VYSOKÉ UČENÍ TECHNICKÉ V BRNĚ
FAKULTA ELEKTROTECHNIKY A KOMUNIKAČNÍCH TECHNOLOGIÍ

Mobile Network Communication Systems

2020/2021

LTE_03

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1 Assignment

Student's name: Assignment: LTE_03

Type pf mobile network	LTE					
Release	8		DL		UL	
EARFCN	21077			DL MHz		UL MHz
BW	3	MHz				
Subcarrier spacing	7,5	kHz				
Number of RBs		-		subcarriers		
Max. total Tx power	4	W		dBm		
Power/subcarrier		W		dBm		
Time of OFDM prefix	extended					
Number of sympols/slot (per RB time)						
Number of antenna ports	2					
Number of reference symbols/RB/symbol interval						
Number of reference symbols/RB						
Total number of reference symbols/symbol interval						
Total number of unusable symbols/slot/antenna						
Number of service symbols/slot/antenna						
UE category	4					
Maximal theoretical UE throughput:						
DL		Mb/s				
UL		Mb/s				
Path loss	82	dB				
RSSI		dBm		W		
RSRP		dBm		W		
RSRQ		dB				

Note: During RSSI measurement, assumed BW utilization is 100% and without noise and interferences from neighbouring cells

Figure 1: My laboratory assignment - LTE˙03

2 Calculations - Solution

2.1 DL and UL frequencies - EARFCN

According to the source [1] the formula to calculate DL and UL frequencies are:

$$Fdownlink = FDLLow + 0,1 * (NDL - NDLOffset) \tag{1}$$

$$Fuplink = FULLow + 0,1 * (NUL - NULOffset) \tag{2}$$

$Fdownlink = 2620 + 0,1 * (21077 - 20750) = \mathbf{2652,7}\, MHz$
$Fuplink = 2500 + 0,1 * (21077 - 20750) = \mathbf{2532,7}\, MHz$

2.2 Number of subcarriers and RBs

1. Number of RBs based on the BW 3MHz are **15** according to [2, slide 10]
2. Subcarriers based on the Subcarrier spacing for 7,5 KHz are $24 * 15 = \mathbf{360}$ [2, slide 18]

2.3 Max. total Tx power

$Tx = 10 * \log(\frac{Max.\_total\_tx\_power}{1mW=0{,}001W}) = 10 * \log(\frac{4}{0{,}001}) = \mathbf{36,025}\, dBm$

2.4 Power/subcarrier

1. $PowerinW = \frac{Max.\_total\_tx\_power}{subcarries} = \frac{4}{360} = \mathbf{\frac{4}{360}}\, W$
2. $PowerindBm = 10 * \log(\frac{power\_in\_W}{1mW=0{,}001W}) = 10 * log(\frac{\frac{4}{360}}{0{,}001}) = \mathbf{10,4575}\, dBm$

2.5 Number of symbols in slot (per RB time)

Number is based on Extended CP type and slot structure $\rightarrow \mathbf{3}[2, slide13]$

2.6 Number of reference symbols/RB/symbol interval

The number of reference symbols/RB/symbol interval is **2** according to [2, slide 21]

2.7 Number of reference symbols/RB

The number of reference symbols/RB is **4** according to [2, slide 21]

2.8 Total number of reference symbols/symbol interval

$Number\_of\_reference\_symbols/symbol\_interval * Number\_Of\_RBs = 2 * 15 = \mathbf{30}$

2.9 Total number of unusable symbols/slot/antenna

$Number\_of\_reference\_symbols/RB * Number\_of\_RBs * Number\_of\_antenna\_ports = 4 * 15 * 2 = \mathbf{120}$

2.10 Number of service symbols/slot/antenna

$(Subcarriers * Number\_Of\_symbols/slot\_per\_TB\_time) -$
$Total\_number\_of\_unusable\_symbols/slot/antenna = (360 * 3) - 120 = \mathbf{960}$

2.11 Maximal theoretical UE throughput

The maximal theoretical throughput of UE category 4 according to [2, slide 9]

1. $DL = \mathbf{150}\, Mbps$
2. $UL = \mathbf{50}\, Mbps$

2.12 RSSI

$Max.\_TX\_total\_TX\_power - Path\_Loss$

1. $RSSI_{dBm} = 36,025 dBm - 82 dBm = \mathbf{-45,975}\, dBm$
2. $RSSI_W = 1W * \frac{10^{\frac{RSSI_{dBm}}{10}}}{1000} = \frac{10^{\frac{-45,975}{10}}}{1000} = \mathbf{2,5263 * 10^{-8}}\, W$

2.13 RSRP

$RSRP = RSSI_{dBm} - 10 * log(\frac{subcarriers}{RBs} * Number\_of\_RBs)$

1. $RSRP_{dBm} = -45,975 - 10 * log(\frac{360}{15} * 15) = \mathbf{-71,5380}\, dBm$
2. $RSRP_W = 1W * \frac{10^{\frac{RSRP_{dBm}}{10}}}{1000} = \frac{10^{\frac{-71,5380}{10}}}{1000} = \mathbf{-7,0177 * 10^{-11}}\, W$

2.14 RSRQ

$RSRQ = 10 * log(Number\_of\_RBs) + RSRP_{dBm} - RSSI_{dBm}$
$RSRQ = 10 * log(15) + (-71,5380) - (-45,975) = \mathbf{-13,8020}\, dBm$

3 Conclusion

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BW	3	MHz				
Subcarrier spacing	7,5	kHz				
Number of RBs	15	-	360	subcarriers		
Max. total Tx power	4	W	36,025	dBm		
Power/subcarrier	4/360 W	W	10,4575	dBm		
Time of OFDM prefix	extended					
Number of sympols/slot (per RB time)	3					
Number of antenna ports	2					
Number of reference symbols/RB/symbol interval	2					
Number of reference symbols/RB	4					
Total number of reference symbols/symbol interval	30					
Total number of unusable symbols/slot/antenna	120					
Number of service symbols/slot/antenna	960					
UE category	4					
Maximal theoretical UE throughput:						
DL	150	Mb/s				
UL	50	Mb/s				
Path loss	82	dB				
RSSI	-45,975	dBm	2,5264*10^-8	W		
RSRP	-71,5380	dBm	-7,0177*10^-11	W		
RSRQ	-13,8020	dB				

Note: During RSSI measurement, assumed BW utilization is 100% and without noise and interferences from neighbouring cells

Figure 2: Results of my laboratory assignment - LTE_03

Použitá literatúra

[1] cablefree.net: LTE Carrier Frequency and EARFCN. [online], 2020. Dostupné z: https://www.cablefree.net/wirelesstechnology/4glte/lte-carrier-frequency-earfcn/

[2] Mozny, R.; Masek, P.: Radio interface of LTE mobile networks EPS. [online], 2020. Dostupné z: https://bit.ly/31eHhHi