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A PERFORMANCE COMPARISON OF AN E-UTRAN CLUSTER IN THE 2100 AND 2600 MHz SPECTRA

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The continuous progress of the mobile telecommunications industry has reached the point of building networks that can carry up to 100 Mbps. The increasing demand in throughput has met an offer very difficult to refuse. To that extent, the upcoming 4G networks need to be invested in, and the first investment is the spectrum license, which seems to be a crossroads to most operators. The paper addresses the issue of spectrum choices for the upcoming 4G networks, suggesting the use of the 2100 MHz spectrum for the urban areas.

Keywords: UMTS, LTE, spectrum reuse, SINR

1. Introduction

The need of spectrum for the new 4G networks is obvious. Many governments have released new spectra, but not all can do that. Also, there is the question of market fairness towards all mobile telecommunication competitors in one country (the government has the power to give one operator an early start in deploying a 4G network before others, which has already happened in the United Kingdom). For the countries where the new spectra, such as the 2600 MHz one, is not an option, or waiting for it to be available is not efficient, this paper suggests using the 2100 MHz spectrum instead. Most of the European operators already use the 2100 MHz spectrum for their 3G networks, while also, lately, deploying 3G in the 900 MHz spectrum, so, we can admitt that there is enough room, or there will be, for an LTE network in the 2100 MHz spectrum. Reusing this spectrum proves to be a good option, as the simulations we did will show. The coverage simulations have been done on a urban cluster of a national wireless network. The same cluster was used for all simulations, we only changed the relevant frequency and bandwidth in order to obtain throughput, interference level and SINR level. The comparison was ment to show that the differences between the use of the two different spectra are very little and that the most important variable in choosing the spectrum is the quantity of bandwidth we can offer. This is why the simulations were done for carriers of 5 MHz, 10 MHz and 20 MHz. Bit

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rate, interference level and SINR can be compared for the three cases. We assumed the 2600 MHz spectrum, being free, would allow the largest bandwidth for the carrier and, so, we ran the simulations for the 20 MHz carrier.

2. Simulation parameters

The performance comparison for the networks we have chosen is done by data rate, interference level and SINR level over the area of the cluster. This will allow the best perspective at the end user. The bit rate refers to the number of bits processed by the system in a certain unit of time. The interference refers to the power of the interfering signals which disturb the useful signal (the sum of signals power coming from other base stations and noise). The SINR is calculated as follows:

$$| SINR1| = PRx1/(PRx2 + PN1) \ \text{[W]} \tag{1}$$

$$|SINR1| \ \text{[dB]} = 10 \lg [SINR1] \ \text{[W]} \tag{2}$$

where:
- *PRx1* – the power of the signal received from the base station 1
- *PRx2* - the power of the signal received from the base station 2
- *PN1* – the power of the noise received by the mobile terminal when connected to the base station 1
- *SINR1* - signal to interference plus noise ratio when the mobile terminal is connected to the base station 1 and is receiving signal from base station 2 as well, the signal received from base station 2 being considered interference.

3. Simulations results

The authors assume that the LTE networks can be very well deployed in the 2100 MHz with insignificant differences from the same networks being deployed in the 2600 MHz spectrum. As such, the same infrastucture as number of sites and cells, and as antenna directionality, as well as site location will be used in order to test the coverage and services for both cases: 2100 MHz and 2600 MHz in an urban area. So, for every country where purchasing the 2600 MHz spectrum is not an option for the operators, the 2100 MHz spectrum can be proven just as good and the authors suggest it may be reused with no problems, as most of the European operators already use it for their UMTS networks.

Simulations have been run on our urban cluster changing only the frequency and the bandwidth so that it would be relevant to our purpose. The simulations have been run in the 2100 MHz spectrum for a 5 MHz and a 10 MHz carriers and for the 2600 MHz spectrum for a 20 MHz spectrum to offer a view on how the bit rate would increase with the increase of bandwidth.

3.1 Simulations results for an LTE network in the 2100 MHz spectrum, with a 5 MHz bandwidth carrier, in an urban area

Simulations show very good results, even with a 5 MHz carrier. As expected, the LTE radio resource management proves to be very efficient providing an impressive network performance.

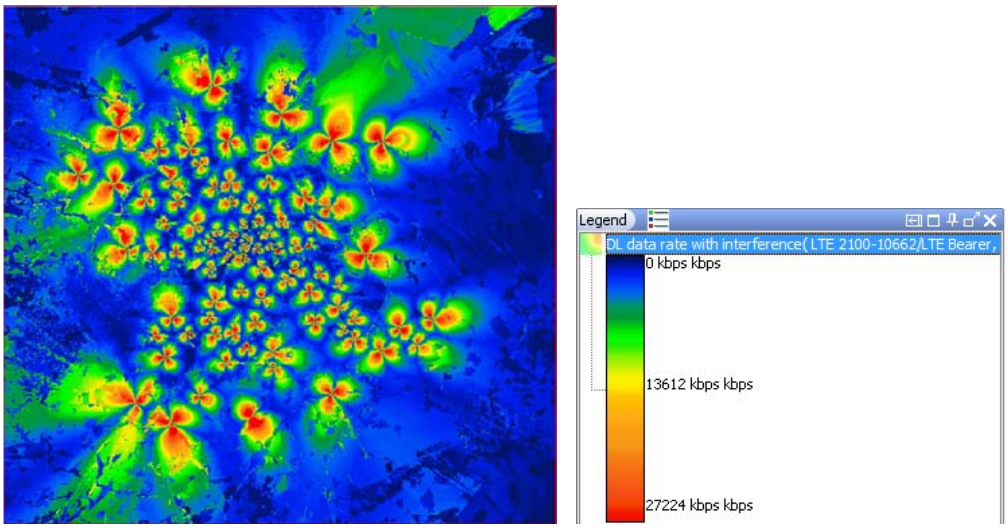

Fig. 1. Bit rate for an LTE network, in the 2100 MHz spectrum, with a 5 MHz bandwidth carrier, in an urban area

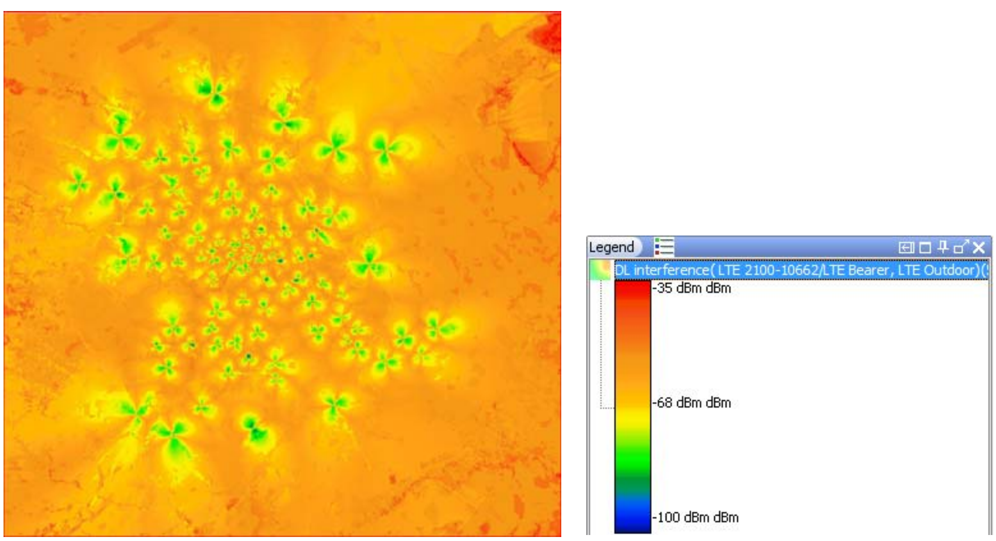

Fig. 2. Downlink interference ((I+N) in dBm) for an LTE network, in the 2100 MHz spectrum, with a 5 MHz bandwidth carrier, in an urban area

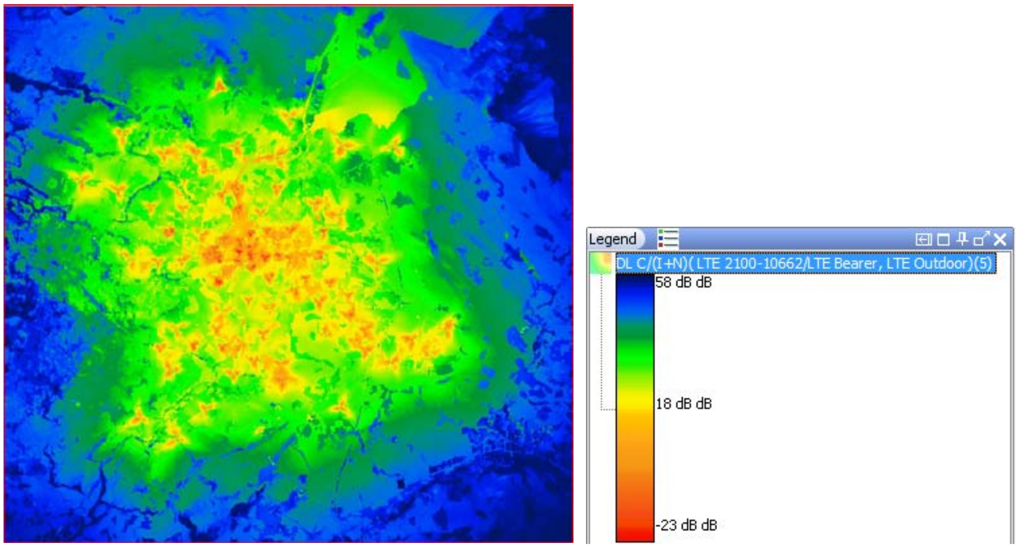

Fig. 3. SINR for an LTE network, in the 2100 MHz spectrum, with a 5 MHz bandwidth carrier, in an urban area

3.2 Simulations results for an LTE network, in the 2100 MHz spectrum, with a 10 MHz bandwidth carrier, in an urban area

With the increase in bandwidth, there is, of course, an increase in throughput. The simulations show that increase is actually two times the throughput with a 5 MHz carrier, while the SINR improves also.

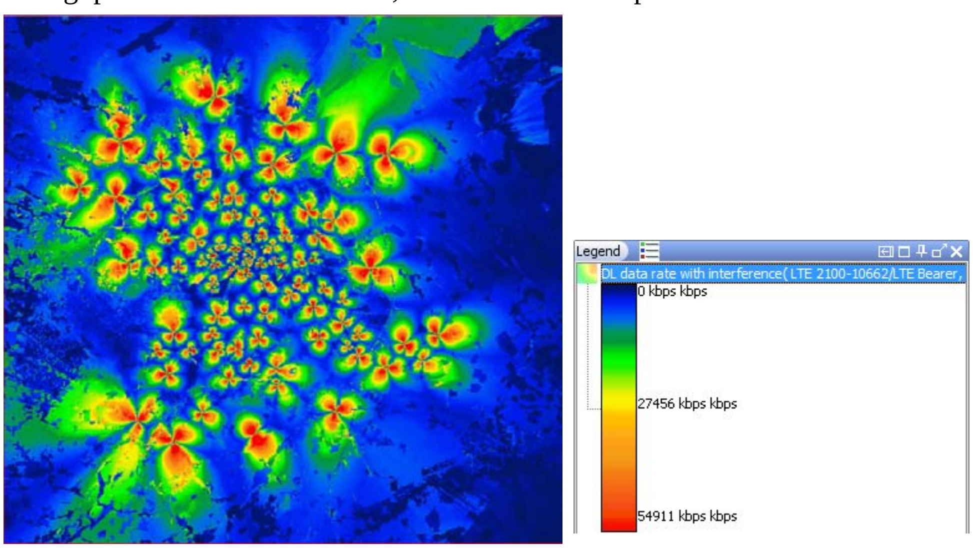

Fig. 4. Bit rate for an LTE network, in the 2100 MHz spectrum, with a 10 MHz bandwidth carrier, in an urban area

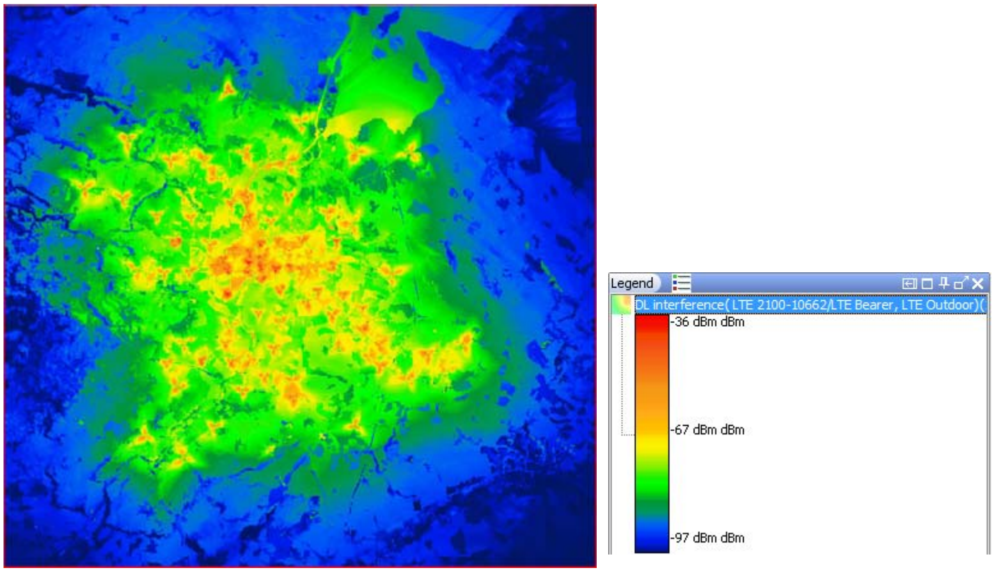

Fig. 5. Downlink interference ((I+N) in dBm) for an LTE network, in the 2100 MHz spectrum, with a 10 MHz bandwidth carrier, in an urban

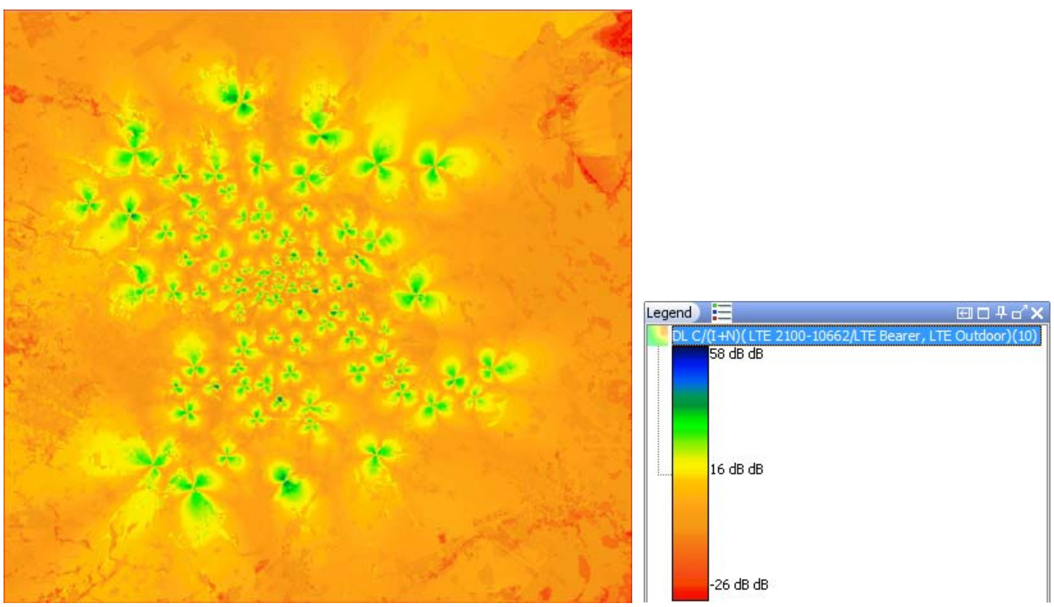

Fig. 6. SINR (C/(I+N) in dB) on downlink for an LTE network, in the 2100 MHz spectrum, with a 10 MHz bandwidth carrier, in an urban area

3.3 Simulations results for an LTE network, in the 2600 MHz spectrum, with a 20 MHz bandwidth carrier, in an urban area

Results show again that doubling the carrier bandwidth doubles the maximum data rate obtained in the near by site areas. The SINR is very good considering the bandwidth, but similar results can be obtained if we consider a 20 MHz bandwidth carrier in the 2100 MHz spectrum.

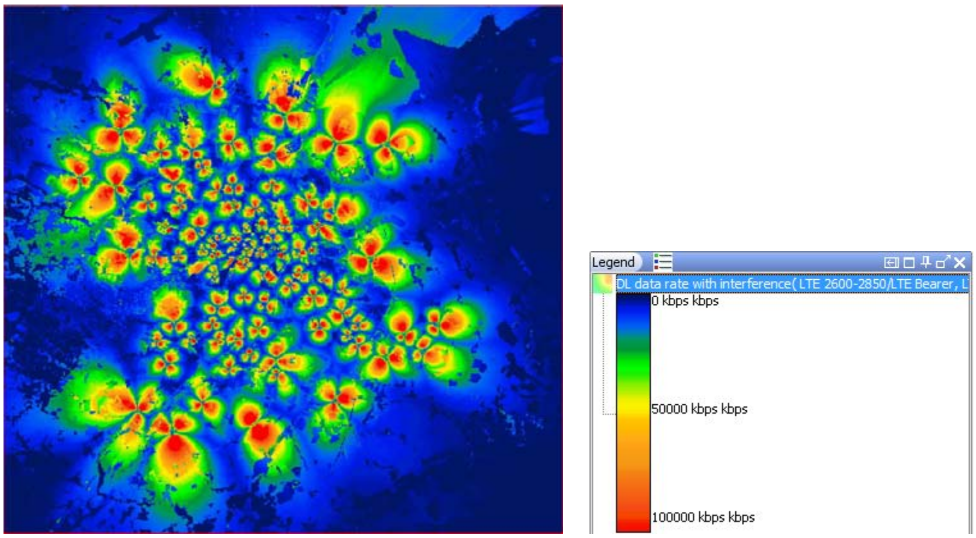

Fig. 7. Bit rate for an LTE network, in the 2600 MHz spectrum, with a 20 MHz bandwidth carrier, in an urban area

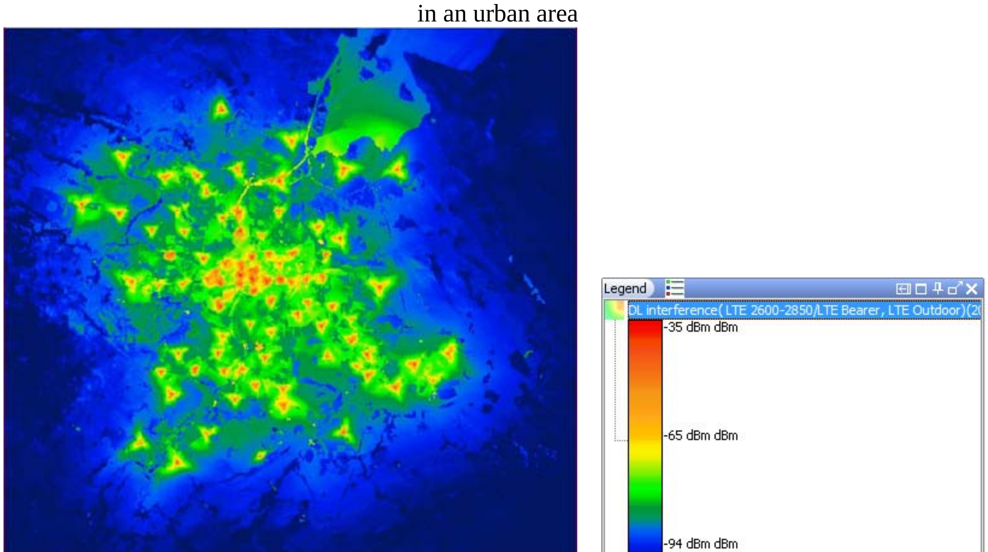

Fig. 8. Downlink interference ((I+N) in dBm) for an LTE network, in the 2600 MHz spectrum, with a 20 MHz bandwidth carrier, in an urban area

So, the question is whether or not investing in the 20 MHz carrier available with the 2600 MHz spectrum is worth, considering the fact that most operators do not have more than 15 MHz bandwidth available in the 2100 MHz spectrum.

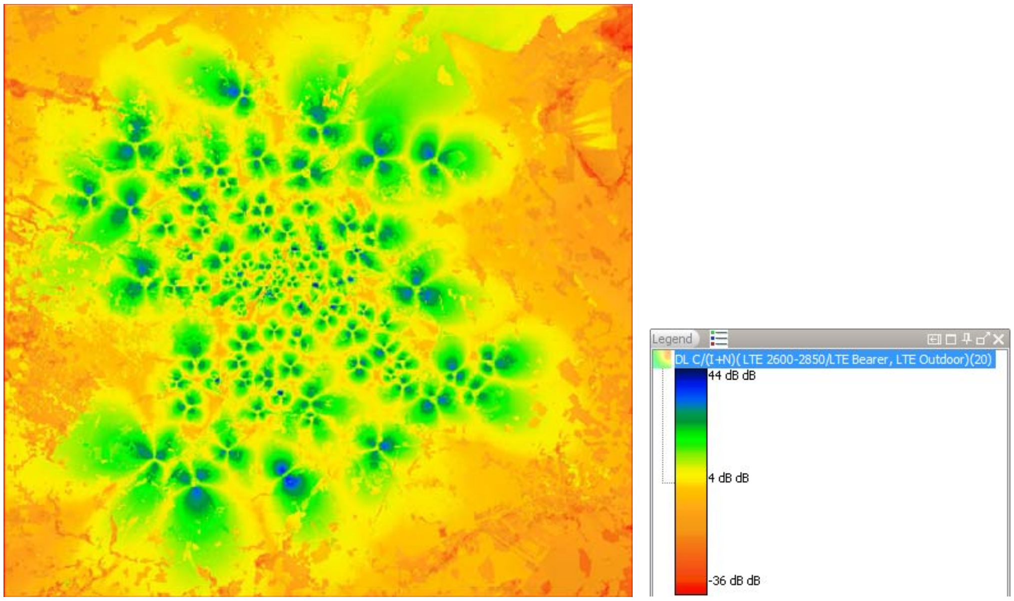

Fig. 9. SINR (C/(I+N) in dB) on downlink for an LTE network, in the 2600 MHz spectrum, with a 20 MHz bandwidth carrier, in an urban area

The huge increase in bandwidth with doubling the bandwidth of the carrier is visible in all the simulations run. The network we simulated proves to be fully functional no matter which one of the two spectra we use. So the 2100 MHz spectrum is no less than the 2600 MHz one when using a network which has the radio management techniques LTE come with. The data rate literally doubles with double bandwidth and the SINR is, of course, better with increase in bandwidth.

4. Conclusions

The simulations were done on an urban cluster using the same number of cells and sites, same locations and antenna directionality, but changing the frequency and the bandwidth of the carrier. The results show that twice the bandwidth offers twice the throughput, not to mention the improvement in SINR level. From a coverage point of view, any of the two spectra are very good to be used in an urban area, given the small differences between them. Still, some minor works would be necessary to improve the SINR level in the case of the 2100 MHz spectrum. These could be done with very little costs, having to do mainly with antenna tilting, which is now possible remotely. The 2100 MHz spectrum, which is now used in Europe for the 3G networks, can be successfully used for the 4G networks with the same number of sites and using the same antennas, this contributing to cost reduction. Furthermore, based on the results of the simulations, any wireless mobile operator can decide what is the maximum throughput it wants to provide to its customers in order to find out what is the maximum bandwidth it needs to purchase.

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