Wireless Generation for 2020 - 5G Technology and Introduction to Its Vital Technology Components

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***Abstract*—**When the advanced technology is introduced it gives more user friendly environment to customers. This is what 5G gives us than earlier wireless generations. 5G provides us enhanced capabilities of LTE-Advanced (LTE-A) i.e. 4G generation. Today 4G is still being under improvement, but early designs have started on its replacement: 5G. The 5G means the fifth generation of wireless or mobile communication. 5G is an end-to-end system which enables a fully mobile and connected society. 5G is capable of gives very high achievable data rates, very little latency and high consistency. It also supports the handling tremendous device densities. The main technology components gives extension to higher frequency bands, advanced multi-antenna transmission, tilt design, user/organize separation, stretchy spectrum usage, balancing device-to-device communication. 5G will supports 1000 times higher mobile data volume per area, 10 times to 100 times higher number of connected devices, 10 times to 100 times higher typical user data rate, 10 times longer battery life for low power Massive Machine Communication (MMC) devices, 5 times reduced End-to-End (E2E) latency[1]. The fifth generation of mobile technology (5G) is located to address the demands and business contexts of 2020 and beyond. It is anticipated to enable a fully mobile and connected society and to permit socio-economic transmissions in number of ways for good organization, sustainability and comfort. The burdens of a fully mobile and connected society are characterized by the fantastic growth in connectivity and amount of traffic.

Keywords- *5G technology; LTE; MMC devices; Key technology components; latency; capabilities*

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I. INTRODUCTION

Yet the 4th Generation cellular systems are being developed, work has started on their successor: 5G. This paper describes the 5th evolution of mobile communication and continued development of mobile and fixed-line communications systems, and explains some background on who is involved and what is currently happening in bringing 5G.

5G is proposed to provide high speed, high capacity, low cost per bit, IP based services. The goal is to have data rates up to 1Gbps. 5G wireless technologies will allow an individual to have immediate access to location-specific services that offer information on demand at an amazingly high speed and low cost. Meet the world of marvelously high-speed data communication and mobile technology at a very low cost. That's 5G.

We want to use streaming services instantly on our all types of devices. We want to share our data such as photos, videos with our loved once wherever they may be. The need for high-speed connectivity is a common goal to look ahead to fifth-generation or 5G networks. 5G going far beyond simple voice and data services and moving to a future state of "everything everywhere and always connected".

The sudden increase of wireless data demand includes analysts predicting anything between 20 and 50 billion devices by the year 2020, ranging from M2M devices that transmit a few bytes per day to applications that stream multiple high definition video channels [1].

Repeated changes in mobile network technology and system specifications have provided higher cell capacity and resulting improvements in single-user data rate.

5G provides latest demand i.e. "flawless connectivity" which is the ability to move an application amongst digital gadgets without any break of the content. To provide this capability we requires multiple network such as WiFi, hotspot, cellular, PSTN, ISDN.

5G is the next step in the evolution of mobile communication after LTE and LTE-A. It gives infinite access to information and allotment of data anyplace and anytime for anyone. 5G will therefore not only be about mobile connectivity for people. 5G will also provide wireless connectivity for a broad range of applications including smart homes, traffic protection and control, and critical infrastructure and industry applications and for very-high-speed data delivery. 5G wireless is an overall solution for the demands and necessities of mobile communication beyond 2020.

In this paper, I try to cover general introduction, developed evolution of wireless mobile communication, applications of 5G, Frequency spectrum for 5G and key technology components.

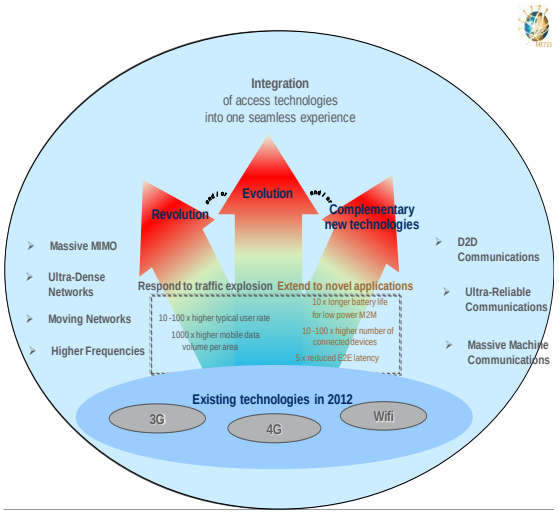

Fig. 1. 5G Future [2]

II. WIRELESS EVOLUTION

1. First generation (1G)

The First Generation of wireless mobile communications was based on analog signals and uses Amplitude modulation were known as Analog Mobile Phone Systems (AMPS) It is based on circuit-switched technology and designed for voice. The service cost of 1G was very high.

2. Second Generation (2G)

The second generation is first digital mobile networks.
Global Systems for Mobile Communications (GSM) is popular 2G mobile technology.
It is a combination of Frequency Division Multiple Access (FDMA) and Time Division Multiple Access (TDMA). GSM systems operate in the 900MHz and 1.8 GHz bands and 1.9GHz band. Personal Digital Communications (PDC) is TDMA-based 2G mobile technology. Code Division Multiple Access (CDMA) technology is one more 2G standard. CDMA technology gives clearer voice quality with less surroundings noise, fewer dropped calls, superior security, greater reliability and greater network capacity.
The Second Generation (2G) wireless networks are based on circuit-switched technology. 2G wirelesses provides advanced voice services, such as Called Line Identification and handle some data services such as fax and short message service at the low data rate. This data rate is not suitable for web browsing and multimedia applications.

3. Two and half Generation (2.5G or 2G+)

The data rates of 2G circuit-switched generations are slow for today's applications. So GSM, PDC and other TDMA-based mobile system providers developed 2.5G technology. These technologies were packet-based and increases the data speeds than 2G.
These 2.5G generations are based on the High Speed Circuit-Switched Data (HSCSD), General Packet Radio Service (GPRS) and Enhanced Data Rates for Global Evolution (EDGE) technologies. The 2.5G deliver voice and circuit-switched data applications
and adds a packet data cover to support additional packet data services.

4. Third Generation (3G)

The important factor of 3G wireless technology is well-matched with its presented cellular standards, such as CDMA, GSM, and TDMA. There are three air interface modes-

1. Wideband CDMA
2. CDMA2000 and
3. Universal Wireless Communication (UWC-136) interfaces.

Wideband CDMA (W-CDMA) is compatible with the current 2G GSM networks. W-CDMA is used for higher capacity applications. The CDMA 2000 is backward compatible with the 2 G CDMA IS-95standards. The Universal Wireless Communications – UWC-136, also known IS-136HS, was proposed by the TIA and designed to comply with ANSI-136 TDMA standard.

3G provides market-focused application, Advanced and lightweight devices, real-time multimedia Communications, Global mobility and roaming, High-speed e-mail and Internet access.

5. Fourth Generation (4G)

4G networks will replace 3G network. Current available technologies are LTE (Long-Term Evolution) and WiMax and IMT-Advanced [4].These are suitably advanced from 3G. The target speed was at least 100 Mbps for the 4G. There are three 4G systems-

1. LTE-Advanced
2. Wireless MAN-Advanced, the most recent version of WiMax, also called WiMax 2.
3. HSPA+ [3]

These technologies can all deliver multiple megabits per second upstream and downstream, far more than most existing 3G networks. 4G is based on entirely packet switched networks and it provides tight network security.
4G provides support for interactive multimedia services such as teleconferencing, wireless Internet, etc. Also supports wider bandwidths, higher bit rates, Global mobility and service portability and low cost [4].

III. WHY 5G BEFORE 4G HAS NOT BEEN DEPLOYED?

The previous generations of wireless networks not provide connectivity for broad range of applications. These applications will cover in 5G networks. Some of the capabilities of 5G as follows:-

1.Huge system capacity

5G system supports large demands of customers in reasonable ways. 5G networks are cheaper than today's existing networks, It will capable to deliver data with much lower cost per bit. 5G gives lower energy consumption per delivered bit. 5G system will support a larger number of devices compared with today.

2. Very high data rates in all places

The latest generation of wireless communication has been associated with higher data rates than prior generation. 5G supposed to provide data rates exceeding 10Gbps in indoor and outdoor environments. Data rates of 100Mbps should be possible in urban and suburban environments. Data rates of at least 10Mbps should be attainable essentially all over, rural areas in both developed and developing countries.

3. Very little latency

Lower latency is the main objective for 3G and 4G evolution. When we use internet protocol, it is difficult to achieve higher data rates and lower latency due to some properties of internet protocol. But 5G gives higher data rates and also lower latency. For some 5G applications 5G should allow end-to-end latency of 1ms or less.

4. Ultra-High consistency and accessibility

5G should also enable connectivity with ultra-high consistency and ultra-high accessibility. With 5G networks

connectivity will always available with essentially no variation.

5. Very low device cost and energy consumption

The main requirement of mobile communication is low cost and low energy consumption of handheld devices. It should be possible for 5G devices to be accessible at very low cost and with a battery life of several years without recharging.

6. High network energy performance

Energy consumption is important factor in mobile communication. If the energy performance is high it reduces the operational and overall ownership cost. High network energy performance allows networks to use decently sized solar panels as power supply and therefore enabling wireless connectivity to the most remote areas [5].

IV. SPECTRUM FOR 5G

For increasing the traffic capacity and for higher data rates 5G will broaden the range of frequencies used for wireless communication. This includes new spectrum below 6 GHz, expected to be allocated for mobile communication. The spectrum associated with 5G wireless access ranges from below 1 GHz up to in the order of 100GHz. Lower frequencies will remain the backbone for mobile communication networks in the 5G epoch, providing omnipresent wide-area connectivity.

V. FEATURES OF 5G

There are some features of 5G

1. It provides high resolution and bi- directional huge bandwidth.
2. It provides high connectivity speed with less traffic.
3. It supports high uploading and downloading speed up to 1 Gbps.
4. It supports virtual private networks.
5. 5G is a more attractive and effective than any prior generations.

VI. APPLICATIONS OF 5G

There are two types of applications in 5G .

1. Mobile Telephony, mobile Broadband and media delivery is the fundamental applications of 5G related to human information.
2. There are some new applications of 5G are related to end to end communication between devices. These device communication applications are known as machine-type communication (MTC).

MTC applications are further classified into two main types.

1. Massive MTC
2. critical MTC

A. Massive MTC applications consists of

1. Scalable and Flexible Access i.e. Scalable and flexible bandwidths and scalable and flexible signaling protocol
2. Capillary networks i.e. short-range radio and cellular

B. Critical MTC applications consists of

1. Very short transmission times
2. Contention-based access and fast channel assignments
3. Multi-level diversity
4. Device-to-device communication [5]

VII. 5G TECHNOLOGY COMPONENTS

There are several other key technology components relevant for the evolution to 5G wireless access.

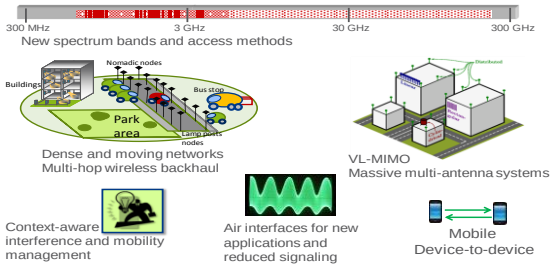

Fig. 2. 5G Technology components [2]

1. Multi-antenna transmission

Multi antenna transmission is used in current generations and in 5 G also. 5G uses high frequencies for higher data rates and extend the coverage. So for beam-forming at transmitter and receiver site and avoid spreading multi-antenna transmission used In 5G.

2. Ultra lean design

Ultra-lean radio-access design is used to achieve high efficiency in 5G networks. Ultra lean design is used for high network energy performance and achieves higher data rates than previous generations. It minimizes transmissions which is not directly related to data such as synchronization signals, different control information etc. It is mostly used in extremely variable traffic conditions. It is useful for all types of deployments[6]

3. User/control partition

The important factor for 5G wireless evolution is separation of user data and system control information. Such separation will allow separate scaling of user data capacity and basic system control functions. Combining ultra-lean design with a user/control partition technology component 5G will enable a much higher degree of device-centric network optimization of the active radio links in the network and provides higher flexibility in terms of evolution.

4. Flexible bandwidth usage

The licensed frequency band is allocated for mobile communication for per operator within a geographical area. This will remain the foundation for mobile communication in

possibility to operate under other spectrum regimes. The spectrum is shared between a limited set of operators.
Differing from conventional per-operator spectrum licensing will mainly be relevant in frequency bands above 10GHz.
The high-frequency bands is mainly used for very wide transmission bandwidths. It may be difficult to find sufficiently large spectrum blocks to allow for per-operator-dedicated spectrum supporting such bandwidths for multiple operators.
Also high-frequency bands will be used for dynamic traffic variations. Statically dividing the spectrum between different operators may, in such situations, not necessarily lead to the most efficient spectrum usage. So operators are jointly access part of spectrum in a dynamic way and the spectrum utilize efficiently.

5. Flexible duplex
FDD is a the duplexing technique used since the beginning of the wireless generations.
In 5G wireless system, for lower frequency bands, FDD will remain the main duplex technique and for higher frequency bands, above 10GHz, targeting very crowded deployments, TDD will use. For active traffic 5G assigns flexible time slots to different transmission directions to use available spectrum efficiently. For maximizing the efficiency, 5G assigns flexible and dynamic TDD time slots [6].

6. Direct device to device communication
In recent LTE, there is limited direct device to device communication is possible.
In 5G fully direct D2D communication is possible. This includes peer-to-peer user-data communication directly between devices.
D2D communication in the background of 5G should be an fundamental part of the overall wireless-access solution rather than a individual solution. The direct D2D communication will extend the capabilities and enhance the overall efficiency of the wireless-access network. For avoiding the interference of unwanted other links, direct D2D communication should be under network control.

7. Backhaul integration
Wireless technology is already frequently used as part of the backhaul solution.
In the 5G era, the wireless-access link and wireless backhaul should therefore not be seen as two separate entities with separate technical solutions. Rather, backhaul and access should be seen as an integrated wireless-access solution able to use the same basic technology and operate using a common spectrum pool. This will lead to more efficient overall spectrum utilization as well as reduced operation and management effort [6].

VIII . FUTURE SCOPE

5G mobile phone technology promises faster communication speeds capacity and different usage formats than prior wireless evolutions. These formats would provide richer content and support for other public networks such as optical fiber and wireless local area networks.

IX. CONCLUSION

In the next decade, mobile Internet services will more advanced and become a core solution for customers and industries. 5G will provide facility to corporations, to allow their employee and field offices to use corporate databases and information sources, and to take part in daily operations from anyplace, any time.
For customers, the ability to talk, get information and conduct transactions over cell phones and mobile devices will increase a new industry of solutions for the mobile user.
5G is the latest step in the evolution of mobile communication and will be a very important component of the Network. For allow connectivity for a broad range of applications the capabilities of 5G wireless access must extend far beyond those of earlier generations. In addition, 5G wireless access needs to support a huge increase in traffic in reasonable and sustainable way with a need for a dramatic reduction in the cost and energy consumption per delivered bit. The key technology components will plays important role to differ the 5G from any other prior wireless generations. Thus 5G offers better speed and better range with more reliability and affordable rate

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