

Group number:

- 1) Proceed with programming the assigned SIM card as directed by the procedure below.

NOTE: your SIM card will be assigned IMSI 001010000000xx, where 'xx' indicates your group number.

```
sudo ./program_uicc --port /dev/tty1 --adm 12345678 --isdn 00000001 --acc 0001
--key fec86ba6eb707ed08905757b1bb44b8f --opc C42449363BBAD02B66D16BC975D77CC1
--spn "OpenAirInterface" --authenticate --imsi 001010000000xx
```

Explanation of parameters:

--adm Administrative Code
--isdn Integrated Services Digital Network
--acc Access Control Class
--key secret authentication key, commonly called K
--opc Operator Code
--spn Service Provider Name
--authenticate Validates key, opc, and other data in SIM/UICC
--IMSI International Mobile Subscriber Identity

- 2) After configuration, insert the SIM card into the UE that has been assigned to your group (Quectel RMU500EK)

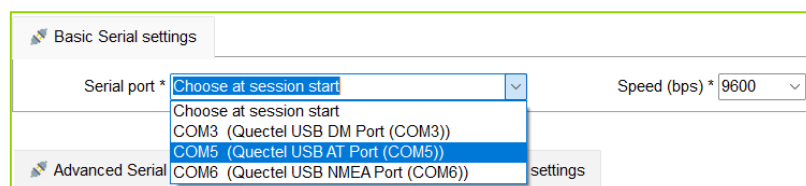
Pay attention to the correct positioning of the SIM card.

- 3) Connect the UE to the PC using the provided USB cable. Wait for the UE's two LED indicators to become active (approx. 30s).

- 4) Launch the **MobaXterm** application.

The MobaXterm application is a versatile terminal emulator, being used in this context to execute commands on the UE (AT commands).

- a) Click on “**Session port**” and then on “**Serial**”. Then select the serial port that includes the “**AT**” designation; the speed must be 9600, as illustrated in the figure below. Then do “**OK**”.



- b) In the command line window that appears, execute the following commands and take note of the responses received

Command	Purpose	Response returned by UE
AT	Checks if the modem is active	
ATE1	Enables echo of entered characters	
ATI	Gets modem information	
AT+CIMI	Gets the IMSI value configured on the SIM card	

AT+CGDCONT?	Asks about PDP contexts and their configurations	<i>Indicate only which contexts are present:</i>
AT+CGDCONT=1,"IP","oai"	Configures PDP context 1 with the given information	
AT+CGDCONT=2	Configures PDP 2 context to empty	
AT+CGDCONT=3	Configures PDP 3 context to empty	
AT+CGDCONT?	Asks again about PDP contexts	<i>Indicate only which contexts are present:</i>

- c) Wait for the gNB (5G base station) to be started by one of the trainers. After indication by the trainer, execute the following command and transcribe the observed answer.

Command				Purpose				Reply returned by the EU					
AT+QENG="servingcell"				Ask about the cell (gNB) that is currently serving the EU.				Fill in the table below					
Mode	Duplex	MCC	MNC	cellID	PCID	TAC	ARFCN	Band	Bandwidth	RSRP	RSRQ	SINR	scs
NR5G-SA													
Expected answer format: +QENG: "servingcell",<state>,"NR5G-SA",<duplex_mode>,<MCC>,<MNC>,<cellID>,<PCID>,<TAC>,<ARFCN>,<band>,<NR_DL_bandwidth>,<RSRP>,<RSRQ>,<SINR>,<scs>,<srxlev>													

- 5) Look at the gNB *Dashboard* and take note of how many UEs are associated with it.

No. of EUs linked to gNB:

Explanation:

- 6) Make a note of the RSRP value observed in the Dashboard for the mobile device (iPhone), in the following situations:

Distance to gNB	Average RSRP value (dBm)
10 cm	<i>(value approx. -60 dBm)</i>
1m	<i>(value approx. -80 dBm)</i>
5m	<i>(value approx. -95 dBm)</i>

- 7) Wait for indication and then observe, in *the Dashboard*, the bandwidth value and the TDD configuration, pre-configured for the gNB.

Preconfigured bandwidth value on gNB:

TDD Configuration:

Periodicity:

- 8) Wait for indication to use your PC and access the url **https://172.31.0.100**

Start a *speedtest* and take note of the observed average values:

gNB Bandwidth	TDD configuration	Metrics / KPIs	Average observed value (Mbps)
20 MHz	DDDFU	Download throughput:	
		upload throughput:	
Analysis of the observed values based on theoretical calculations			SEE ATTACHMENT
Max. number of <i>resource blocks</i> for streaming:			Table 1
No. of subcarriers per <i>resource block (slot)</i> :			Figure 1
No. of symbols used for PDSCH in each <i>resource block (slot)</i> :			Figure 1
Duration of each <i>resource block (slot)</i> :			Figure 1
Duration of each TDD frame:			Figure 1
Transmission pattern (TDD frame configuration):			
Total <i>resource elements</i> per <i>resource block</i> of type D:			Figure 1
Total <i>resource elements</i> in downlink per <i>resource block</i> of type F:			Figure 2
Total <i>resource elements</i> in uplink per <i>resource block</i> of type F:			Figure 2
Total of <i>resource elements</i> per <i>resource block</i> of type U:			Figure 1
Total <i>resource blocks (slots)</i> per second of type D:			
Total <i>resource blocks (slots)</i> per second of type F:			
Total <i>Resource Blocks (Slots)</i> per second of Type U:			
Total <i>resource elements</i> in downlink :			
Total <i>resource elements</i> in uplink :			
Transmission rate for downlink (256 QAM <i>code rate</i> = 1):			

Transmission rate for **uplink** (16 QAM | code rate = 0.6):

- 9) Wait for indication to change the bandwidth of the gNB to **40MHz**. When it's your group's turn, run *speedtest again* and take note of the average values observed:

gNB Bandwidth	TDD Configuration	Metrics/KPIs	Average observed value (Mbps)
40 MHz	DDDFU	Download throughput:	
		Upload throughput:	
Analysis of the observed values based on theoretical calculations			SEE ATTACHMENT
Max. number of <i>resource blocks</i> for streaming:			Table 1
No. of subcarriers per <i>resource block (slot)</i> :			Figure 1
No. of symbols used for PDSCH in each <i>resource block (slot)</i> :			Figure 1
Duration of each <i>resource block (slot)</i> :			Figure 1
Duration of each TDD frame:			Figure 1
Transmission Standard (TDD Weave Configuration):			
Total de <i>resource elements</i> por <i>resource block</i> do tipo D :			Figure 1
Total <i>resource elements</i> to downlink per <i>resource block</i> of type F :			Figure 2
Total <i>resource elements</i> for uplink per <i>resource block</i> of type F :			Figure 2
Total de <i>resource elements</i> por <i>resource block</i> of type U :			Figure 1
Total <i>resource blocks (slots)</i> /second of type D :			
Total <i>resource blocks (slots)</i> /second of type F :			
Total <i>Resource Blocks (Slots)</i> /Second of Type U :			
Total <i>resource elements</i> para downlink :			
Total <i>resource elements</i> para uplink :			
Transmission Pace for Downlink (256 QAM <i>code rate</i> = 1):			
Transmission rate for uplink (16 QAM <i>code rate</i> = 0.6):			

10) Wait for the trainer's indication and observe, in *the Dashboard*, the change of the TDD configuration to

DDFFUU

a) Wait for UE to re-establish the connection and then go to url **https://172.31.0.100**

Start a *speedtest* and take note of the average values observed:

gNB Bandwidth	TDD Configuration	Metrics/KPIs	Average observed value (Mbps)
40 MHz	<div>DDFFUU</div>	Download throughput:	
		Upload throughput:	
Analysis of the observed values based on theoretical calculations			SEE ATTACHMENT
Max. number of <i>resource blocks</i> for streaming:			Table 1
No. of subcarriers per <i>resource block (slot)</i> :			Figure 1
No. of symbols used for PDSCH in each <i>resource block (slot)</i> :			Figure 1
Duration of each <i>resource block (slot)</i> :			Figure 1
Duration of each TDD frame:			Figure 1
Transmission pattern (TDD frame configuration):			
Total of <i>resource elements</i> per <i>resource block</i> of type D :			Figure 1
Total <i>resource elements</i> in downlink per <i>resource block</i> of type F :			Figure 2
Total <i>resource elements</i> in uplink per <i>resource block</i> of type F :			Figure 2
Total of <i>resource elements</i> per <i>resource block</i> of type U :			Figure 1
Total <i>resource blocks (slots)</i> per second of type D :			
Total <i>resource blocks (slots)</i> per second of type F :			
Total <i>Resource Blocks (Slots)</i> per second of type U :			
Total <i>resource elements</i> in downlink :			
Total <i>resource elements</i> in uplink :			
Transmission rate for downlink (256 QAM <i>code rate</i> = 1):			
Transmission rate for uplink (16 QAM <i>code rate</i> = 0.6):			

ANNEX

Table 1: Maximum number of Resource Blocks for transmission

Bandwidth [MHz]	5	10	15	20	25	30	40	50	60	70	80	90	100
N_{RB}	11	24	38	51	65	78	106	133	162	189	217	245	273

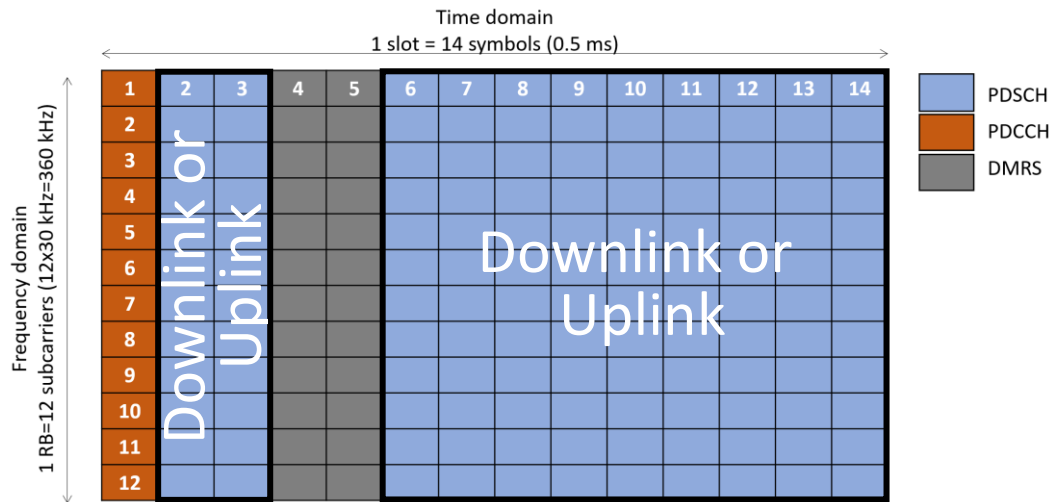


Figure 1: Structure of a Resource Block in 5G [30KHz Subcarrier Spacing (SCS)]



Figure 2: Structure of a Resource Block of type F (SCS 30KHz)