FAQ – Webinar 5, PART 1:

What LTE parameters need to be Dimensioned and Optimized

1. **What are the main differences between LTE and WiMAX technologies in terms of RF resource utilization? Why isn't WiMAX as popular as LTE?**
   - WiMAX uses sub-carrier permutation schemes, which results in transmit diversity and interference averaging. LTE does not.
   - WiMAX uses a mapping that explicitly informs the destination and data location.
   - WiMAX has segmentation for mapping and data, LTE does not support segmentation. LTE considers reuse of 1, although it provides some mechanisms in terms of user data allocation to minimize interference. No such mechanism exists for control (mapping).
   - Adoption of a technology is a political decision. Marketing plays a role in adoption.

2. **Having same TAC ID for multiple bands of LTE technologies, advantages, disadvantages, effect on performance. Can you explain?**
   - TAC is a network level identifier. TAC assignment depends on how your network is configured. Does your UE search cells in the different bands or stays in one band?
   - All of this has to be considered.

3. **What should be best offset for PCI? Sometimes there is no offset among PCI for different cells in the eNB. Won't this create issues? Why?**
   - PCI is very important for the network performance; it should be planned considering reuse of 3, 6, 30 and 150 as explained in the webinar.

4. **Why does CCE sort of things are required, why not it is just said that these numbers of REs are required. Why does this concept come in place?**
   - CCE is required to minimize the number of blind decoding done by the UE. If CCEs were not defined the UE would not know where to perform blind decoding.

5. **Why there is no dynamic power control in Downlink LTE? As we have it for WCDMA, please explain in detail.**
   - Power control is not used as it is more efficient to use a better modulation scheme. There are 28 MCS, which are separated by few dBs. Power control could be used when the maximum MCS is used, but this corresponds to such a small area that is not worthy to do it.

6. **What are typical multipath delays in a tunnel? For example, if a tunnel is 10 kilometers long, would multipath delay be of the order of 5 kilometers, 1 kilometer or 100 meters? All I am interested is the order of the magnitude relative to the tunnel length**
   - It depends on the width of the tunnel and the antenna used. The best way to know for sure is to measure the multipath with tools like CellSpectrum. My guess is that it will be in the range of 1 to 3 km (just a guess).

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7. If RBG is the smallest LTE scheduling unit, wouldn't each VoIP call have to be given one RBG? It seems very inefficient, as 1 RB is 180 kHz, and VoIP only needs 8.8 kb/s data rate.

- It depends on the MCS used.
- Below is a table with the different data rate and packet sizes. There is one packet every 20 ms.

Mode	Bit Rate (kbps)	Speech payload (bit)	Header (bit)	Padding (bit)	Total Size (bit)	Total Size (Byte)	Aggregate Bit Rate (kbps)
0	4.75	95	10	7	112	14	5.6
1	5.15	103	10	7	120	15	6
2	5.9	118	10	0	128	16	6.4
3	6.7	134	10	0	144	18	7.2
4	7.4	148	10	2	160	20	8
5	7.95	159	10	7	176	22	8.8
6	10.2	204	10	2	216	27	10.8
7	12.2	244	10	2	256	32	12.8

- The next two tables give the number of RBG used for different TBS indexes.

Number of RBGs used per VoIP packet										
MCS=0, TBS Index=0										
Mode	Bit Rate (kbps)	Transport Block (TB) Size (bit)	TB +CRC (bit)	Number of RB pairs	Bandwidth (MHz)					
					1.4	3	5	10	15	20
					Number of RBGs					
0	4.75	112	136	6	6	3	3	2	2	2
1	5.15	120	144	6	6	3	3	2	2	2
2	5.9	128	152	6	6	3	3	2	2	2
3	6.7	144	168	7	7	4	4	3	2	2
4	7.4	160	184	8	8	4	4	3	2	2
5	7.95	176	200	8	8	4	4	3	2	2
6	10.2	216	240	10	10	5	5	4	3	3
7	12.2	256	280	11	11	6	6	4	3	3

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Number of RBGs used per VoIP packet											
MCS=28, TBS Index=26											
Mode	Bit Rate (kbps)	Transport Block (TB) Size (bit)	TB +CRC (bit)	Number of RB pairs	Bandwidth (MHz)						
					1.4	3	5	10	15	20	
					Number of RBGs						
0	4.75	112	136	1	1	1	1	1	1	1	
1	5.15	120	144	1	1	1	1	1	1	1	
2	5.9	128	152	1	1	1	1	1	1	1	
3	6.7	144	168	1	1	1	1	1	1	1	
4	7.4	160	184	1	1	1	1	1	1	1	
5	7.95	176	200	1	1	1	1	1	1	1	
6	10.2	216	240	1	1	1	1	1	1	1	
7	12.2	256	280	1	1	1	1	1	1	1	

- In the next table I calculated the efficiency of RBG usage, for two extreme configurations. This efficiency can be improved if two VoIP packets are aggregated and sent together.

RBG usage						
	Bandwidth (MHz)					
	1.4	3	5	10	15	20
MCS=0, TBS Index=0, 4.75 kbps	89%	89%	89%	89%	67%	67%
MCS=0, TBS Index=0, 12.2 kbps	97%	89%	89%	89%	89%	89%
MCS=28, TBS Index=26, 4.75 kbps	19%	10%	10%	6%	5%	5%
MCS=28, TBS Index=26, 12.2 kbps	39%	20%	20%	13%	10%	10%

- The table below gives the number of TBs per TTI, based on the availability of CCEs.

Maximum Number of TBs per TTI	One antenna, Normal Cyclic Prefix, PCFICH=3, PHICH=1/6					
	Channel Bandwidth (MHz)					
	1.4	3	5	10	15	20
	1 antenna, Normal CP, PCFICH=3, PHICH=1/6					
Free REGS	62	120	205	415	627	837
CCEs	6	13	22	46	69	93
Max TB Format 0	6	13	22	46	69	93
Max TB Format 1	3	6	11	23	34	46
Max TB Format 2	1	3	5	11	17	23
Max TB Format 3	0	1	2	5	8	11

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The table below gives the limit of number of users based on the control part (PDCCH) due to the number of CCEs.

Maximum VoIP users per cell (CCE limited)								
packet/s	packet/TTI	packet/TB	Bandwidth (MHz)					
50	0.05	1	1.4	3	5	10	15	20
Max VoIP users Format 0			120	260	440	920	1380	1860
Max VoIP users Format 1			60	120	220	460	680	920
Max VoIP users Format 2			20	60	100	220	340	460
Max VoIP users Format 3			0	20	40	100	160	220

3GPP has added some features that minimize the limitation caused by the control part:

- TTI bundling
- Semi-Permanent Scheduling

8. How come the uplink RSSI value could differ for PUSCH and PUCCH specially for LTE TDD NW. In my nw the values are pucch -95 dBm and pusch is -105 dBm.

- In webinar 4 we explained that RSSI measurements are very misleading and 3GPP does not clearly specify how and what they should measure.
- Some units measure RSSI per sub-carrier, others for the whole channel. In the uplink the number of subcarriers varies from one transmission to another, so some units give the power per sub-carrier.
- An UE has to share its power between the number of sub-carriers used. PUCCH uses only 24 sub-carriers, while PUSCH may have many more.

9. What are the minimum coverage requirements for supporting VoLTE in terms of SNR.

- There are no special requirements for VoLTE, as it is sent as a digital stream. The requirement of SNR depends on the MCS used and the environment (Gaussian or Rayleigh or anything in between).

10. I am not clear at which layer packet scheduling is done: Layer 3 or MAC?

- Packet scheduling is done at the RRM and does not belong to any of the layers.

11. In a public venue, what is the most valuable data to collect SINR?

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- SINR is generally measured over the Cell Reference Signals, but it can also be calculated by measuring the DTX slots. There is not a single method to measure it and you should refer to the test equipment manual to find out how it is being measured.

12. What QoS model should be used to guarantee priority calls in the LTE network especially during massive network congestion?

- QCI 5 has the highest priority.

13. Correct me if I misunderstood but Mr. Leonhard said that SC-FDMA was not the greatest option for the UL access. What did he mean specifically and if he could point out some access schemes more suitable for the UL.

- LTE only gives one option for the uplink, that is SC-OFDM.
- This access method is supposed to reduce the PAPR requirement what it does. The practical reduction is in the order of 2 to3 dB. This results in a possible power increase of the same amount, or a longer battery life.
- On the other hand SC-OFDMA introduces a distortion in the signal that requires 3 to 4 dB better SNR, nulling the previous advantage.
- SC-OFDMA restricts transmit diversity, and reduces system capacity by restricting spectrum usage to a contiguous block allocation.
- 3GPP recognized this and is allowing now multiple blocks to provide some transmit diversity.
- In summary it would be better not to use SC-OFDMA , keeping the same transmission scheme of the downlink as is done in WiMAX.