LABORATORY 1: INTRODUCTION TO 5G HAT AND AT COMMANDS

Learning Outcomes

By the end of this laboratory, student should be able to

- Familiarise with 5G Hat and RPI4
- Send basic AT Commands
- Conduct speed test

Activities

- Understand the concept of the 5g module
- Send AT Commands to analyse the network status of the module
- Conduct a speed test for the 5g module

Equipment

- Windows OS laptop
- Quectel RM502Q-AE 5G module
- Waveshare RM502Q-AE 5G Hat
- USB3.0 cable
- Sim card
- QCOM
- Quectel Drivers

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Introduction

Figure 1: Quectel RM502Q-AE module (PONDESK, n.d.)

The Quectel RM502Q-AE is a 5G module optimised especially for eMBB & IoT applications. Based on Qualcomm's commercial 5G platform, Snapdragon X55, it supports both 5G NSA and SA modes as well as LTE Cat 20.

Figure 2: Wasveshare 5G Hat with Raspberry Pi 4 Model B (Without Casing)

The RM502Q-AE module together with Waveshare 5G Hat and Raspberry Pi 4 Model B supports all the main Operating Systems including Linux, Windows, Android, and Ubuntu. It also supports 5G network slicing functions, enabling customers to immediately deploy a wide range of 5G devices and applications across North America, such as home CPE/gateway, industrial router, VR/AR glass, cloud gaming device, laptop, industrial PDA, rugged tablet PC, 8K TV/video camera and more.

The RM502Q-AE 5G module is designed to support major 5G NR bands worldwide (n1/n2/n3/n5/n7/n8/n12/n20/n25/ n28/n38/n40/n41/n48/n66/n71/n77/n78/n79), Citizens Broadband Radio Service (CBRS) for Private Network, and integrated GNSS for location service.

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1. Waveshare RM502Q-AE 5G Hat

- USB 3.1 port (USB 2.0 compatible) for connecting to PC, Raspberry Pi, or Jetson Nano host board to enable high-speed 5G communication.
- Onboard UART, PWR, and RST control pin, built-in voltage level translator, enabled via DIP switch, for use with hosts like Raspberry Pi or Arduino.
- Onboard USB-C connector, enabled via a switch, for connecting the standalone power supply for the module, allows more loads, a stable amd flexible power supply.
- Onboard power supply on/off switch, reset button and LED indicator, easy to turn on/off the module or monitor the operating status.
- 2 x SIM card slot, dual card single standby, switchable via AT command.
- High-efficiency power supply circuit, up to 3A output current

Figure 3: Waveshare 5G Hat with RM502Q-AE 5G module

Question 1:

What is the difference between USB2 and USB3?

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2. Setting up Waveshare RM502Q-AE 5G Hat and QCOM

2.1 Install drivers on windows OS laptop to communicate with RM502Q-AE 5G hat modem.

2.2 In Lab1_materials folder, unzip the folder and download all **3** drivers inside folders that start with the name "Quectel". Right-Click on the "setup" inside each driver's folder and select "run as administrator".

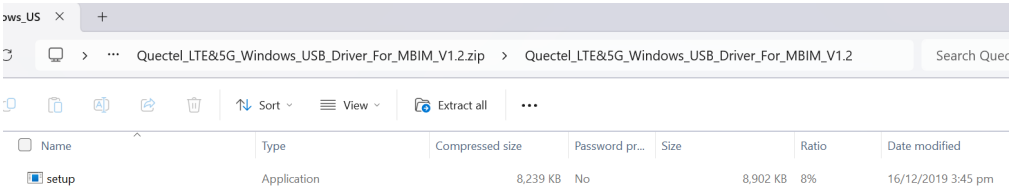
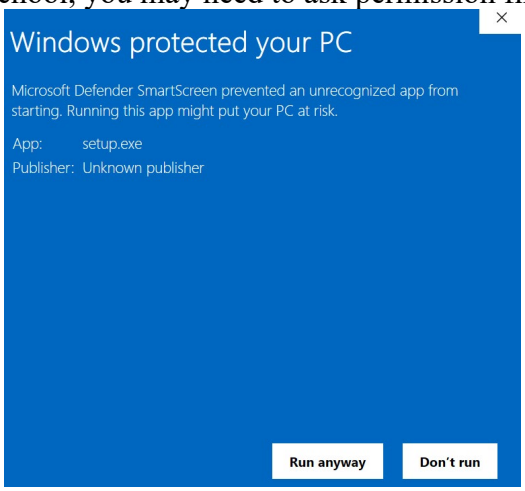
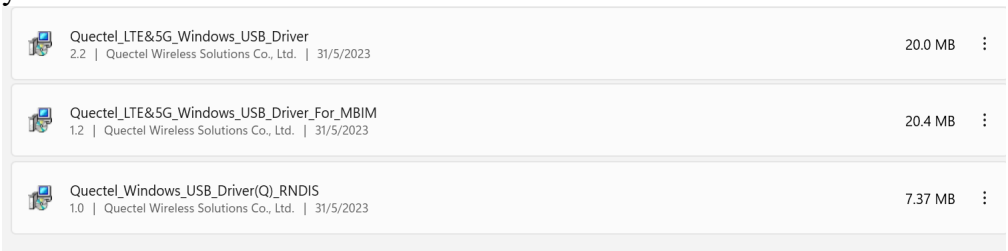


Figure 4: Installing Quectel_LTE&5G_Windows_USB_Driver_For_MBIM_V1.2 example

2.3 If you encounter this warning, click more info, and select "run anyway". If your laptop belongs to the school, you may need to ask permission first.



2.4 If the 3 drivers are installed successfully, go to settings > Apps > Installed apps where you will see all 3 installed drivers.



2.5 Attach all 4 antennas to the 5G Hat.

2.6 Use USB cable to connect the 5G Hat to your laptop.

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Figure 5: Connect 5G Hat to Laptop

2.7 Open Device Manager, under “Port”, identify the port number used for “Quectel USB AT port.” ****Note that you need to first install the 3 drivers, port number may change sometimes so it is good to always to check the AT port**

Figure 6: Quectel USB AT Port COM number is 9 (may change)

2.8 Set up QCOM to send AT commands to RM502Q-AE module.
2.9 Insert Sim Card carefully into the top sim slot of the 5G Hat. Insert the sim card front up in figure 7.

Figure 7: Red box shows sim slot 1 of 5G Hat

Figure 8: Inserting Sim card in the correct position

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2.10 Open ‘QCOM’ from the Lab1_materials folder.

2.11 Open ‘QCOM’, select ‘COM PORT’ and choose the correct AT port number obtained in 2.1 step 5. (e.g. COM14)

2.12 Ensure that the baud rate is set to 115200.

2.13 Under ‘OPERATION’, enable ‘Send with Enter’.

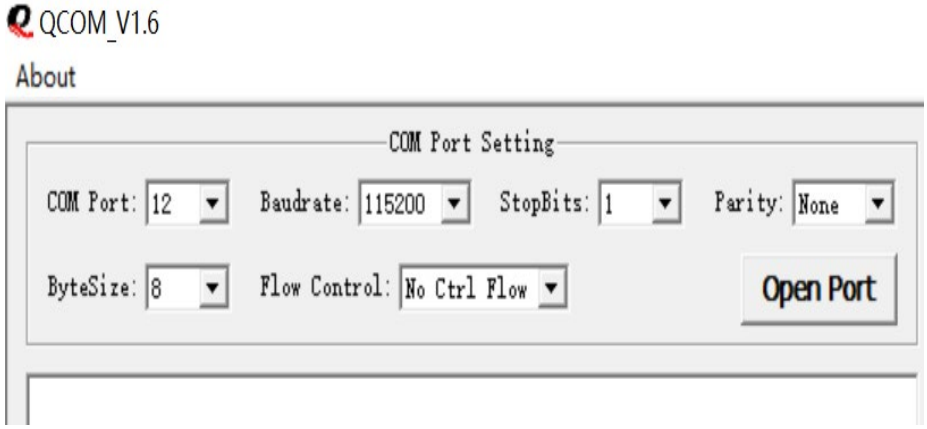

Figure 9: QCOM settings

2.14 Send an AT command **AT+QENG="servingcell"** to query the information of serving cell.

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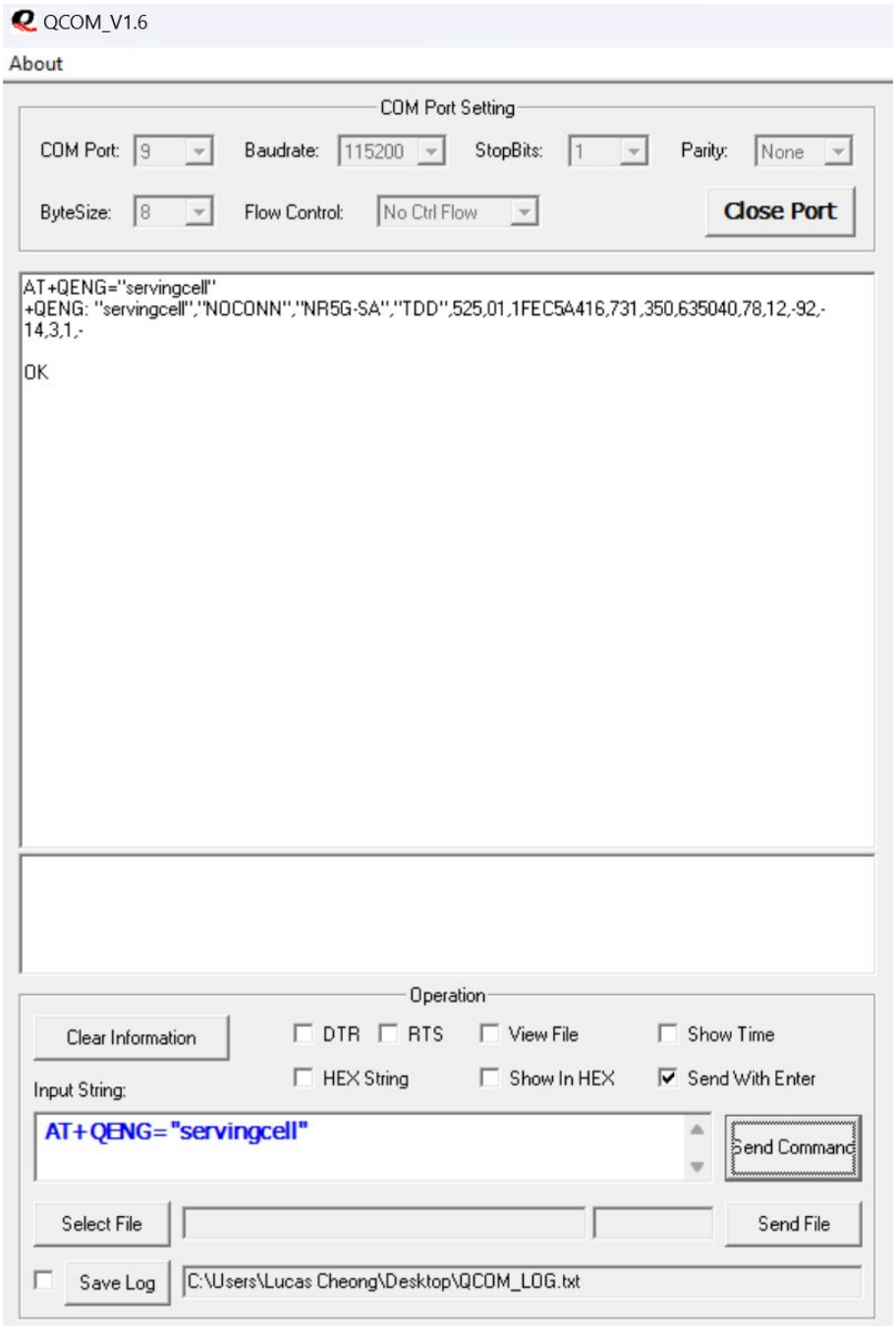

Figure 10: AT+QENG="servingcell"

Question 2:

From the picture above, what cellular network RM502Q-AE 5G Hat is giving now?

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3. Dial Up 5G Cellular Network for RM502Q-AE using AT commands

3.1 SIM Cards Selection

The 5G HAT has two SIM card slots onboard, a dual SIM card, and single standby, which can be switched and enabled by AT command. Send all the following **6** AT commands**:**

AT+QUIMSLOT? (Check Sim Slot)
AT+QUIMSLOT=1 (Switch Sim Slot to 1)

3.2 MBIM Dial-up Internet Access

AT+QNWPREFCFG= “mode_pref”, NR5G (Force to 5G Standalone)
AT+QENG="servingcell" (Query network status)
AT+QCFG="usbnet", 2 (Switch to MBIM mode)
AT+CFUN=1,1 (Save and reboot the RM502Q-AE module)

3.3 Go to Control panel > Network and Internet > Network Connection, you will see the “Cellular” network connection. However, it may sometimes disappear and reappear again.

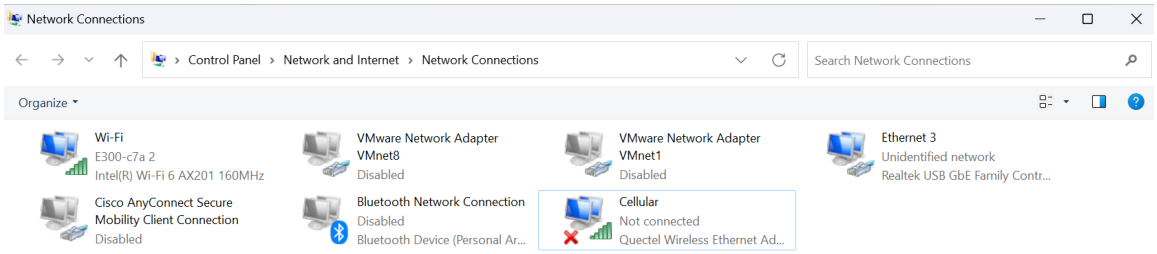

Figure 11: "Cellular" appears in network connections

3.4 To solve this issue, update the driver to generic band. Right-Click on “Cellular”. Select properties > configure > Update Driver > Generic Mobile Broadband Adapter.

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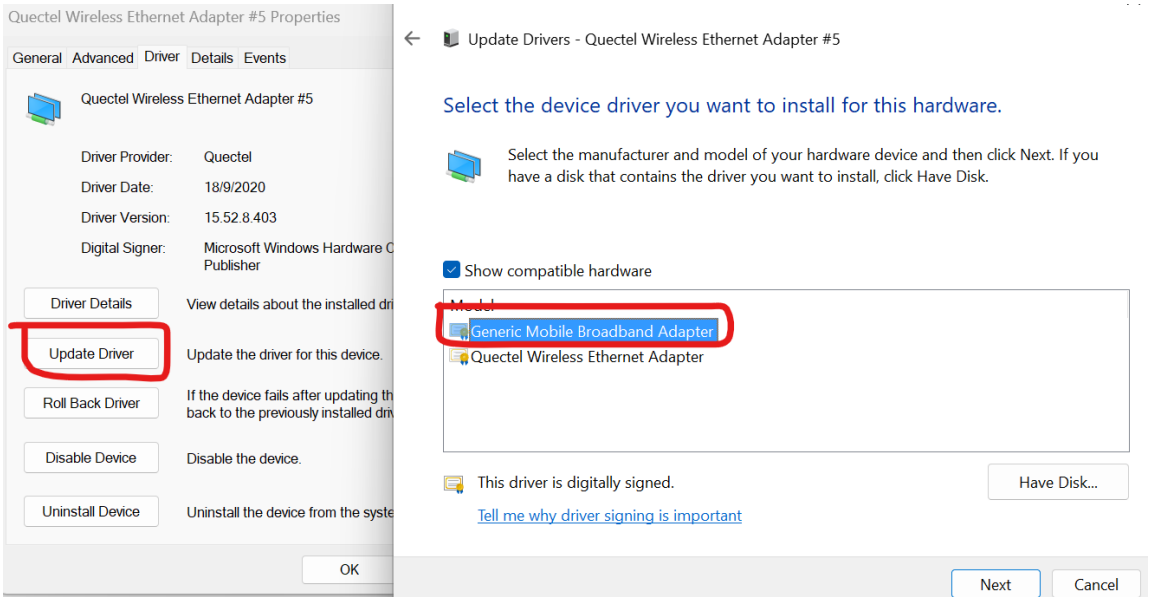

Figure 12:"Cellular" network properties

3.5 Turn off wi-fi and connect to “Cellular” network.

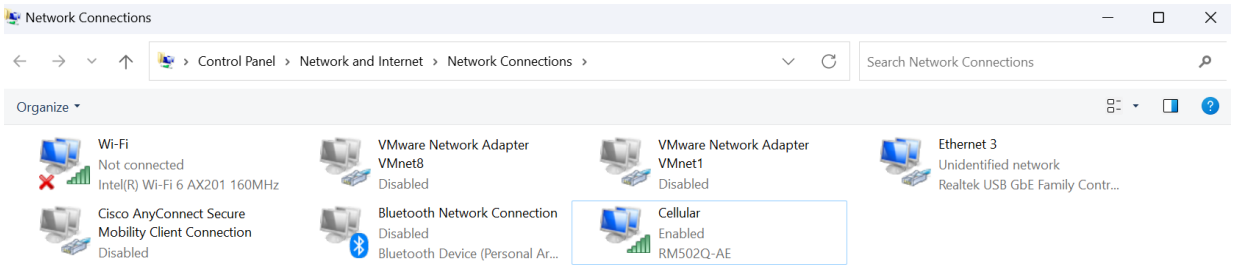

Figure 13: If "Cellular" does not appears, refresh the page and try again from 3.2

3.6 If the Access Point Name (APN) is not set automatically on your windows laptop. You can set the APN yourself. Go to Settings > Network & internet > Cellular > Mobile operator settings. Click “Add APN”. Copy the following to set up an internet APN. Then click “save”. ****Note that different sim cards have different APN e.g. SingTel commercial sim cards uses the APN “e-ideas” while Starhub prepaid sim cards uses the APN “shppd”.**

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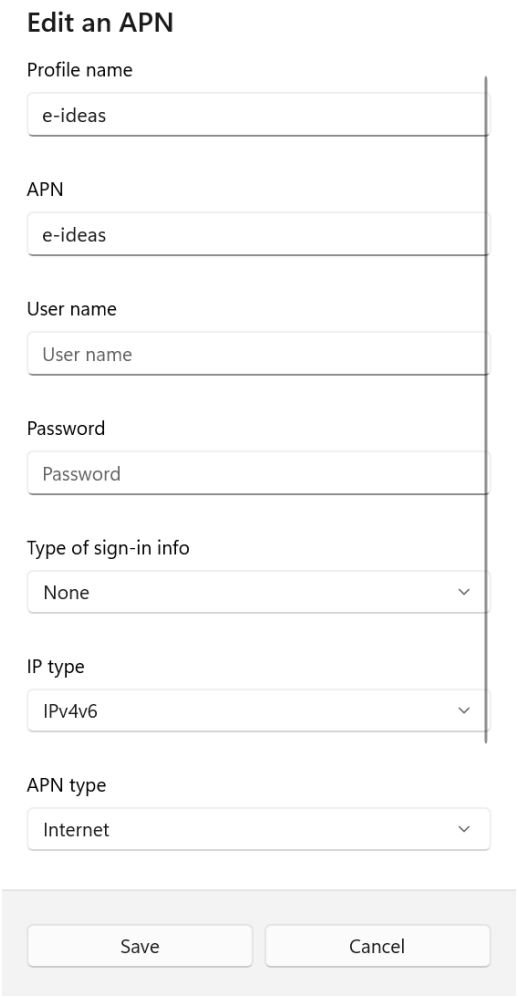

Figure 14: APN details

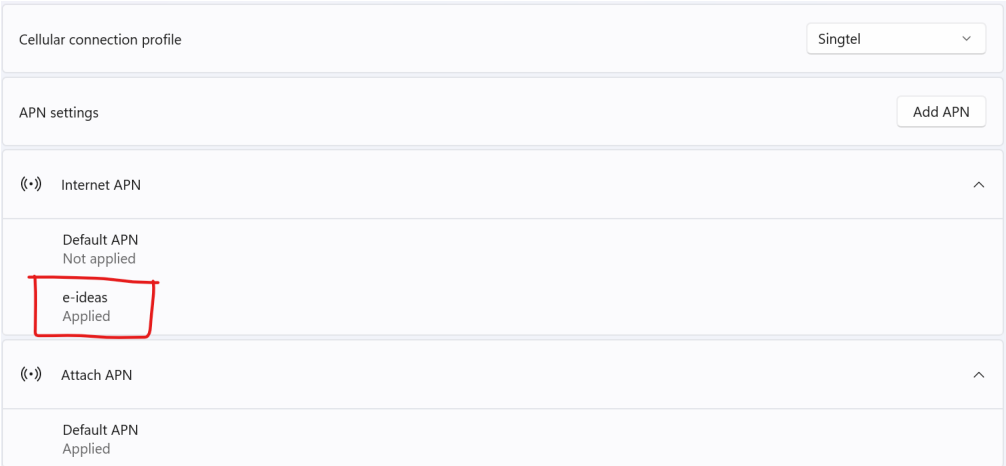

Figure 15: Internet APN applied

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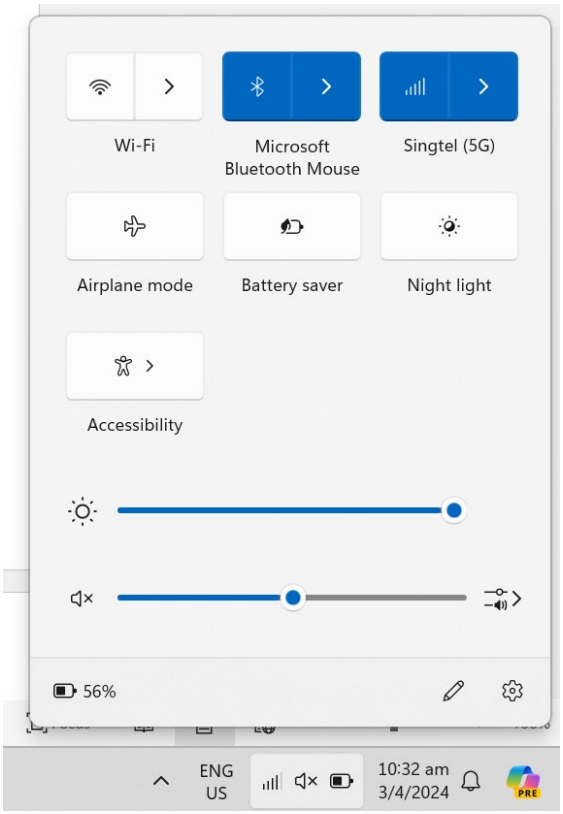

Figure 16: Windows Laptop getting 5G network from modem

Question 3:

What is MBIM?

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Activity 1: Try following AT commands.

Record down the reply for each command and try to analyse network status of 5G Module.

1. AT+CGPADDR=1 (Query IP address)

2. AT+QENG= “servingcell” (Query network status)

3. AT+QNWINFO (Query Network Info)

4. AT+QNWPREFCFG= “nr5g_band”, 77:78 (Setting up 5G Frequency bands)

5. AT+COPS? (Query network operator) G frequency band to n77&n78)

6. AT+QNWPREFCFG= “mode_pref”, NR5G (Force to 5G SA mode)

7. AT+QNWPREFCFG=” mode_pref”, AUTO (Changes to normal)

8. AT+QNWPREFCFG= “nr5g_disable_mode”, 0 (Enable both 5G NSA and SA)

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9. AT+QNWPREFCFG= “nr5g_disable_mode”, 2 (Disable 5G NSA mode)

10. AT+CGCONTRDP (Query public/SIM IP address)

11. AT+CSQ (returns signal strength (dBm) and bit error rate e.g. 31,99 respectively)

4. Conduct a SPEEDTEST (Optional)

**DO NOT DO SPEEDTEST IF YOU DO NOT HAVE PERMISSION FROM LECTURER BECAUSE IT WILL CONSUME A LOT OF DATA

A speed test measures the speed between your device and a test server, using your device's internet connection.

4.1 Ensure that laptop is using cellular network provided by RM502Q-AE.
4.2 Go to https://www.speedtest.net/ .
4.3 Make sure that the right server is selected. (Singtel)
4.4 Click “GO” to start the test.

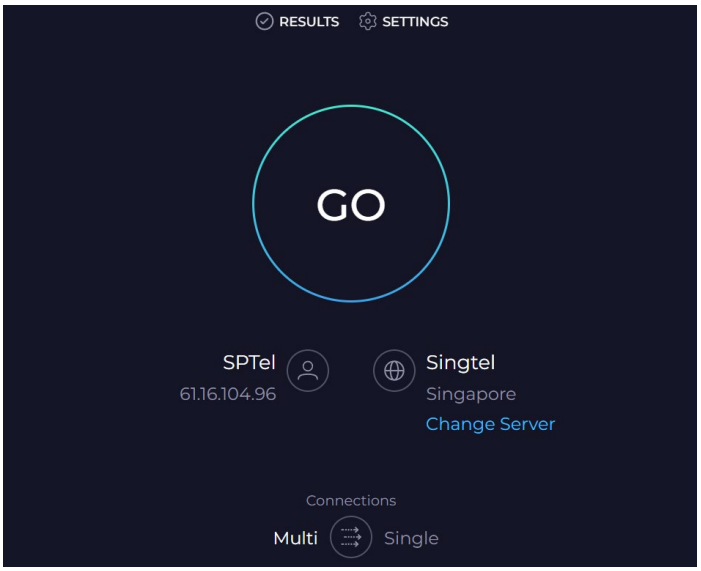

Figure 17: SpeedTest by Ookla

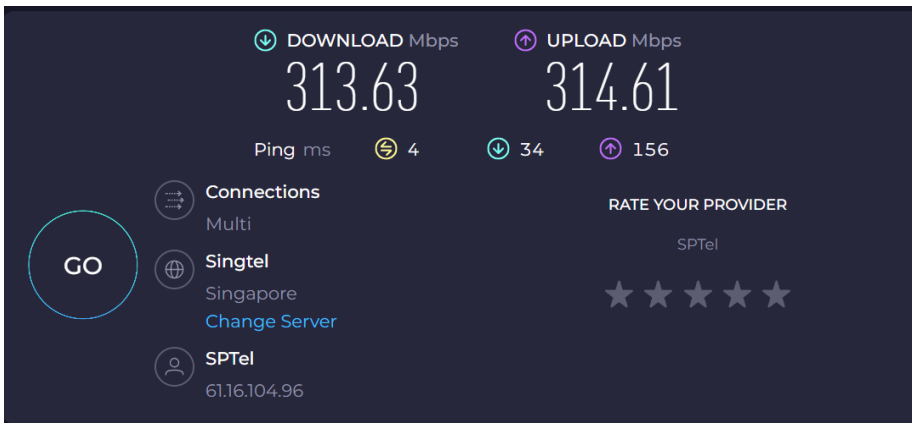

Figure 18: Download and upload speed (What is the average download and upload speed of 5G network?)

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Reference

- PONDESK (no date) Quectel RM502Q-ae IOT/embb-optimized 5G sub-6 GHz M.2 module, PONDESK. Available at: https://www.pondesk.com/product/Quectel-RM502QAE-IoTeMBBOptimized-5G-Sub6-GHz-M2-Module_NWEL-035 (Accessed: 04 April 2024).