Czech
Journal of Multidisciplinary Innovations
Volume 28, April, 2024.
ISSN (E): 2788-0389
Website: www.peerianjournal.com
Email: editor@peerianjournal.com

Correct Use of Radio Frequency Spectral Resources in Radio Communication Systems

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Annotation: At present, the issue of using radio frequencies in mobile radio communication systems is relevant. This paper presents an analysis and method of efficient use of the radio frequency band in different standards, depending on the type of modulation, using the spectrum of radio frequencies in mobile radio communication systems

Keywords: Base stations, MCS, CDMA standard, AMPS, GSM standards, DCS-1800 (16) standard, communication systems, spectrum, RET,frequency band.

I. Introduction

Requirements for the number of base stations (BS) of the main indicators of the network, the number of subscribers served by one BS, the output power of the BS, the radius of sata per one active subscriber to provide the required level of service to subscribers of mobile communication systems evaluated. Different standards for mobile communication systems (MCS) that meet the above requirements use the 2 GHz band.

II. Main Part

Comparisons of the use of this range of different standards can be used to draw conclusions about the effective use of the radio frequency spectrum, which in turn summarizes information about the key performance of the different standards.

The following conclusions can be drawn from the analysis [1]:

- Increasing the bandwidth allocated for MCS will lead to an increase in the number of subscribers serving a single BS;

- The number of subscribers serving one BS in MCS based on different standards varies;

- The maximum number of subscribers using the allocated frequency band as a result of the use of the CDMA standard is the highest, the minimum when using the AMPS (1) standard;

- BS will be able to increase the number of subscribers through the use of sector 3 and 6 antennas and a relatively wide frequency band;

- If the allocated frequency band is narrow, the use of sector antennas is not advisable, because the division of individual bands into networks reduces the number of subscribers and, as a result, the possibility of blocking under Erlang's law. decreases, which leads to a decrease in the number of subscribers serving one sota;

-Using different standards, the number of subscribers in the urban area for $N_a = 30000$ and $G = 8$ дБ is studied in relation to the frequency band of the number of BS in the MCS. The analysis shows that increasing the number of BSs can narrow the required frequency band. If a frequency

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band is provided, the number of BSs serving the number of subscribers in a MCS set up using different standards will vary. The CDMA standard requires less BS than other standards.

Different MCSs are compared in terms of efficient use of the radio frequency spectrum. In this case, of course, the more BS in a given bandwidth, the more effectively the RCHS is used. In this case, the cost of building a network of MCS - and the current costs of its operation will be even lower.

Different standard MCSs indicate the number of subscribers per BS service when the bandwidth is $B_f = 11$ MGHz. The following conclusions can be drawn from the analysis of the calculation results for this case, which compares the MCS in the AMPS, GSM and CDMA standards:

- CDMA has the largest number of subscribers serving one BS in a given frequency band than other standards, and has an advantage of 3 ... 6 times greater than the use of the GSM-1800 (16) standard;

- In the GSM-1800 (8) standard, one BS AMPS (3) standard can serve the number of subscribers equal to or slightly more than the number of subscribers served;

- The AMPS (1) system is obsolete and the RFS (radio frequency spectrum) is less efficient than modern systems;

- The number of subscribers can be doubled using the CDMA standard and three-sector antennas in BS. In other standards, the use of three-sector antennas can reduce the number of subscribers by 20 ... 30%, but the use of 6-sector antennas can reduce the number of subscribers;

- When the number of subscribers in the cities is known $B_f = 6$ and the frequency band 10 MGHz, a table of the number of BSs required to organize the MCS when using different standards. An analysis of this table also shows that the CDMA standard is superior to others. If the bandwidth is MHz, 11 BSs will be required to serve 100 000 subscribers, and when using the DCS-1800 (16) standard, about 6 times more BSs will be required. In addition, the narrowing of the frequency band leads to an increase in the number of BSs used in the MCE, but in this CDMA system, a decrease in the frequency band from 10 MHz to 6 MHz has little effect on the number of BSs, for other standards the number of BSs doubles or more comes [2].

It is necessary to take into account the complex nature of the wave propagation in the urban area, resulting in an increase in the number of BSs by 3-4 times. In the organization of radio services in the allocated radio frequency band, special attention should be paid to the following key issues. If the number of radio channels to be established is known, what is the minimum frequency band required to establish radio communication in adjacent areas of the region. To solve this problem, first of all, it is necessary to know the technical characteristics of the transmitting and receiving devices, the method of modulation and the requirements for the quality of the received signal. In this case, only the minimum value of the frequency band required to create this network;

It is necessary to know the type of modulation used in each transmission, as well as to take measures to reduce (narrow) the frequency band as much as possible to establish a radio communication and broadcasting network during the optimal processing of signals in radio transmission and reception devices. The minimum optimal (proportional) value of the frequency band required for the provision of these radio services F_{opt} ,can be determined on the basis of data theory. The efficiency of using the radio frequency spectrum in an optimal and real communication

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system based on the value of F_{opt} can be expressed by the ratio of F_{opt} to F_s , $\mu = \frac{F_{opt}}{F_S}$ where the real required frequency bandwidth.

Figure 1 shows the type of periodic repetitive frequencies for radio communication and broadcasting. In this way, it is possible to analyze the radio service network of adjacent service areas in the area. One or more frequency channels are allocated for each location, and one frequency can be reused in another location in the region. In order to simplify the problem in Figure 1, we assume that the spaces are taken in the form of squares, and the radio transmitters of radio communication, moving communication systems are located in the center of these squares [1]. Assume that the radius r of the service area is given. In this figure, in order to use the same frequencies in spaces marked with the same numbers, the distance between them is determined by the condition that the effect of the interference is small as required. If the frequency channel used in each space is Ms, then to cover the entire area with radio services

$$N = M_S\{\text{int}[R/2r]+1\}^2$$

frequency channel is required (*int* represents the whole part of the number in square brackets). If we define the bandwidth of a single radio channel, then the bandwidth of the frequencies required for the radio network

$$F_S = NF_m$$

In the analysis, it is convenient to use the expression for the frequency spectrum of these and frequency modulating signals, i.e.

$$\tilde{F}_m = F_m / F_0 \text{ and } \tilde{F}_S = F_S / F_0 .$$

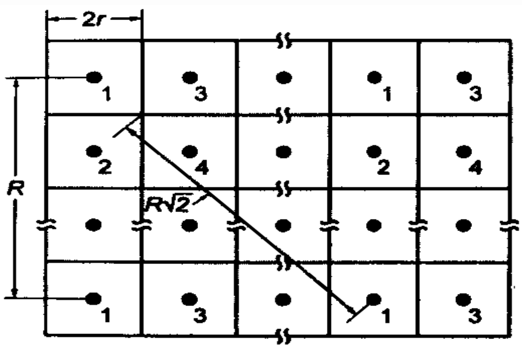

Figure:1

The distance-dependent attenuation of the signal level is usually expressed by the expression, in which the antenna takes values from 2 to 4, depending on the height of the mast on which it is mounted, and the signal / interference at the input of the radio is determined as follows:

$$\rho = \frac{\beta}{4}\left(\frac{R}{r}\right)^{k+2} ; \qquad \beta = \frac{2}{1+2^{-(k+2)/2}} .$$

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$$R/r = (4\rho/\beta)^{1/(k+2)} \text{ and } N = M_S\left\{\left[(1/2)(4\rho/\beta)^{1/(k+2)}\right] + 2\right\}^2. \qquad (1)$$

The signal / interference ratio β at the input of the receiver must not be less than the protection / interference ratio ρ_0 that must be provided at ρ_s its output. $\Psi = \rho_S(\rho_0)$ - function values also depend on the type of modulation [3].

The following expression is used to determine what is optimal for RET based on data transmission theory:

$$\rho_S(\rho_0) = (1+\rho_0)^{1/F_m} - 1.$$

(2) is appropriate for cases where the transmission and reception methods used in the RET are optimal according to the Shenon theorem. If available, it will be reduced when using broadband modulation types.

For a ChM signal, the expression that connects the ρ_s, ρ_0 $\tilde{F}_m$ looks like this:

$$\rho_S(\rho_0) = \chi^2\rho_0 \Big/ \left[3\tilde{F}_m(\tilde{F}_m - 2)^2\right],$$

This: $\tilde{F}_m = 2(1+\chi m_C)$; m - modulation index; x is the ratio of the maximum value of the message to the average value, usually $\chi = 3 \ldots 4$.

Amplitude modulated single-band signal $\rho_S = \rho_0$ for AM-BP signal.

For impulse-code modulation (ICM) system, which transmits messages using M - state phase modulated FM - M signal

$$p_s(p_0) = \frac{\left[2\left(\frac{n}{\tilde{F}_m}+1\right)ln2 + p_0\right]}{sin^2(2\pi^{-\left(\frac{2n}{\tilde{F}_m}\right)})};$$

where $\tilde{F}_m = \frac{2n}{\lg M}$, $\rho_0 = 2^{2n-1} - 1$, and n is the number of elementary signals used in the encoding for the message transmission [3].

For n-IKM signal using 16-QAM (quadrature amplitude modulation) signal

$$\rho_S(\rho_0) = 10\left\{\ln\left[180\Big/\sqrt{10\ln 180\rho_0}\right] + \ln\rho_0\right\}.$$

Conclusion

The given dependencies are intermediate, and the square of the whole numbers given at the breakpoints (4, 8, 16) is the number of frequencies that must be used in the region to create a single frequency channel $(M_C = 1)$ in space.

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