👥 Group C:

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📄 Assignment 4: OAIBOX

1. In this lab session we will do some experiments with the OAIBOX.

Before starting, please create an account at https://dashboard.oaibox.com with your eurecom mail address.

Please read the OAIBOX manual and in particular Labs 1, 2, 3, and 4 during the lab session.

The instructor will change the parameters according tot he instruction and the students will read and document the measurements using the dashboard.

Please also write a short interpretation of the results.

The labs are:

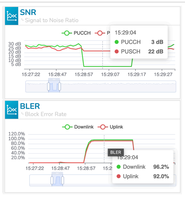
- 2 - LAB-1: Changing the 5G NR bandwidth
- 3 - LAB-2: Changing the 5G NR central frequency carrier
- 4 - LAB-3: Changing the 5G NR TDD slot configuration
- 5 - LAB-4: Changing the 5G NR Modulation and Coding Scheme

2.3 LAB-1: Changing the 5G NR bandwidth

- Table 2-3: Average values measured for the UE PHY layer parameters

Bandwidth	RSSI	RSRP	RSRQ	SINR	SNR (PUSCH)	CQI	MCS	BLER (Downlink)
40 MHz	-92.9 dBm	-73 dBm	-11 dB	22 dB	22 dB	15	9	96.2%
20 MHz	-90.7 dBm	-71 dBm	-11 dB	26 dB	32 dB	15	9	4.0%

40MHz 20MHz



- Table 2-4: Throughput measured and theoretical bit rate values

Bandwidth	Measured bit rate [DL]	Theoretical bit rate [DL]	Measured bit rate [UL]	Theoretical bit rate [UL]
40 MHz	49.5 Mbps	83 Mbps	17.3 Mbps	21 Mbps
20 MHz	23.5 Mbps	40 Mbps	8.1 Mbps	10 Mbps

LAB-1: Suggested topics for discussion:

- Analise the impact of the 5G signal bandwidth on the measured DL and UL bitrates.
- Based on the measured air interface parameters, classify the overall received 5G signal quality at UE.
- Compute the theoretical Shannon capacity of the 5G link and explain the difference from the measured bit rate.
- Compute the SNR considering the thermal noise floor for 20 MHz and 40 MHz bandwidth and compare it with the measured value.
- Elaborate on the impact of the measured BLER on the 5G link throughput.

3.3 LAB-2: Changing the 5G NR central frequency carrier

- Table 3-2: Average values measured for the UE PHY layer parameters for Band n77 and n78

Scenario 1 - LoS

3GPP Band	RSSI	RSRP	RSRQ	SINR	SNR (PUSCH)	CQI	MCS	BLER(Downlink)
n77	-89	-93	-11	14	30	15	9	2.1
n78	-91	-72	-11	23	29	15	9	0.0

n77 n78

Scenario 2 - LoS

3GPP Band	RSSI	RSRP	RSRQ	SINR	SNR(PUSCH)	CQI	MCS	BLER(Downlink)
n77	-89	-93	-11	14	17	15	9	14.6
n78	-92	-84	-11	19	26	15	9	100.7

n77 n78

- Table 3-3: Throughput measured for Band n77 and n78

Scenario 1 - LoS

Measured bit rate

3GPP Band	[DL]	[UL]
n77	49.5	17.3
n78	49.5	17.3

Scenario 2 - LoS

Measured bit rate

3GPP Band	[DL]	[UL]
n77	49.5	17
n78	49.5	17.3

LAB2: Suggested topics for discussion:

- Analyse the impact of the 3GPP Band on the 5G air interface KPIs.
- Analyse the impact of the propagation scenario (LoS vs. NLoS) on the 5G air interface KPIs.
- Based on the measured RSRP value at the UE which is indicated in the OAIBOX^{TM} Dashboard, estimate the overall Path Loss in dB between the gNB and the UE (see Figure 3-2).
- Using the 3GPP 38.873 UMa propagation model for LoS (Section 3.1.1.1), estimate the OAIBOXTM cell radius for 3GPP n77 and n78 central frequencies. Consider 10 dB transmit power in the gNB, cable losses of 1 dB, gNB antenna gain of 3 dB, UE antenna gain of 1 dB, a bandwidth of 40 MHz (required to compute the Thermal Noise Floor – equation (3.4), UE NF of 5 dB and a target SNR of 10 dB.
- Optional: Using a spectrum analyser (see Figure 3-3) measure the central frequency and bandwidth of 5G radio signals in bands n77 and n78. Discuss the results.

4.3 LAB-3: Changing the 5G NR TDD slot configuration

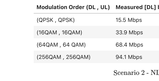
Note: This exercise is using 2560AM

- Table 4-1: Average values measured for different TDD configurations

TDD configuration	DL throughput: Measured bit rate [DL]	DL throughput: Theoretical bit rate [DL]	UL throughput: Measured bit rate [UL]	UL throughput: Theoretical bit rate [UL]
3-1-1 (D D D S U [DL oriented])	142.9 Mbps		17.5 Mbps	
2-1-2 (D D S U U [balanced])	94.1 Mbps		43.3 Mbps	

TDD configuration D U

3-1-1



2-1-2

LAB-3: Suggested topic for discussion:

- Analise the impact of the TDD configuration on the DL and UL throughput.

5.3 LAB-4: Changing the 5G NR Modulation and Coding Scheme

- n78 Table 5-1: Measured DL and UL throughputs vs Modulation Order vs Scenario

Scenario 1 - LoS

Modulation Order (DL , UL)	Measured [DL] bit rate	Measured [UL] bit rate
(QPSK , QPSK)	15.5 Mbps	14.6 Mbps
(16QAM , 16QAM)	33.9 Mbps	31.8 Mbps
(64QAM , 64 QAM)	68.4 Mbps	53.6 Mbps
(256QAM , 256QAM)	94.1 Mbps	43.2 Mbps

Scenario 2 - NLoS

Modulation Order (DL , UL)	Measured [DL] bit rate	Measured [UL] bit rate
(QPSK , QPSK)	15.6 Mbps	14.6 Mbps
(16QAM , 16QAM)	33.8 Mbps	479.9 kbps
(64QAM , 64 QAM)	68.5 Mbps	46.5 Mbps
(256QAM , 256QAM)	88.6 Mbps	39.8 Mbps

- Table 5-2: Measured DL and UL spectrum efficiency

Scenario 1 - LoS

Modulation Order (DL , UL)	DL spectrum efficiency (b/s/Hz)	UL spectrum efficiency (b/s/Hz)
(QPSK , QPSK)		
(16QAM , 16QAM)		
(64QAM , 64 QAM)		
(256QAM , 256QAM)		

Scenario 2 - LoS

Modulation Order (DL , UL)	DL spectrum efficiency (b/s/Hz)	UL spectrum efficiency (b/s/Hz)
(QPSK , QPSK)		
(16QAM , 16QAM)		
(64QAM , 64 QAM)		
(256QAM , 256QAM)		

LAB-4: Suggested topics for discussion:

- Analize the impact of the Modulation Order on the spectrum efficiency and measured bit rate. Explain why in some scenarios, a 256-QAM modulation order may not be possible.
- Analize the impact of the propagation scenario (LoS vs. NLoS) on the measured bit rate considering the adaptative modulation and coding scheme.

References

In [ ]: