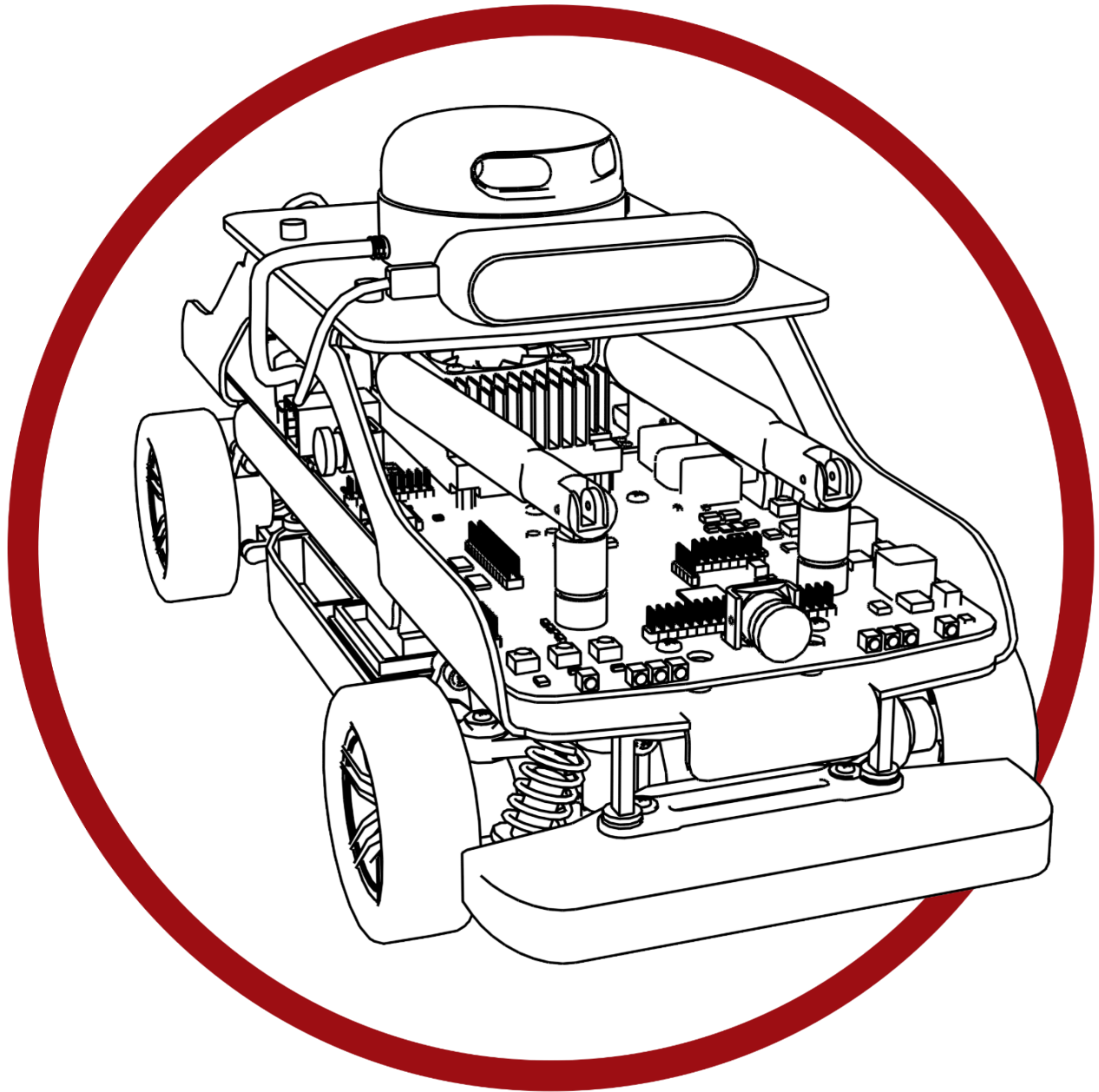


# Self-Driving Car Research Studio



## User Guide – Connectivity

V 1.1 (November 2020)



## Caution

**This equipment is designed to be used for educational and research purposes and is not intended for use by the general public.** The user is responsible to ensure that the equipment will be used by technically qualified personnel only.

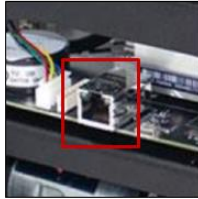
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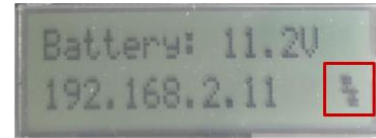
## A. Network Setup

### 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	-	<b>Quanser_UVS</b> (2.4GHz) or <b>Quanser_UVS-5G</b> (5 GHz)
Password	-	<b>UVS_wifi</b>

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 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. 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.
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.

In this case, the LCD will show a wireless symbol highlighted in Figure 2, as well as the IPv4 address of the platform dynamically assigned by the provided router or the network of your choice.



Figure 2. 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 3 below. The network can be set up using LAN as described in section A.i.



Figure 3. Direct setup with the QCar platform

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

Table 1. Login credentials for QCar

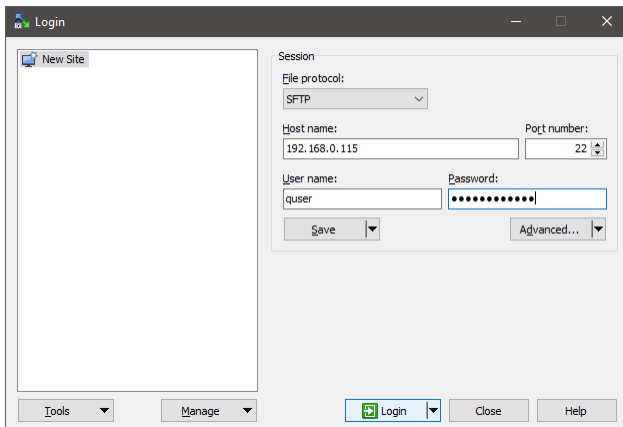
This setup will typically be used when developing applications using Python/ROS directly on the QCar platform. Examples include: viewing collected datasets, training neural networks on-board, or post processing collected data during an experiment.

### ii. Remote

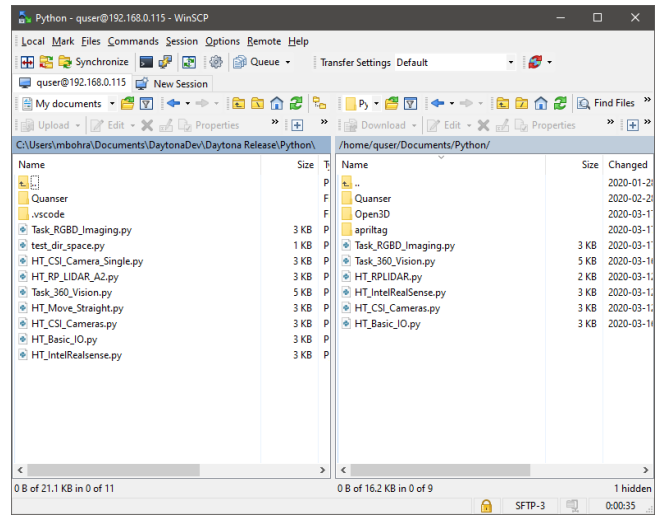
For applications that require the platform to be moving or require remote access, a direct setup is not feasible. In such cases, a wireless setup may be used, with the provided Ground Control Station (GCS) (if the QCar was purchased as part of the Self-Driving Car Research Studio) or a machine of your choice. It must be connected to the same network as the QCar and will deploy applications to the platform. To 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](#). 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](#). A PuTTY terminal provides 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. 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.
2. Use the **ping** command (Windows or Ubuntu) to check your connection to the QCar, eg  

```
>> ping 192.168.2.115 -t
```
3. Open **WinSCP**.
4. Enter the QCar's IP address as the host name, **nvidia** as the username, and **nvidia** as the password, as shown in Figure 4a. You can now use the WinSCP browsers to transfer files from the GCS (left browser) to the QCar (right browser), shown in Figure 4b.



a. WinSCP login

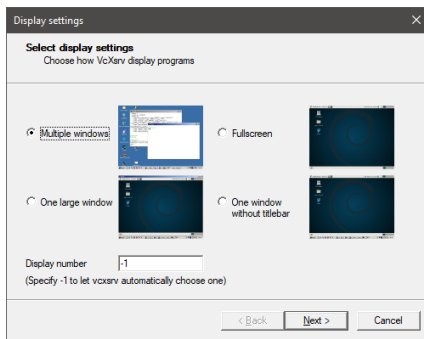


b. WinSCP browser to transfer files

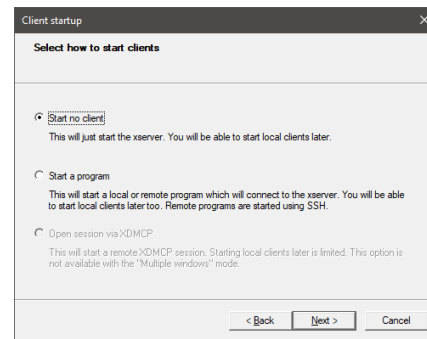
Figure 4. WinSCP usage for file transfer

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

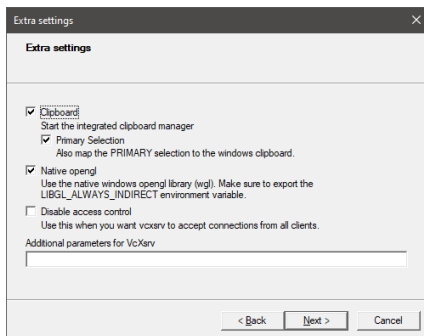
6. Pass through all four tabs with default options or set up your own configuration as in Figure 5 (as long as the 'start no client' option is selected as in Figure 5b) and click Finish.



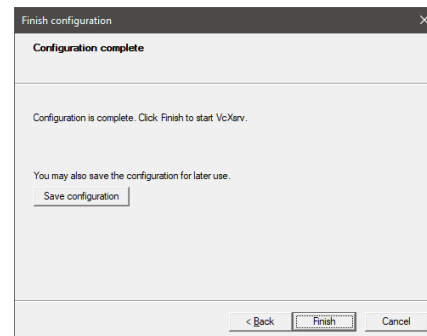
a. Multiple windows default



b. Ensure 'Start no Client' is selected



c. Start the clipboard manager and opengl



d. Save configuration if desired

Figure 5. XLaunch to start a display server on the GCS

7. An XLaunch display server should now be visible in your toolbar as shown in Figure 6.

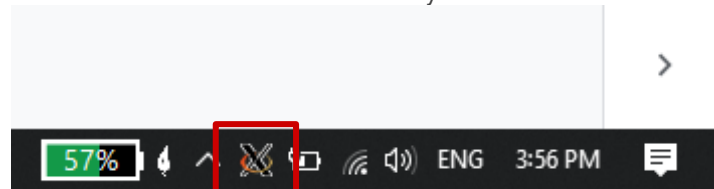
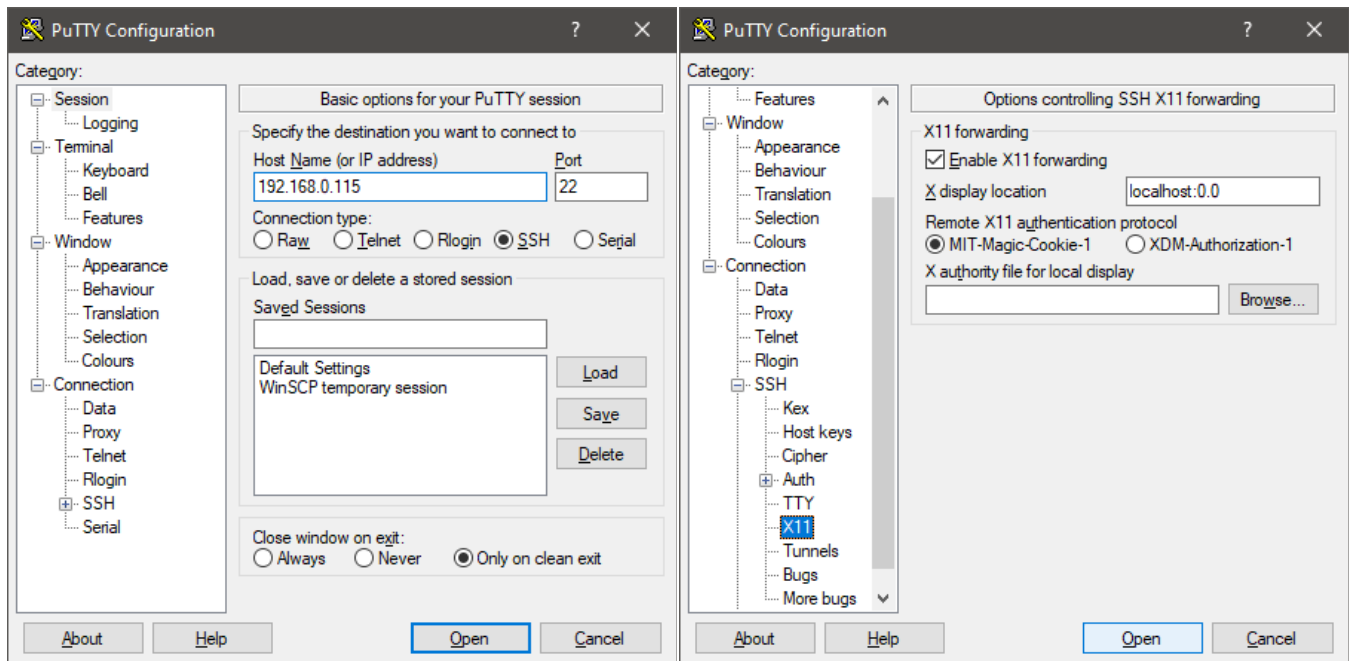


Figure 6. XLaunch display server

8. Launch **PuTTY**.

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

9. Enter the IP address of the QCar under the Host Name field as shown in Figure 7a. Navigate to the **Connection/SSH/X11** tab as shown in Figure 7b. 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 7. PuTTY usage to setup a remote terminal

10. Login using the QCar credentials (username **nvidia**, and password **nvidia**).
11. 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 8.



```
quser@qcar-15: ~
login as: quser
quser@192.168.0.115's password:
Welcome to Ubuntu 18.04.4 LTS (GNU/Linux 4.9.140+ aarch64)

 * Documentation:  https://help.ubuntu.com
 * Management:    https://landscape.canonical.com
 * Support:       https://ubuntu.com/advantage

 * Latest Kubernetes 1.18 beta is now available for your laptop, NUC, cloud
   instance or Raspberry Pi, with automatic updates to the final GA release.

   sudo snap install microk8s --channel=1.18/beta --classic

 * Multipass 1.1 adds proxy support for developers behind enterprise
   firewalls. Rapid prototyping for cloud operations just got easier.

   https://multipass.run/
This system has been minimized by removing packages and content that are
not required on a system that users do not log into.

To restore this content, you can run the 'unminimize' command.

487 packages can be updated.
40 updates are security updates.

Last login: Fri Feb 21 12:53:02 2020 from 192.168.2.19
quser@qcar-15:~$ echo $DISPLAY
localhost:10.0
quser@qcar-15:~$
```

Figure 8. PuTTY remote terminal connected to a display server

12. Type in a test command,  
    **>> chromium-browser**

And the chromium application from the QCar should display on your GCS display server. Applications such as python scripts now deployed via the remote PuTTY terminal will forward their display outputs (if any) to the GCS.

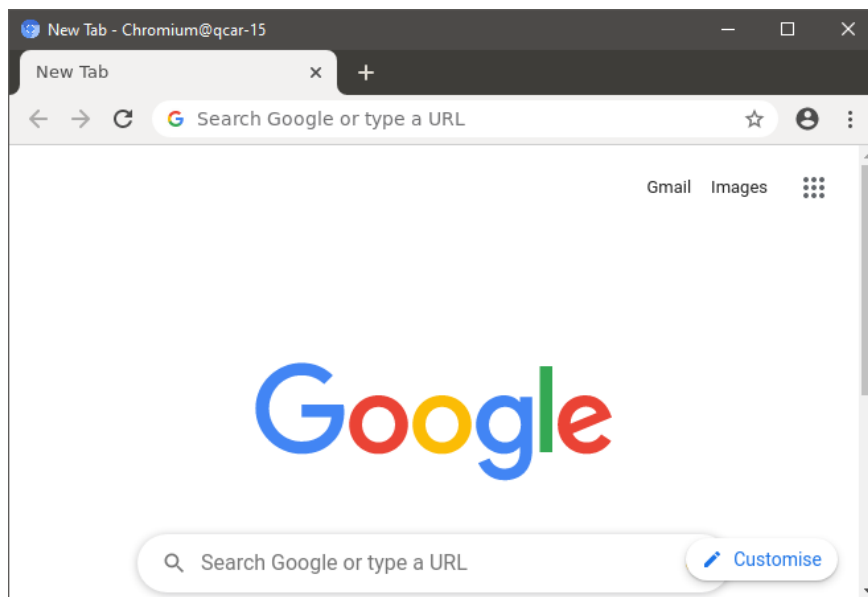


Figure 9. QCar's Chromium application launched on GCS

## Using VNC Viewer:

Another method of remote access with the QCar is to use a remote desktop application such as VNC Viewer. A VNC server is running automatically on the QCar, however for a remote desktop connection you will need to perform the following steps:

For the QCar

1. Connect a keyboard and monitor 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. Manually log into the QCar by entering the password at the login window.
5. You may remove the HDMI cable and keyboard from the QCar.

For the Ground station:

1. Open VNC viewer (if you do not have VNC Viewer installed you may download the application by going [here](#))
2. In the VNC connect window put the IP address of the QCar which can be found on the LCD screen shown in the section above

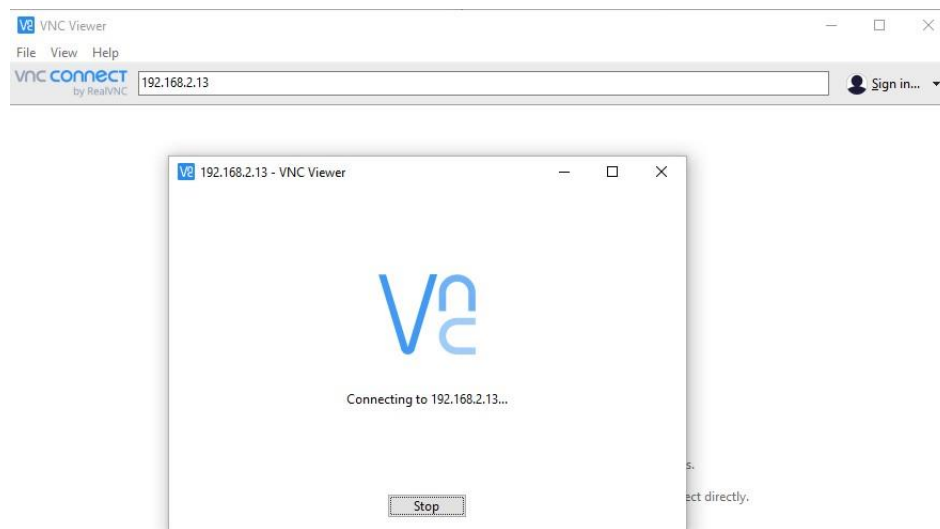


Figure 10: VNC Viewer connection screen.

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

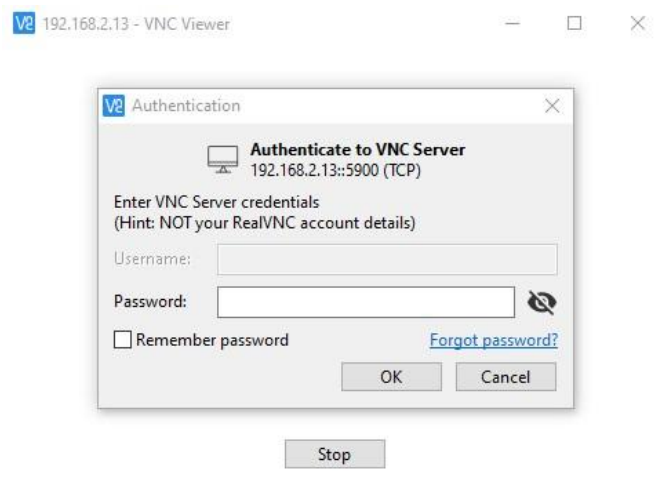


Figure 11: VNC Viewer QCar credential screen.

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

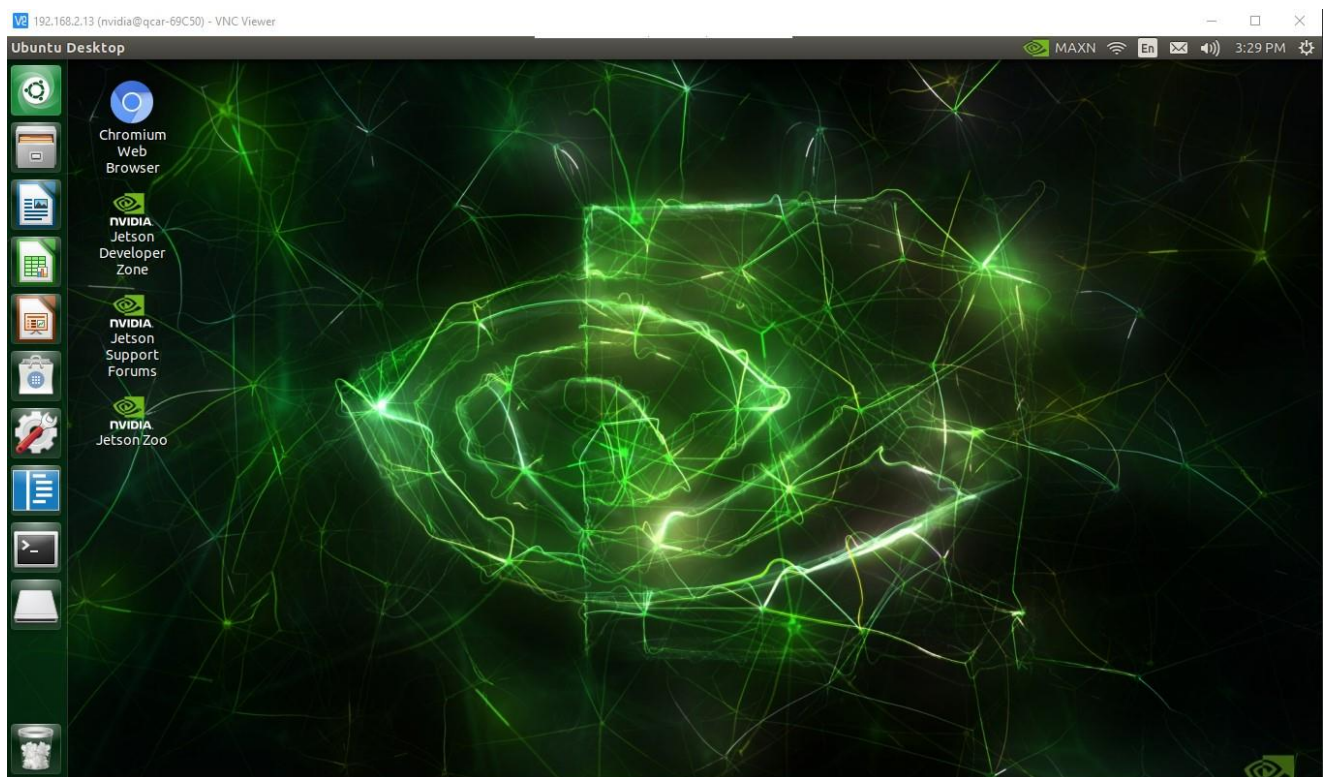


Figure 12: QCar Ubuntu user screen

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