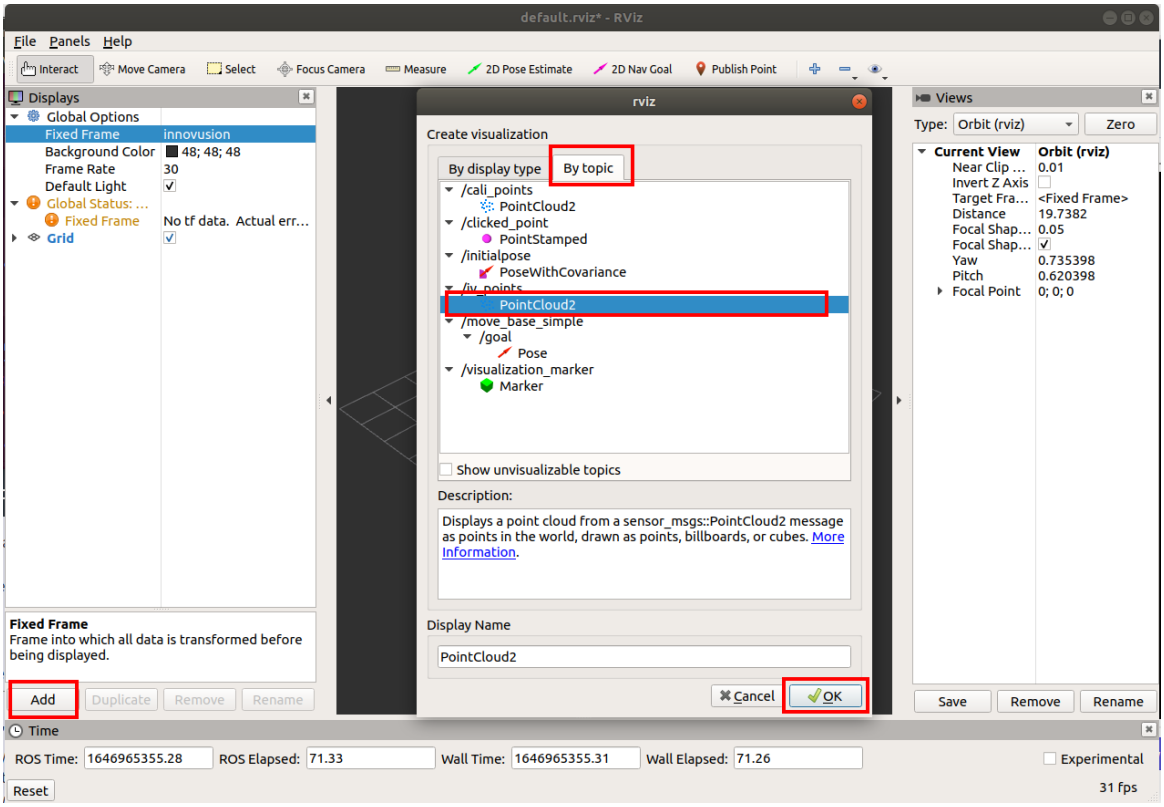
5. Add and configure **PointCloud2**.

   i. Add **PointCloud2** to the Displays.

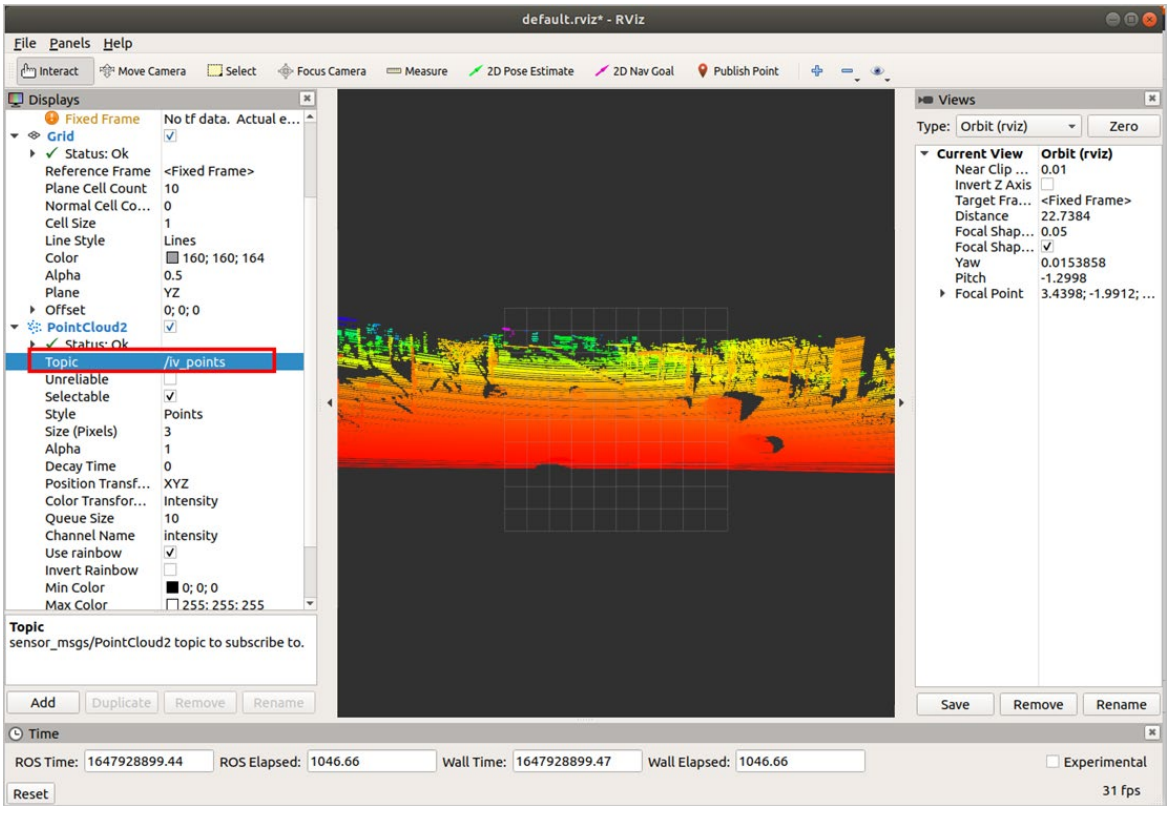
      a. Click **Add.**

      b. Select By topic > display type > PointCloud2.

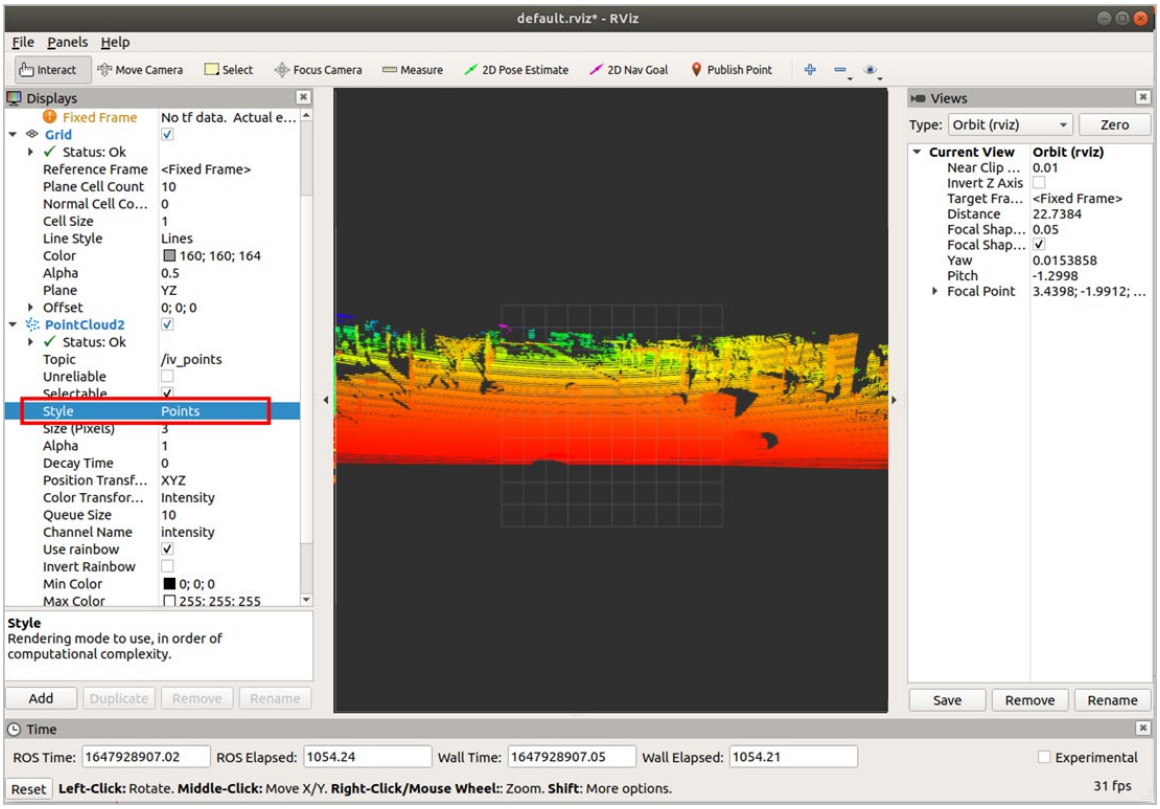
      c. Click **OK**.



ii. Select **PointCloud2** > **Topic**. Set the Topic value to **/iv_points**.



iii. Select **PointCloud2** > **Style**. Set the Style value to **Points**.

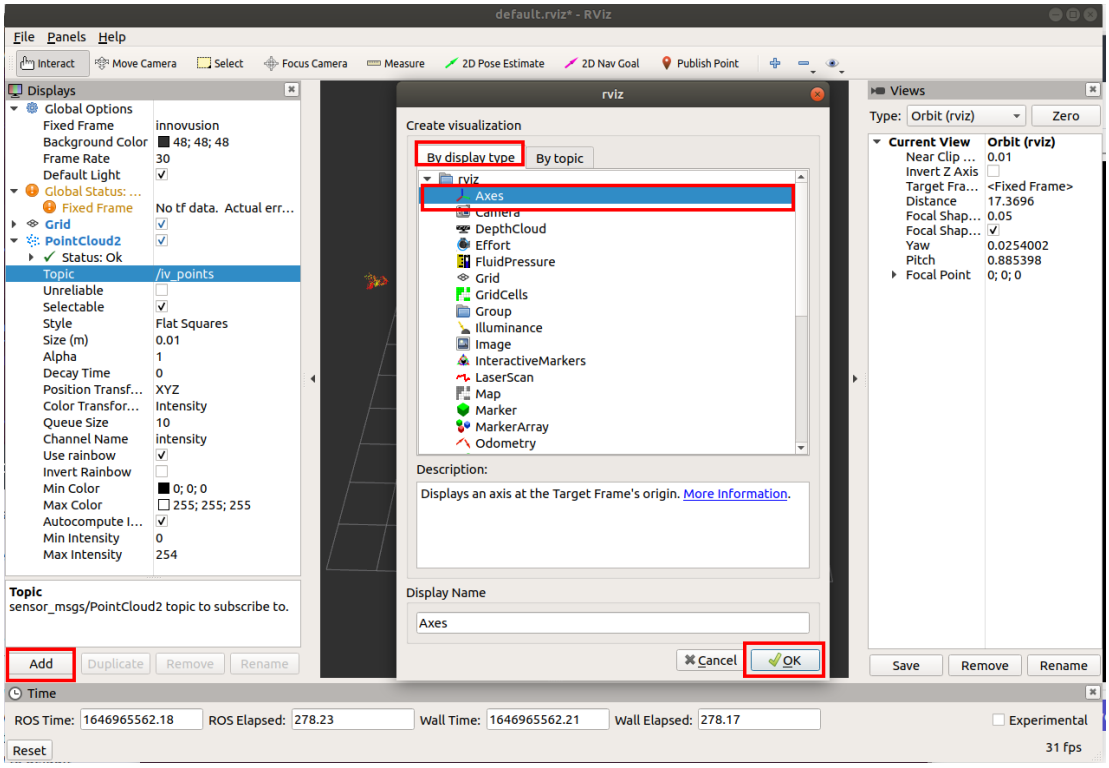


6. (Optional) You can change the angle and distance of the real-time point cloud status and get more information as needed.

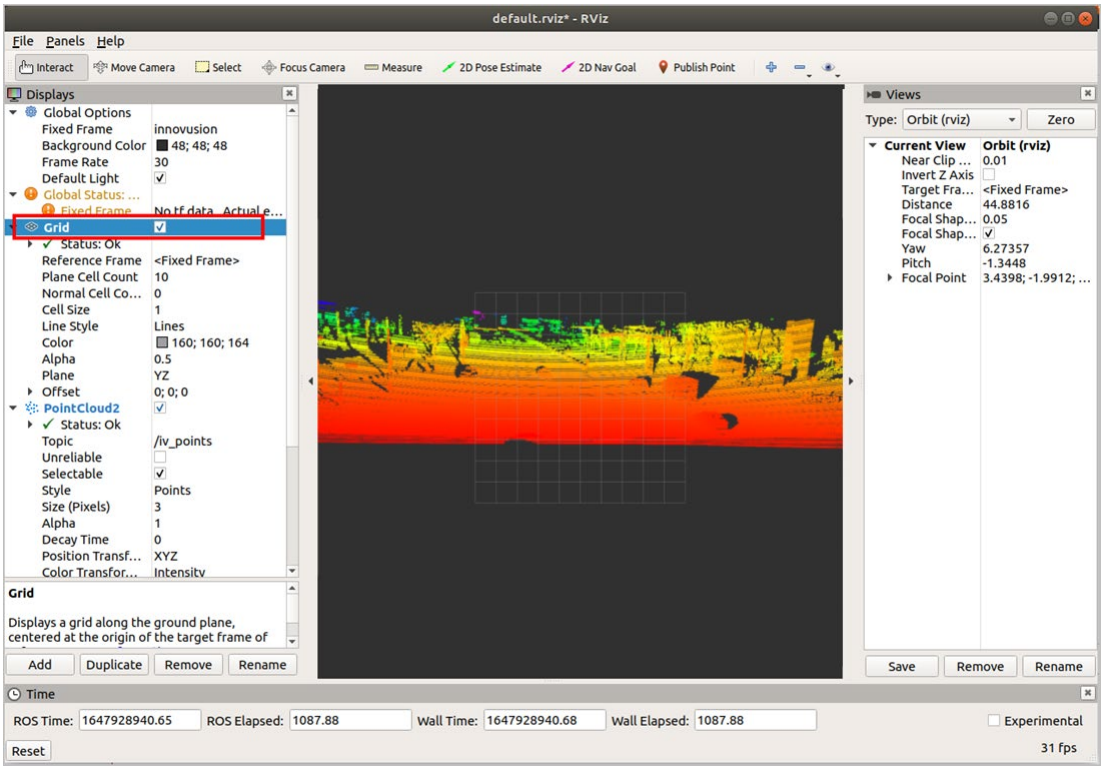
- You can select **Axes** to add the coordinate system to the diagram as a reference.

  a. Select Add > By display type > Axes.

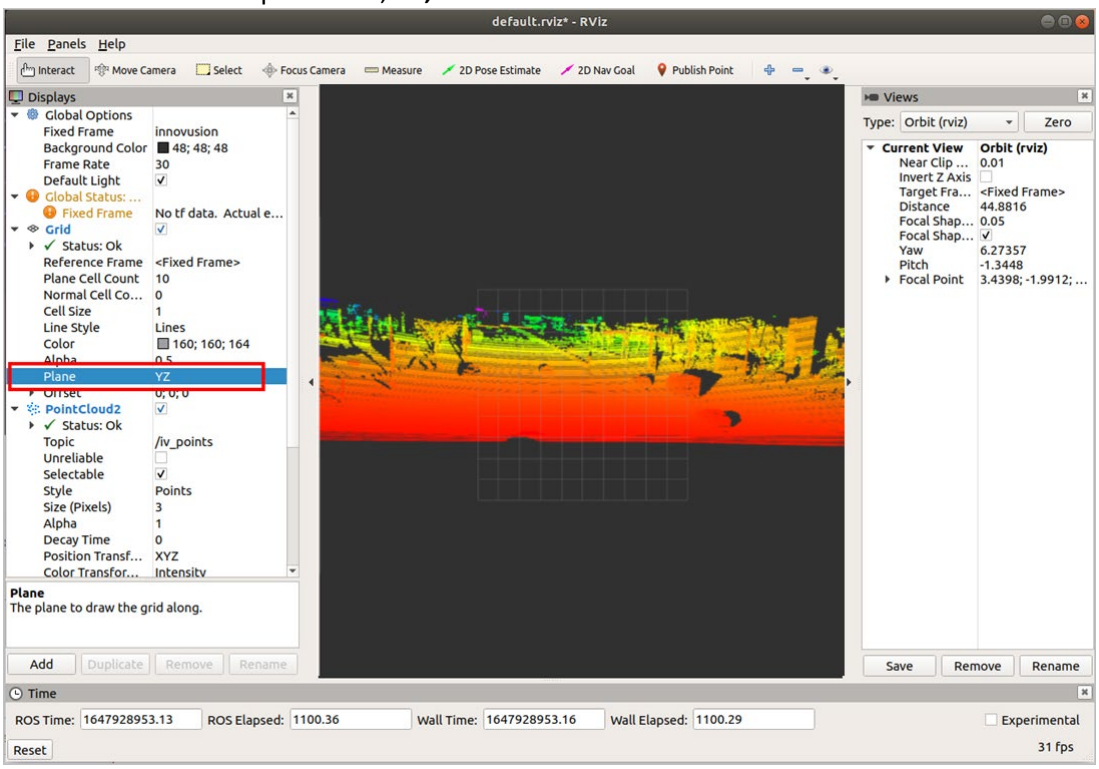
  b. Click **OK**.



- Select **Grid** to add the grid to the diagram as a reference. Grid is enabled by default when **rviz** is started.



- Set the **plane** value to view the point cloud status under different coordinate systems. There are three options: **XY**, **XZ,** and **YZ**.



7. Press **Space** to pause playback of the point cloud data file.

4.2.1.6 Shut down the LiDAR

Disconnect the power supply to shut down the LiDAR.

4.2.2 Operate in ROS2 environment

The operations in this chapter are based on the Ubuntu 20.04. The version of ROS is foxy.

4.2.2.1 Start the LiDAR

1. Connect the power supply to start the LiDAR.
2. The LiDAR completes initialization and generates data after powering on for 11 to 18 seconds.

Note

The LiDAR does not have a power switch. It will become operational when power is applied.

4.2.2.2 Obtain point cloud data

Note

The ROS driver needs to be restarted after the LiDAR is shut down or the software is restarted.

For the installation method of ROS2, please refer to https://docs.ros.org.

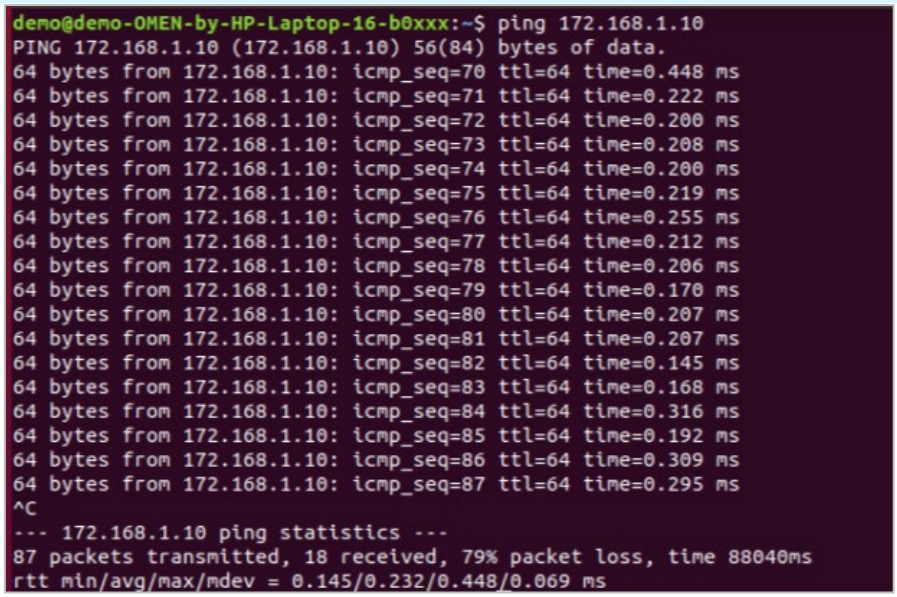
1. Connect the computer to the LiDAR.

   Verify the protocol mode of the lidar for sending data. When the lidar sends data using UDP, it should be ensured that the host and LiDAR are on the same network segment. For how to change the computer IP on Windows, see *2.2.3 Change the computer IP address*.

Note

The default LiDAR IP address is 172.168.1.10.

It is recommended to check the access to the LiDAR IP address via the ping command. The return value is shown in the figure below.



2. View the system details and obtain the corresponding driver. Copy the driver to the root directory of the system. Execute the following command to install the driver.

```
sudo dpkg -i <package.deb>
```

Note

package.deb is the driver's name of the LiDAR. Obtain the latest driver version based on the actual conditions.

Table 8 Available system

ROS2 version	System Version	CPU
Foxy, Galactic	Ubuntu 20.04	ARM
		X86
Humble	Ubuntu 22.04	ARM
		X86

3. You could obtain the point cloud data of the LiDAR via TCP or UDP.

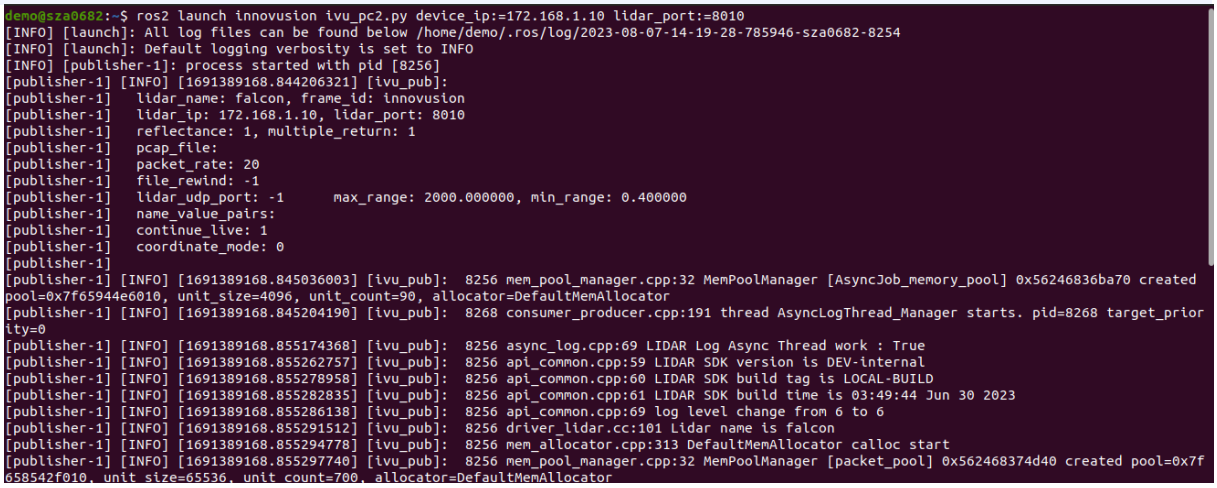
Note

Execute the following command and re-run the obtain command and if the point cloud data was obtained correctly.

```
source /opt/ros/foxy/setup.bash
```

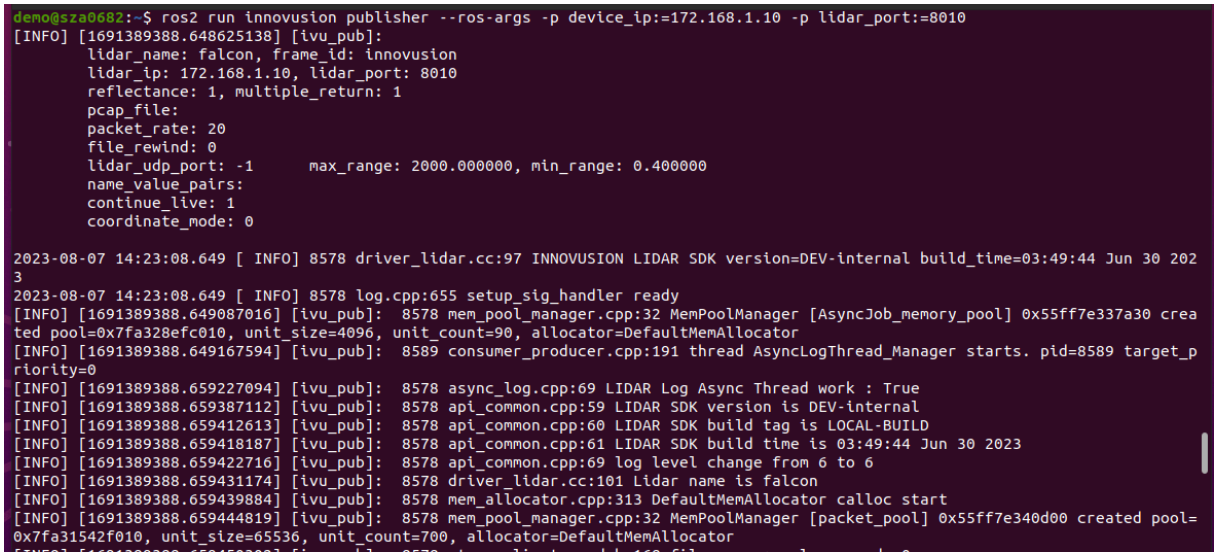
- Obtain the point cloud data via TCP.
  - Method 1

```
ros2 launch innovusion ivu_pc2.py device_ip:=<device_ip> lidar_port:=<TCP_port>
```



  - Method 2

```
ros2 run innovusion publisher --ros-args -p device_ip:=<device_ip> -p lidar_port:=<TCP_port>
```



Note

The default value of device_ip is 172.168.1.10. By default, the TCP port number is 8010. You can run the `ros2 launch innovusion ivu_pc2.py` or `ros2 run innovusion publisher` directly to obtain the point cloud data with the default settings.

- Obtain the point cloud data via UDP.
  - Method 1

```
ros2 launch innovusion ivu_pc2.py device_ip:=<device_ip> udp_port:=<UDP_port>
```

  - Method 2

```
ros2 run innovusion publisher --ros-args -p device_ip:=<device_ip> -p udp_port:=<UDP_port>
```

Note
The default value of device_ip is 172.168.1.10. Please notice that the LiDAR transmits the data via TCP by default.

4.2.2.3 View LiDAR point cloud data

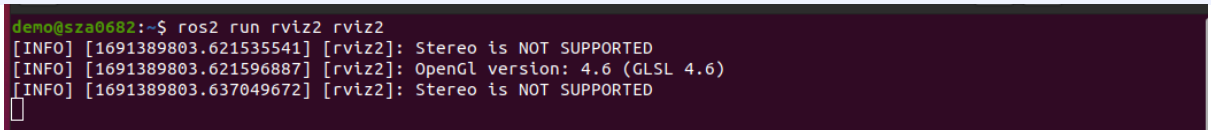
Note
Before viewing the point cloud data, please confirm that the point cloud data has been obtained.

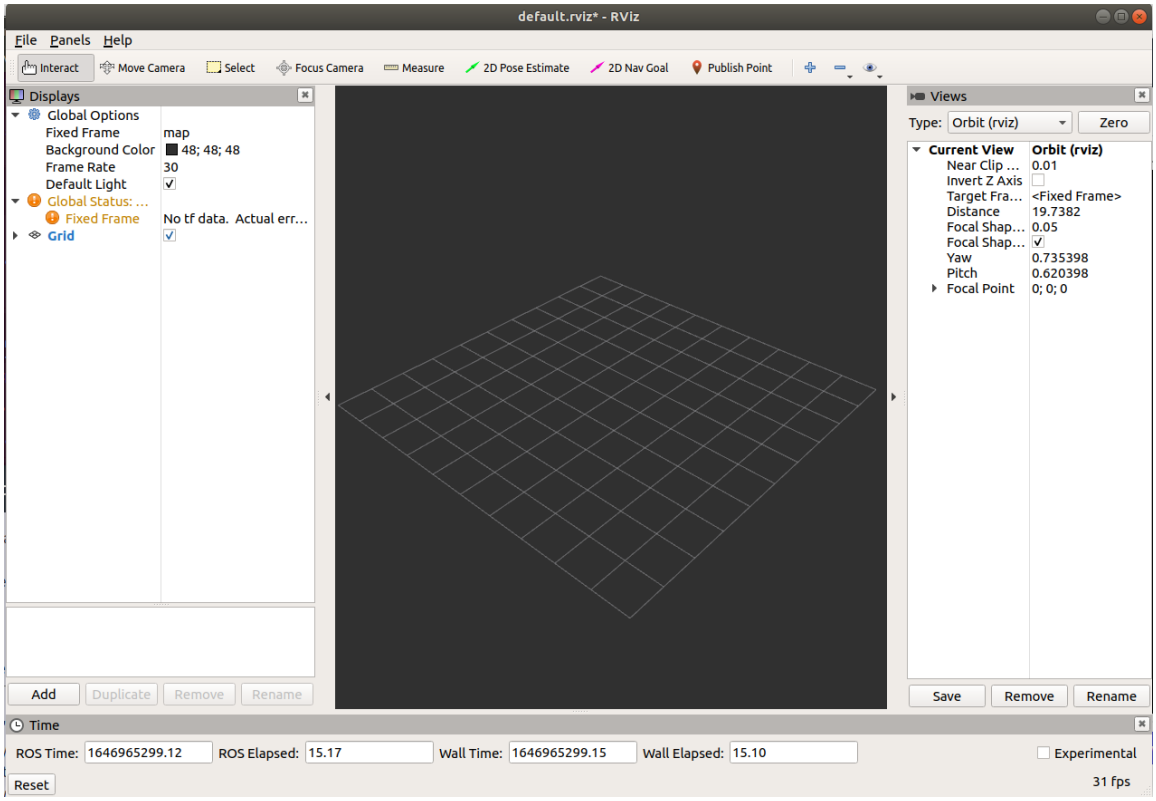
1. Open a new terminal and execute the command to source the setup file.

```
source /opt/ros/foxy/setup.bash
```

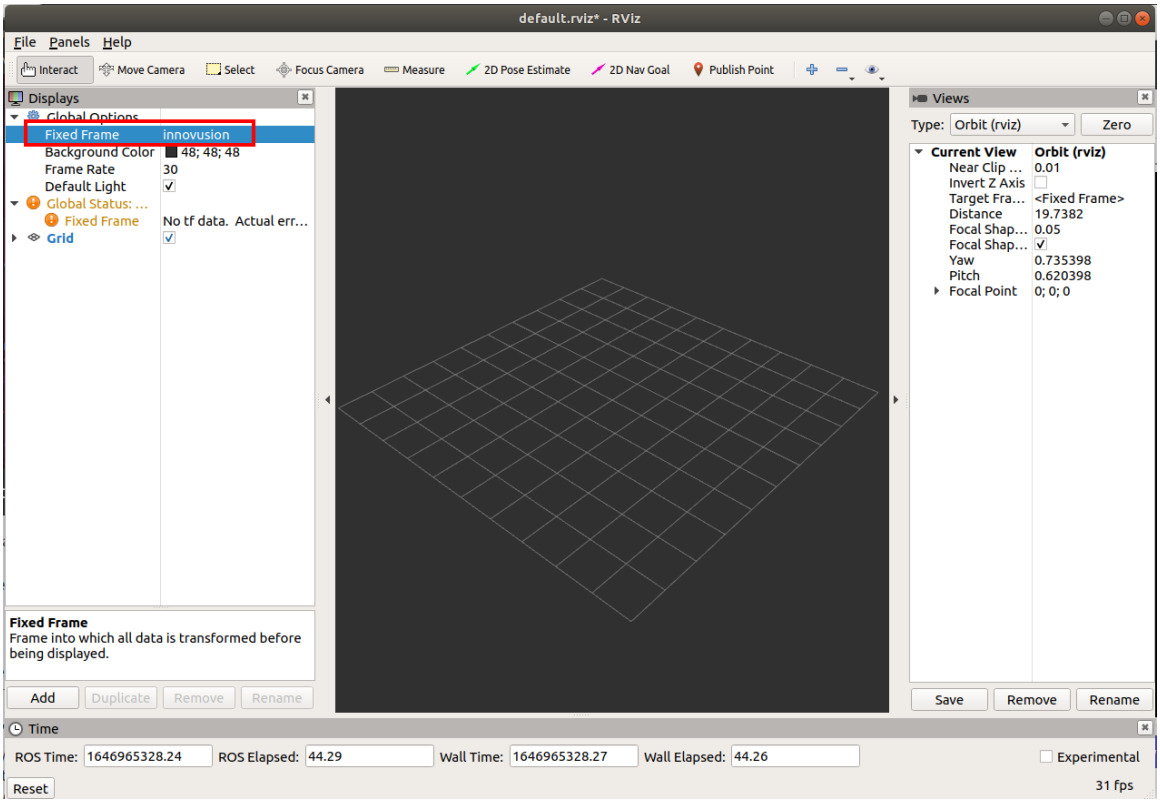
2. Start the graphical tool **rviz**. The return value and **rviz** interface are shown below.

```
ros2 run rviz2 rviz2
```





3. Select **Global Options** > **Fixed Frames**. Set the Fixed Frames value to **innovusion**.

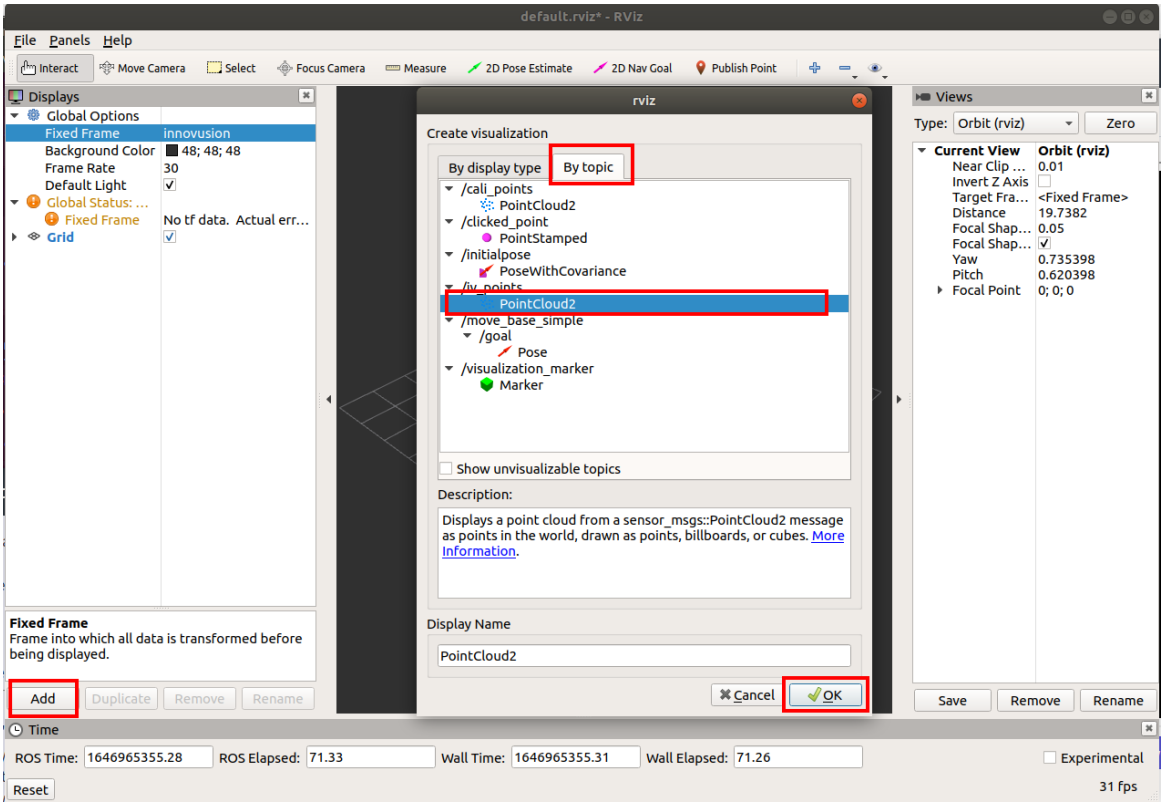


i. Add PointCloud2 to Displays.

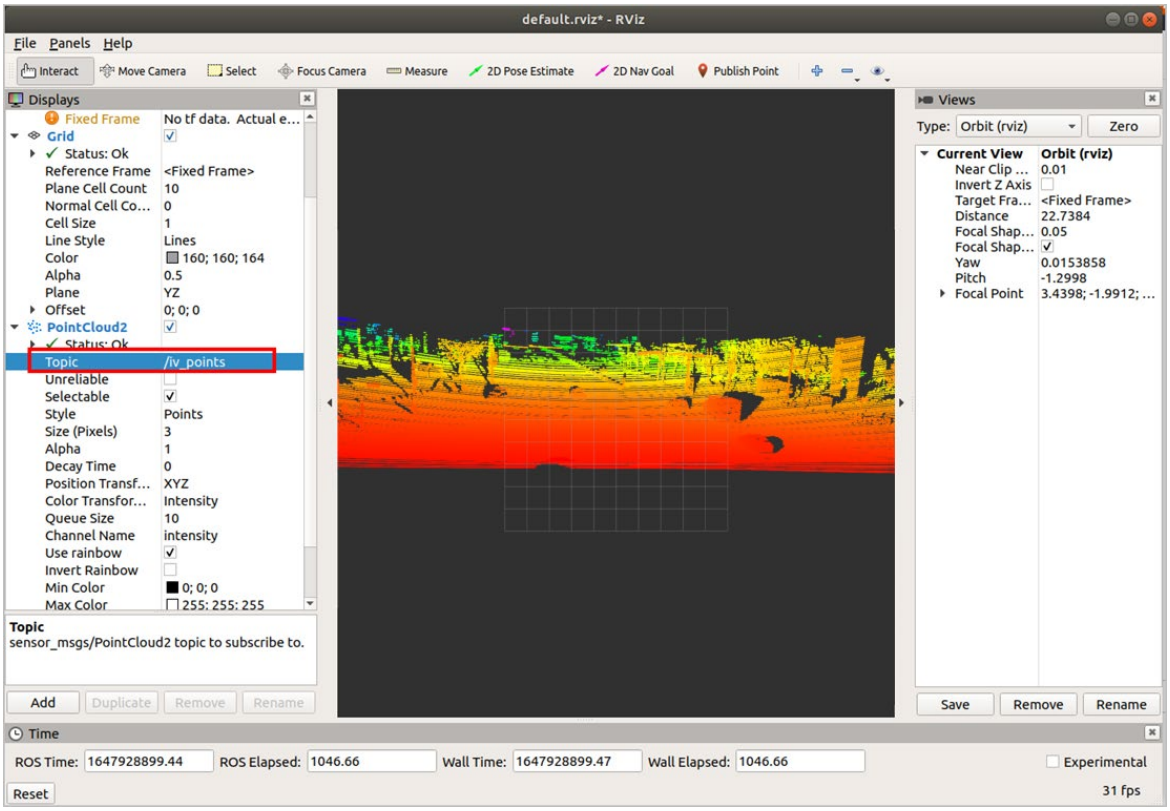
a. Click **Add.**

b. Select **By topic** > **iv_points** > **PointCloud2**.

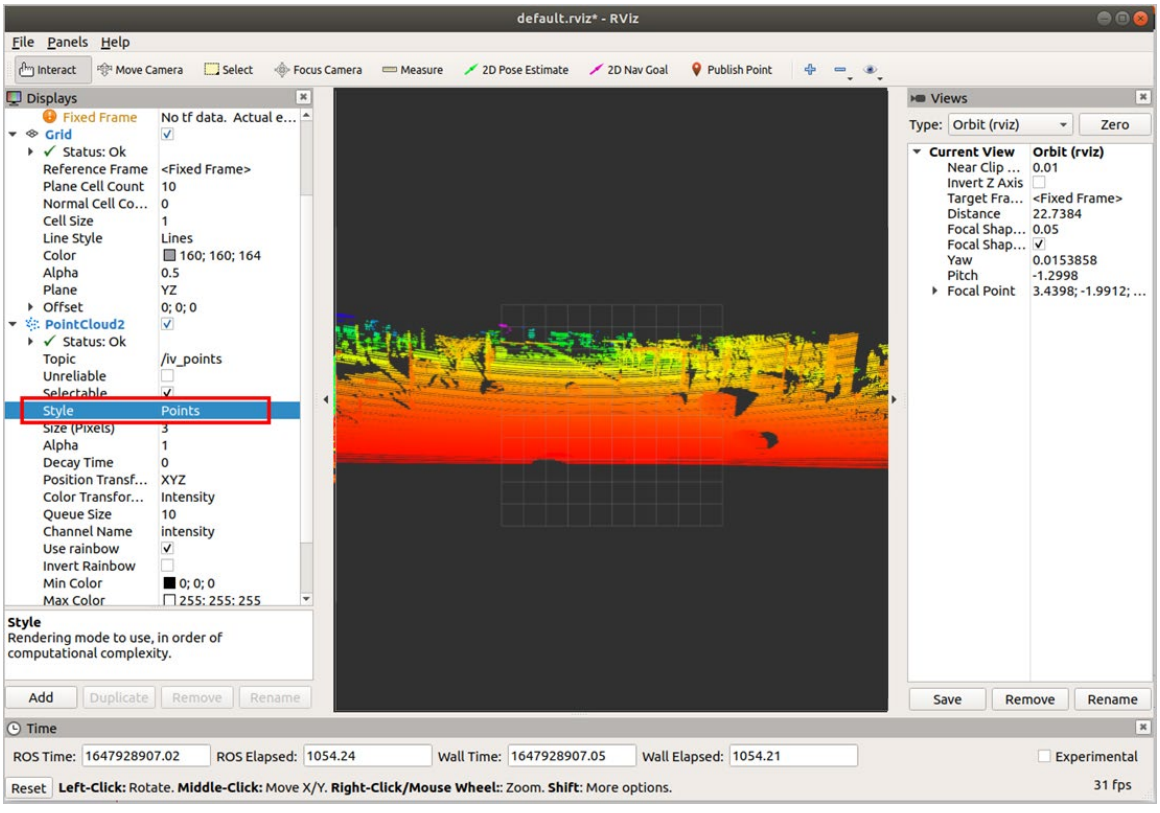
c. Click **OK**.



ii. Select **PointCloud2** > **Topic**. Set the Topic value to **/iv_points**.



iii. Select **PointCloud2** > **Style**. Set the Style value to **Points**.

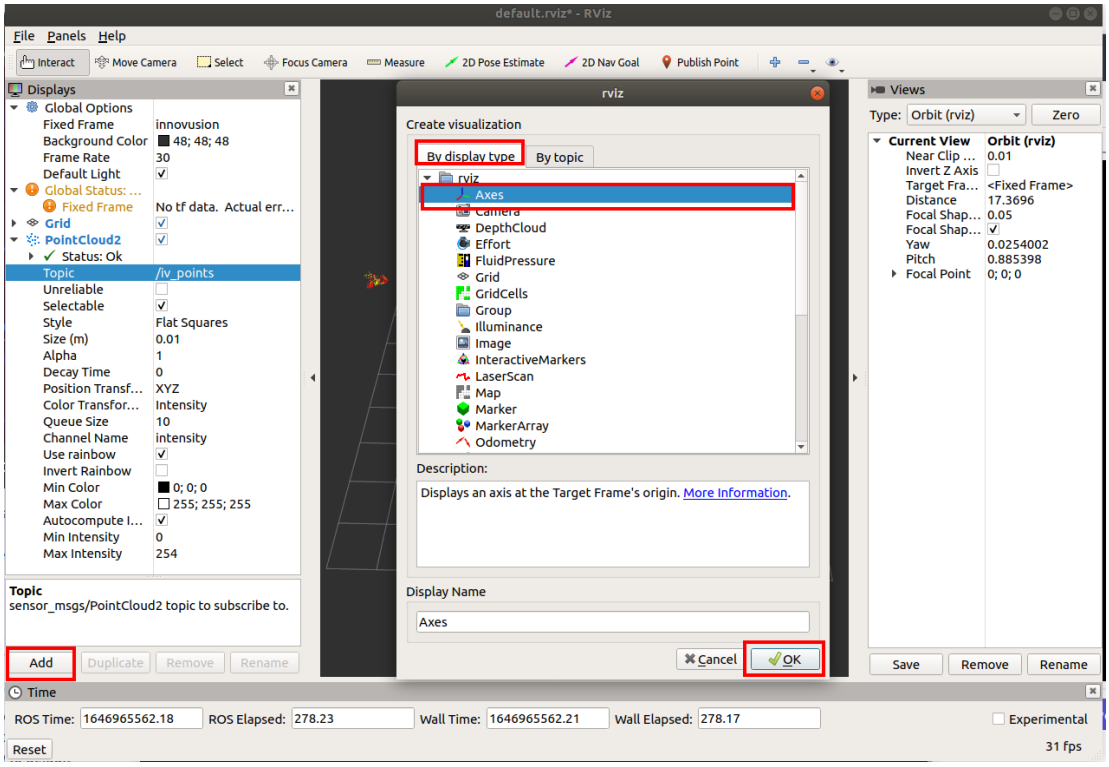


4. (Optional) You can change the angle and distance of the real-time point cloud status and get more information as needed.

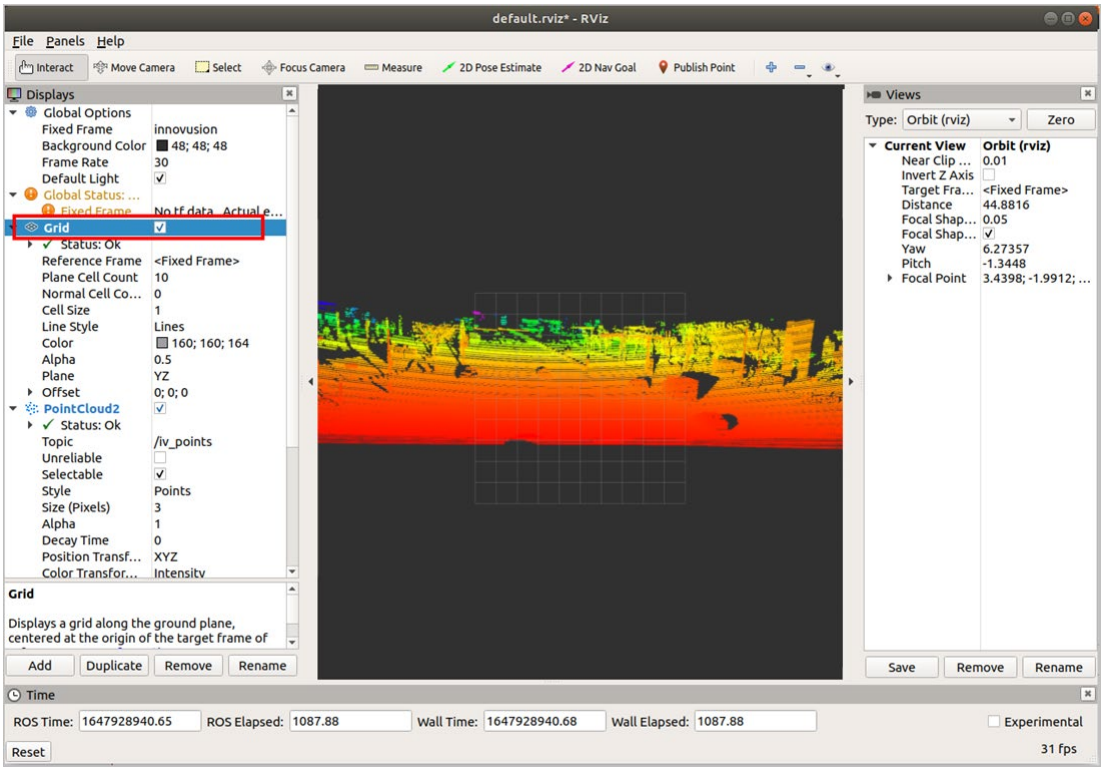
- You can select **Axes** to add the coordinate system to the diagram as a reference.

  a. Select **Add** > **By display type** > **Axes**.

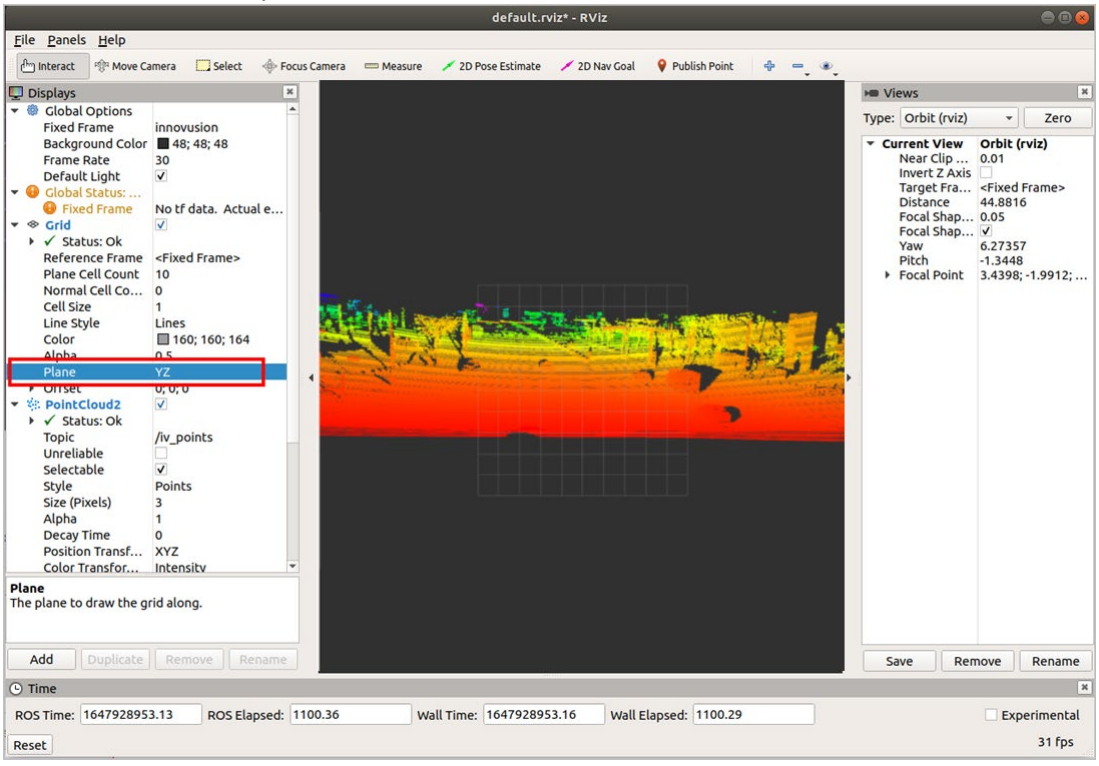
  b. Click **OK**.



- Select **Grid** to add the grid to the diagram as a reference. Grid is enabled by default when rviz is started.



- Set the **plane** value to view the point cloud status under different coordinate systems. There are three options: **XY**, **XZ**, and **YZ**.



4.2.2.4 Replay LiDAR point cloud data

You can replay the point cloud data in pcap format in ROS environment.

Note

Before replaying LiDAR point cloud data, please confirm that the recorded point cloud data file has been obtained.

You could capture the pcap data with Wireshark.

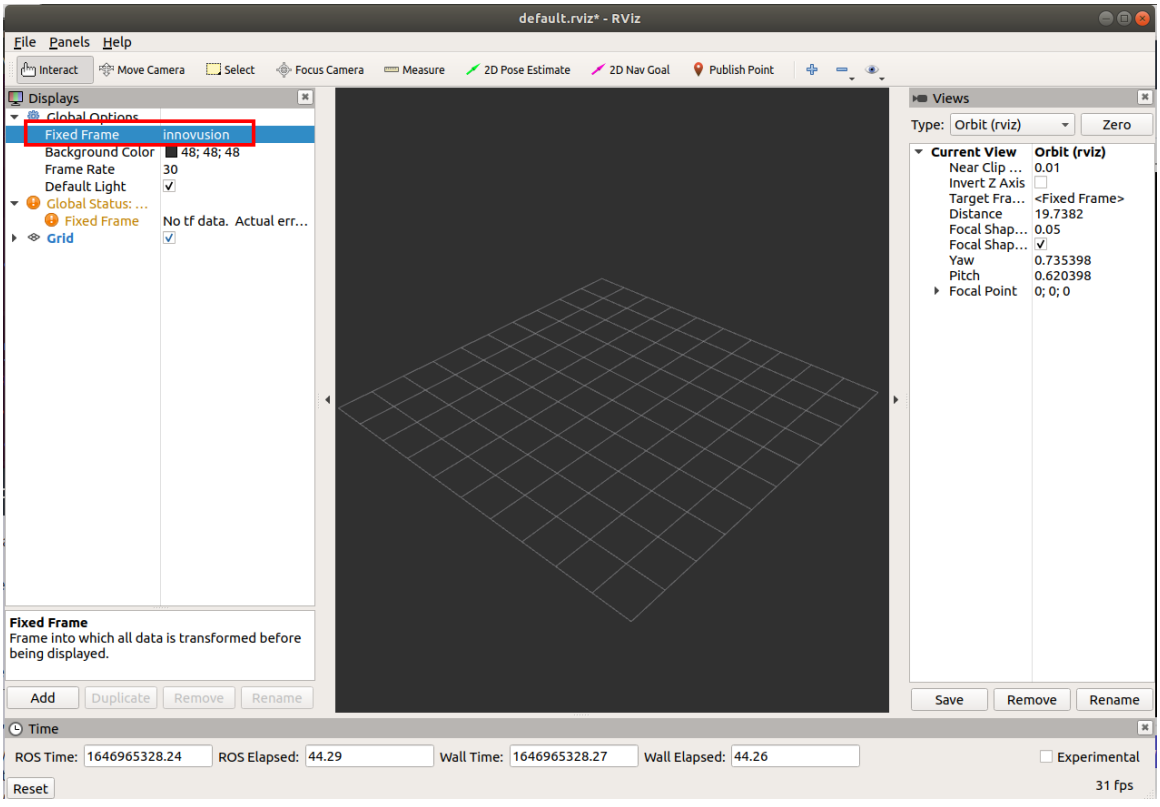
Only data captured in UDP can be replayed in ROS.

1. Start the graphical tool **rviz**. The return value and **rviz** interface are shown below.

```
ros2 run rviz2 rviz2
```

```
demo@sza0682:~$ ros2 run rviz2 rviz2
[INFO] [1691389803.621535541] [rviz2]: Stereo is NOT SUPPORTED
[INFO] [1691389803.621596887] [rviz2]: OpenGl version: 4.6 (GLSL 4.6)
[INFO] [1691389803.637049672] [rviz2]: Stereo is NOT SUPPORTED
```

2. Select **Global Options** > **Fixed Frames**. Set the **Fixed Frames** value to **innovusion**.



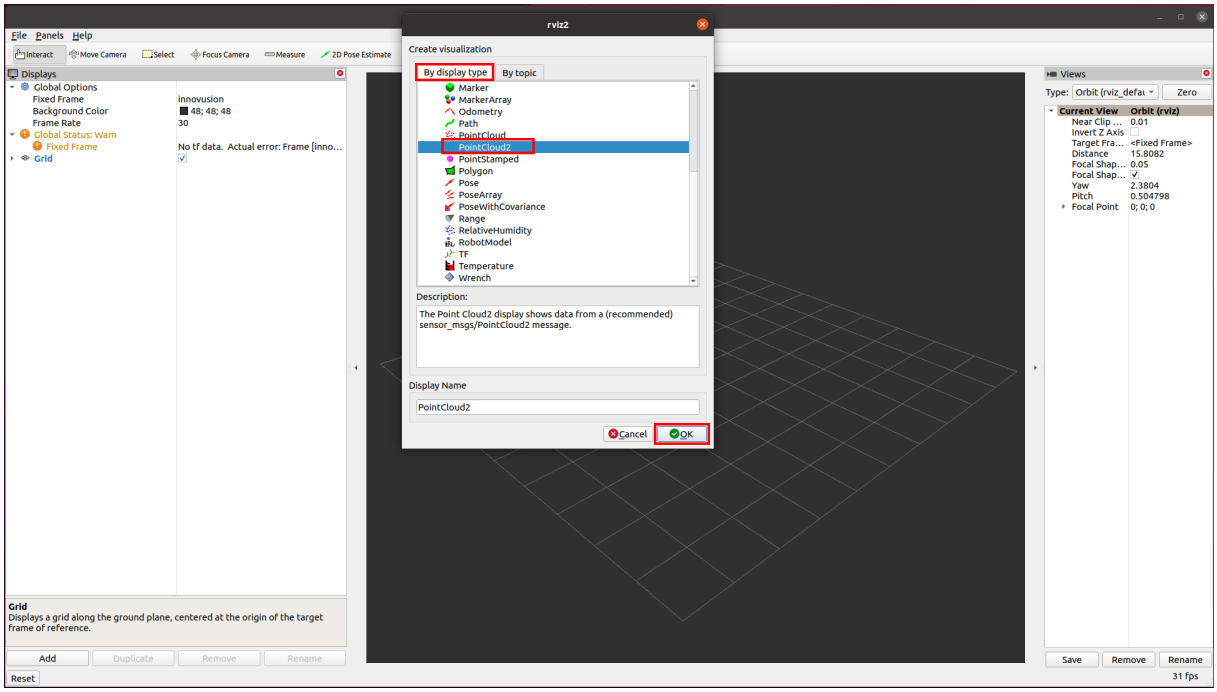
3. Add and configure **PointCloud2**.

   i. Add **PointCloud2** to the Displays.

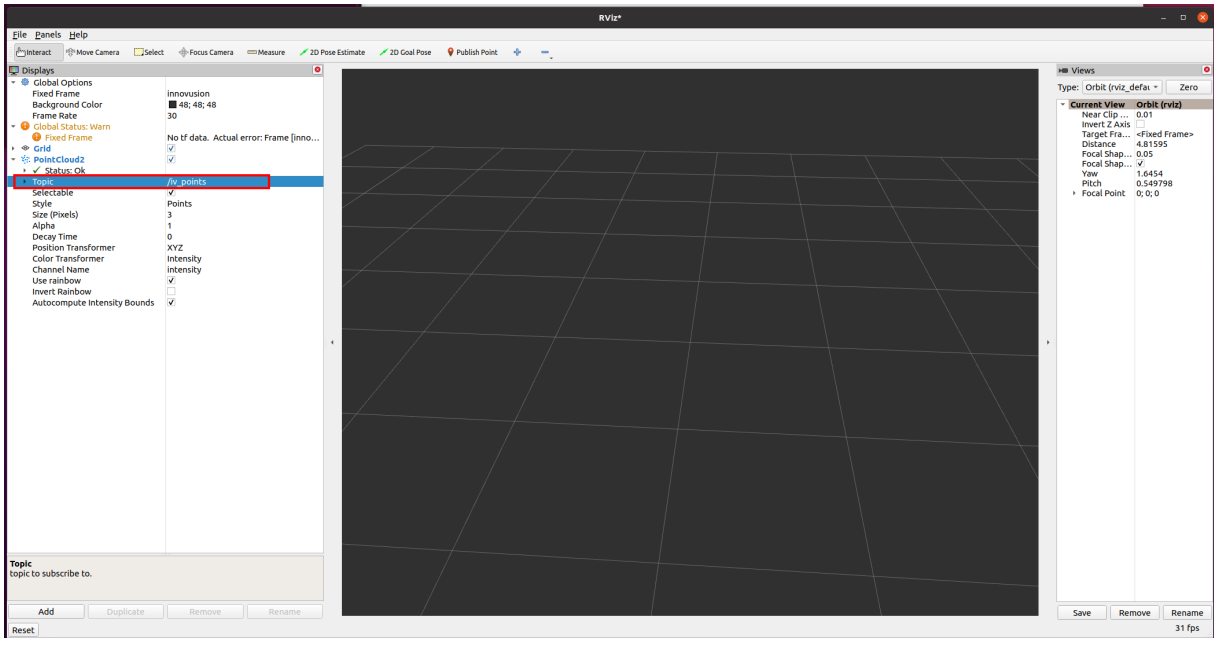
      a. Click **Add.**

b. Select By topic > display type > PointCloud2.

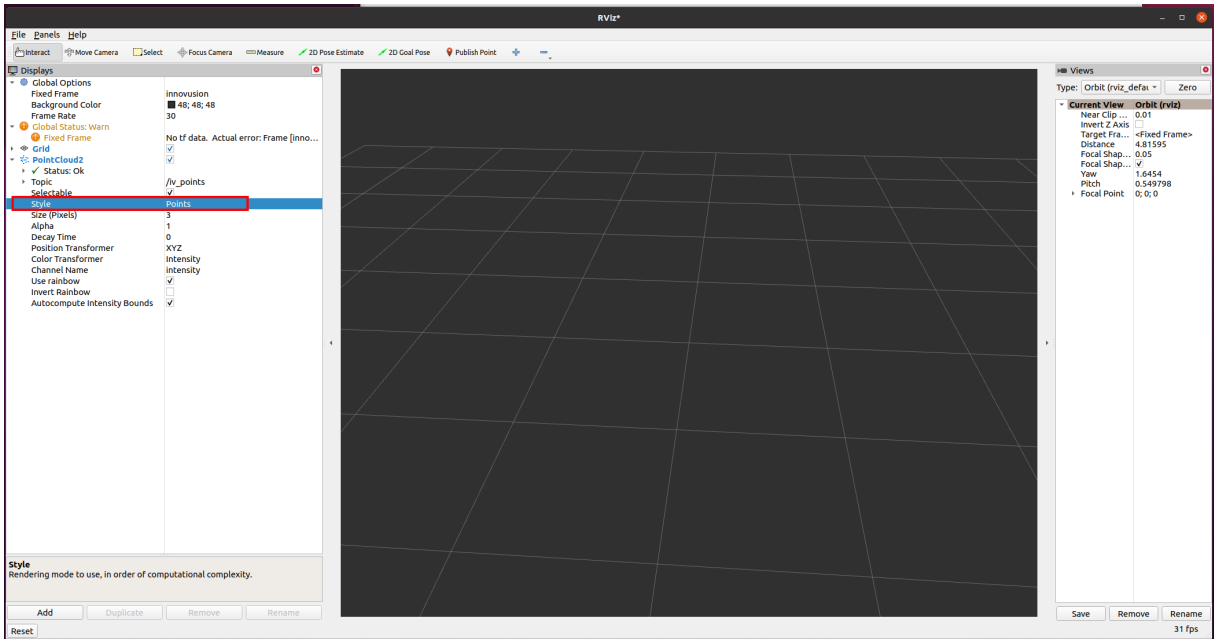
c. Click **OK**.



ii. Select **PointCloud2** > **Topic**. Set the Topic value to **/iv_points**.



iii. Select **PointCloud2** > **Style**. Set the Style value to **Points**.

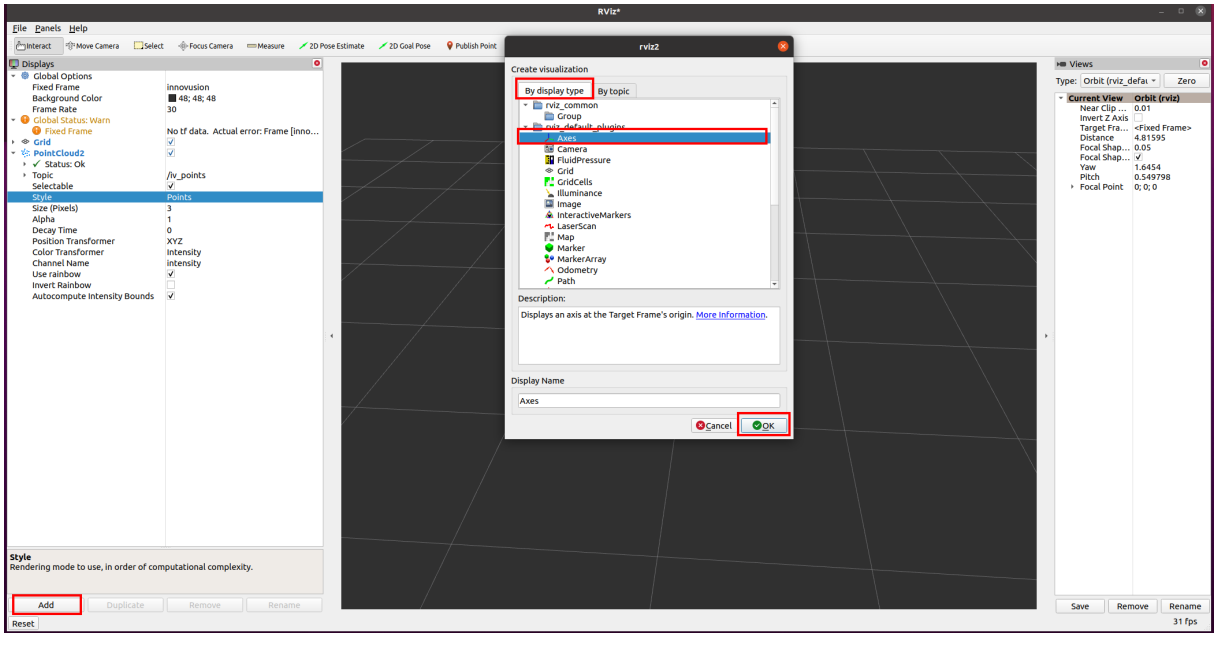


4. (Optional) You can change the angle and distance of the real-time point cloud status and get more information as needed.

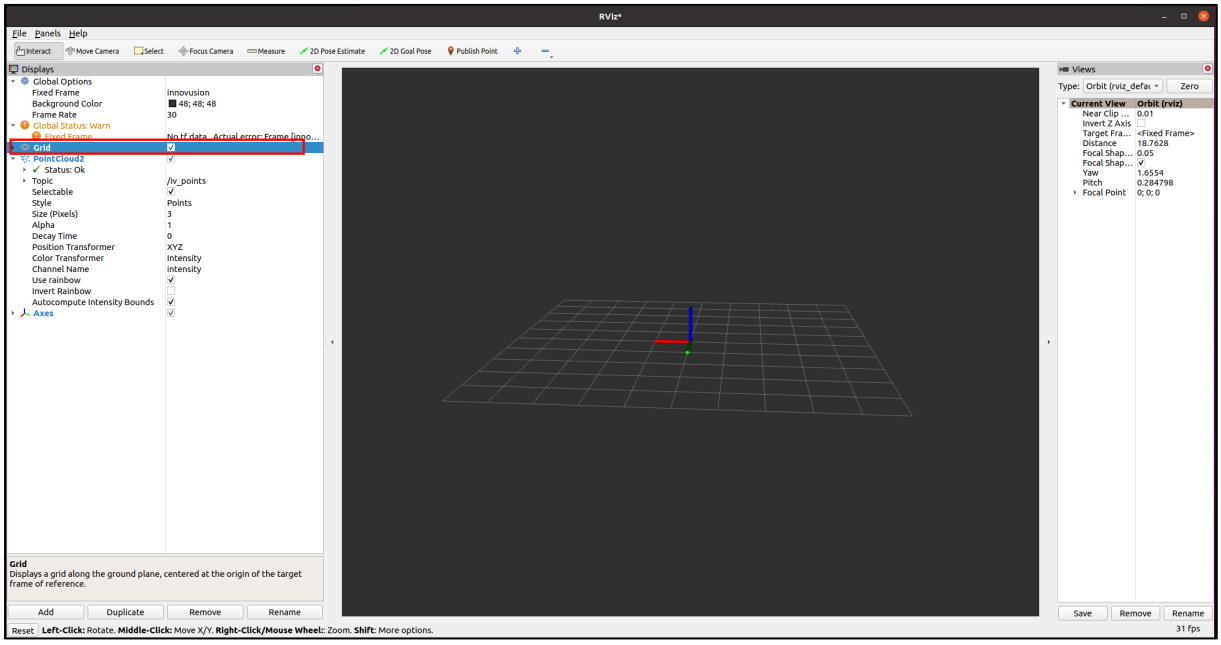
   - You can select **Axes** to add the coordinate system to the diagram as a reference.

     a. Select **Add** > **By display type** > **Axes**.

     b. Click **OK**.



- Select **Grid** to add the grid to the diagram as a reference. Grid is enabled by default when **rviz** is started.



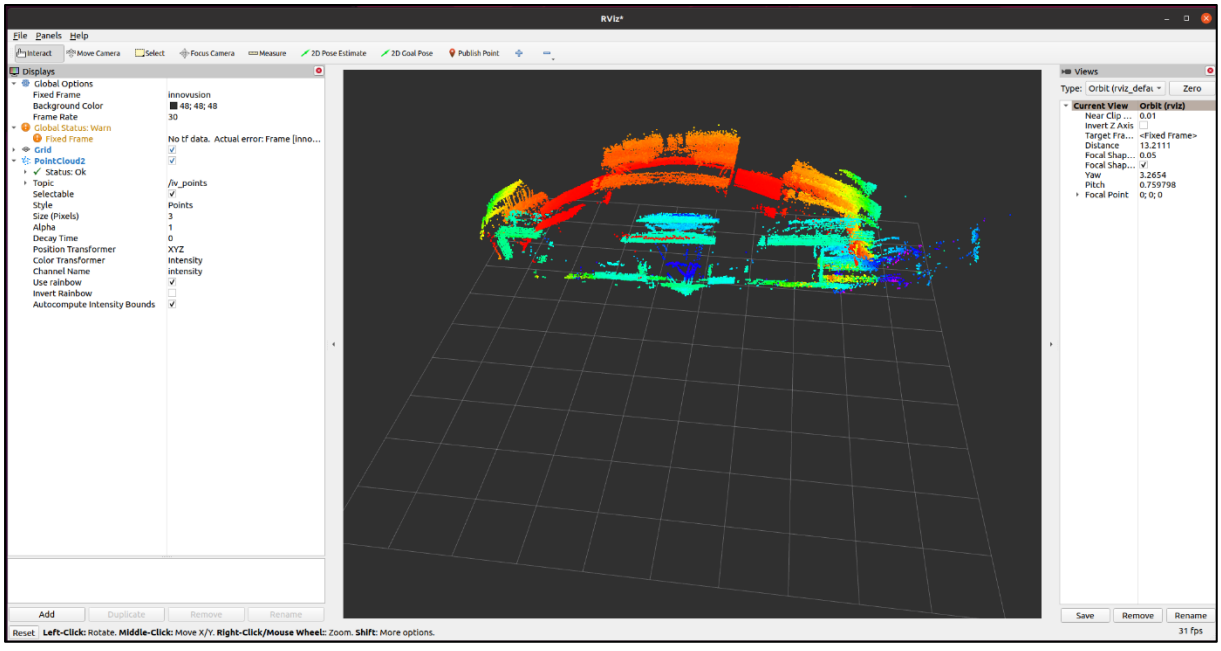
- Set the **plane** value to view the point cloud status under different coordinate systems. There are three options: **XY**, **XZ,** and **YZ**.

5. Replay LiDAR point cloud data in **rviz**.

```
ros2 run innovusion publisher  --ros-args -p device_ip:=<data_ip> -p pcap_file:=<pcap_file>
-p udp_port:=<data_port> [-p packet_rate=:<playback_rate>] | [-p file_rewind=<file_rewind>]
```

```
demo@sza0682:~/Desktop/ros2 installation$ ros2 run innovusion publisher --ros-args -p device_ip:=172.168.1.10 -p pcap_file:=test_for_ros.pcap
-p udp_port:=8010 -p file_rewind:=-1
[INFO] [1691390060.940374577] [ivu_pub]:
       lidar_name: falcon, frame_id: innovusion
       lidar_ip: 172.168.1.10, lidar_port: 8010
       reflectance: 1, multiple_return: 1
       pcap_file: test_for_ros.pcap
       packet_rate: 20
       file_rewind: -1
       lidar_udp_port: 8010    max_range: 2000.000000, min_range: 0.400000
       name_value_pairs:
       continue_live: 1
       coordinate_mode: 0

2023-08-07 14:34:20.940 [ INFO] 9124 driver_lidar.cc:97 INNOVUSION LIDAR SDK version=DEV-internal build_time=03:49:44 Jun 30 2023
2023-08-07 14:34:20.941 [ INFO] 9124 log.cpp:655 setup_sig_handler ready
[INFO] [1691390060.941026431] [ivu_pub]:  9124 mem_pool_manager.cpp:32 MemPoolManager [AsyncJob_memory_pool] 0x55bf5655d650 created pool=0x7fa
e3c838010, unit_size=4096, unit_count=90, allocator=DefaultMemAllocator
[INFO] [1691390060.941093389] [ivu_pub]:  9135 consumer_producer.cpp:191 thread AsyncLogThread_Manager starts. pid=9135 target_priority=0
[INFO] [1691390060.951170615] [ivu_pub]:  9124 async_log.cpp:69 LIDAR Log Async Thread work : True
[INFO] [1691390060.951279656] [ivu_pub]:  9124 api_common.cpp:59 LIDAR SDK version is DEV-internal
[INFO] [1691390060.951316848] [ivu_pub]:  9124 api_common.cpp:60 LIDAR SDK build tag is LOCAL-BUILD
[INFO] [1691390060.951324099] [ivu_pub]:  9124 api_common.cpp:61 LIDAR SDK build time is 03:49:44 Jun 30 2023
[INFO] [1691390060.951330346] [ivu_pub]:  9124 api_common.cpp:69 log level change from 6 to 6
[INFO] [1691390060.951341801] [ivu_pub]:  9124 driver_lidar.cc:101 Lidar name is falcon
[INFO] [1691390060.951347649] [ivu_pub]:  9124 driver_lidar.cc:206 ## pcap_file is test_for_ros.pcap, device_ip_ is 172.168.1.10, play_rate is
 20, rewind id -1, 8010/8010/8010 ##
[INFO] [1691390060.951353721] [ivu_pub]:  9124 mem_allocator.cpp:313 DefaultMemAllocator calloc start
[INFO] [1691390060.951359799] [ivu_pub]:  9124 mem_pool_manager.cpp:32 MemPoolManager [packet_pool] 0x55bf56566960 created pool=0x7fae1d42f010
, unit_size=65536, unit_count=700, allocator=DefaultMemAllocator
[INFO] [1691390060.951371560] [ivu_pub]:  9124 lidar_base.h:622 Setting play rate to 20
[INFO] [1691390060.951378886] [ivu_pub]:  9124 lidar_base.h:630 Setting play rate to 20 MB/s
[INFO] [1691390060.951386293] [ivu_pub]:  9124 stage_client_read.h:168 filename: test_for_ros.pcap, play_round: 0
[INFO] [1691390060.952968825] [ivu_pub]:  9124 stage_client_read_pcap.h:42 filename: test_for_ros.pcap, play_round: 0
[INFO] [1691390060.953000055] [ivu_pub]:  9124 stage_client_read_pcap.h:43 pcap_filter_str_: src host 172.168.1.10 and udp
[INFO] [1691390060.953007031] [ivu_pub]:  9124 api_common.cpp:385 add lidar 1 (total=1 total_active=1)
[INFO] [1691390060.953020603] [ivu_pub]:  9124 lidar_client.cpp:230 file replay fake set reflectance
[INFO] [1691390060.953026072] [ivu_pub]:  9124 lidar_client.cpp:243 file replay fake set return mode
[INFO] [1691390060.953031237] [ivu_pub]:  9124 driver_lidar.cc:220 Use name_value_pairs
[INFO] [1691390060.953037633] [ivu_pub]:  9124 driver_lidar.cc:56 ## first call for ros2 driver ##
[INFO] [1691390060.953044330] [ivu_pub]:  9124 lidar_base.h:552 message_callback: name=falcon level=6, code=1, message=Header file inno_lidar_
```



[Parameter description]

- device_ip: The IP address of the LiDAR from which the data was captured.
- pcap_file: The file name to be replayed.
- UDP port: The UDP port of the LiDAR from which the data was captured.

- packet_rate(Optional): The replay speed of the file. The default value is 20.
  - When the play_rate=0, the play speed is as fast as possible.
  - When the play_rate≤100, the unit of play speed is MB/s. e.g., When play_rate=50. the play speed is at 50 MB/s.
  - When the play_rate>100, the play speed=play_rate/10000.0. e.g., When play_rate=15000. the play speed is at 1.5 times.
- file_rewind(Optional): The number of times file is replayed.
  - A default value of 0 means no repeat.
  - A negative value means the file will be repeated indefinitely until the program is manually stopped.

4.2.2.5 Shut down the LiDAR

Disconnect the power supply to shut down the LiDAR.

4.3 Operate in Docker

4.3.1 Start the LiDAR

1. Connect the power supply to start the LiDAR.
1. The LiDAR completes initialization and generates data after powering on for 11 to 18 seconds.

Note

The LiDAR does not have a power switch. It will become operational when power is applied.

4.3.2 View the LiDAR point cloud data

Note

For more information about Docker installation, please contact the seyond staff.

1. Change the computer IP address to the same subnet with the LiDAR.

Note

The default LiDAR IP address is 172.168.1.10.

You can check the access to the LiDAR IP address via the ping command.

2. Enter the Docker path.
3. View the status of the LiDAR point cloud.

```
./launch-docker.py --deb-file  < package.deb>--lidar-ip <INPUT_LIDAR_IP>  --ros-version <ros version>
```

```
demo@demo-OMEN-by-HP-Laptop-16-b0xxx:~/install_docker/catkin_ws/src/rosprocessor/build/docker$ ./launch-docker.p
y --deb-file ros-kinetic-innovusion-driver-release-2.4.0-rc237-public.deb  --lidar-ip 172.168.1.10 --ros-version
 kinetic
Script is starting 2022May11-191440
docker launch command: xhost +local:root; nvidia-docker run -it --rm --label rosdocker  --env="DISPLAY" --env="Q
T_X11_NO_MITSHM=1" --env="IV_CWD=/home/demo/install_docker/catkin_ws/src/rosprocessor/build/docker"  -v=/home/de
mo/install_docker/catkin_ws/src/rosprocessor/build/docker/ros-kinetic-innovusion-driver-release-2.4.0-rc237-publ
ic.deb:/root/ros-kinetic-innovusion-driver-release-2.4.0-rc237-public.deb  -v=/home/demo/install_docker/catkin_w
s/src/rosprocessor/build/docker:/root/docker  -v=/home/demo/install_docker/catkin_ws/src/rosprocessor/build/dock
er:/home/demo/install_docker/catkin_ws/src/rosprocessor/build/docker -v="/home/demo/.rviz_kinetic:/root/.rviz" -
v="/home/demo/.ros_kinetic:/root/.ros"  -v=/home/demo/.innovusion:/root/.innovusion  -v=/home/demo/install_docke
r/catkin_ws/src/rosprocessor/build/docker/output:/root/output  --volume="/tmp/.X11-unix:/tmp/.X11-unix:rw" ivusw
/ros-driver-test-public:ubuntu1604-kinetic-jsk-ceres bash -c "(echo start roscore; rm -fr /root/.ros/log/; rosco
re; echo roscore done) & (echo start rviz; until rostopic list 2>/dev/null; do sleep 0.2; done; rosrun rviz rviz
 -f innovusion; echo rviz done) & dpkg -i "/root/ros-kinetic-innovusion-driver-release-2.4.0-rc237-public.deb" &
& echo dpkg install done && until rostopic list 2>/dev/null; do sleep 0.2; done; find /root/docker/cali_manager
-user root -exec chmod guo+rw {} \; && roslaunch innovusion_pointcloud innovusion_points.launch  device_ip:=172.
168.1.10  lidarhome:=//root/.innovusion "
=====
inside docker command: (echo start roscore; rm -fr /root/.ros/log/; roscore; echo roscore done) & (echo start rv
iz; until rostopic list 2>/dev/null; do sleep 0.2; done; rosrun rviz rviz -f innovusion; echo rviz done) & dpkg
-i "/root/ros-kinetic-innovusion-driver-release-2.4.0-rc237-public.deb" && echo dpkg install done && until rosto
pic list 2>/dev/null; do sleep 0.2; done; find /root/docker/cali_manager -user root -exec chmod guo+rw {} \; &&
roslaunch innovusion_pointcloud innovusion_points.launch  device_ip:=172.168.1.10  lidarhome:=//root/.innovusion

=====
'main' command: roslaunch innovusion_pointcloud innovusion_points.launch  device_ip:=172.168.1.10  lidarhome:=//
```

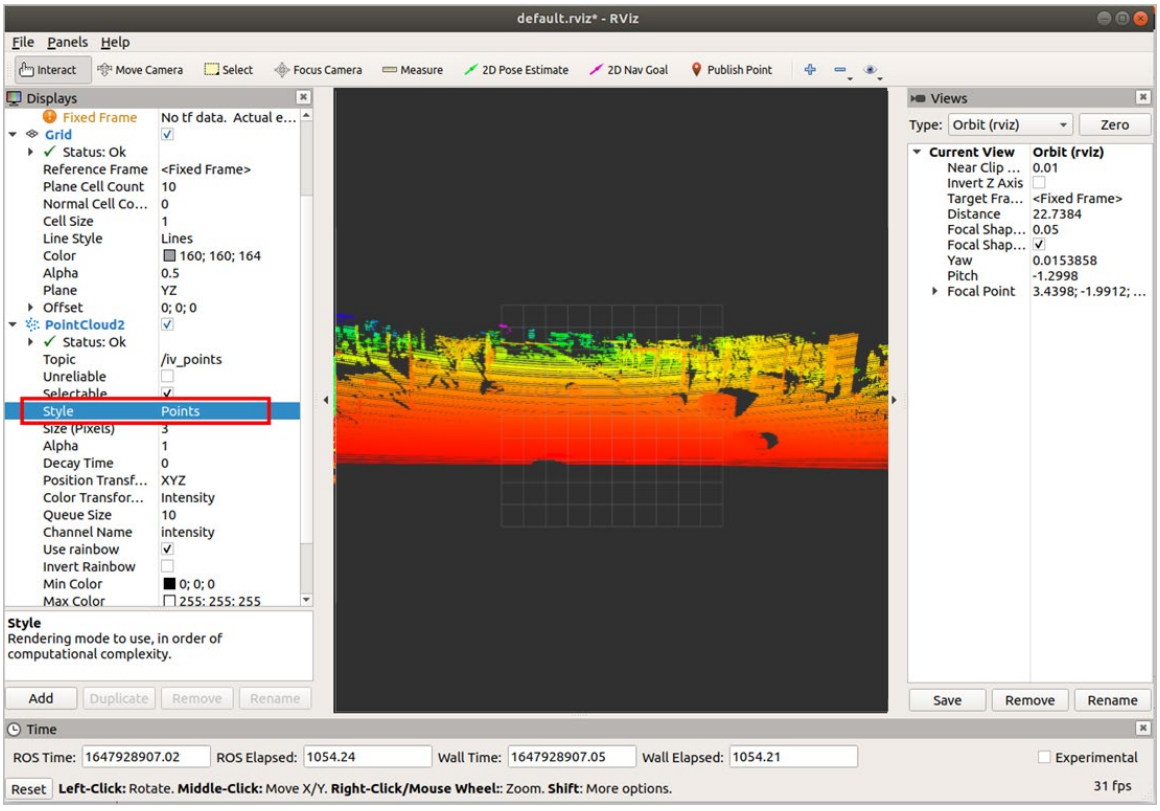
Note

<package.deb> is the driver's name. Please get the latest driver based on the actual conditions of the computer. If the existing driver does not match the computer's version, please contact Seyond staff.

The default LiDAR IP address is 172.168.1.10.

<ros version> is the version of the ROS environment.

4. **rviz** is started to show the current point cloud status. For a better display effect in rviz, refer to *4.2.1.3 View LiDAR point cloud data*.



4.3.3 Replay LiDAR point cloud data

The point cloud data in inno_raw format can be replayed by Docker.

1. Enter the Docker path. View the status of the LiDAR point cloud.

```
./launch-docker.py --deb-file < package.deb> --yaml <file name.yaml> --pcap
<filename.inno_raw> --ros-version <ros version>
```

Note

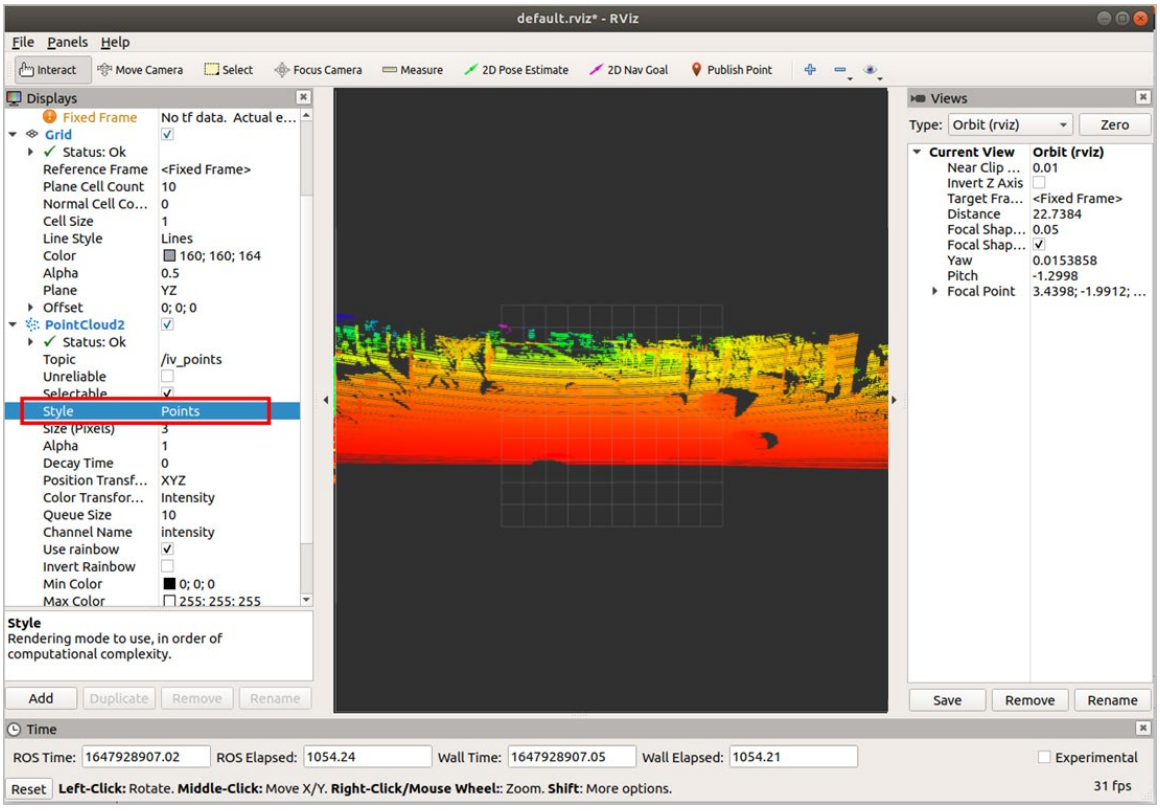
<package.deb> is the driver's name. Please get the latest driver based on the actual situation of the computer. If the existing driver does not match the computer's version, please contact Seyond staff.

<filename.yaml> is the configuration file. You can download this file using ILA.

<file name.inno_raw> is LiDAR point cloud data in .inno_raw.

<ros version> is the version of the ROS environment.

2. **rviz** is started to show the current point cloud status. For a better display effect in rviz, refer to *4.2.1.3 View LiDAR point cloud data*.



4.3.4 Shut down the LiDAR

Disconnect the power supply to shut down the LiDAR.

5 SDK configuration

You can operate the LiDAR using the following executable files. For more information, please contact Seyond staff to obtain related manuals.

Table 9 executable file instructions

NO.	Software Interface	Description
1	get_pcd	This lightweight executable file allows the user to record data files and convert data between different formats. It is very useful for scripted/automated data collection.
2	Innovusion_lidar_util	The command line utility enables you to obtain and change the configuration of the LiDAR. You can use the commands to get the status of LiDAR and check the firmware logs.
3	SDK	The SDK offers the most flexibility for customization regarding data streaming and lidar control.
4	cURL commands	cURL commands provide a convenient way to adjust ROI location, download system logs, and start/stop the pointcloud server (PCS).

5.1 SDK download

You can access the resource Hub or contact the seyond staff to obtain the SDK package you need. You can log into ILA and select **Sensor Config** > **Falcon values** to check the SDK version information.

5.2 SDK Installation

Table 10 Installation environment requirements

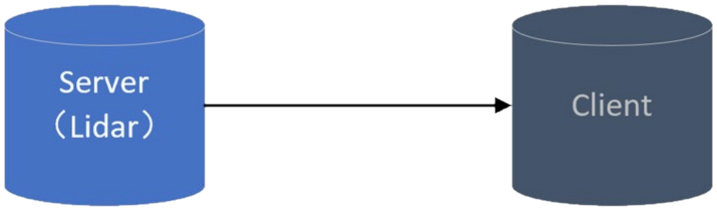
Installation environment requirements	Architecture
Ubuntu 16.04 + GCC 5.4.0 and higher	x86/ARM
Ubuntu 18.04 + GCC 7.4.0 and higher	x86/ARM

6 Communication protocol

You can obtain the point cloud data via TCP or UDP.

6.1 Data transmission via TCP

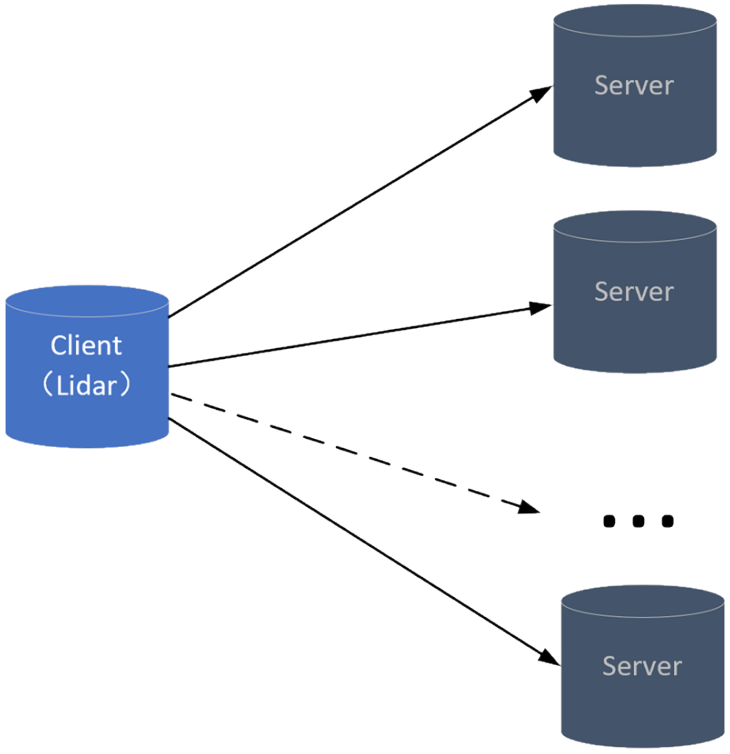
TCP (Transmission Control Protocol) is a connection-oriented unicast transmission protocol. The LiDAR serves as the server, and the client serves as the client in TCP. The client initiates a connection request to the server. After a reliable connection is established, the server will actively send data to the client.



6.2 Data transmission via UDP

The LiDAR serves as the client, and the customer serves as the server in UDP (User Datagram Protocol). The client actively sends data to one or more servers.

Since UDP may lead to packet loss when transmitting mass data, it is only recommended to transmit a small amount of data. The connection diagram is shown in the figure below.



7 Time synchronization

The point cloud data has associated timestamp information due to the measurement feature of LiDAR. Time information management is essential to facilitate device debugging, multi-sensor fusion, operation, maintenance, and other functions during the use of LiDAR in the network environment. The mainstream time synchronization methods include GPS, NTP, and PTP (including gPTP). Currently, Falcon supports PTP, gPTP and NTP as their time synchronization method.

Note

If you want to adopt NTP, please contact Seyond staff for technical support.

7.1 PTP time synchronization

Precision Time Protocol (PTP) is divided into Hardware timestamp synchronization (precision at sub-microsecond), Software timestamp synchronization (precision at tens of microseconds).

Table 11 Time Synchronization Method Instructions

Synchronization method		Synchronization principle	Synchronization precision
PTP	Hardware	Hardware timestamp synchronization	Sub microsecond
	Software	Software timestamp synchronization	Tens of microseconds

Note

Before sync time in PTP mode, you need to ensure the following conditions.

- The network between the computer and the Falcon is connected.
- You have obtained the innovusion_lidar_util tool.

7.2 gPTP time synchronization

You need to confirm that all network nodes support PTP time synchronization before adopting gPTP as the time synchronization mode.

Note

Before sync time in gPTP mode, you need to ensure the following conditions.

- The network between the computer and the Falcon is connected.
- You have obtained the innovusion_lidar_util tool.

Appendix A. Computer configuration reference

The following table provides the reference for configuring the computer. Users can select suitable computers according to the table.

Note

The computer configuration recommended in this table only enables you to view point cloud data. If you have other requirements, please consult Seyond staff.

This table is only for reference to the minimum configuration requirements of the server. Users can upgrade the computer's configuration based on this table's requirements.

Table 12 Configuration reference for the computer

Attribute	Configuration
CPU	Dual-core CPU Intel I7-9th generation or other types of processors with equivalent performance or above
RAM	1 GB
Free hard drive space	≥ 1000 MB
Ethernet connection	1 G/s

Appendix B. Command line instructions

Table 13 Command line instructions

Format	Description
< >	The content in "< >" needs to be replaced by the actual value. e.g., ./innovusion_lidar_util 172.168.1.10 get_version
[ ]	The contents in "[ ]" is optional.
[x | y | ...]	Only one option can be selected.
//	The content after "//" is a comment.

Appendix C. Abbreviations and terms

Table 14 Abbreviations

Abbreviations	Full name
AC	Alternating Current
DC	Direct Current
ETH	Ethernet
FAQ	Frequently Asked Questions
FOV	Field of View
GEN	Generation
GND	Ground
GPS	Global Positioning System
H × W × D	Height × Width × Depth
IP	Internet Protocol
LiDAR	Light Detection and Ranging
MAC	Media Access Control
MEC	Multi-Access Edge Computing
NTP	Network Time Protocol
PPS	Pulse Per Second
PTP	Precision Time Protocol
PWR	Power
ROI	Region of Interest
ROS	Robot Operating System
SDK	Software Development Kit
SN	Serial Number
SW	Software
TCP	Transmission Control Protocol
TOF	Time of Flight
UDP	User Datagram Protocol

Table 15 Technical Terms

Terms	Definition
Class 1 laser products	Within the corresponding wavelength and emission duration, the exposure of personnel to laser radiation is not allowed to exceed Class 1 laser products that can reach the emission limit.
NTP	Network Time Protocol (NTP) is a protocol used to synchronize computer time. It is widely used to synchronize computers to Internet time servers, such as radio or satellite receivers or telephone modem services.
PTP	Precision Time Protocol (PTP) is a high-precision time synchronization

	protocol. It is used for high-precision time synchronization between devices but can also be used for frequency synchronization between devices.
Installer	Installers refer to those who have received professional training and have rich experience in the relevant field, fully understand the application of protective devices on the machine, and can assess its working safety state.
Commissioning personnel	Commissioning personnel have received professional training and have rich experience in the relevant field, fully understand the application of protective devices on the machine, and can assess its working safety state.
Time of flight (TOF)	The time-of-flight (TOF) realizes distance measurement by determining the time-of-flight interval between transmitting and receiving signals. For the formula, see the **Principles of operation** section.
Laser product	Combination of any products or components used to construct or prepare for use to construct a laser or a laser system. An electronic component sold as a component to another manufacturer is not a laser product.
Laser	An electromagnetic radiation device that mainly generates or amplifies the wavelength in the range of 180nm ~ 1mm through a controlled laser emission process.
Laser equipment	A combination of laser products or laser products containing lasers.
Server	A computer that can directly issue operation and control commands. The server sends commands first to the slave computer, and then the slave computer controls the device according to this command. The slave computer reads the device status data from time to time, converts it into a digital signal, and feeds it back to the server.
Configuration personnel	The configuration personnel should have expertise and experience in the relevant field and have sufficient experience to evaluate whether the machine is in a safe operation status after using protective equipment.
Eye safety	Although the product design meets the Class 1 eye safety standard, to protect your safety to the greatest extent, do not use amplification equipment (such as a microscope and magnifying glass) to look at the laser light in transmission directly.
Service personnel	Qualified service personnel refer to those who have received professional training and have rich experience in the relevant field, fully understand the application of protective devices on machines, and have received the guidance of the machine operation supervisor.

Appendix D. Revision history

Revision history

Version number	Revised content	Revision time
V2.1.2	The draft for Resource Hub	2024/03/19