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METHODS TO IMPROVE THE MILLIMETER RANGE SYSTEM BASED ON HYBRID TECHNOLOGY THROUGHPUT ANALYSIS

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АНАЛІЗ МЕТОДІВ ПІДВИЩЕННЯ ПРОПУСКНОЇ ЗДАТНОСТІ СИСТЕМ МІЛІМЕТРОВОГО ДІАПАЗОНУ НА ОСНОВІ ГІБРИДНИХ ТЕХНОЛОГІЙ

У статті показано, що використання різних гібридних топологій структури мережі, оптоелектронних методів формування і обробки сигналів, формування діаграм спрямованості антен, а також аналіз обмежуючих факторів і компенсуючих методів може підвищити спектральну і енергетичну ефективності перспективних систем зв'язку в діапазонах 75-110 ГГц, 200-450 ГГц.

The article shows that the use of different hybrid topologies network structures, optoelectronic methods of formation and signal processing, the formation of the antennas directional diagrams, and the analysis of limiting factors and compensatory techniques can improve the advanced communication systems spectral and energy efficiency in the range of 75-110 GHz, 200-450 GHz.

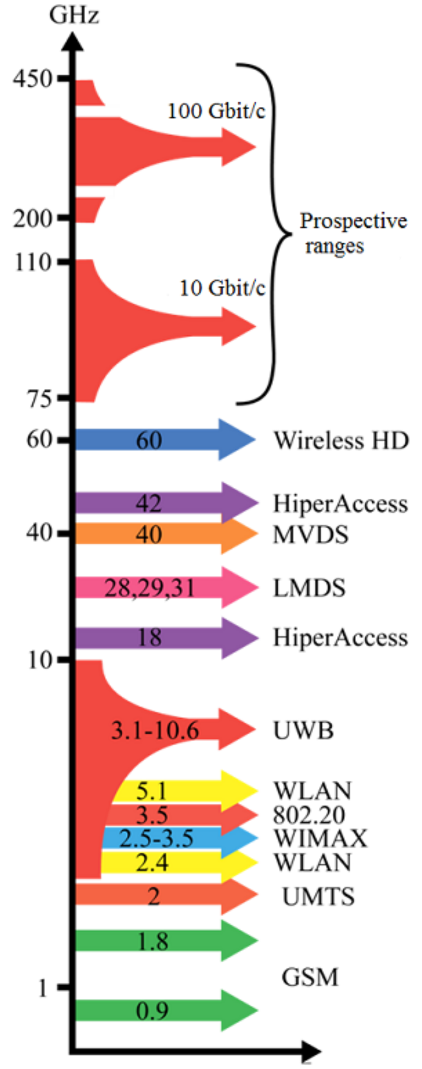

Fig. 1 The Use of spectrum by different radio performances. GSM: global system for mobile system; UMTS: universal mobile telecommunication system; WIMAX: worldwide interoperability for microwave access; WLAN: wireless local area network; UWB: ultra-wideband; LMDS: local multipoint distribution service; MVDS: multipoint video distribution system.

Most modern radio standards operate in the microwave range from 2 to 5 GHz, which theoretically limits the potential resources to increase capacity (Fig.1.). However, the projected increase in mobile traffic, the possibility of live UHDTV format or 3DTV transmission, and other services that requires a higher information transmission rates over 1 GBit/s. This requires the extension of the frequency resources to the millimeter range (MMR, 30 - 300 GHz) and even more short-wave terahertz (300-3000 GHz). However, the distribution of millimeter-wave (MMW) is limited by high losses in the atmosphere, urban areas, foliage of trees, the human body, etc [1]. However, due to the characteristics of the MMR signals spreading (radiation) spectral efficiency increases with the increase of distribution density of base stations (place density phazed emitting elements, antenna arrays), which is contrast to the interference limitations of the UHF band for cellular communication.

While there is no generally accepted model for energy budget and the algorithm of such networks operation. Possible reasons are the insufficient study of the physical properties distribution of the MMW and hardware limitations, although the 2018-2020 years is already projected use of millimeter range in mobile systems [2,3].

The fundamental solutions for the implementation of MMR systems are hybrid technologies such as [3-6]:

- optoelectronic methods for processing and generating radio signals;
- hybrid network topology RoF (radio-over-fiber, radiofiber-optical communication);
- hybrid analog-digital methods of the antennas directional diagrams formation (MIMO technology);
- radar sensing information to the radiochannals.

In all of these technologies provides wide bandwidth for one channel up to 10 GHz. More impor-tant in the MMR development experts believe the ranges in the atmospheric transparency windows 75-110 GHz transmission capability up to 10 Gbit/s. For ultra-high performance network experts consider spectral windows in the frequency range from 200 to 450 GHz where the low additional losses due to water absorption, and at least you can organize the information transmission over short distances up to 100 m [6]. Each of these windows has a bandwidth of several tens GHz, making them suitable for ultrahigh transmission of 100 Gbit/s without the use of high spectral efficiency formats modulate (e.g., 512-QAM).

The use of hybrid technologies based on optoelectronic and electrooptical conversions gives great prospects in the development of MMW systems. However, limiting factors to date, for example, the use of complex types (formats) for the MMR due to the phase noise modulation IQ imbalance, nonlinear effects are also associated with further progress in the above mentioned hybrid technology and study of the physical features of distribution of the MMW. The development of balancing techniques, for example, shown in Fig.2, may contribute to the development of fully all of the frequency and energy resource potential of MMR. In conclusion, we can draw the following conclusions. The development of millimeter and terahertz range are necessary to further increase the telecommunication systems bandwidth. However, the physical features of the MMW, for example, diffusion and radiation, significantly distinguishable from the waves of the microwave range, hardware-based methods based on the use of photonic technology and optoelectronic conversion and other hybrid technology can significantly affect the architecture of work and the quality of the MMW system. On the model of a single channel is not possible to evaluate the network performance, spectral efficiency, power budget, and other characteristics. To create the model, architecture systems MMR and terahertz range, you should be mindful and compensating methods in each area associated with the development of these ranges.

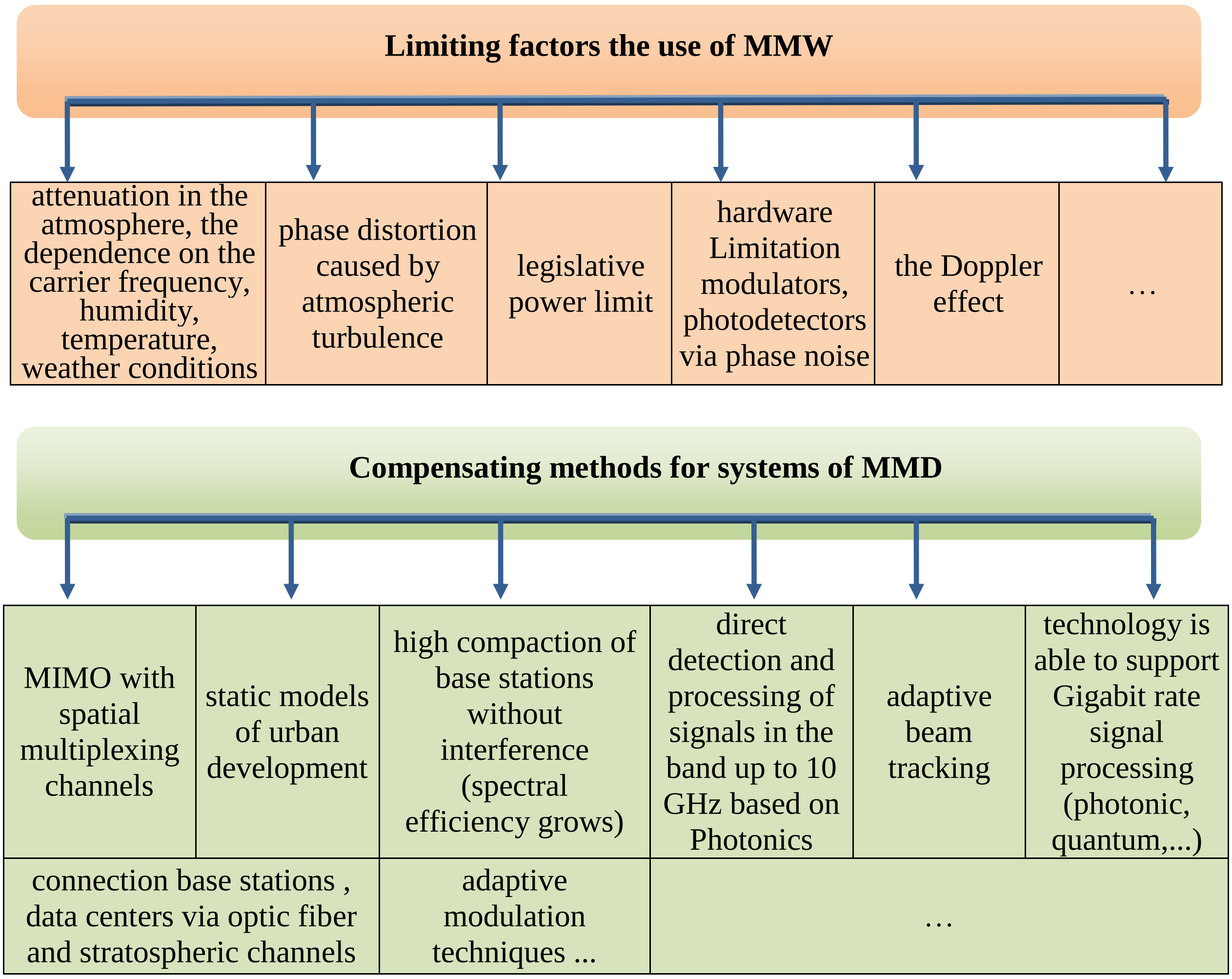

Fig. 2. Limiting and compensating factors to evaluate network performance MMR.

References

1. Пи, Жоую. Введение в широкополосные системы связи миллиметрового диапазона / Жоую Пи, Фарук Хан // Электроника: наука, технология, бизнес.— 2012.— № 3.— С. 86–94.
2. Preparing for a 5G World. Richard Adler. Communications and Society Program. 2016 : https://www.yumpu.com/en/document/view/55693626/preparing-for-a-5g-world.
3. Sarabjot S. Tractable Model for Rate in Self Backhauled Millimeter Wave Cellular Networks / S. Sarabjot et al. // IEEE Journ. on Sel. Areas in Commun., Oct. 2015., vol.33, no.10, pp. 2196-2211.
4. Heath R. W. An Overview of Signal Processing Techniques for Millimeter Wave MIMO Systems / R. W Heath et al. // IEEE Journal of Selected Topics in Signal Processing, April 2016.
5. Koenig S. Wireless sub-Thz communication system with high data rate / S. Koenig et al. // Nat Photon, 7(12). 2013. pp. 977–981.
6. Урик, Винсент Дж. Основы микроволновой фотоники: [монография] / Винсент Дж. Урик-мл., Джейсон Д. МакКинни, Кейт Д. Вилльямс ; пер. с англ.: М. Е. Белкин, И. В. Мельников, В. П. Яковлев ; под ред.: С. Ф. Боева, А. С. Сигова // Москва: Техносфера. — 2016. — 375 с.