INFORMATIONAL MODELS OF THE ADVANCED SYSTEMS OF RADIOACCESS TO THE TELECOMMUNICATIONS NETWORKS COMPARISON

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Abstract: *Informational models of the advanced systems of radioaccess to the telecommunications networks comparison. LTE (Long Term Evolution) technology compared with the 802.1x protocol family.*

Keywords: *wireless networks, WPAN, WMAN, LTE, HSDPA, OFDM.*

ACM Classification Keywords: *C.2 Computer-Communication Networks; C.2.1 Network Architecture and Design – Wireless communication.*

Introduction

Building effective wireless radio systems to telecommunication networks has always been a daunting task, and its relevance is not lost over time, and acquires new contours. Currently, wireless radios technologies appear abound, and before network operator is to choose technologies optimally, solving the problem delivery of any kind of traffic to their subscribers. Naturally, generic solution to this problem does not exist: each technology has its range of application, its advantages and disadvantages.

Comparison of Basic Standards

At the moment there are the following wireless standards. All of them are divided into four broad categories:

- WPAN (Wireless personal area network);
- WLAN (Wireless Local Area Network);
- WMAN (Wireless Metropolitan Area Networks);
- WWAN (Wireless Wide Area Network).

Category WLAN intended for communication between a varieties of devices. It, like LAN, is based on twisted pair or fiber. This category is characterized by high speed data transmission over short distances. Interaction devices are described by family of standards IEEE 802.11. The data technology Wi-Fi is related to this standard [Baklanov, 2008].

Category WPAN - wireless network is designed to communicate wirelessly between various types of devices in a limited area (e.g. within the apartment, office workplace). Standards that define the methods of network operation are described in the family specifications IEEE 802.15. To this standard relate Bluetooth technology and ZigBee technology.

The category WMAN – can be attributed to a variety of different technologies – these are terrestrial Radio and television broadcasting, and cellular communications and tranking system. Note that the based on the standards wireless local area networks quite successfully build a Metropolitan Area Network. This category includes: WiMax, 3G, LTE (Long Term Evolution) [Semenov, 2005].

Global Network WWAN Wireless is different from WLAN wireless local area networks so that provide data transmission which is used in wireless mobile communication technologies, such as the UMTS, GPRS, CDMA2000, GSM, CDPD, Mobitex, HSDPA, 3G, LTE. Appropriate communication services offered, are usually on a fee basis by operators of regional, national or even a global scale. WWAN technology enables the user to gain access to the World Wide Web, use e-mail and connect to virtual private networks from anywhere within the coverage of a wireless carrier. Many modern laptops have integrated adapters WWAN (for example, HSDPA).

Currently the market of Ukraine has the prospect of a new technology LTE. LTE is a standard for wireless data communications technology and an evolution of the GSM/UMTS standards. The goal of LTE was to increase the capacity and speed of wireless data networks using new DSP (digital signal processing) techniques and modulations that were developed around the turn of the millennium. A further goal was the redesign and simplification of the network architecture to an IP-based system with significantly reduced transfer latency compared to the 3G architecture. The LTE wireless interface is incompatible with 2G and 3G networks, so that it must be operated on a separate wireless spectrum.

In its radio components new methods of modulation are used: OFDM. OFDM in its primary form is considered as a digital modulation technique, and not a multi-user channel access method, since it is utilized for transferring one bit stream over one communication channel using one sequence of OFDM symbols. However, OFDM can be combined with multiple accesses using time, frequency or coding separation of the users.

In orthogonal frequency-division multiple accesses (OFDMA), frequency-division multiple accesses is achieved by assigning different OFDM sub-channels to different users. OFDMA supports differentiated quality of service by assigning different number of sub-carriers to different users in a similar fashion as in CDMA, and thus complex packet scheduling or Media Access Control schemes can be avoided. OFDMA is used in:

- The mobility mode of the IEEE 802.16 Wireless MAN standard, commonly referred to as WiMAX;
- The IEEE 802.20 mobile Wireless MAN standard, commonly referred to as MBWA;
- The 3GPP Long Term Evolution (LTE) fourth generation mobile broadband standard downlink. The radio interface was formerly named High Speed OFDM Packet Access (HSOPA), now named Evolved UMTS Terrestrial Radio Access (E-UTRA);
- The now defunct Qualcomm/3GPP2 Ultra Mobile Broadband (UMB) project, intended as a successor of CDMA2000, but replaced by LTE.

OFDMA is also a candidate access method for the IEEE 802.22 Wireless Regional Area Networks (WRAN). The project aims at designing the first cognitive radio based standard operating in the VHF-low UHF spectrum (TV spectrum).

In Multi-carrier code division multiple accesses (MC-CDMA), also known as OFDM-CDMA, OFDM is combined with CDMA spread spectrum communication for coding separation of the users. Co-channel interference can be mitigated, meaning that manual fixed channel allocation (FCA) frequency planning is simplified, or complex dynamic channel allocation (DCA) schemes are avoided.

In OFDM based wide area broadcasting, receivers can benefit from receiving signals from several spatially dispersed transmitters simultaneously, since transmitters will only destructively interfere with each other on a limited number of sub-carriers, whereas in general they will actually reinforce coverage over a wide area. This is very beneficial in many countries, as it permits the operation of national single-frequency networks (SFN), where many transmitters send the same signal simultaneously over the same channel frequency. SFNs utilize the available spectrum more effectively than conventional multi-frequency broadcast networks (MFN), where program content is replicated on different carrier frequencies. SFNs also result in a diversity gain in receivers situated midway between the transmitters. The coverage area is increased and the outage probability decreased in comparison to an MFN, due to increased received signal strength averaged over all sub-carriers.

Although the guard interval only contains redundant data, which means that it reduces the capacity, some OFDM-based systems, such as some of the broadcasting systems, deliberately use a long guard interval in order to allow the transmitters to be spaced farther apart in an SFN, and longer guard intervals allow larger SFN cell-sizes. A rule of thumb for the maximum distance between transmitters in an SFN is equal to the distance a signal travels during the guard interval – for instance, a guard interval of 200 microseconds would allow transmitters to be spaced 60 km apart.

A single frequency network is a form of transmitter macro diversity. The concept can be further utilized in dynamic single-frequency networks (DSFN), where the SFN grouping is changed from timeslot to timeslot.

OFDM may be combined with other forms of space diversity, for example antenna arrays and MIMO channels. This is done in the IEEE802.11 Wireless LAN standard.

MIMO technology has attracted attention in wireless communications, because it offers significant increases in data throughput and link range without additional bandwidth or increased transmit power. It achieves this goal by spreading the same total transmit power over the antennas to achieve an array gain that improves the spectral efficiency (more bits per second per hertz of bandwidth) and/or to achieve a diversity gain that improves the link reliability (reduced fading). Because of these properties, MIMO is an important part of modern wireless communication standards such as IEEE 802.11n (Wi-Fi), 4G, 3GPP Long Term Evolution, WiMAX and HSPA+.

MIMO technology, which was used in the HSPA + (2x2 antennas) has been further developed (4x4 antennas and more, depending on the release and supporting 3GPP terminals). This technology allows more bandwidth radio interface [Tanenbaum, 2005].

As in many other areas, wireless data is no universal technology. Under each specific task a definite technology is suited. If the task is to provide broadband access to the user - it is more suitable WiMax, LTE as the technology was originally developed for this purpose.

However, if the task is to provide broadband access in a limited space, the technology Wi-Fi, Bluetooth or WiMax is equally well suited for decision, provided that a low level of interference or noise doesn't existent. And for the introduction of wireless alarm systems or CCTV is more suitable Wi-Fi, ZigBee because this issue is quite well developed. In Table 1 has been carried comparison of wireless standards.

Every of these technologies have its own advantages and disadvantages. The main advantage of all these technologies is that they are wirelesses, and therefore do not need to pull the cable. From Table 1 can be concluded that technologies: Wi-Fi, Bluetooth and ZigBee working in one frequency band 2/4 GHz, than that interfere with one other. WiMax operates in the band from 1.5 GHz to 20 GHz.

The advantages of Bluetooth and ZigBee devices are low cost and low energy costs to the disadvantage belong a short range and low bandwidth.

Among the advantages of Wi-Fi is that the devices are widely circulated in the market, which ensures compatibility of the equipment thanks to mandatory certification of equipment logo Wi-Fi. Because of low cost and ease of installation, Wi-Fi is often used to provide customers' fast Internet access. The disadvantage is that in the range of 2,4 GHz running a variety of devices, such as devices that support Bluetooth, and even microwave ovens, which degrades the electromagnetic compatibility and interfere with the work of Wi-Fi. Wi-Fi system is a short-acting, usually covering 20-300 of meters that uses unlicensed frequency bands to provide access to the network.

Usually Wi-Fi is used by users to access of their own network, which may not be connected to the Internet. If WiMAX, LTE can be compared to mobile communications, the Wi-Fi is more like a landline cordless phone.

WiMAX allows you to access the Internet at high speeds, with much greater coverage than Wi-Fi-networks. This allows the use of technology as a "mainline channel", a continuation of that traditional DSL and leased lines, as well as local area networks. As a result, this approach allows you to create scalable, high-speed networks within the framework of cities [IEEE, 2010].

The advantage of LTE is high bandwidth in 326 Mbit/s, and large radius of action up 5 to 100 km. Given that the technology is relatively new, there are prospects for development in a given direction.

The LTE specification provides downlink peak rates of 300 Mbit/s, uplink peak rates of 75 Mbit/s and QoS provisions permitting a transfer latency of less than 5 ms in the radio access network. LTE has the ability to manage fast-moving mobiles and supports multi-cast and broadcast streams. LTE supports scalable carrier bandwidths, from 1.4 MHz to 20 MHz and supports both frequency division duplexing (FDD) and time-division duplexing (TDD). The IP-based network architecture, called the Evolved Packet Core (EPC) and designed to replace the GPRS Core Network, supports seamless handovers for both voice and data to cell towers with older network technology such as GSM, UMTS and CDMA2000.

The simpler architecture results in lower operating costs (for example, each E-UTRA cell will support up to four times the data and voice capacity supported by HSPA).

Considering that is formally referred to as LTE 4G generation, which can be called the first stage of 3G + and implement hardware 3G, by modernizing only the software.

Table 1. Comparison of Wireless Standards

Technology	Standard	Category	Throughput	Action radius	Frequencies	Cost
Wi-Fi	802.11a	WLAN	up to 54 Mbit/s	up to 300 m	5,0 GHz	from $30
Wi-Fi	802.11b	WLAN	up to 11 Mbit/s	up to 300 m	2,4 GHz	from $30

Wi-Fi	802.11g	WLAN	up to 54 Mbit/s	up to 300 m	2,4 GHz	from $30
Wi-Fi	802.11n	WLAN	up to 450 Mbit/s	up to 300 m	2,4 GHz, 5 GHz	from $30
Bluetooth 1.1	802.15.1	WPAN	up to 1 Mbit/s	up to 10 m	2,4 GHz	from $10
Bluetooth 2.0	802.15.3	WPAN	up to 2.1 Mbit/s	up to 100 m	2,4 GHz	from $10
Bluetooth 3.0	802.11	WPAN	3-24 Mbit/s	up to 100 m	2,4 GHz	from $10
Bluetooth 4.0	802.11	WPAN	up to 0.26 Mbit/s	up to 100 m	2,4 GHz	from $10
ZigBee	802.15.4	WPAN	20 – 250 Mbit/s	up to 100 m	868 MHz, 915 MHz, 2,4 GHz	from $45
WiMax	802.16d	WMAN	up to 75 Mbit/s	25-80 km	1,5-20 GHz	from $90
WiMax2	802.16m	WMAN	up to 75 Mbit/s	25-80 km	1,5-20 GHz	from $90
LTE	3GPP LTE	WMAN	up to 326,4 Mbit/s	up to 5 up to 100 km	800 MHz, 1,8 GHz, 2,6 GHz	from $50

Conclusion

The report represents a comparative analysis of promising wireless radio systems for telecommunications networks. A special attention was paid to perspective of a new technology LTE based on the protocol 3GPP LTE. Technology allows working at long distances, at high data rates.

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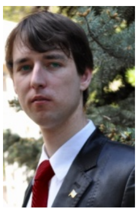
Major Fields of Scientific Research: improvement of radioaccess systems for computer telecommunications networks



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