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# OPTIMIZATION OF THE RADIO FREQUENCY SPECTRUM OF MOBILE TELECOMMUNICATION OPERATORS IN CASE OF INCREASED MULTISERVICE TRAFFIC

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***Abstract*** *- The focus of our research is the analysis of growth traffic in mobile telecommunication networks, which based on the statistical data gives us ability to optimize frequency spectrum for telecommunication mobile operators in case of increased multiservice traffic. Experiment is based on statistical data, which was taken from the radio access network, according to ITU-T recommendations. The results obtained from the experiment gives ability to increase the quality of multiservice traffic, suggested to subscribers by mobile telecommunication operators.*

***Keywords:*** *cellular telecommunications, optimization, multiservice traffic*

The "Cisco" company in its annually published report, which is dedicated to traffic growth trend studies, the number of internet users around the world will grow up to 66% by 2023 and this value in mobile operator telecommunication networks, for the citizens of central and eastern European countries will equal to 78%, caused by 8.7 billion of mobile users and more than 4.4 billion M2M (Machine to Machine) variety of methods of accessing the network [1].

According to the studies mentioned above, there is a continuous growth trend of connected devices and Internet users to the network of mobile operators, which requires the necessity of ensuring the proper quality of service – QoS (Quality of Service). Therefore, the use of multiservice traffic is one of the most difficult tasks in the networks, solution of which requires a complex approach, that's the reason of growth importance for the frequency resource throughput, owned by mobile telecommunication operators.

At present, two methods for solving this problem are known. First case involves decision such as the efficient use of the frequency resources owned by cellular operators, that means optimization and re-planning of the existing radio-frequency spectrum and increasing the throughput. The second way of solving the problem is the use of new frequency resources and/or roll out 5G technology, which, implies preparation of the infrastructure of effective Internet resources for such technologies as: AI - Artificial Intelligence, IoT - Internet of Things, Tele-Medicine and etcetera. In spite that 5G technology has been ready for rolling out, there are a lot of questions to be answered regarding safety [2, 3].

During the network planning, for the moment operators in order to use more effectively the range of frequencies they hold, opt for the first way. The reason for such an option represents optimization of financial resources and radio frequency spectrum rescheduling opportunity, that is the base for ensuring proper quality for the increased corresponding multiservice traffic. We would like to underline that as the development trends of the telecommunication industry indicates, most technological innovations haves its own euphoria and frequently the expectations are exaggerated far from reality. For example, we can remember technologies such as IN - Intelligent Network, Wi-Max, ISDN - Integrated Services Digital Network and others. Besides, implementation of the new technologies in the network of mobile operators, requires a large amount of investments and new radio frequency resources [4, 5].

The objective of our research, based on the statistical data studied at the mobile telecommunication company network, is the analysis of the use of multiservice traffic, which allows us to determine the parameters of traffic intensity and plan and optimize the radio frequency

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spectrum resources owned by the operators accordingly, to improve the quality of multiservice traffic.

For this purpose, it is expedient to overview one of the telecommunication operator's radio frequency spectrum. As we can see from the table №1. As we can see from the table, the operator has a quite flexible and wide range radio frequency spectrum, which gives ability to effectively plan and increase the channel throughput, to provide increased signal to noise ratio with minimum delay and reduce the high cost of traffic. This is a new opportunity for the users to use higher quality network resources with affordable tariffs for each services in the radio access network and a new economic potential and source of income for the operators.

Table №1.

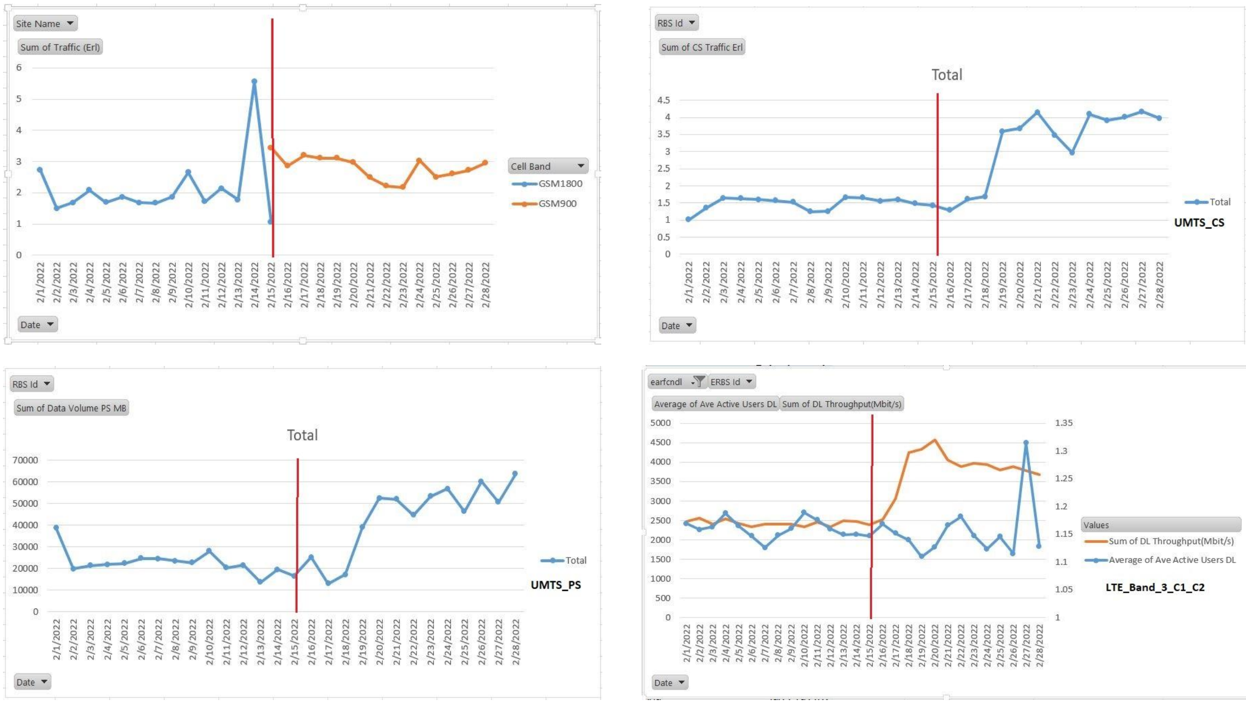
| Name | ARFCN | Uplink(MHz) | Downlink(MHz) | | | | |
|---|---|---|---|---|---|---|---|
| GSM 900 MHz | 1 - 58 | 890.2 - 901.6 | 935.2 - 946.6 | | | | |
| GSM 900/U900 | 1 - 32 | 890.2 - 896.4 | 935.2 - 941.4 | | | | |
| UMTS 900 MHz | 34 - 58 | 896.7 - 901.7 | 941.7 - 946.7 | | | | |
| **GSM 1800 MHz** | **612 - 661** | **1730.2 - 1740.2** | **1825.2 - 1835.2** | | | | |
| Name | Band | Uarfcn DL | Downlink (MHz) | Uarfcn UL | Uplink (MHz) | | |
| UMTS 900MHz | 8 | 3021 | 941.7-946.7 | 2796 | 896.7-901.7 | | |
| UMTS 2100MHz | 1 | 10712 | 2139.9-2144.9 | 9762 | 1949.9-1954.9 | | |
| | 1 | 10737 | 2144.9-2149.9 | 9787 | 1954.9-1959.9 | | |
| | 1 | 10762 | 2149.9-2154.9 | 9812 | 1959.9-1964.9 | | |
| Name | ARFCN | Band | MODE | Earfcn DL | Downlink (MHz) | Earfcn UL | Uplink (MHz) |
| LTE 1800MHz | 512 - 611 | 3 | FDD | 1300 | 1805-1825 | 19300 | 1710-1730 |
| **LTE 1800 MHz** | **612 -661** | **3** | **FDD** | **1444** | **1825.6_1833.4** | **19300** | **1730.6-1738** |
| LTE 900 MHz | | 8 | FDD | 3642 | 941.7-946.7 | 21642 | 896.7-901.7 |
| Name | ARFCN | Band | MODE | Earfcn | Earfcn Range | | |
| LTE2300 MHz | | 40 | TDD | 38750/38948 | 2300-2320/2320-2339.8 | | |

To carry out the experiment, we have chosen a base station in mobile telecommunication network randomly, which provides radio coverage of pre-defined geographical area by use of technologies such as GSM/UMTS/LTE and on the basis of statistical data obtained from the mobile telecommunication network, we have analyzed the results of the use of multiservice traffic for each technology.

For the implementation of the experiment, appropriate software tool allows us to define the statistical data in accuracy from 15min to a 1hour, for any specific BSC- relevant base station, which gives us ability to observe the demand for multiservice traffic to determine the intensity use of the corresponding services of the mobile telecommunication technologies and define the optimal planning of frequency resources owned by cellular operators.

The network section observation and statistical data recording was carried out in accordance with ITU-T recommendations. Based on the 28-day observation processing, the frequency spectrum range of 10 Mhz for GSM-1800 technology was blocked, (see table №1) which caused voice traffic redistribution on GSM-900 as well as on UMTS-2100 technologies. Data traffic has been distributed on UMTS-2100 and LTE technologies, - (for more details see diagram №1).

Diagram №1




We underline that, after the traffic redistribution and growth on corresponding technologies, radio and channel resource overloading has been avoided. Furthermore, as demand for services like multi-service traffic is a continuously increasing process, we decided to use blocked 10 Mhz frequency spectrum range for LTE technology and as we can see from appropriate diagrams, channel throughput increased from 2.5 mb/ps to 4 mb/ps and in spite that average daily number of subscribers didn't increased, these decision as we can see from the results, significantly improved the quality of data service, provided from the mobile telecommunication operator.

During the experiment, throughout the total observation period while recording the collected data (KPI - Key Performance Indicators), in the selected base station of the mobile network, it was revealed that for GSM-1800 technology average load made up 0.703 erlang. After blocking the mentioned frequency band, corresponding to technology mentioned above, voice traffic redistributed on GSM-900 and UMTS-2100 frequency bands and daily average load made up 0.937 and 0.524 erlang, which is a quite low value and is defined as the load time – $Y$, calculated as the total service time of all incoming requests - $X_i$, between $t_1 - t_2$ difference time period, divided by the value of this time interval [6]:

$$Y = \frac{\sum x_i}{t_2 - t_1} \tag{1}$$

In the same way we calculated requests for Internet services during the $n$ days. It was investigated, that the use of additional frequency band for LTE technology, improved the radio channel throughput from 2.4 mb/ps to 4 mb/ps. That supports to increase quality of multiservice traffic, which represents probability of demand losses - $P_B$, where $P_B$ is the probability for demand loss in $(t_1 - t_2)$ interval of time. In a given period of time for the requests $C_b(t_1, t_2)$, is defined as relationship between amount of demand losses and total number of requests, which have been received at the same period of time - $C(t_1, t_2)$ [6]:

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$$P_B = \frac{C_B(t_1, t_2)}{C(t_1, t_2)} \tag{2}$$

For the implementation of the experiment and optimization of the radio recourses the software SAP Business Object – BO was applied, which is used in manufacturing industry for the statistical data processing and result's analysis. The software product enabled us ability to observe traffic intensity for the different technologies.

We also used a software product ENM - Ericsson Network Manager, which is a product of the international telecommunication equipment manufacturer and operator – Ericsson. The mentioned software allows us to provide the network monitoring in online mode and to solvevarious tasks: detect the faults of radio connection to the network and their subsequent elimination. The program also provides information about the parameters such as power, the number and the radio frequency of base station transmitters. Moreover, it provides the observation of all possible sections of the radio network, traffic monitoring and registration of the statistical data of customer services used for their further processing, which implies delivery of the data to the relevant service department, which, based on the statistical traffic data, will develop the recommendations and planned works for further implementation of network optimization.

Here we propose the results obtained from the experiment:

- It was determined the CS/PS traffic intensity used in contemporary mobile telecommunication network for each technology;
- It was established that, after blocking the 10 Mhz frequency band, which was used for GSM-1800 technology, voice traffic redistributed on GSM-900 and UMTS-2100 frequency bands, without radio resource congestion and the average daily traffic made up 0.937 erlangs and 0.524 erlangs respectively;
- The experiment, revealed the possibility of 10 Mhz frequency band shifting and using it for LTE-1800 technology. This gives opportunity for the radio spectrum optimization and ensuring the proper quality of service – QoS;
- The average value of channel throughput for multiservice traffic increased and made up 4 mb/ps.

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