Restrictions on Wideband Systems of Mobile Communications of New Generations at Declared Expansion of Data Transfer Rates

Vladimir Mordachev
EMC R&D laboratory
Belarusian State University of Informatics and Radioelectronics
Minsk, Belarus
emc@bsuir.by

Abstract— **Estimations of required radiated power of user's stations and expected operating distances in next-generation (4G, 5G) systems of mobile communications are resulted at declared expansion of frequency bands and data transfer rates of radio channels of these systems. Expressions for an estimation of limits on operating distances of high-rate mobile data transmission in urban area are received at the accepted levels of radiated power of user's stations. Influence of intranetwork EMC on characteristics of backward channel of next-generation systems of mobile communications is investigated.**

Keywords—cellular communications, data rate, 5G, operating distance, intranetwork EMC, electromagnetic safety

I. INTRODUCTION

Fast evolution of cellular (mobile) communications in the direction of a sharp increase in the set of datacom services and the declared increase in the data rates and volumes both in forward (from the base (BS) to the subscriber (SS) stations) and in backward (from SS to BS) communication channels are watched. Declared increase in data rates up to 5-10 Gbps, accompanied by an increase in the bandwidths of separate radio channels to 10-40 MHz (4G systems) and up to 20-160 MHz (5G systems at its integration with WLAN networks) are expected [1-6]. But it can be attended by the catastrophic consequences for electromagnetic environment in corresponding frequency bands, electromagnetic ecology of human environment and electromagnetic safety of the population, in spite of the known achievements in increasing the spectral efficiency of mobile communication systems, including due to the use of MIMO technology.

SS electromagnetic radiation (EMR) is a source of danger to public health. The currently accepted practical criterion for the experimental assessment of the SS EMR hazard, based on measurements of controlled levels of the EMR power flux density generated by mobile SS of communication systems [7], makes it possible to consider the permissible EMR power of UHF mobile phones no more than 50-55 mW, at the maximum SS EMR power of the cellular GSM, UMTS, LTE within the limits of 0.1-0.25 W (20-24 dBm). The expected increase in data rates on the backward channel in 4G, 5G systems can be associated with a significant increase in the required SS EMR power and, as a result, with an unacceptable increase in forced and voluntary environmental risks for the population.

The declared increase in data transmission rates in next-generation mobile communications requires the development of radio networks infrastructure to maintain their safety, but it is extremely expensive. In fact, telecoms operators are saving on rates of pico-cell's development and expanding the macro-cell BS by increasing the number of radio channels in each BS sector, i.e. by increasing their total equivalent isotropic radiated power (EIRP), if it is not strictly limited.

As a result, the total BS EIRP levels in macro-cells of 2G/3G/4G cellular networks reaches 12-15 kW and more in urban areas (it can be watched today in cellular networks of Belarus and other regions). This, in turn, is resulted in dangerous increase in the level of electromagnetic background created in urban areas, and also is attended by the undesirable increase in SS average radiated power in all operating modes.

The goal of this paper is to estimate the expected limitations on the characteristics of mobile communications of new generations (4G, 5G) in the conditions of keeping the restrictions on SS EMR power, at the declared expansion of the frequency bands of radio channels and the increase in data transfer rates through these channels, and also considering the existence of intranetwork EMC problem.

II. BASIC MODELS AND RELATIONS

For implementation of this aim it is useful to recall a certain fundamentals of information theory.

1. In accordance with the fundamental Shannon-Hartley theorem [8], the potential channel capacity C_P [bps], meaning the theoretical upper bound of the data rate through the analog communication channel with additive white Gaussian noise of power N, with the average signal power S, is such as

$$C_P = \Delta F \cdot log_2(1 + SNR), \quad SNR = S/N \,, \tag{1}$$

where ΔF is the channel bandwidth, Hz; S is the total signal power in the band ΔF, W; N is the total noise power in the band ΔF, W; SNR is the signal-to-noise ratio in the communication channel.

2. For a radio channel with bandwidth ΔF_R: if frequency spectrum of radio signal of power S_R is close to rectangular, its width corresponds to ΔF_R, and its power spectral density

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$S_0 \approx S_R/\Delta F_R$ [W/Hz] in the ΔF_R band can be regarded as approximately constant, then at a constant noise power spectral density $N_0 \approx N/\Delta F_R$ [W/Hz] (what is true for the receiver's internal noise, and in the initial approximation can be assumed to be valid also for the spectral density N_{INT} of the intra-network interference in modern & future cellular communications and in radio channels of wireless broadband access systems Wi-Fi, WiMAX), the expression for the potential radio channel capacity can be reduced to the following form:

$$C_P \approx \Delta F_R \cdot log_2\left(1+CNR\right), \quad CNR = S_0/N_0\ , \qquad (2)$$
$$S_{EP} = C_P/\Delta F_R \approx log_2\left(1+CNR\right),$$

where S_{EP} [bps/Hz] is the potential spectral efficiency of data transfer in radio channel, CNR is the carrier-to-noise ratio.

3. Using (2) we can determine the minimum power P_{DSN} of the useful signal in radio channel (at the radio receiver input) at which the C_P capacity of the channel is provided, if the channel noise is only the internal thermal noise of the receiver:

$$P_{DSN} = \Delta F_R N_0 \left(2^{S_{EP}} - 1\right) \qquad (3)$$

4. The actual data rate C_R of the radio channel is m times smaller than the potential channel capacity C_P; as much as the real spectral efficiency S_{ER} in this channel is less than the potential one:

$$C_P = mC_R\,, \quad S_{ER} = S_{EP}/m\ . \qquad (4)$$

5. In modern digital mobile communications, the difference in the width ΔF_N of the channel noise bandwidth and its standard frequency band ΔF_R can be neglected: $\Delta F_N \approx \Delta F_R$. The spectral power density of the radio channel thermal noise is determined by the known relation [9]:

$$N_0 = kT_0K_N\,, \qquad (5)$$

where k is the Boatman's constant, $1.38 \cdot 10^{-23}$ W/K.; K_N is the radio receiver noise factor, units; T_0 is an ambient temperature (T_0=290K-300K).

6. Thus, the minimum power P_{DSN} of the useful signal transmitted with the spectral efficiency $S_{ER}= S_{EP}/m$ over the radio channel with thermal noise spectral density N_0, will be:

$$P_{DSN} = S_0 \cdot \Delta F_R = \Delta F_R kT_0K_N\left(2^{mS_{ER}} - 1\right). \qquad (6)$$

7. If the subject of the analysis is a cellular communication system in which the noise in the radio channel is determined by the level $P_{INT}=N \cdot K_{CC}$ of intranetwork interference, where the coefficient $K_{CC} \approx N_{INT} / N_0$ characterizes the created excess of the level of internal noise by interference level ($K_{CC} \geq 3 \div 5$), then under the assumption, that the properties of intranetwork interference are close to the properties of Gaussian noise, and the differences in the influence of intranetwork noise and thermal noise of equal power on the radio channel capacity can be neglected, we can write down the expression for the minimum power P_{DSIN} of the useful signal in a radio channel with thermal noise and intranetwork interference (real radio reception sensitivity):

$$P_{DSIN} = \left(K_{CC}+1\right)P_{SDN} = N_\Sigma \Delta F_R\left(2^{mS_{ER}} - 1\right),, \qquad (7)$$
$$N_\Sigma \approx N_0 + N_{INT} \approx \left(K_{CC}+1\right)kT_0K_N = const\ .$$

It is obvious that the factor m makes it possible to characterize both the ratio of the potential and really achievable spectral efficiency of the radio channel, and the contribution of MIMO technology to improving the spectral efficiency of data transmission over the radio channel; in the last case, m can be less than 1.

As an example, let us consider the GSM radio channel, in which 8 traffic channels are received with their subsequent time division. For this radio channel (ΔF_R=200 kHz, $C_R=2^{18}$=262144 bps, CNR=9 dB) with K_N=5, T_0=290K, K_{CC}=0 (only the receiver's thermal noise is taken into account). At these conditions we get $P_{SDN} = \Delta F_R \cdot k \cdot T_0 \cdot K_N \cdot CNR = 2 \cdot 10^5 \cdot 1.38 \cdot 10^{23} \cdot 290 \cdot 5 \cdot 8 \approx 3.2 \cdot 10^{-14} \approx$ -135 dBW = -105 dBm. This value corresponds to the values of radio reception sensitivity of GSM SS and BS (-104 ... -105 dBm), given in [10]. In the Table 2 placed below, the case of ΔF_R=200 kHz, K_{CC}=0 corresponds to a value of P_{DSIN} = -129 dBW, i.e. 6 dB more; this is because the calculations are made for the CNR value of 15 dB (which corresponds to the value of S_{EP}=5), which is 6 dB greater than the threshold value CNR = 9 dB used in the verification calculations. Further, using (5), let's estimate the noise level of the GSM radio receiver, transformed to its input: $P_N = \Delta F_R \cdot k \cdot T_0 \cdot K_N \cdot = 2 \cdot 10^5 \cdot 1.38 \cdot 10^{23} \cdot 290 \cdot 5 \approx \approx 4 \cdot 10^{15}$ = -144 dBW = -114 dBm. The resulting P_N value is less than the P_{SDN} value obtained above, on CNR = 9 dB. At the same time, the potential spectral efficiency of S_{EP}=3.16 corresponds to the value of CNR = 9 dB (according to (2), (3)), and the real spectral efficiency of data transmission in the GSM radio channel is $S_{ER} = C_R/\Delta F_R$ = 1.31, so that the "imperfection factor" $m = S_{EP} / S_{ER} \approx 2.4$.

III. ANALYSIS RESULTS

The basic relationships given above make it possible to pay attention to the following:

- The increase in the radio channel data transmission rate due to the expansion of its frequency band increases the level of the receiver internal noise; the last impairs the real radio reception sensitivity and increases the necessary EIRP of the transmitter at the same transmission distance.
- Expansion of frequency bands of radio channels up to 10-20 MHz or more in conditions of allocation of the separate relatively narrow UHF frequency ranges for mobile communications, sharply reduces the number of frequency channels used on separate BS and the possibility of reducing the levels of intranetwork interference due to frequency-terrestrial sharing. As a result, it should be expected that in (7) the value of the K_{CC} parameter for 4G & 5G networks, which characterizes the intranetwork EMC, will not be lower than for 2G, 3G networks, which, in turn, is also associated with a deterioration in the real radio reception sensitivity and with the increase in necessary EIRP of transmitters.

- Increasing the radio channel spectral efficiency in order to increase its capacity is possible both by improving the modulation/demodulation and encoding/decoding methods, as well as using the MIMO technology (which is provided at the system development stage), and by the direct increasing the value of the *CNIR*=$P_{SDIN}/(N+P_{INT})$ (carrier-to-"noise-plus-interference" ratio) by cellular operators in real networks. This increasing at the best can be reached at the expense of the restriction of intranetwork interference levels at essential growth of a minimum level of the useful signal due to the increase in the EIRP of radio transmitters.

An evident results of calculations illustrating the quantitative relationship between *SNIR*, S_{EP} and C_P, are given below In Table 1. The calculated values of the useful signal minimum necessary power P_{DSIN} for $0<K_{CC}<1000$, $m=1$, $K_N=5$ for a number of typical bandwidth values of the cellular communications, clearly illustrating the growth of the equivalent noise level in the cellular radio channel with the expansion of its frequency band, are given below in Table 2.

TABLE I. VALUES OF THE RADIO CHANNEL POTENTIAL SPECTRAL EFFICIENCY AND CAPACITY FOR DIFFERENT *CNIR* VALUES

***CNIR*, dB**	**S_{EP}.**	**Radio channel capacity C_P, Mbps**		
		ΔF_R =10 MHz	***ΔF_R =40 MHz***	***ΔF=160 MHz***
10	3.46	34.6	138	554
20	6.66	66.6	266	1066
30	9.97	100	399	1595
40	13.3	133	532	2126
50	16.6	166	664	2658
60	19.9	199	797	3188

TABLE II. CALCULATED VALUES OF THE USEFUL SIGNAL MINIMUM NECESSARY POWER AT VARIOUS LEVELS OF INTRANETWORK INTERFERENCE FOR $M=1$, *CNR*=15 DB ($S_{EP}=5$)

ΔF_R, MHz	**P_{SDIN}, dBW**				
	$K_{CC}=0$	***$K_{CC}=1$***	***$K_{CC}=10$***	***$K_{CC}=100$***	***$K_{CC}=1000$***
0.025	-138.0	-135.0	-127.6	-118.0	-108.0
0.2	-129.0	-126.0	-118.6	-109.0	-99.0
1.25	-121.1	-118.0	-110.6	-101.0	-91.1
5.0	-115.0	-112.0	-104.6	-95.0	-85.0
20	-109.0	-106.0	-98.6	-89.0	-79.0
80	-103.0	-100.0	-92.6	-83.0	-73.0

TABLE III. CALCULATED VALUES OF THE RADIO RECEPTION THRESHOLD SENSITIVITY FOR DIFFERENT DATA RATES AND DIFFERENT RATIOS OF LEVELS OF INTRANETWORK INTERFERENCE AND INTERNAL NOISE

C, Mbps	**P_{SDIN}, dBW**				
	$K_{CC}=0$	***$K_{CC}=1$***	***$K_{CC}=10$***	***$K_{CC}=100$***	***$K_{CC}=1000$***
0.032	-143.9	-140.9	-133.5	-123.8	-113.9
0.512	-131.8	-128.8	-121.4	-111.8	-101.8
2	-125.8	-122.8	-115.4	-105.8	-95.8
32	-113.8	-110.8	-103.3	-93.7	-83.8
512	-101.7	-98.7	-91.3	-81.7	-71.7

Declared increase in 2-8 times in LTE radio channels spectral efficiency due to MIMO technology [1,2] allows to conclude that at the present stage of mobile communications development the application of this technology actually allows only to compensate for the nonideality of modulation / demodulation and coding / decoding processes (in cellular radio channels without MIMO technology $m\approx 2 \ldots 10$ [11]); in this case, the resultant value of m is close to 1. Therefore, further analysis will be performed for $m=1$ under the assumption that the radio channel capacity C in cellular communications is close to the potential in the definition (1): $C\approx C_P$, and

$$P_{DSIN} = N_\Sigma C_P\left(2^{S_{EP}}-1\right)/S_{EP}\,, \qquad (8)$$
$$N_\Sigma = \left(K_{CC}+1\right)kT_0 N_N = const.$$

Thus, for a given potential spectral efficiency directly related to the *CNIR* value, the maximum data rate in the considered radio channel is determined by the channel bandwidth and the total level of internal noise and intranetwork interference in this channel. Calculated data of the radio reception threshold sensitivity P_{SDIN} for $m=1$, *CNR*=15dB (S_{EP} = 5) for various K_{CC} are given in Table 3.

The required minimum power $P_{MS\,R}$ of the non-directional SS EMR with antenna gain close to 1, at which the required data rate on the backward radio channel is ensured, is related to the losses L_t in the radio waves propagation (RWP) from SS to the BS, as follows:

$$P_{MS\,R} = L_t P_{DSIN} = N_\Sigma C_P L_t\left(2^{S_{EP}}-1\right)/S_{EP}\,, \qquad (9)$$
$$N_\Sigma = \left(K_{CC}+1\right)kT_0 N_N = const.$$

It is necessary to use a pessimistic estimation L_t of RWP losses in this expression, taking into account the influence of the city building and the need to ensure a high quality of communication; in particular, it is reasonable to use the following pessimistic model of the RWP conditions (formula (3) in [12]), taking into account the multipath of RWP in these conditions:

$$L_t = \begin{cases} 1600\pi^2 d^{2,5}/\left(\lambda^2 G_{BS} R_{BP}^{0.5}\right), & d \le R_{BP}\,; \\ 1600\pi^2 d^4/\left(\lambda^2 G_{BS} R_{BP}^2\right), & d > R_{BP}\,; \end{cases} \qquad (10)$$
$$R_{BP} = 4H_{eBS}H_{eSS}/\lambda\,,$$

where d is the distance between SS and BS, m; λ is the wavelength, m; G_{BS} is the BS antenna gain, units; R_{BP} is the conditional boundary of distances between the BS and SS (breakpoint distance) beyond which the attenuation increases substantially due to multipath RWP; H_{eBS} and H_{eMS} are the equivalent antenna height of the antenna above the underlying surface (terrestrial, building walls, etc.) for BS and SS, respectively.

Using the model (10), it is possible to obtain an expression for estimating the maximum permissible cell size R_{MAX} (maximum communication range) in urban area for a given level of SS EIRP P_{MS}:

$$R_{MAX} = \begin{cases} \left(\dfrac{P_{MS}S_{EP}\lambda^2 G_{BS}R_{BP}^{0.5}}{1600\pi^2\left(K_{CC}+1\right)kT_0K_NC_P\left(2^{S_{EP}}-1\right)}\right)^{0,4}, \\ R_{MAX} \le R_{BP}\,; \\ \left(\dfrac{P_{MS}S_{EP}\lambda^2 G_{BS}R_{BP}^{2}}{1600\pi^2\left(K_{CC}+1\right)kT_0K_NC_P\left(2^{S_{EP}}-1\right)}\right)^{0,25}, \\ R_{MAX} > R_{BP}\,. \end{cases} \qquad (11)$$

Figure 1 shows the calculated dependencies of $P_{MSR}(d)$ for K_{CC}=0 (red line 1), K_{CC}=1 (blue line 2), K_{CC}=10 (brown line 3), K_{CC}=100 (pink line 4) and K_{CC}=1000 (black line 5), obtained for C_P=1 Gbps, S_{EP}=5, K_N=5, T_0=293K, G_{BS}=50 (17dB), and also assuming that the equivalent BS and SS antenna heights relative to the reflecting surface (reflection from the building walls) are H_{eBS}=5m, H_{eSS}=1.5m (R_{BP}=200m); λ=0.15m (2GHz). Figure 2 shows the same dependencies, but for the data rate in the backward channel C_P=10 Gbps. Taking into account the fact that in modern cellular radio networks SS EIRP is limited at the level of 100-250 mW, and the level of intranetwork interference significantly exceeds the noise level of the radio receiver, (K_{CC}=10...1000), these dependencies indicate that

- Data transfer rates from SS to BS up to 5 Gbps declared for 5G systems can be realized only for short distances at safe power levels of SS EMR (no more than 10-20 m, because the pico-cell's BS gain factors of antennas are much smaller, than for BS of mini- and macro-cells).
- Data transmission over the backward channel (if it is a singular radio-frequency transmission line) serving cells with a radius of several hundred meters (micro-cells in the definition [12]), requires SS EIRP from few watts to tens of watts at the similar data rates, which is significantly outside the scope the acceptable levels from the viewpoint of electromagnetic safety and electromagnetic ecology, and requires the use of external access points with external directional antennas.

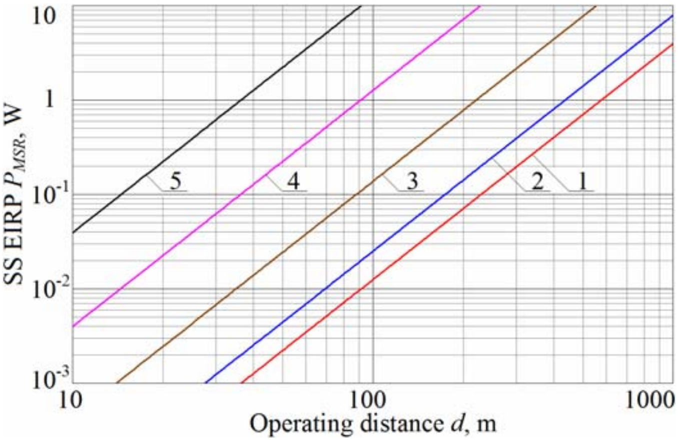

Fig.1. Dependencies of $P_{MSR}(d)$ for C_P=1 Gbps, obtained for different K_{CC} values for S_{EP}=5, K_N=5, T_0=293K, G_{BS}=50, R_{BP}=200m (H_{eBS}=5m, H_{eSS}=1.5m), λ=0.15m (2 GHz)

Figure 3 shows the calculated dependencies of P_{MSR}(d) for C_P=1 Mbps (red line 1), C_P=10 Mbps (blue line 2), C_P=100 Mbps (brown line 3), C_P=1 Gbps (pink line 4) and C_P=10 Gbps (black line 5), obtained for K_{CC}=10 (the intranetwork interference exceeds the receiver's internal noise on 10dB) with other parameters (9), (10) similar to parameters accepted for curves in Fig. 1, 2. Figure 2 shows the same dependencies, but for K_{CC}=100 (the intranetwork interference exceeds the receiver's internal noise on 20dB). These dependencies clearly indicate that data transmission on the backward channel with data rates of 1-10 Mbps, which are typical for UMTS and LTE systems in the early stages of infrastructure development, is possible only at the high quality of network's frequency-spatial planning (which provides interference limitation at K_{CC}≤10dB) even in micro-cells with a radius of only several hundred meters.

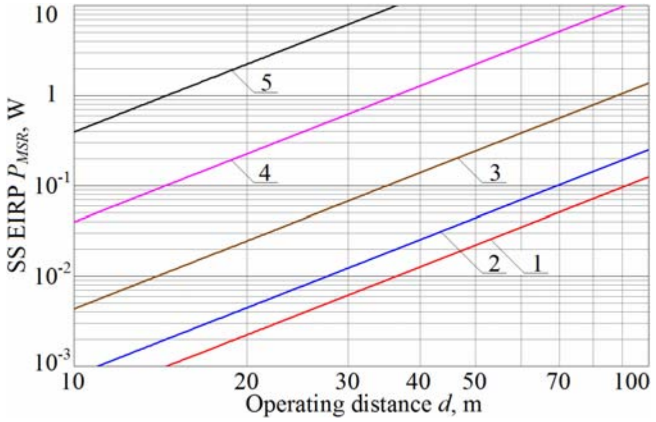

Fig.2. Dependencies of $P_{MSR}(d)$ for C_P=10 Gbps, obtained for different K_{CC} values for S_{EP}=5, K_N=5, T_0=293K, G_{BS}=50, R_{BP}=200m (H_{eBS}=5m, H_{eSS}=1.5m), λ=0.15 m (2 GHz)

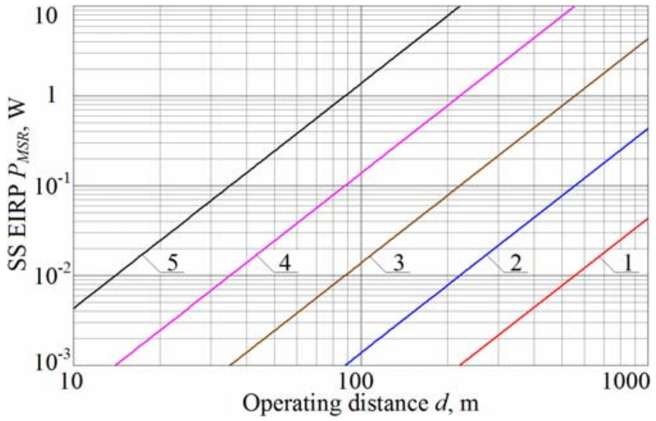

Fig.3. Dependencies of $P_{MSR}(d)$ for K_{CC}=10, obtained for different C_P values for S_{EP}=5, K_N=5, T_0=293K, G_{BS}=50, R_{BP}=200m (H_{eBS}=5m, H_{eSS}=1.5m), λ=0.15m (2 GHz)

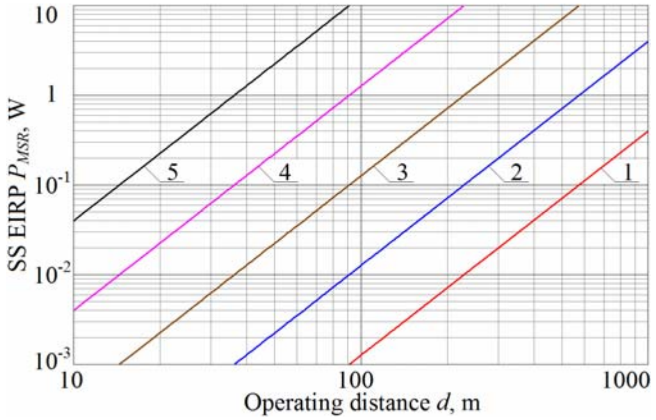

Fig.4. Dependencies of $P_{MSR}(d)$ for K_{CC}=100, obtained for different C_P values for S_{EP}=5, K_N=5, T_0=293K, G_{BS}=50, R_{BP}=200m (H_{eBS}=5m, H_{eSS}=1.5m), λ=0.15m (2 GHz)

Figure 5 shows the calculated dependencies of $P_{MSR}(d)$ for a number of frequency ranges which are used or intended for use by mobile communication systems: for λ=0.67m (450 MHz, red line 1), λ=0.5m (600 MHz, blue line 2), λ=0.33m (900 MHz, brown line 3), λ=0.17m (1.8 GHz, pink line 4) and λ=0.11m (2.7 GHz, black line 5), obtained for C_P=1 Gbps and K_{CC}=10 with other parameters (9), (10), similar to parameters accepted for curves in Fig. 1–4. Figure 6 shows the same dependences, but for H_{eBS}=30m, which significantly expands the applicability of the upper branch of the model (10) of the RWP conditions for each of the considered frequency bands. The dependencies shown in these figures clearly indicate that

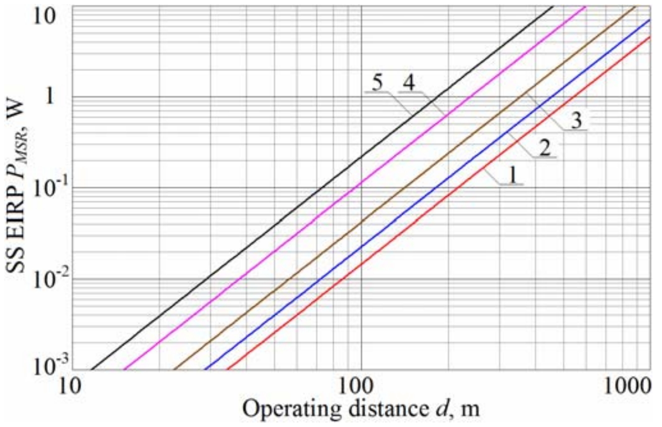

Fig.5. Dependencies of $P_{MSR}(d)$ for H_{eBS}=5m, H_{eSS}=1.5m, obtained for different wavelengths λ at C_P=1 Gbps, K_{CC}=10, S_{EP}=5, K_N=5, T_0=293K, G_{BS}=50

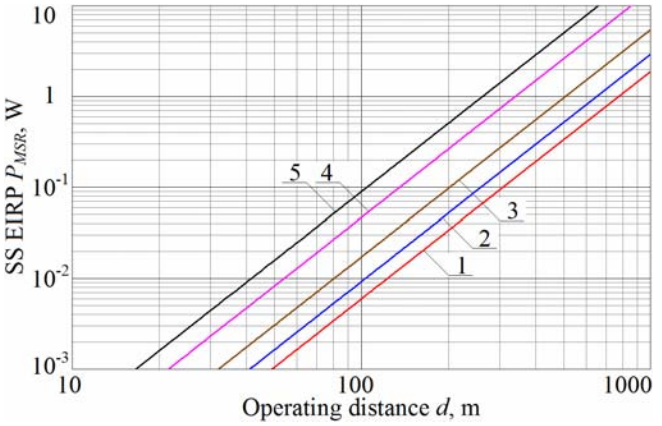

Fig.6. Dependencies of $P_{MSR}(d)$ for H_{eBS}=30m, H_{eSS}=1.5m, obtained for different wavelengths λ at C_P=1 Gbps, K_{CC}=10, S_{EP}=5, K_N=5, T_0=293K, G_{BS}=50

- Data rates over the backward radio channel, declared for next-generation broadband mobile communication systems, can be implemented for hundreds of meters (in micro-cells) with safe levels of SS EIRP only in the lower part of UHF frequency range, where the assignment of frequency bands of required width for data transmission at such data rates is practically impossible due to the intensive use of this part of the radio-frequency spectrum by other radio services.
- The use of frequency bands in the upper part of the UHF frequency range and of SHF frequency range also requires to use the SS EIRP levels from few watts to tens of watts for these purposes in next-generation mobile communication systems, which is significantly exceeds the limits acceptable from the viewpoint of electromagnetic safety and electromagnetic ecology, and requires the use of external access points.

Figure 7 shows the calculated dependencies of $P_{MSR}(C_P)$ for different transmission distances over the backward channel: d=10m (red line 1), d=30m (blue line 2), d=100m (brown line 3), d=300m (pink line 4) and d=1000m (black line 5), obtained for K_{CC}=10, λ=0.15m and for other parameters (9), (10), similar to parameters accepted for curves in Fig. 1-4. Figure 2 shows the same dependencies, but for K_{CC}=100 (the intranetwork interference exceeds the receiver's internal noise on 20dB). These dependencies confirm the earlier conclusions, clearly indicate that the safe implementation of the declared ultra-high data rate backward channels from mobile SS in next-generation cellular (mobile) communication systems that have micro-cells with a radius of hundreds of meters, is impossible.

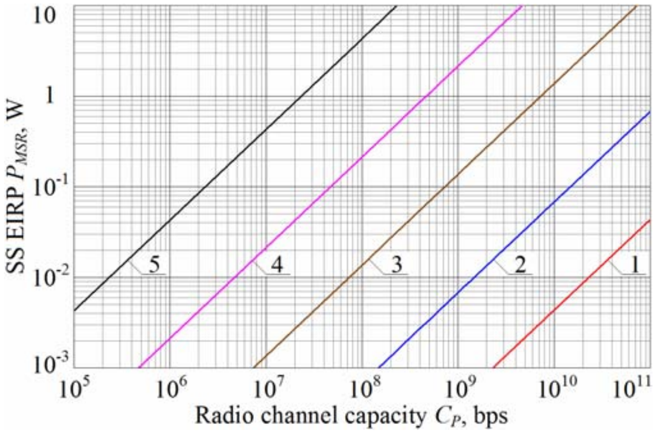

Fig.7. The P_{MSR} (C_P) dependences for K_{CC}=10, obtained for a different operating distance d of the backward channel for S_{EP}=5, K_N=5, T_0=293K, G_{BS}=50, R_{BP}=200m, λ=0.15m

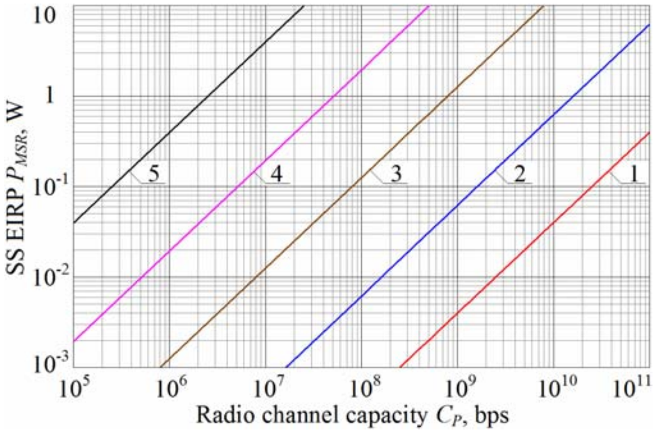

Fig.8. The P_{MSR} (C_P) dependences for K_{CC}=100, obtained for a different operating distance d of the backward channel for S_{EP}=5, K_N=5, T_0=293K, G_{BS}=50, R_{BP}=200m, λ=0.15m

Electromagnetic safety of the considered systems and electromagnetic ecology of urban areas covered by these systems, which are acceptable from the point of view of modern hygienic restrictions, are possible only due to significant investments in 4G & 5G networks infrastructure, and due to the refusal of high-rate data transmission by individual SS over distances of more than several tens of meters at a system data rate at the declared level to ≥ 1 Gbps at the backward channel, i.e. in fact, due to the implementation of such data rates at the backward channel only with the line of sight access points in premises, or with the help of access points outside buildings.

IV. CONCLUSION

1. At the expected width of the frequency bands of radio channels of 4G & 5G systems, and at the adopted SS EIRP restrictions, the maximum possible data transfer rates from SS to BS in these systems are limited to 10-100 Mbps. Data rates ≥ 1 Gbps in separate radio links "SS-BS" of backward radio channel are unrealistic for real operating distances and can be realized only in the whole set of radio links forming the backward channel.

2. Data transmission from SS to BS in next-generation mobile communication networks at rates about 10-100 Mbps with high quality at relatively safe SS EIRP levels is possible only at distances not exceeding 100-200 m. An increase in the operating distance at extremely high data rates widely declared for the backward channel in 4G & 5G networks, requires an extremely significant increase in SS EIRP to the levels that are essentially dangerous to the health of both the subscriber and the surrounding people. Since the SS EIRP, at least in the 3G-4G networks, is limited at the level of 24 dBm (0.25 W) [1], an increase in the operating distances of the backward channel in these networks is possible only due to the corresponding decrease in the communication quality and data rate.

3. The mobile Internet with data rates of 1-10 Mbps in macro-cell's backward channels at distances to 0.5-1.0 km can be relatively safe for the subscriber's health only when used in the open area in the BS line of sight conditions and at a high quality of the frequency-spatial network planning, which provides a low level of intranet interference ($K_{CC} \leq 10$). Mobile Internet, both with such and with higher data rates, available in premises at the outdoors BS location with spatial density of few BS/km^2 in urban area, requires a dangerously high levels of SS EIRP, because unlike the SS in phone mode, in the SS data transmission mode the maximum EIRP levels are used to achieve the highest possible data rate.

4. Relatively safe mobile Internet with backward channel extra high data rates, declared for 4G & 5G networks, is the Internet of the minimum distances between the BS and the SS. It can be safe only when using pico-cells with operating distances from several meters to several tens of meters, i.e. when BS are located in the premises. However, in these conditions it becomes possible to replace the network wireless access with the network wire access, which significantly improves the environmental characteristics of these premises. The latter seems quite urgent in connection with the expected essential expansion of the scope of wireless broadband access within the framework of mobile 5G mobile communications and concepts "Smart House", "Internet of Things", etc.

5. The increase in the radio channel data rate due to the expansion of its frequency band and the increase in its spectral efficiency is accompanied by an increase in both the internal noise level reduced to the receiver input and an increase in the required *CNIR* ratio. This greatly increases the necessary level of SS & BS EIRP, or, taking into account the existing of hygienic restrictions, entails a reduction by an order of values of the reliable operating distance over the radio channels of cellular communications in urban area, and, as a consequence, the necessity to implement its multi-level hierarchy with an emphasis on the mass use of pico-BS (access points) in housing and pico-cells in places of local SS concentration in urban areas (both inside and outside the premises).

6. The relative narrowness of the separate frequency bands allocated and planned for allocation in next-generation mobile communications [2] restricts the possibilities for increasing the data rates in separate radio links and for creating a full-fledged homogeneous cluster structure of frequency plans, frequency diversity of radio channels of neighboring BS sectors, etc., and is a negative factor encouraging telecoms operators to increase the spectral efficiency of radio channels by increasing the *CNIR* and, as a consequence, increasing the EIRP of SS (in accessible limits) and BS.

7. The curves in Figs. 1-4, 7,8 convincingly testify to the very strong dependence of the basic characteristics of next-generation broadband mobile communication systems built on the cellular principle, on the quality of the intranetwork EMC (on the K_{CC} level); high levels of intranetwork interference can be the reason for the reduction in accessible operating distances and data rates by an 1-2 orders of magnitude or even more.

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