

TD LTE

Exercise 1: LTE throughput

Frequency band 2600 MHz in France

LTE Band #7 used with FDD mode for LTE and LTE-A

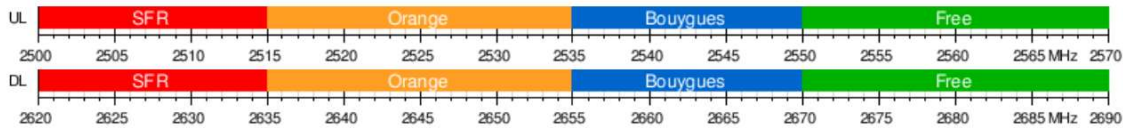


Figure above show the distribution of the 2600MHz spectrum over the four mobile operators in France.

In case, the operators use Normal cyclic prefix mode,

- What is the different BW allocated to each operator ?
- What is the maximal theoretical downlink throughput provided by Orange using the entire spectrum with the modulation scheme 64-QAM with SISO antenna ?
- What is the maximal theoretical downlink throughput provided by Bouygues using the entire spectrum with the modulation scheme 64-QAM with MIMO 2x2 antenna ?
- What is the maximal theoretical uplink throughput available for a SFR subscriber when the UE uses 16QAM ?

Solution 1: LTE throughput Freguen,,1 band 2600 MHz. in France

LTE Band #7 used with FDD mode for LTE and L TE-A Figure above show the distribution of the 2600MHz and over the four mobile operators in France.

- What g the different BW allocated to each Operator?

SFR : UL=2515MHz-2500MhZ-15MHz; OL=15MHz

Orange : UL=20MHz; DL=20MHz

Bouygues : UL=15MHz; DL=15MHz

Free: UL=20MHz; DL=20MHz

What is the maximal theoretical down-link through gut ,provided by Orange using the entire spectrum with the modulation scheme 64-QAM?

In L TE subcarrier=15KHz-> 1 symbol -> 1/15000 sec

-> 15000 symbols In, 1 sec

64-QAM-> 000000 (0) ... 111111(63)

-> 15000*6 bits In. 1 sec

-> since Y!!!i have 20MHz->1200 subcarriers which means that throughput=1200 * 15000*6 bits per sec

Throughgut=108 Mbps

What is the maximal theoretical down-link throughput provided by Bouygues using the entire spectrum with the modulation scheme 64-QAM?

ThroughPut= 900 *15000*6=81 Mbps

What is the maximal theoretical uplink throughput available for a SFR subscriber with 64-QAM?

OFOMA -> SC-FDMA

1 SC= 60KHz

Uglink throughgut= 60000 symbols * 6 bits = 360Kbps

Exercise 2: LTE radio signal transmission

Knowing that the number of samples per slot, when BW=10MHz, is of 7680, and the number of samples of the useful FDMA symbol is of 1024, what is the number of samples per CP (cyclic prefix) in the extended cyclic prefix mode?

Solution 2:

1 slot = 7680 samples

6 OFDM symbols per slot

1024 samples per useful symbol

-> $6144 = 1024 * 6$ samples concerning the useful part of the symbols

-> $1716 = 7680 - 6144$ samples concerning the prefix part of the 6 symbols

-> $286 = 1716 / 6$ samples concerning one prefix

Exercise 3: Radio resource allocation

The transmission of user data had occupied 6 PRB (private resource blocks) during 5 time slots using the Q-PSK modulation mode.

How many bits are transmitted if we use a normal cyclic prefix?

Solution 3:

Number of used subcarrier = $6 \text{ PRB} * 12 = 72$ subcarriers

Number of OFDMA symbols per subcarrier = $7 \text{ OFDMA symbols} * 5 \text{ time slots} = 35$

symbols Number of ofdma symbols sent = $72 \text{ subcarriers} * 35 \text{ symbols} = 2520 \text{ symbols}$.

1 symbol -> 2 bits

The amount of data sent = $2520 * 2 = 5040 \text{ bits}$

Exercise 4: Complement of the course

What is the meaning of the information contained in SIB6, SIB7 et SIB17 parts of SIB?

SIB6: contains UTRAN (UMTS) re-selection information -> helps to switch from LTE to UMTS technology

SIB7: contains GTRAN (GSM) re-selection information -> helps to switch from LTE to GSM technology

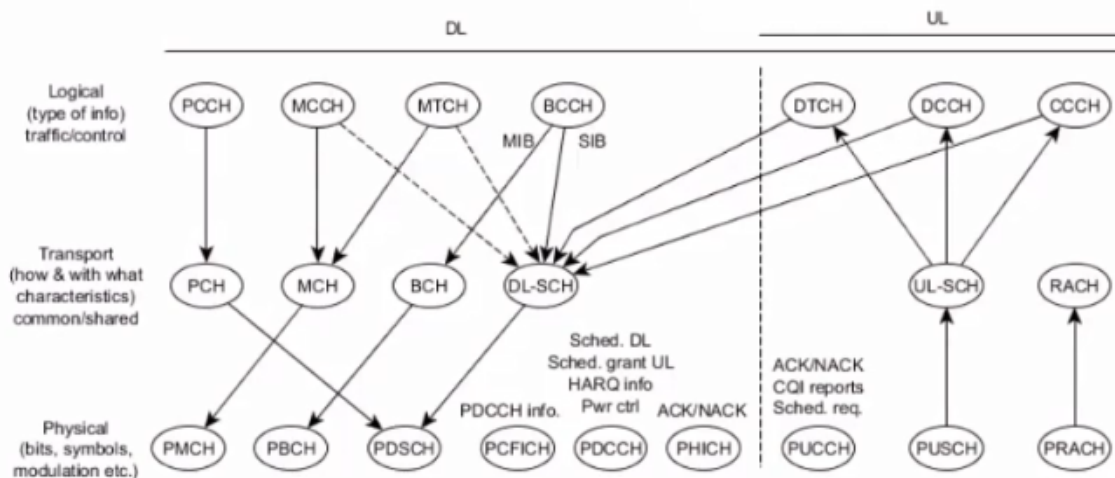
SIB17: contains WIFI re-selection information -> helps to switch from mobile technology,

Exercise 5: Mac layer channels

Give the sequence of channels (logical, transport and physical) used to:

- **To send data from the eNodeB to the UE**
Downlink on the transmitter: DTCH (Dedicated Traffic Channel) -> DL-SCH -> POSCH
- **To receive data from the eNodeB on the UE**
Downlink on the receiver: POSCH -> DL-SCH -> DTCH
- **To send data from the UE to the eNodeB**
Uplink on the transmitter: DTCH -> UL-SCH -> PUSCH
- **To receive data from the UE on the eNodeB**
Uplink on the receiver: PUSCH -> UL-SCH -> DTCH

- MAC layers ensures multiplexing of logical channels to transport channels
- Links the transport channel with physical channels
 - Physical channels are mapped on resource blocks



Exercise 6: Synchronization symbols PSS and SSS

Let a LTE system with a BW=3MHz. Show the occupation of the sub-carriers by the PSS and SSS synchronization symbols. Use the following grid.

Solution:

$3\text{MHz} = 1024\text{ samples}$

$1\text{ Ts} = 7680\text{ samples}$

$1\text{ useful symbols} = 1024\text{ samples}$

$1\text{ Ts} = 1\text{ useful symbol} + 1\text{ (CP)} \times 6$

$T\text{ ts} = 6\text{ useful symbols} + 6\text{CP}$

$\text{number of symbols of } 6\text{CP} = 7680 - 6 \times 1024 = 1536$

$\text{number of sample per CP} = 1536 / 6 = 256$