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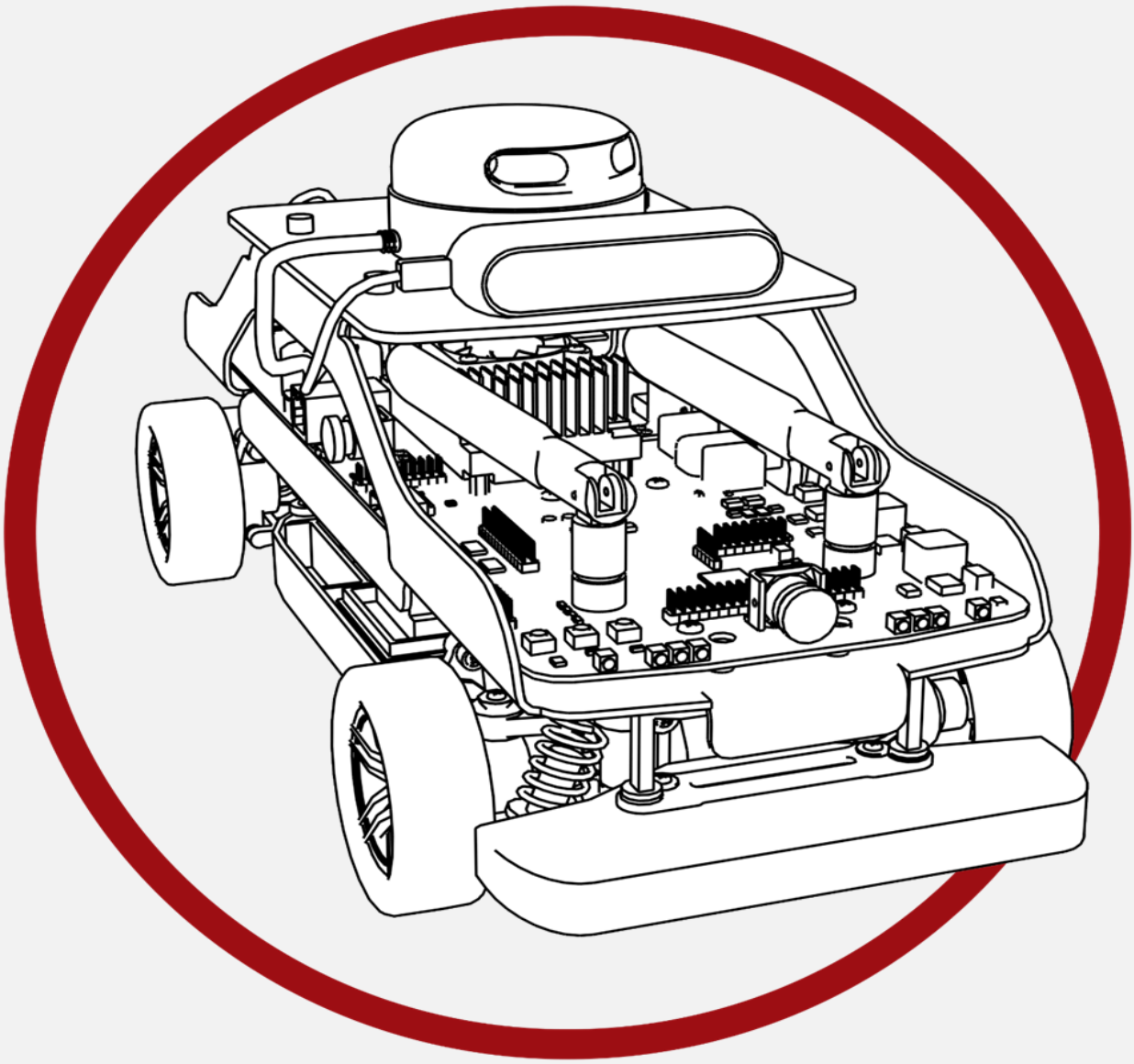


QCar

Connectivity User Manual

v 1.0 — 9*th Jan* 2023

For more information on the solutions Quanser Inc. offers, please visit the web site at: http://www.quanser.com

Quanser Inc.
119 Spy Court
Markham, Ontario
L3R 5H6, Canada

info@quanser.com
Phone : 19059403575
Fax : 19059403576
printed in Markham, Ontario.

FCC Notice This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Industry Canada Notice This Class A digital apparatus complies with Canadian ICES-003. Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

Waste Electrical and Electronic Equipment (WEEE)

This symbol indicates that waste products must be disposed of separately from municipal household waste, according to Directive 2002/96/EC of the European Parliament and the Council on waste electrical and electronic equipment (WEEE). All products at the end of their life cycle must be sent to a WEEE collection and recycling center. Proper WEEE disposal reduces the environmental impact and the risk to human health due to potentially hazardous substances used in such equipment. Your cooperation in proper WEEE disposal will contribute to the effective usage of natural resources.

CE Compliance CE

This product meets the essential requirements of applicable European Directives as follows:

- 2006/95/EC; Low-Voltage Directive (safety)
- 2004/108/EC; Electromagnetic Compatibility Directive (EMC)

Warning: This is a Class A product. In a domestic environment this product may cause radio interference, in which case the user may be required to take adequate measures.

Caution

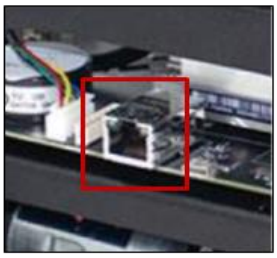
This equipment is designed to be used for educational and research purposes and is not intended for use by the public. The user is responsible to ensure that the equipment will be used by technically qualified personnel only. While the end-effector board provides connections for external user devices, users are responsible for certifying any modifications or additions they make to the default configuration.

Table of Contents

A. Network Setup

i. LAN

The QCar may be connected to the supplied router or network of your choice using an ethernet cable connected to the 10/100/1000 Base-T Ethernet jack highlighted in Figure 1a. In this mode, the LCD will show an ethernet symbol highlighted in Figure 1b.



a. Ethernet jack on QCar

b. LCD showing wired connectivity

Figure 1. Ethernet setup with the QCar platform

The LCD will also show the IPv4 address of the platform assigned dynamically by the DHCP server on the provided router or the network of your choice.

ii. Wireless

The QCar is configured to automatically connect to the router provided with the Self-Driving Car Research Studio. The wireless access point (AP) settings for the network with the provided router are,

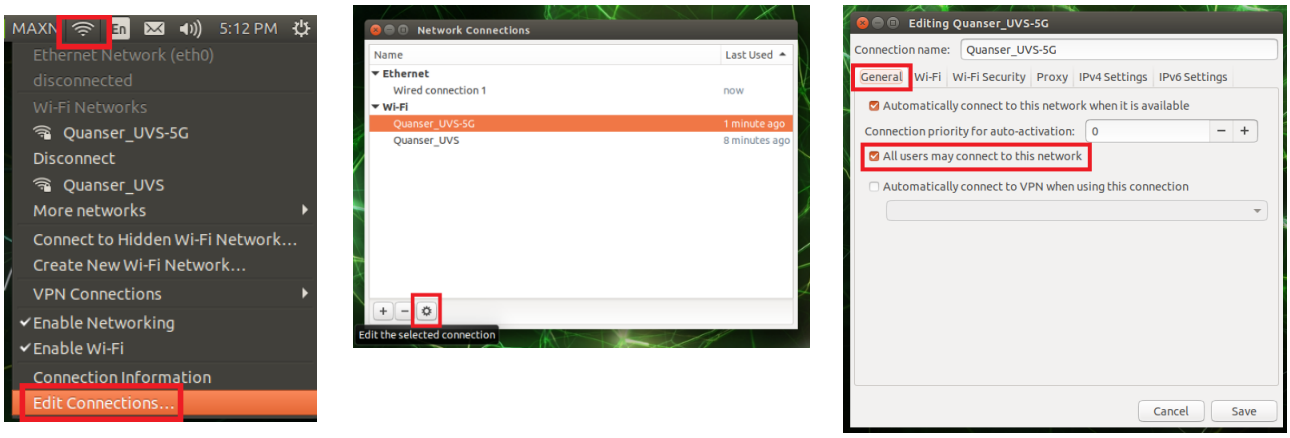
SSID	-	**Quanser_UVS** (2.4GHz) or **Quanser_UVS-5G** (5 GHz)
Password	-	**UVS_wifi**

If the QCar was not purchased as part of the studio package or if you choose to set up your own network, you will need to manually configure the Wi-Fi. Please keep the following considerations in mind:

1. The QCar can use either the 2.4GHz (full spectrum) or 5GHz (limited spectrum) bands. The 5GHz band at higher frequencies is disabled on the platform. Ensure that your 5GHz network is broadcasted over the channels in the range 36 to 60 and not higher. **Note**: The 2.4GHz band offers coverage over farther distances but performs at slower speeds. The 5GHz network offers higher bandwidth and data rates over shorter distances.
2. Ensure that your router has the Dynamic Host Configuration Protocol (DHCP) server enabled. This will ensure that the router automatically assigns an IP address to the platform when it connects.
3. To have the QCar connect to your network, connect the car directly as shown in section B. i. and use the Ubuntu Wifi configuration menu to connect to the desired

network of your choice.

4. After connecting to your network, follow these steps to ensure that the platform can connect to the network when a user is not logged in (See Figure 2 for details).
    a. While the QCar is still connected directly as in section B. i, go to Wi-Fi Configuration > Edit Connections.,.. > Select your new network
    b. Click on the gear at the bottom of the screen
    c. Navigate to the General Tab and check the box that reads “All users may connect to this network”.



a. edit connections b. edit network configuration c. allow all users to connect

Figure 2. Allowing the QCar platform to connect to a network when not logged in

In this case, the LCD will show a wireless symbol highlighted in Figure 3, as well as the IPv4 address of the platform dynamically assigned by the provided router or the network of your choice.

Figure 3. Wi-Fi setup with the QCar platform

B. User Interface

i. Direct

The QCar platform can be used directly as a computer, complete with a 6-core CPU, an NVIDIA GPU, a built-in speaker, microphones and an extensive sensor suite. Connect a keyboard/mouse using the provided USB ports, and connect up to 2 monitors using the HDMI ports on board. An example setup is shown in Figure 4 below. The network can be set up using LAN as described in section A. i.

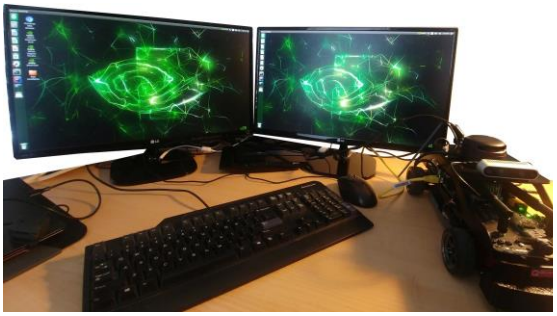


Figure 4. Direct setup with the QCar platform

Username: **nvidia**
Password: **nvidia**

Table 1. Login credentials for QCar

This setup will typically be used when developing applications using Python/ROS directly on the QCar platform. Examples include: viewing collected datasets, training neural networks on-board, post processing collected data during an experiment, or developing image processing algorithms where fluid motion is required by the user.

ii. Remote

For applications that require the platform to be moving or require remote access, a direct setup is not feasible. In such cases, a wireless setup may be used, with the provided Ground Control Station (GCS) (if the QCar was purchased as part of the Self-Driving Car Research Studio) or a machine of your choice. It must be connected to the same network as the QCar and will deploy applications to the platform.

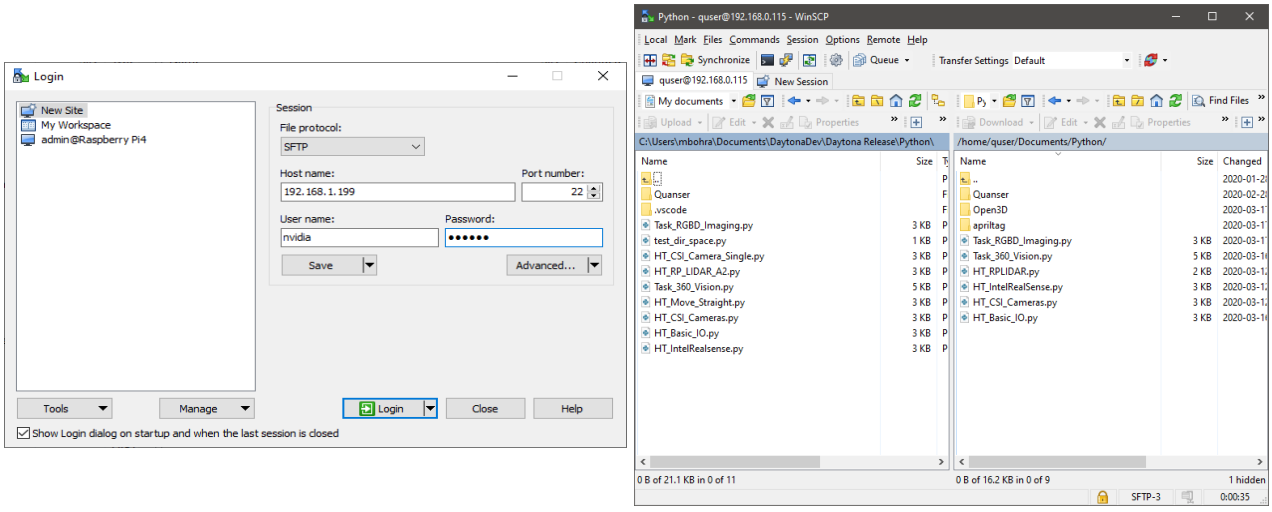
To ensure that your GCS is connected to the same network as the platform. Use **`ipconfig`** (in a Windows command prompt) or **`ifconfig`** (in Ubuntu terminal) to check your current connectivity. You can also use the **`ping`** command in both Windows and Ubuntu to check your connection to the QCar, eg.

```
>> ping 192.168.2.115 -t
```

File Transfer

To transfer files between the GCS and the platform manually, a software tool **WinSCP** can be used, and is installed by default on the provided GCS. Find more information on WinSCP here. This can be used for one-time transfers of files, or you can navigate to a file onboard the QCar, double click on it in WinSCP, and it will open in your default text editor in Windows. When the file is saved, it will automatically be transferred back to the QCar.

To use WinSCP, enter the QCar's IP address as the host name, **`nvidia`** as the username, and **`nvidia`** as the password, as shown in Figure 5a. You can now use the WinSCP browsers to transfer files from the GCS (left browser) to the QCar (right browser), shown in Figure 5b. Double clicking a file on the right will automatically transfer a copy of the file to your PC and open it in your default editor. Clicking save in your editor will automatically transfer the saved version back to the QCar.



a. WinSCP login b. WinSCP browser to transfer files

Figure 5. WinSCP usage for file transfer

PuTTY

Once your files are transferred, you can deploy them via remote terminal using a tool - **PuTTY**, which is also installed on the provided GCS. Find more information on PuTTY here. If you are familiar with Linux command-line text editors, you can also edit code on the QCar via PuTTY. PuTTY by itself is sufficient to access the file system and execute code that does not require any graphical feedback display.

To use PuTTY, open the application and enter the hostname or IP address of the QCar in the hostname field as shown in Figure 6 then click Open. You will be prompted to login (username **`nvidia`**, and password **`nvidia`**). Note that you can open more than one PuTTY terminal to the QCar if you need to.

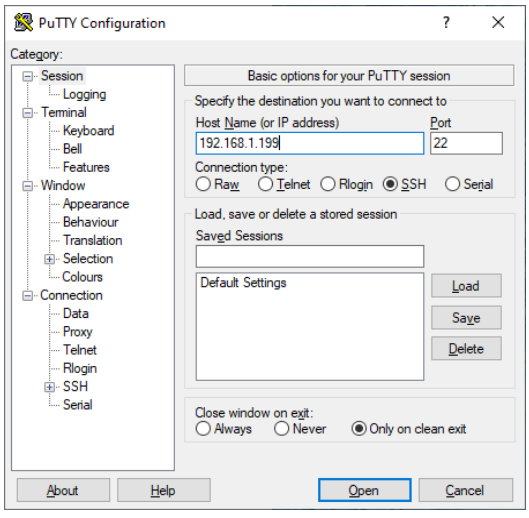


Figure 6. Connecting to the QCar with PuTTY

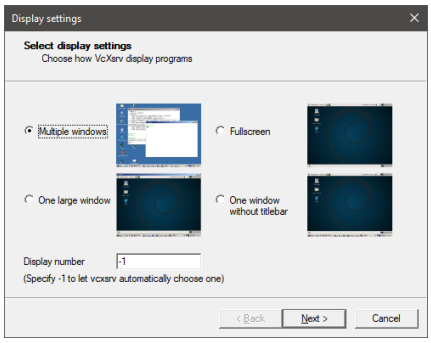
VcXsrv/XLaunch

If your code requires graphical feedback such as displaying image processing results, an X11 server can be used. This approach works well for plots, indicators, and low-frequency image displays, but since it sends uncompressed data over the WiFi, large image displays will have very slow frame rates. If you need to see image processing results in real-time, the **VNC** method is recommended instead. The advantage of the X11 interface is that it can be connected to the QCar from a cold boot (see the next section regarding VNC limitations).

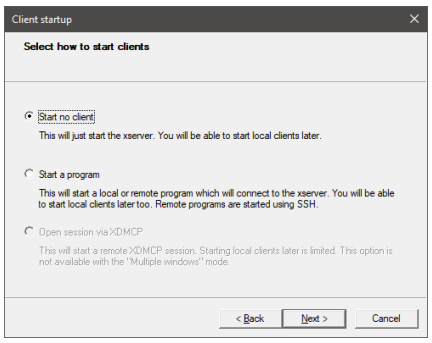
A PuTTY terminal is used to provide X11 forwarding but a display server must be present on the GCS. A tool - **VcXsrv** (under the name **XLaunch** in the start menu), has also been installed on the GCS by default for this purpose. Find more information on VcXsrv here. The basics steps are summarized below:

1. Launch **XLaunch** (VcXsrv server application).

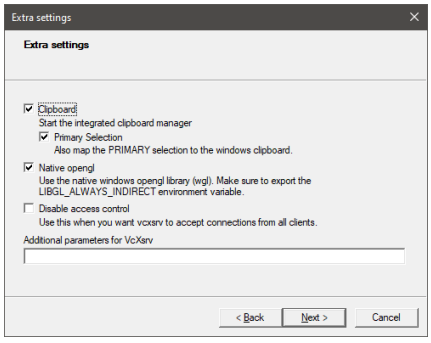
2. Pass through all four tabs with default options or set up your own configuration as in Figure 7 (as long as the 'start no client' option is selected as in Figure 7b) and click Finish.



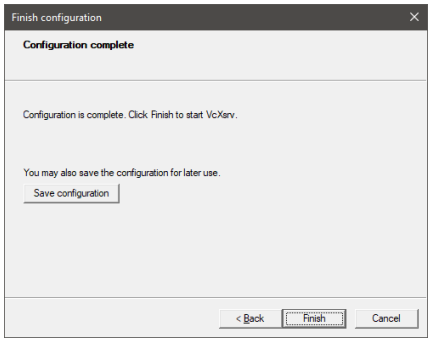
a. Multiple windows default



b. Ensure 'Start no Client' is selected



c. Start the clipboard manager and opengl



d. Save configuration if desired

Figure 7. XLaunch to start a display server on the GCS

3. An XLaunch display server should now be visible in your toolbar as shown in Figure 8.

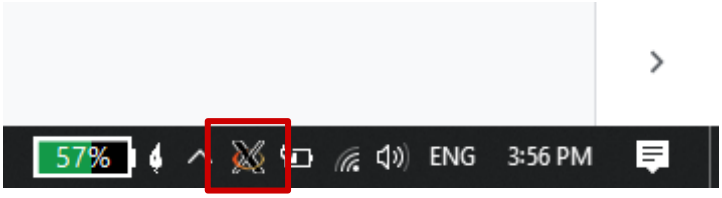
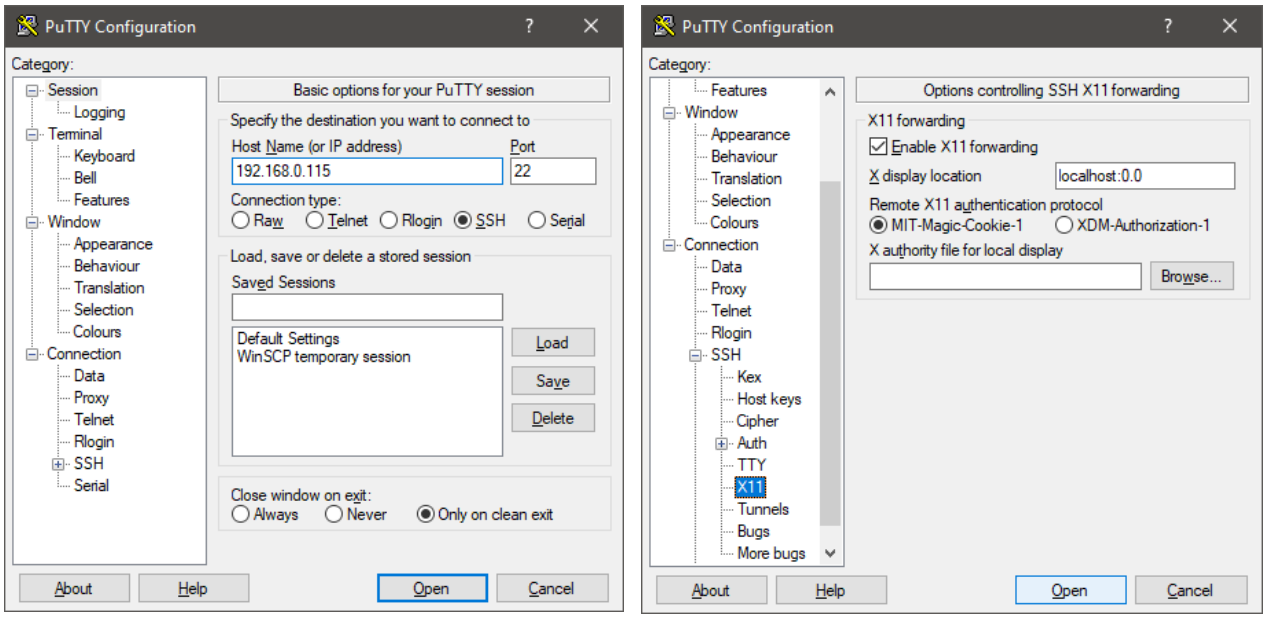


Figure 8. XLaunch display server

4. Launch **PuTTY**.
   NOTE: A PuTTY terminal can be launched from WinSCP, but this will not allow you to conveniently set up X11 forwarding. Launch Putty directly for additional set up capabilities.

5. Enter the IP address of the QCar under the Host Name field as shown in Figure 9a. Navigate to the **Connection/SSH/X11** tab as shown in Figure 9b. Check ON the **Enable X11 forwarding** option, and enter `localhost:0.0` in the **X display location** field. Click on Open.



a. PuTTY login

b. X11 forward

Figure 9. PuTTY usage to setup a remote terminal

6. Login using the QCar credentials (username **`nvidia`**, and password **`nvidia`**).

7. Type the following command to ensure that the display server is set up.
   >> echo $DISPLAY

   This should return an output similar to the one shown in Figure 10.

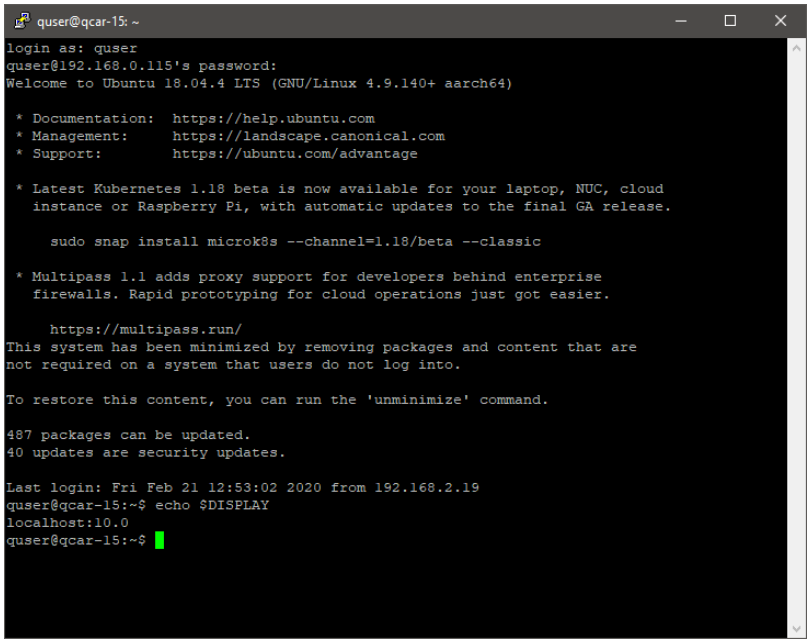


Figure 10. PuTTY remote terminal connected to a display server

8. Type in a test command,
   >> chromium-browser
   And the chromium application from the QCar should display on your GCS display server in Windows. Applications such as python scripts now deployed via the remote PuTTY terminal will forward their display outputs (if any) to the GCS.

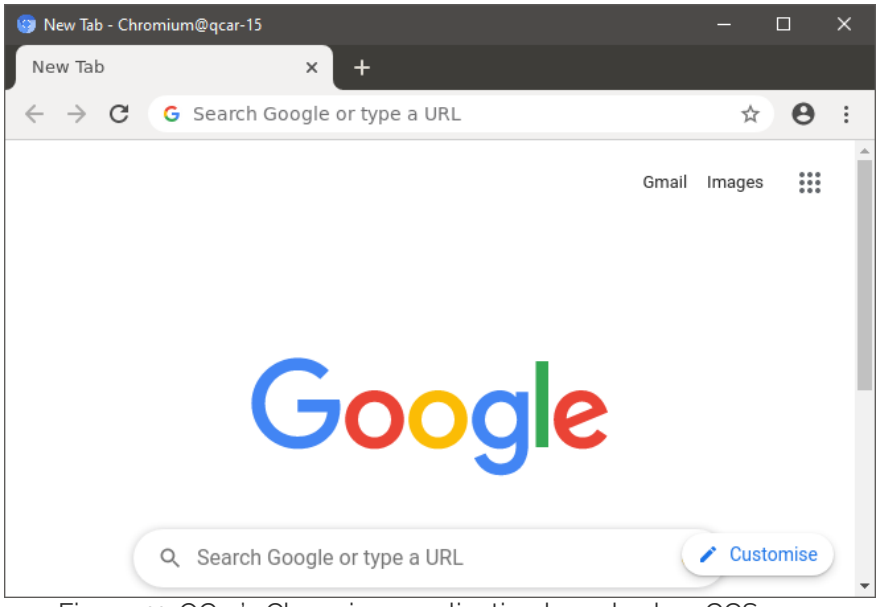


Figure 11. QCar's Chromium application launched on GCS

VNC Viewer

The final method of remote access with the QCar is to use a remote desktop application such as VNC Viewer (if you do not have VNC Viewer installed you may download the application by going here). The advantage of this approach compared to using VcXsrv/XLaunch is that the QCar desktop VNC server sends compressed image data to the remote desktop which allows for higher frame rates (though not as high as the direct connection method). This is useful for remotely monitoring image processing outputs. This approach also gives you the full graphical desktop which may be easier for users less familiar with Linux commands. The disadvantage of this approach is that the QCar must be first powered up with an HDMI monitor or HDMI dummy adapter before a VNC connection can be established.

A VNC server has been pre-installed on the QCar. To connect from the GCS you will need to perform the following steps:

For the QCar

1. Connect a monitor or HDMI dummy to a HDMI port on the QCar
2. Connect a power source to the QCar, this can either be the provided 3s 3300 mAh LiPo battery or the supplied power supply for the QCar.
3. Power **ON** the QCar.
4. Once the QCar is at the desktop, you may remove the HDMI cable and keyboard from the QCar.

   Note: If the QCar does not automatically log into the desktop, you will need to connect a keyboard to enter the password (**nvidia**). You may optionally follow the steps in the User Manual - Troubleshooting **Section C Connectivity** to enable auto-login.

For the Ground station:

1. Open VNC viewer
2. In the VNC connect window enter the IP address of the QCar which can be found on the LCD screen shown in the section A.

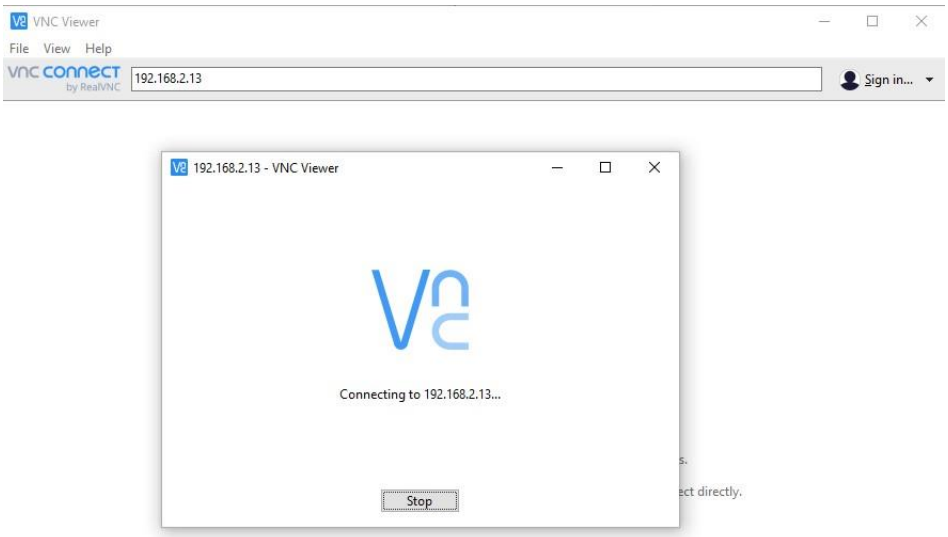


Figure 12. VNC Viewer connection screen.

3. When prompted to allow the remote desktop connection click on yes.
4. You will be asked for the user password for the QCar in order to start the remote desktop connection. You may optionally check the box to 'Remember password'.

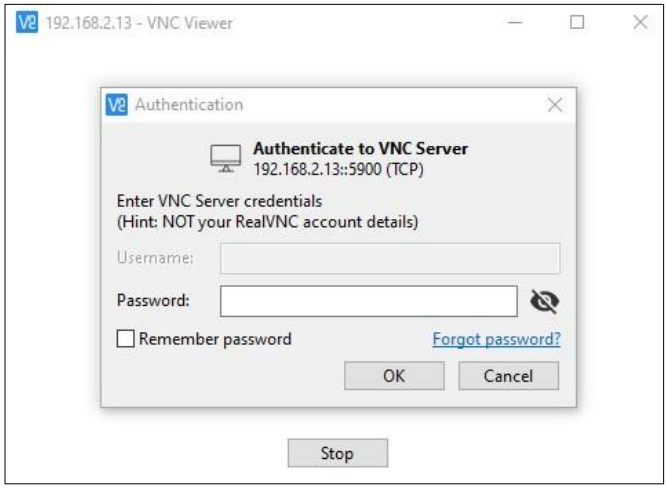


Figure 13. VNC Viewer QCar credential screen.

5. A successful connection will take you to the main user desktop.

Figure 14. QCar Ubuntu user screen

Note, an Ethernet connection will provide a more responsive interface than WiFi, but you can also try reducing the desktop resolution, and Appearance Behavior from High visual effects to Low visual effects. You can select which combination of features, desktop space, and interface responsiveness work best for your workflow. A resolution of 800x600 should produce a very responsive display over WiFi.

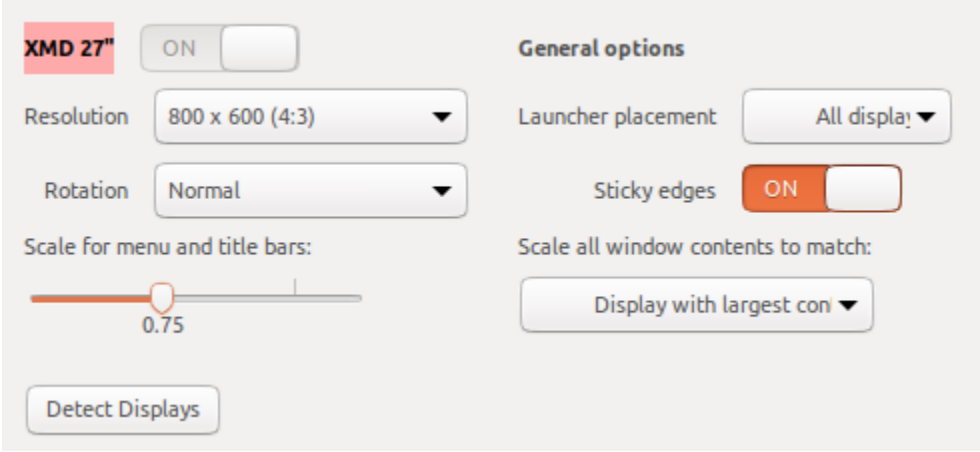


Figure 15. Setting the display settings in Ubuntu to 800 x 600 will produce a responsive display.

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