A PERFORMANCE ANALYSIS BASED ON BANDWIDTH OF LTE AND UMTS TECHNOLOGIES IN THE 900 MHZ SPECTRUM

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In the context of continuous progress of the mobile telecommunications industry towards building the 4G networks, this paper analyzes the performances of such a network by comparison with a 3G network using the same spectrum, infrastructure and bandwidth. The networks performances have been analyzed in several simulations done in Mentum Cell Planner, on a cluster located in a rural area considering a careful radio planning of the cells.

Keywords: UMTS, LTE, spectrum reuse, SINR, spectrum refarming.

1. Introduction

Operators have already purchased spectrum licenses for the upcoming LTE networks, choosing to implement their networks in the 800 MHz and/or 2600 MHz spectrums. However, these two spectrums are not available in all countries, so some of the operators need to find other solutions [1].

This paper suggests the reuse of the GSM widely used 900 MHz spectrum for the deployment of the new LTE networks. To that extent, a series of coverage simulations were done on a rural area, on a test cluster with a radio planning similar to that of a public wireless network.

The goal is to observe the performances of the LTE and UMTS networks in the 900 MHz spectrum, asuming the number of sites and location as well as antenna directionality is the same in both cases.

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2. Simulation parameters

The application we have used to simulate the networks, Mentum Cell Planner, is a world leader in radio planning and optimization software, especially in LTE.

In order to evaluate and compare the networks' performances we have used indicators like the bit rate, the interference level and the SINR. The bit rate refers to the number of bits processed by the system in a certain unit of time [2]. 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) [2]. The SINR is calculated as follows [3]:

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

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

when:
- *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 simulation results for an LTE network in the 900 MHz spectrum in a rural area are presented next.

3.1 The LTE network in the 900 MHz spectrum, with a 1.4 MHz carrier, in a rural area

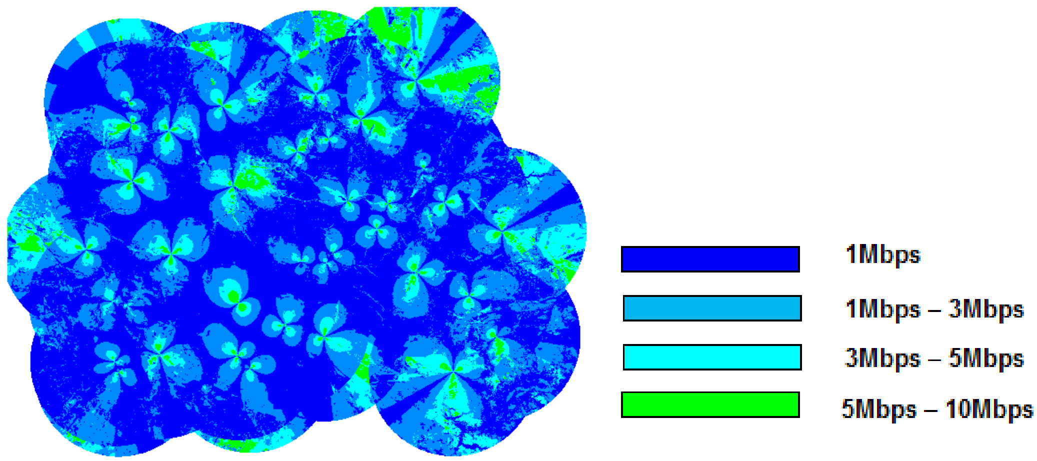

Fig. 1. Bit rate for an LTE network in the 900 MHz spectrum, with a 1.4 MHz spectrum, in a rural area (in ranges).

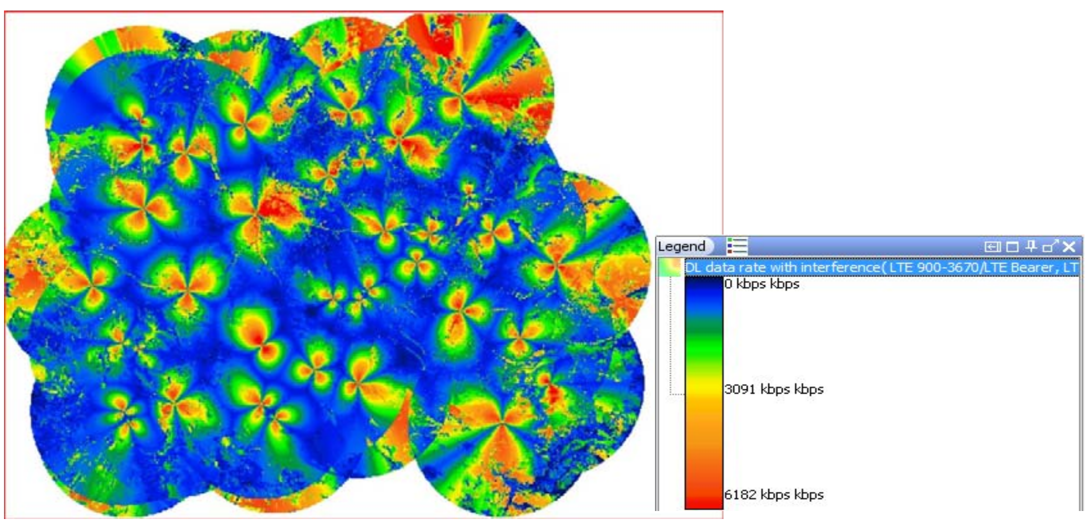

Fig. 2. Bit rate for an LTE network in the 900 MHz spectrum, with a 1.4 MHz spectrum, in a rural area

This second representation for the calculated bit rate (without the ranges specially selected in the first figure) clearly shows that the maximum bit rate in this case is 6182 kbps, and that the 3 Mbps throughput is the most widely spread service.

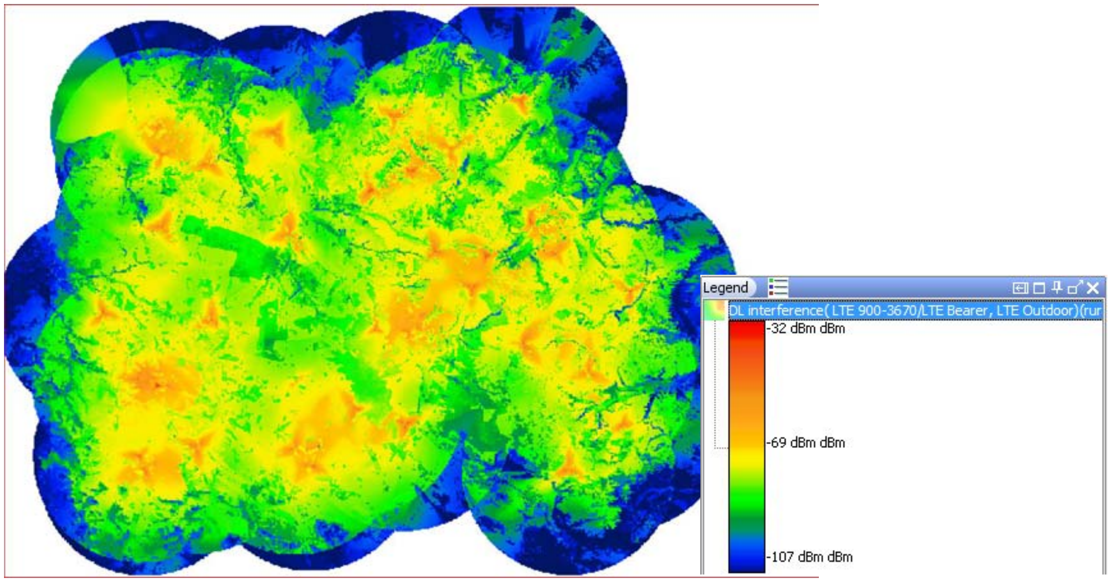

Fig. 3. Downlink interference ((I+N) in dBm) for an LTE network in the 900 MHz spectrum, with a 1.4 MHz carrier, in a rural area

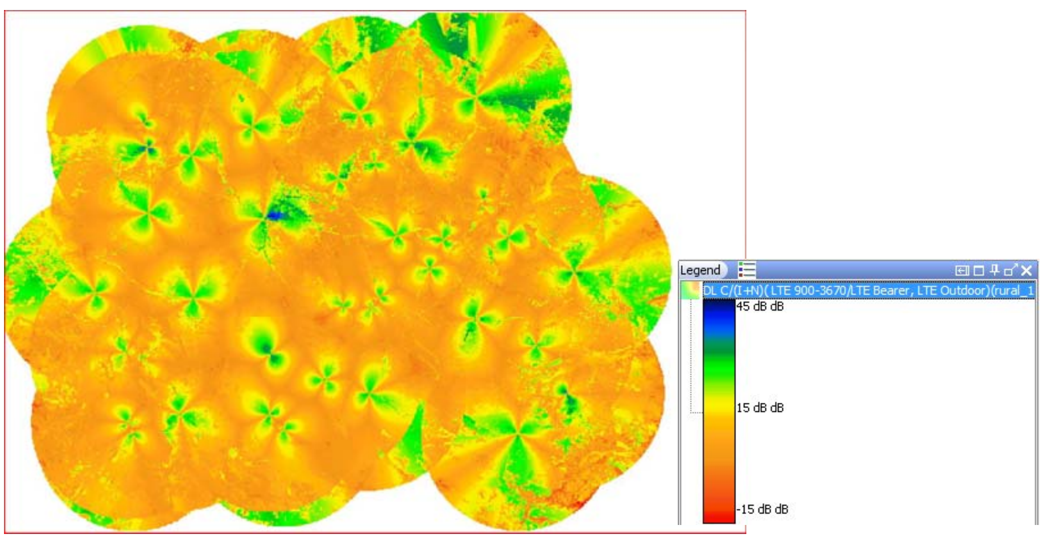

Fig. 4. SINR (C/(I+N) in dB) on downlink for an LTE network in the 900 MHz spectrum, with a 1.4 MHz carrier, in a rural area

We can see from the simulation results that the SINR, therefore the signal level is a good one. The interference level is acceptable and should be easily improved through normal techniques and with minimum costs.

3.2 The LTE network in the 900 MHz spectrum, with a 5 MHz carrier, in a rural area

Next, we will analize the same network, but with a wider bandwidth – that is 5 MHz, just as much as an UMTS single carrier is using [4].

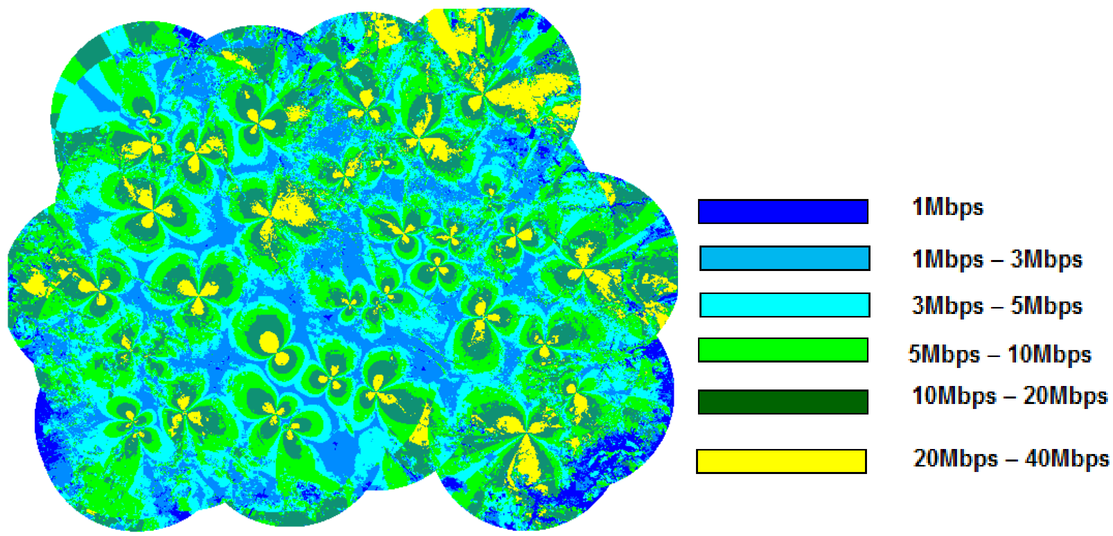

Fig. 5. Bit rate for an LTE network in the 900 MHz spectrum, with a 5 MHz carrier, in a rural area (in ranges)

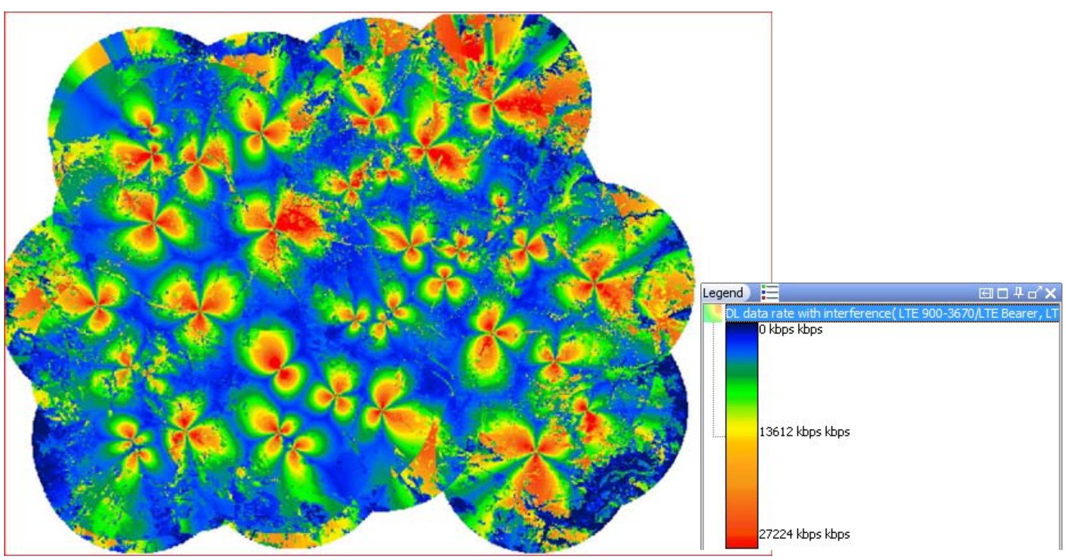

Fig. 6. Bit rate for an LTE network in the 900 MHz spectrum, with a 5 MHz carrier, in a rural area

Considering the results above, we can see that the 5 MHz carrier brings a significant improvement in bit rate compared to the 1.4 MHz carrier. So, the maximum bit rate is now almost 27 Mbps, as compared to 6 Mbps as we had before. Still, at a closer look, the area where the maximum bit rate is probable is not that wide, so the decision remains with the operator whether this is a good investment or not, given this is a rural area.

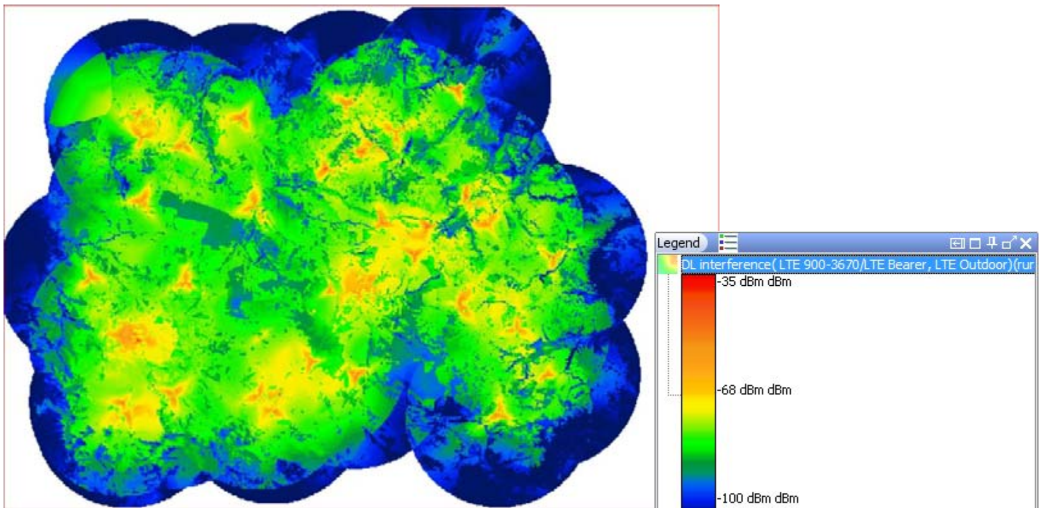

Fig. 7. Downlink interference ((I+N) in dBm) for an LTE network in the 900 MHz spectrum, with a 5 MHz carrier, in a rural area

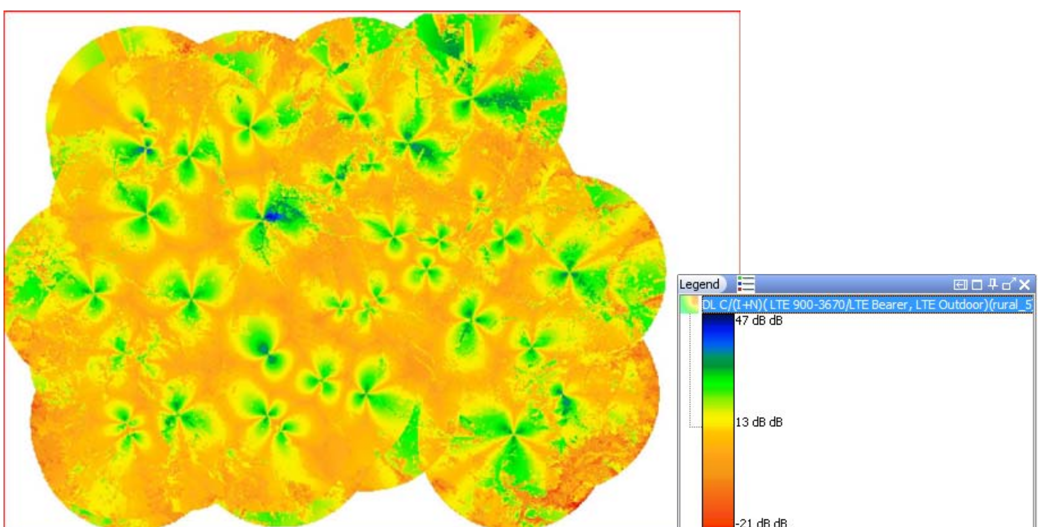

Fig. 8. SINR (C/(I+N) in dB) on downlink for an LTE network in the 900 MHz spectrum, with a 5 MHz carrier, in a rural area

As expected, the radio conditions resulted from the simulations are acceptable.

3.3 The UMTS network in the 900 MHz spectrum, with a 5 MHz carrier, in a rural area

The simulation results for the UMTS network are presented next.

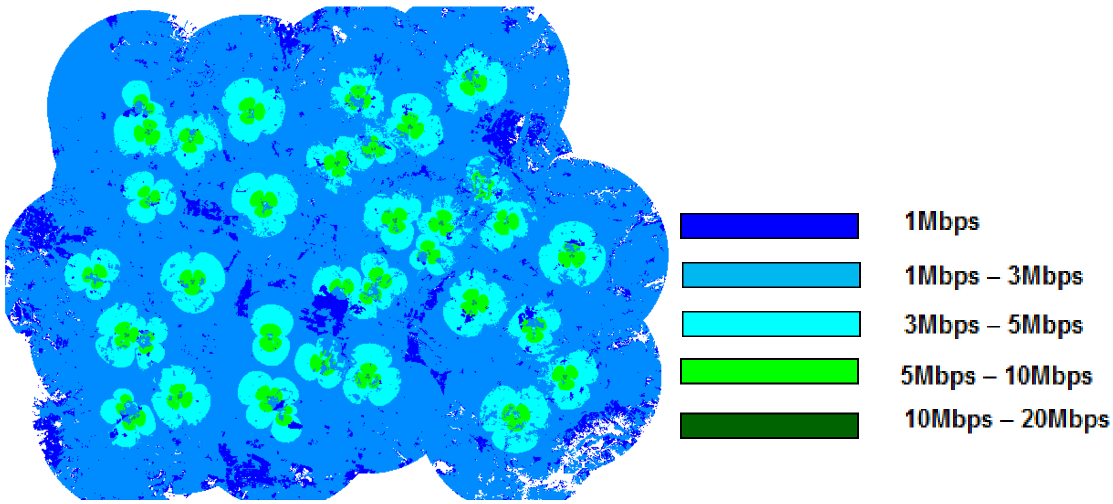

Fig. 9. HSDPA bit rate for an UMTS network in the 900 MHz spectrum, with a 5 MHz carrier, in a rural area (in ranges)

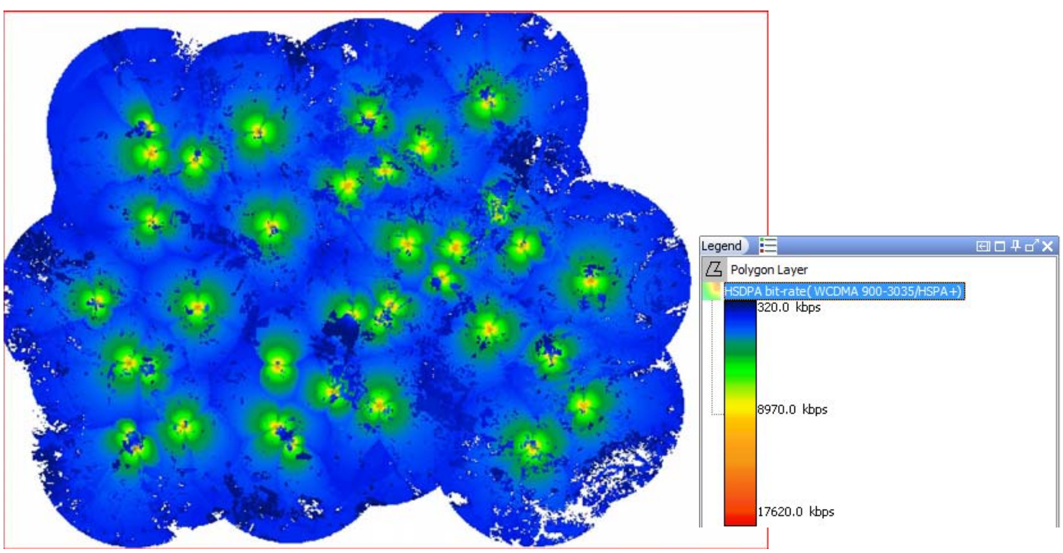

Fig. 10. HSDPA bit rate for an UMTS network in the 900 MHz spectrum, with a 5 MHz carrier, in a rural area

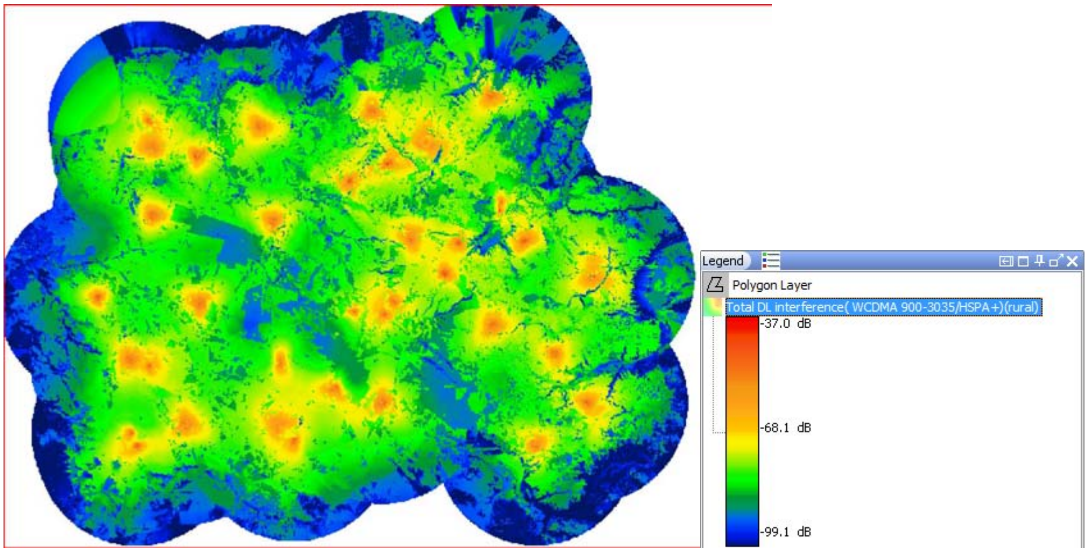

Fig. 11. Downlink interference (total interference power) for an UMTS network in the 900 MHz spectrum, with a 5 MHz carrier, in a rural area

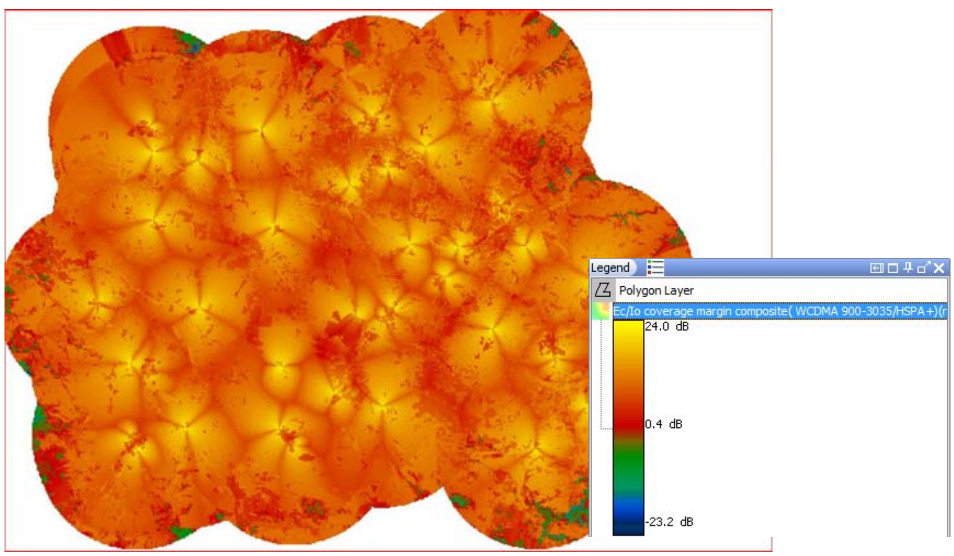

Fig. 12. SINR (Ec/Io) on downlink for an UMTS network in the 900 MHz spectrum, with a 5 MHz carrier, in a rural area

Analyzing the above simulations results, we can conclude that the UMTS network in the 900 MHz spectrum with a 5 MHz carrier (a single carrier) offers a good service, but not as good as the LTE network with a 5 MHz carrier. Still the UMTS performances are far better than those of the LTE network with a 1.4 MHz carrier. As such, investing in an LTE network with only 1.4 MHz reserved for the carrier, while already having a single carrier HSXPA network is totally inefficient. Still, replacing a potential UMTS network in the 900 MHz spectrum with an LTE network in the same spectrum using the same bandwidth proves to be a very good idea, as performances are significantly improved.

4. Conclusions

An LTE network in the 900 MHz spectrum in a rural area has been analyzed from a performance point of view by comparison with an UMTS network in the same conditions. We have assumed an identical number of sites and cells for both the LTE and UMTS networks and we have simulated these networks with different bandwidth for the radio carrier. The results of the simulations show that in order to exceed the performances in term of throughput of a HSXPA single carrier network, the LTE network should be deployed with a radio carrier bandwidth larger than 1.4 MHz. The performance of the LTE network with a 1.4 MHz radio carrier is disappointing and inefficient if the mobile operator also has a HSXPA network. From the point of view of a coverage analysis, we can conclude that the 900 MHz spectrum is suitable for the UMTS as well as the LTE technologies, but it’s recommended only for the rural areas.

R E F E R E N C E S

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