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Key Concepts of 5th Generation Mobile Technology

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Abstract**—**The 5th generation of mobile networks is term used in various research papers and projects to identify the next major phase of mobile telecommunications standards. 5G wireless networks will support higher peak data rate, lower latency and provide best connections with QoS guarantees.

In this article, we discuss various promising technologies for 5G wireless communication systems, such as IPv6 support, World Wide Wireless Web (WWWW), Dynamic Adhoc Wireless Networks (DAWN), BEAM DIVISION MULTIPLE ACCESS (BDMA), Cloud Computing, cognitive radio technology and FBMC/OQAM.

This paper is organized as follows: First, we will give introduction to 5G systems, present some goals and requirements of 5G. In the next, basic differences between 4G and 5G are given, after we talk about key technology innovations of 5G systems and finally we will conclude in last Section.

Keywords**—**WWWW, BDMA, DAWN, 5G, 4G, IPv6, Cloud Computing, cognitive radio, FBMC/OQAM.

I. Introduction

IN the last years, Mobile and wireless networks have made remarkable development. High demands for broadband mobile wireless communications and the emergence of new wireless multimedia applications have constituted the motivation to the development of broadband wireless access technologies.

The mobile communication systems and the wireless communication technologies have been improving very fast day by day, from 1G to 4G the world of telecommunications has seen a number of improvements along with improved performance with every passing day.

Smartphones and new mobiles devices that support a wide range of applications and services such as image transfer, video streaming and cloud services increased need for a new mobiles communications system with even further enhanced capabilities.

The fifth generation wireless communication systems presents the next major phase of mobile telecommunications standards supers the current and the new standard releases beyond 4G systems that are in progress [3].

However, The 5G systems that are expected to be deployed in many countries between 2020 and 2030 are not considered as new mobile generations and is not a term officially used for any particular standardization bodies such as 3GPP, WiMAX Forum, or ITU [10], [11].

5G should make an important difference and add more services and features to the world over 4G and should be more intelligent technology that interconnects the entire world without limits [9].

The goals of a 5G-based telecommunications network would ideally answer the challenges that a 4G model would present once it has entered widespread use.

New standard releases beyond 4G are in progress by standardization bodies, but at this time are not considered as new mobile generations [1], [2].

In order to present and study the 5G systems, many works are done for the definition of a 5G systems [3], [5] present the future concepts of mobile communication, such as Internet services, Cloud computing, All IP network, and Nanotechnologies.

Reference [4] gives an overview of the 5G Model as an open platform on different layers and protocol stack and [6] is being made on development of World Wide Wireless Web (WWWW), Dynamic Adhoc Wireless Networks (DAWN) and Real Wireless World.

The major difference between current generations and 5G systems could be something else than increased maximum throughput.

There are many technical capabilities and goals that must be addressed with 5G system. All these capabilities are defined by the user requirements and include:

- Capabilities to support massive capacity and massive connectivity.
- Data Bandwidth: higher than 1 Gbps.
- Spectrum efficiency: Flexible and efficient use of all spectrums.
- Low latency: latency of one millisecond.
- Better coverage and high data rates available at each cell
- Collect, manage and store the customers' accounts information from multiple service providers.
- Finest and intelligent quality of service (QoS) management.
- Lower battery consumption.
- Technology convergence.
- Providing best connection with QoS guaranty.
- Capabilities of mobile terminal to store QoS parameters and use intelligent algorithms to provide best connection: routing information and QoS history will be stored in intelligent database with goal to be used by intelligent algorithms running in the mobile terminal.
- Providing reconfigurable core network called the MasterCore Network.

To achieve those goals and requirements, various promising technologies for 5G wireless communications are required.

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TABLE I
BASIC COMPARISON AMONG 4G AND 5G TECHNOLOGIES

Generation	4G				5G
3GPP Releases	Rel-8/9	Rel-10	Rel-11/12	Rel-13 and beyond	Re-16 and beyond
Technology	LTE	LTE-Advanced		B4G	>=1Gbps
Peak data rate (DL)	100 Mbps	1Gps	1Gbps	>=1Gbps	
Peak data rate (UL)	50 Mbps	500 Mbps	500 Mbps	>=500 ms	
Latency round trip time	10 ms			=< 10 ms	tends to zero
Access technology	OFDMA(downlink) /SC-FDMA (Uplink)				BDMA
Modulation Types	QPSK, 16QAM, 64QAM (Uplink and downlink)				FBMC/OQAM
Frequency Band	2-8 GHz				3-300 Ghz
Start from	2010				2020

These technologies include:

- BDMA (Beam Division Multiple access)
- IPv6 support
- Mobile Cloud Computing support
- WWWW and DAWN
- Cognitive radio technology
- FBMC/OQAM

The deployment of the 5G network will drive the future evolution of the internet and will solve some problems such as the problem of frequency licensing and spectrum management.

II. RELATED CONCEPTS OF 5G SYSTEMS

A. WWWW and DAWN

One of the major goals of 5G research is the development of World Wide Wireless Web (WWWW) that will be capable of supporting applications and services in 2020 to 2030 and interconnecting the world.

With wwww, world web will be capable to support a wireless based web applications that includes full graphics and multimedia-capability at 5G system.

The 5G system will be capable of supporting wwww allowing Dynamic Adhoc Wireless Networks (DAWN) that is identical to Mobile Adhoc Network (MANET) or Wireless Mesh Network (WMN) combined with smart antennas and flexible modulation [5].

DAWN was established to address the limitations of the current networks in terms of modeling ad hoc networks, their protocols and to develop a general theory of complex and dynamic wireless communications networks. It is new approach for deploying MANET protocols, achieving concise specifications, policy-based adaptation and inter-protocol forwarding across different protocols [20].

The DAWN can provide many benefits such as delay tolerant; secure Multicast using, QoS support, improving End-to-End Transport, and efficient routing.

B. Ipv6 Support

The goal of 5G system is to establish single worldwide network. It will be based on IPv6 which is used for mobility. In 5G IPv6-based, each node will be identified with home address and its home IP subnet.IPv6 will facilitate phone movement between cells. Each IP interface in the terminal is characterized by its IP address and net mask and parameters associated with the routing of IP packets across the network [21]. The deployment of IPv6 will add many improvements to IPv4 such as [7]:

- Address Auto-configuration
- Native multicast support
- Network layer security by integrating IPsec (IP security) in the protocol specification.
- Native mobility support

In summary, the use of IPv6 in 5G systems will offer scalable, secure and high-performance mobility management.

C. BDMA

The ambitions of 5G mobile systems are to provide enhanced and flexible services to a larger number of subscribers and to make higher bit rates available in larger portion of the cell. To achieve those goals multiple access technique is required.

In wireless communications systems, cellular system divides any area into cells where a mobile station in each cell communicates with a base station in order to increase the capacity of channel.

There are various multiple access techniques FDMA, CDMA and OFDM. In these techniques time and frequency are divided among multiple users [3].

- Frequency Division Multiple Access (FDMA): The FDMA was the initial multiple-access technique for cellular systems in which each
- Individual user is assigned a pair of frequencies while making or receiving a call i.e. The FDMA technique divides frequency resource and allots them to respective mobile stations, allowing to give multiple accesses.
- Time Division Multiple Access (TDMA): In TDMA, the entire bandwidth is available to the user but only for a finite period of time i.e. The TDMA technique divides time resource, and allots respective mobile stations to give multiple accesses.
- Code Division Multiple Access (CDMA): The CDMA utilizes the specific coding for each telephone call or data session that allows the mobile equipment to ignore other transmissions on the same frequency i.e. The CDMA technique allots orthogonal codes to respective mobile stations, which allows the mobile stations to give multiple access
- Orthogonal Frequency Division Multiple Access (OFDMA): In OFDM, multiple access is achieved by assigning subsets of subcarriers to individual users. This

allows simultaneous low data rate transmission from several users.

Korean research has proposed a new technique called BDMA (Beam Division Multiple Access) which is not depend on frequency and time.

The principle of BDMA technology is to divide an antenna beam according to locations of mobile stations to provide multiple accesses by increasing the capacity of the system.

When mobile stations are located at different angles with Base Station, the Base Station transmits different beams at different angles; an orthogonal beam is allocated to each mobile station

In BDMA technique, the beam is three dimensionally divided. In fact, each beam accommodates more users. Mobiles stations positioned at a similar angle share one beam to communicate with base station, the mobile station sharing the same beam divide same frequency/time, resources and orthogonal resources. At the first time, base station and mobile station don't know each other's positions; the mobile stations detect their positions and transmit the detected positions and moving speeds information to the base station.

According to the position and moving speed information of the mobile station received from the mobile station, the base station calculates a direction and width of a downlink beam. This downlink beam and calculated direction and width are transmitted to the mobile station. When the mobile station receives the calculated a direction and a width of the downlink beam, it tracks a direction of the downlink beam to set a direction of an uplink beam, and transmits the uplink beam in the set direction. After the mobile station is made up link beam, a beam update is time to time performed between mobile station and the base station.

To use the BDMA technology into 5G mobile networks, the switched beam antennas will have the ability to switch its beam and will support radio positioning via angle of arrival information collected from base and mobile stations.

In conclusion, the BDMA have lot of advantages, these advantages include:

- Solving interference problems inter-cell.
- Maximize use of frequency/time resources.
- Maximize the system capacity of a base station by the number of beams in the base station.
- Problems of a control channel occurring because mobile stations having good channels and mobiles stations having bad channels using the same base station at the same time will be solved.
- Efficient division of a space resource.

D.Cloud Computing

In 5G mobile networks, an increasing demand for resource management, data storage and mobile sensing has motivated the development and use of cloud computing. 5G technology will support cloud services in multi-technology networks.

Cloud Computing is a new technology uses the internet and remote server to maintain data services and applications [8], user can access all data from anywhere in the world. In 5G systems, the remote server could be a content provider [9] and all applications and services are stored on server, and all processes are done on cloud i.e. processes and data will not physically be stored on the phone, which will offer low processing capability, low data storage and less power mobile. This could make real time application and to utilize 5G network efficiently and effectively.

E. Cognitive Radio Technology

In recent years, the number of user requirements of radio spectrum increase day by day. The wireless environment is practically unable to satisfy all its users. However, to support various wireless applications and services, the fixed spectrum access (FSA) policy has adopted by spectrum regulators [14] and only licensed users have the right to exploit the spectrum and other users are not allowed to use it. Thus, according to many researches it has been found that the licensed spectrum is not utilized properly. In order to resolve these problems and provide optimum use of the spectrum the cognitive-radio CR technology is innovated. CR is one of the most promising technologies for 5G mobiles systems. The principal goal of the CR technology is to find unused spectrum and adapting the transmission schemes requirements of technologies currently sharing the spectrum [13] i.e. Initially, CR identify the existing spectrum [15].

In order to make sure that the frequency spectrum is not in use and identify unused spectrum, both parties of communication have to scan spectrum and inform each other about the spectral conditions. Therefore, the receiving sensitivity of both parties has an integral role in determining the range of communication [16]. The first step to implement CR system is that the secondary users need to detect the presence of primary users in a licensed spectrum and quit the band as quickly as possible if the corresponding primary radio emerges in order to avoid interference to primary users. This technique is called spectrum sensing [12]. The second step is the spectrum management. The goal of this step is to identify how long the secondly users can use a white spaces in licensed bands i.e. unused frequency bands. Spectrum sharing is to share the white spaces among the secondary users and finally, the spectrum mobility maintain unbroken communication to better spectrum [12], [13].

F.FBMC/OQAM

Multicarrier Modulation (MCM) has been attracting a lot of attention and has been exhibited its potential to transmit large amounts of data across a channel. The concept of MCM is based on sending parallel streams of information in the frequency domain on different center frequencies.

With Multicarrier Modulation (MCM) schemes, a system can achieve much higher spectral efficiency in frequency selective channels compared to those using single carrier modulation techniques.

In recent years, orthogonal frequency division multiplexing (OFDM) has enjoyed its dominance as the most popular signalling method in 4G system [17].

Seen as novel MCM technique, OFDM has been adopted in DSL standards as well as in the majority of 4G standards such as 3GPP-LTE, and LTE-Advanced.

In OFDM technique, each subcarrier signal can be demodulated in the absence of inter carrier interference (ICI) and intersymbol interference (ISI) which make OFDM robust to channel multipath dispersion. However, OFDM is based on cyclic prefix (CP) which is associated with the reduction in the spectral efficiency and also in certain applications such as cognitive radio and uplink of multicarrier systems [19].

In addition, the increased symbol duration makes an OFDM system more sensitive to the time variations of mobile radio channels. In particular, the effect of Doppler spreading destroys the orthogonality of the subcarriers, resulting in intercarrier interference (ICI) due to power leakage among OFDM subcarriers.

One solution to those problems is to employ a new family of multicarrier system referred to as FBMC/OQAM.

The FBMC/OQAM modulation is being studied and considered nowadays by research projects as a key enabler for the future flexible 5G air interface [18].

This scheme exhibits better spectrum shape compared to the traditional OFDM (Orthogonal Frequency-Division Multiplexing) and enables better spectrum usage and mobility support.

In FBMC/OQAM technique, a prototype filter is designed to achieve a certain goal, such as minimizing inter-symbol interference (ISI) and inter-carrier interference (ICI)

Based on the FBMC/OQAM technology, 5G will achieve high peak data rate, efficient use of the spectrum and make spectral holes suitable for cognitive radios by providing efficient spectrum sharing, efficient spectrum sensing and guaranteed separation of users.

These superior qualities of FBMC make it an ideal choice for CR communications and multiple access networks.

III. Conclusion

There are lots of improvements from 1G to 5G in the world of wireless communication technology.

The 5G mobile technology will offer high data rate, efficient and reliable communication at an affordable rate and will drive the future evolution of the internet.

5G technology will be a new mobile revolution in mobile market. Through 5G technology you can use worldwide cellular phones based on WWWW technology.

This paper presents 5G technology which depends on DAWN, WWWW, Cloud computing, BDMA, and IPv6 technologies.

In our future work, more technologies, challenges and models of 5G systems will be discussed.

References

[1] Srishti Mishra, Rakesh Patel, Chhaya Mehar, "Study on 5G Wireless Communication System" Global Journal of Engineering Science and Research Management ISSN: 2349-4506, October, 2014.

[2] Vikas Kumar, Nidhi Mishra "5G: Future of Wireless Network" Volume 1 Issue 5 | ISSN: 2349-6002, IJIRT 2014.

[3] Suvarna Patil, Vipin Patil, Pallavi Bhat, "A Review on 5G Technology" International Journal of Engineering and Innovative Technology (IJEIT) Volume 1, Issue 1, January 2012

[4] Meenal G. Kachhavay et al, "5G Technology-Evolution and Revolution" International Journal of Computer Science and Mobile Computing, Vol. 3 Issue. 3, March- 2014, pg. 1080-1087

[5] D. Hema Latha, D. Rama Krishna Reddy, K. Sudha, Azmath Mubeen, T. S. Savita "A Study on 5th Generation Mobile Technology - Future Network Service" (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 5 (6), 2014, 8309-8313.

[6] Asvin Gohil, Hardik Modi, Shobhit K Patel "5G Technology of Mobile Communication: A Survey" International Conference on Intelligent Systems and Signal Processing (ISSP) 2013.

[7] A. Ksentini "IPv6 over IEEE 802.16 (WiMAX) networks: Facts and challenges" Journal of Communications, vol. 3, no. 3, July 2008.

[8] Peter Mell and Timothy Grance, "The NIST Definition of Cloud Computing" US National Institute of Standards and Technology Special Publication 800-145, September 2011.

[9] S. Hossain " 5G Wireless Communication Systems" American Journal of Engineering Research (AJER) e-ISSN : 2320-0847 p-ISSN : 2320-0936 Volume-02, Issue-10, pp-344-353www.ajer.org

[10] A. Deep Varshney, S. Dubey, "Convergence of 5G Technology by Using Distributed System" (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 5 (2), 2014, 1223-1226.

[11] J. Sheetal "Architecture of 5G Technology in Mobile Communication" Proceedings of 18th IRF International Conference, 11th January 2015, Pune, India, ISBN: 978-93-84209-82-7.

[12] Mansi Subhedar and Gajanan Birajdar "Spectrum Sensing Techniques in Cognitive Radio Networks: A Survey" International Journal of Next-Generation Networks (IJNGN) Vol. 3, No.2, June 2011.

[13] Saurabh Patel, Malhar Chauhan and Kinjal Kapadiya "5G: Future Mobile Technology-Vision 2020" International Journal of Computer Applications (0975 – 8887) Volume 54– No.17, September 2012.

[14] Ying-Chang Liang and Geoffrey Ye Li "Cognitive Radio Networking and Communications: An Overview" IEEE Transactions on Vehicular Technology, vol. 60, no. 7, September 2011

[15] Cornelia-Ionela Badoi, Neeli Prasad, Victor Croitoru and Ramjee Prasad "5G Based on Cognitive Radio" Published online: 8 July 2010, Springer Science+Business Media, LLC. 2010.

[16] Mustafa E. Şahin and Hüseyin Arslan "System Design for Cognitive Radio Communications" 1-4244-0381 -2/06 2006 IEEE.

[17] Behrouz Farhang-Boroujeny "Filter Bank Multicarrier Modulation: A Waveform Candidate for 5G and Beyond" Hindawi Publishing Corporation Advances in Electrical Engineering Volume 2014, Article ID 482805, 25 pages.

[18] Jeremy Nadal, Charbel Abdel Nour, Amer Baghdadi, Hao Lin" Hardware prototyping of FBMC/OQAM baseband for 5G mobile communication" IEEE International Symposium on Rapid System Prototyping, 16-17 October 2014, New Delhi, India, 2014, pp. 135-141.

[19] Bidyalaxmi Devi Tensubam, Sonika Singh "A Review on FBMC: An Efficient Multicarrier Modulation System". International Journal of Computer Applications (0975 – 8887) Volume 98– No.17, July 2014

[20] Changbin Liu, Ricardo Correa, Xiaozhou Li, Prithwish Basu, Boon Thau Loo, and Yun Mao "Declarative Policy-Based Adaptive Mobile Ad Hoc Networking" IEEE/ACM Transactions on Networking, Vol. 20, No. 3, June 2012.

[21] Sapana Singh, Pratap Singh "Key Concepts and Network Architecture for 5G Mobile Technology" International Journal of Scientific Research Engineering & Technology (IJSRET) Volume 1 Issue 5 pp 165-170 August 2012.