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COMMUNICATION 5 GENERATION

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This article discusses the construction of the fifth generation networks. Their characteristics are considered. Development prospects are analyzed.

The telecommunications market is developing dynamically. Creation of communication networks of the next generation 5G is the main condition for the development of the information society and the digital economy. The main advantages of 5G networks are high access speed with minimal delays, support for many concurrent devices, high energy efficiency. Fifth-generation networks will provide an opportunity to introduce smart home technologies, smart cities, artificial intelligence, the Internet of Things, and unmanned vehicles into everyday life.

The main requirements for the 5G standard, which are put forward by the International Telecommunication Union:

- data transfer rate in Downlink mode - up to 20 Gbps;
- data transfer rate in Uplink mode - up to 10 Gbps;
- the number of supported devices in an area of 1 square kilometer - at least 1 million;
- delay for eMBB (high-speed communication) services - no more than 4 ms;
- delay for URLLC (ultra-reliable communication) services - no more than 0,5;
- for point-to-point connections, it is also planned to use additional bands 71-76 and 81-86 GHz.

These requirements are achieved at the expense of multichannel (parallelism in frequencies and base stations), increasing the carrier radio frequencies from units to tens of GHz (radio channel bandwidth).
The alignment of standard 4G and 5G by technical characteristics is shown in table 1

Table 1. – Comparison of 4G and 5G standards

Network Generation	Maximum throughput, GBits/sec		Network latency, ms	Spectral efficiency bit/Hz		Device connection density per 1 sq. m
	Uplink	Downlink		Uplink	Downlink	
4G	1,5	3	5	15	30	—
5G	10	20	0,5 — 4	6,75	15	1 million

For networks of the fifth generation, it is proposed to use the radio frequency ranges of 700 MHz, 3.6 GHz, 26 GHz. Low frequencies range 600-850 MHz provide full coverage of the territory. This is about the same range that existing 4G networks use, with a data transfer rate of 50–250 Mbit/s. 5G-compatible devices can connect to low-frequency 5G networks and operate at speeds similar to those of 4G / LTE networks.

The medium frequency range of 2.5-3.7 GHz provides the ability to transmit data at a speed of 100-900 Mbit /s. Despite the smaller coverage radius of each cell tower, this type of 5G will become the most common practical solution for 5G networks for many years. This is a good ratio between the speed of the network and the signal propagation range-both in urban areas with an average density of buildings, and in rural areas with less dense buildings.

High frequencies in the 25-39 GHz range are required for applications that require high data rates. The disadvantage of high-frequency 5G networks is that millimeter-wave transmitters have a very limited coverage radius. The normal operation of the network requires the installation of many small transmitters, and this is only possible in urban agglomerations, where transmitters can be installed near buildings.

When implementing fifth-generation networks, the following disadvantages must be taken into account: the availability of the radio frequency spectrum, compliance with the requirements for protection from the effects of electromagnetic fields created by base stations, payment for the allocation and use of the radio frequency spectrum for the 5G standard.

In Belarus, 5G networks were tested by operators MTS, Unitary Enterprise A1, Belarusian Cloud Technologies, Beltelecom in the cities of Minsk, Kopyl (fig.1), Gomel, the Great Stone Industrial Park.

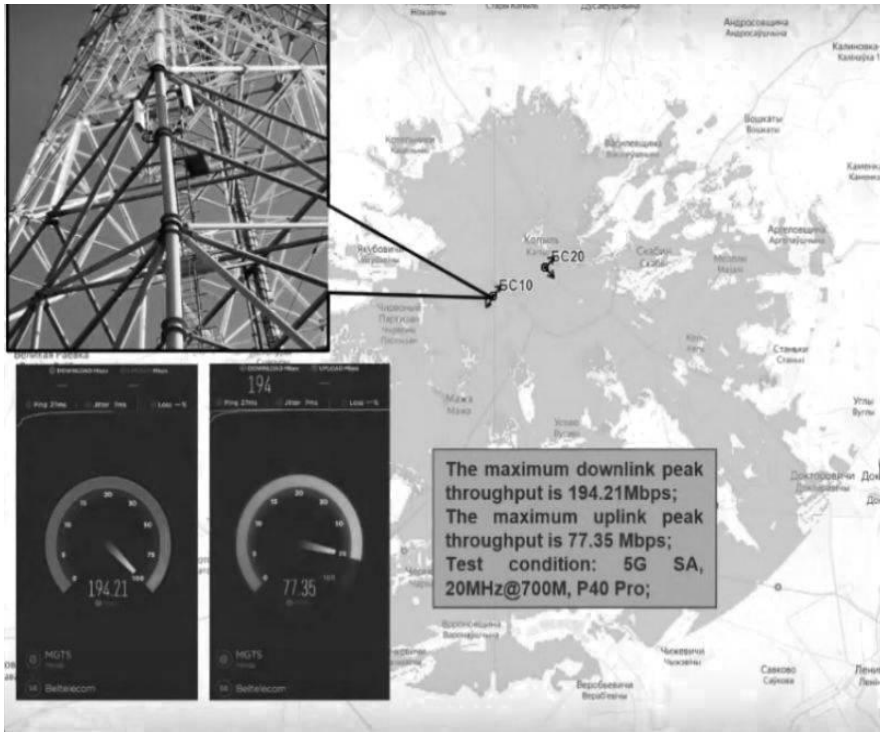

Fig.1. – 5G test in Kopyl

The conditions for the use of the radio frequency spectrum are developed after the definition of a model for the implementation of 5G networks.

The infrastructure model involves the construction of 5G infrastructure by a single operator.

The competitive model involves the construction of a passive and active 5G network infrastructure by each of the operators. In order to optimize costs, it is assumed that operators will jointly participate in the construction of transport infrastructure – fiber-optic communication lines.

The passive infrastructure sharing model involves the construction of an active 5G network infrastructure by each of the operators within the allocated radio frequency spectrum, and the construction of a passive infrastructure – a transport network, antenna-mast structures, fiber-optic communication lines-by a single infrastructure operator. The joint use of active and passive infrastructure can be carried out by all operators, provided that appropriate changes are made to the legislation governing the use of the radio frequency spectrum.

The basic principles of building 5G networks are as follows: the division of network nodes into elements, the division of network elements into network layers (Network Slicing), implementation of network elements in the form of virtual network functions (Virtual Network Functions), support for simultaneous access to centralized and local services, defining a converged architecture, combining different types of access networks, support of uniform algorithms and authentication procedures, support for stateless network functions (stateless), support for roaming with traffic routing both through the home network (Home routed) and with local landing (Local breakout) in the guest network (VPLMN).

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