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# COMPARATIVE ANALYSIS OF LPWAN NETWORK

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*The article presents a review and comparative analysis of technologies, LPWAN (Low-power Wide-area Network). The advantages and disadvantages of each of them. Comparative analysis helps to identify more effective and preferable network technology LPWAN.*

*LORA technology*

LoRa Alliance developers believe that LoRa technology has significant advantages over WiFi and cellular networks, thanks to the possibility of deploying machine-to-machine (M2M) inter-machine connections for distances up to 20 km at speeds up to 50 Kbp/s, and also has minimum power consumption which provides several years of battery life on one AA battery. The scale of applications of this technology is great: from home automation and the Internet of things to industry and smart cities [1, 2]. LoRa is the next step in the development of the LPWAN solution, which was developed and patented by Semetch Corporation. The essence of the technology is reduced to the variation of linear frequency modulation (Chirp Spread Spectrum, CSS). The technology uses data encoding with broadband pulses with frequencies that decrease or increase over a certain time interval. This solution allows the receiver to be resistant to frequency deviations from the nominal value and simplifies the requirements for the clock generator, thereby allowing the use of inexpensive quartz resonators.

*SigFox technology*

SIGFOX is a private company that aims to create a worldwide network specially designed for devices IoT (Internet of Things). The technology allows data transfer over long distances with low power of the transmitter and low battery capacity [3]. The network is great for simple and stand-alone devices that send a small amount of data to this network. So the SIGFOX network is similar to the cellular infrastructure, but is more energy efficient and at the same time less expensive. SIGFOX uses an ultra-narrow band (Ultra Narrow Band, UNB) based on radio technology to connect devices to the global network. The use of UNB is a key factor in ensuring a very low power level of the transmitter that will be used during the state of maintaining a reliable data connection. The network operates in the existing unlicensed bands on a global scale and coexists in these frequencies with other radio technologies without the problem of overlapping the network or bandwidth problem. In Europe, the 868.8 MHz band is widely used, and in the US 915 MHz.

*NB-IoT technology*

NB-IoT (NarrowBand IoT - "narrowband Internet of things"), the same standard LTE-Cat. Has a number of advantages such as a wide coverage area, rapid modernization of the existing network, low power consumption, guaranteeing a 10-year lifespan batteries, low cost of the terminal, plug and play, increased reliability and a high carrier class security network [4]. The NB-IoT ideally meets the requirements of the LPWAN market, allowing operators to expand this new area. NB-IoT allows modern operators to work with traditional IoT directions, such as smart metering, tracking systems, thanks to ultra-low cost, and also opens up more industry opportunities, for example, "smart City", e-health systems. NB-IoT technology considers evolution from the cellular communication industry to the Internet of things. This is a wireless narrowband version of global networks with low power consumption, which is primarily designed for M2M (Machine-to-Machine) applications. The NB-IoT standard was specified by the 3GPP agreement in Release 13 (LTE Advanced Pro).

*Weightless P Technology*

Leader of the development of the standard Weightless was the industrial IoT company Ubiik [5]. Weightless – is an open standard for LPWAN networks of increased power, designed for network performance. In the special interest group Weightless (Special Interest Group, SIG), three different protocols are proposed - Weightless-H, Weightless-W, and Weightless-P, which support various forms and uses. Weightless-W is an open standard designed to work in the television frequency range (TV white space, TVWS). Weightless-W is ideal for use in the oil and gas industry. Weightless-N focuses on an extremely wide coverage area instead of high data rates. Although it is limited to one-way traffic. Weightless-N supports greater range and lower power consumption.

*Comparison of long-range network technologies LPWAN*

A comparison of long-range network technologies is presented in Table 1. As shown in the table, the technologies have a long range of communication, increased noise immunity, low data transfer rate, low power consumption and, as a result, a high degree of autonomy of terminal devices.

Table 1. – Comparison of long-range network technologies

| Technical specifications | LoRa | SIGFOX | NB-IoT | Weightless P |
|---|---|---|---|---|
| Modulation method | CSS | - | OFDMA | FDMA/TDMA |
| Band | IMS | IMS | licensed | IMS |
| Speed | 0.3-50 kb/s | 100 bit/s | 1-144 kb/s | 0.2-100 kb/s |
| Autonomy time | > 10 years | - | < 10 years | 3-5 year |
| Security | AES-64 / 128 | AES | - | AES-128 / 256 |
| Range | < 2.5 km | < 10 km | - | < 2 km |
| Support | LoRa Allianse, Semtech | SigFox, Samsung | Huawei, Intel | Ubiik, Weightless SIG |

*Conclusion*

The analysis revealed that each technology has a lot of advantages and features and none of the above options can be left out and takes place in the modern technology world. According to an independent assessment, the state and future development of global networks with low energy consumption for the Internet market Things for the next one or two years the most popular technology will be LoRaWAN and probably SIGFOX. In the future, it will be possible to expect the joint use of 3GPP-enabled technologies (for example, LTE-M) and the existing LPWAN technologies.

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