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Wireless Communication Using 5G Technology

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Abstract: This article describes five technologies that could lead to both architectural and component disruptive design changes. This paper also focuses on all preceding generations of mobile communication along with fifth generation technology. The paper throws light on network architecture of fifth generation technology. Currently 5G term is not officially used. In fifth generation researches are being made on development of World Wide Wireless Web (WWWW), Dynamic Ad hoc Wireless Networks (DAWN) and Real Wireless World. Fifth generation focus on (Voice over IP) VOIP-enabled devices that user will experience a high level of call volume and data transmission. The main features in 5G mobile network is that user can simultaneously connect to the multiple wireless technologies and can switch between them.

Keywords: 5G, features, cellular networks, architecture, Ad hoc Wireless Networks.

I. INTRODUCTION

Radio technologies have evidenced a rapid and multidirectional evolution with the launch of the analogue cellular system in 1980s.There after, digital wireless communication systems are consistently on a mission to fulfill the growing need of human beings (1G....4G, and now 5G).So, this article describes the 5G technology emphasizing on its salient features, technological design, advantages, shortcomings, challenges, and future scope.

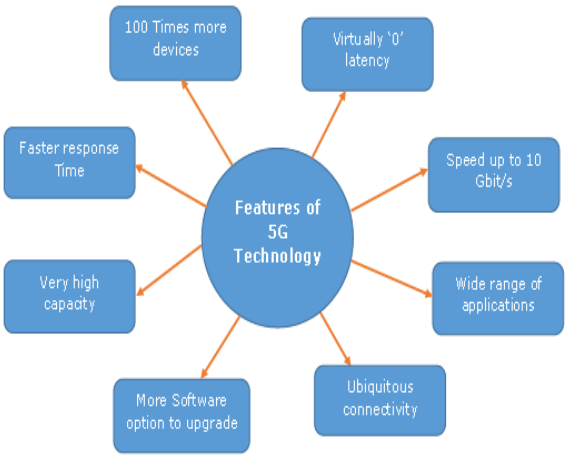

Fig.1 Features of 5G

SALIENT FEATURES OF 5G

5th Generation Mobile Network or simply 5G is the forthcoming revolution of mobile technology revolution of mobile technology. The features and its usability are much beyond the expectation of a normal human being. With its ultra-high speed, it is potential enough to change the meaning of cell phone usability.

With a huge array of innovative features, now your smart phone would be more parallel to the laptop. You can use broadband internet connection; other significant features that fascinate people are more gaming options, wider multimedia options, connectivity everywhere, zero latency, faster response time, and high quality sound and HD video can be transferred on other cell phone without compromising with the quality of audio and video.

II. 5G-TECHNOLOGY

If we look back, we will find that every next decade, one generation is advancing in the field of mobile technology. Starting from the First Generation (1G) in 1980s, Second Generation (2G) in 1990s, Third Generation (3G) in 2000s, Fourth Generation (4G) in 2010s, and now Fifth Generation (5G), we are advancing towards more and more sophisticated and smarter technology.

Fig.2 Generations of wireless network

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The 5G technology is expected to provide a new (much wider than the previous one) frequency bands along with the wider spectral bandwidth per frequency channel. As of now, the predecessors (generations) mobile technologies have evidenced substantial increase in peak bit rate. Then-how is 5G different from the previous one (especially 4G)?The answer is –it is not only the increase in bit rate made 5G distinct from the 4G,but rather 5G is also advanced in terms of-

- High increased peak bit rate.
- Larger data volume per unit area(i.e. high system spectral efficiency).
- High capacity to allow more devices connectivity concurrently and instantaneously.
- Lower battery consumption.
- Better connectivity irrespective of the geographic region, in which you are
- larger number of supporting devices.
- Lower cost of infrastructural development.
- Higher reliability of the communications.

As researchers say, with the wide range of bandwidth radio channels, it is able to support the speed up to 10 Gbps, the 5G Wi-Fi technology will offer contiguous and consistent coverage –" wider area mobility in true sense."

III. PROMISING KEY 5G WIRELESS TECHNOLOGIES

In this section, based on the above proposed heterogeneous cellular architecture, we discuss some promising key wireless technologies that can enable 5G wireless networks to fulfill performance requirements. The purpose of developing these technologies is to enable a dramatic capacity increase in the 5G network with efficient utilization of all possible resources. Based on the well-known Shannon theory, the total system capacity Csum can be approximately expressed by

$$C_{\text{sum}} \approx \sum_{\text{HetNets}} \sum_{\text{Channels}} B_i \log_2\left(1+\frac{P_i}{N_p}\right) \qquad (1)$$

Where: Bi is the bandwidth of the ith channel, Pi is the signal power of the ith channel, and Np denotes the noise power. From Eq. 1, it is clear that the total system capacity Csum is equivalent to the sum capacity of all sub channels and heterogeneous networks. To increase Csum, we can increase the network coverage (via heterogeneous networks with macro cells, microcells, small cells, relays, MF emto cell , etc.), number of sub channels (via massive MIMO, spatial modulation [SM], cooperative MIMO, DAS, interference management, etc.), bandwidth (via CR networks, mm-wave communications, VLC, multi-standard systems, etc.), and power (energy-efficient or green communications). In the following, we focus on some of the key technologies.

1) Device-centric architectures: The base-station-centric architecture of cellular systems may change in 5G. It may be time to reconsider the concepts of uplink and downlink, as well as control and data channels, to better route information flows with different priorities and purposes toward different sets of nodes within the network. We present device-centric architectures.

2) Millimetre wave (mm Wave): While spectrum has become scarce at microwave frequencies, it is plentiful in the mm Wave realm. Such a spectrum "el Dorado" has led to an mm Wave "gold rush" in which researchers with diverse backgrounds are studying different aspects of mm Wave transmission. Although far from being fully understood, mm Wave technologies have already been standardized for short-range services (IEEE 802.11ad) and deployed for niche applications such as small-cell backhaul. We discuss the potential of mm Wave for broader application in 5G.

3) Massive MIMO: Massive multiple-input multiple-output (MIMO) 1 proposes utilizing a very high number of antennas to multiplex messages for several devices on each time-frequency resource, focusing the radiated energy toward the intended directions while minimizing intra and inter cell interference. Massive MIMO may require major architectural changes, particularly in the design of macro base stations, and it may also lead to new types of deployments. We discuss massive MIMO.

4) Smarter devices: 2G-3G-4G cellular networks were built under the design premise of having complete control at the infrastructure side. We argue that 5G systems should drop this design assumption and exploit intelligence at the device side within different layers of the protocol stack, for example, by allowing device-to-device (D2D) connectivity or exploiting smart caching at the mobile side. While this design philosophy mainly requires a change at the node level (component change), it also has implications at the architectural level. We argue for smarter devices.

5) Native support for machine-to-machine (M2M) communication: A native2 inclusion of M2M communication in 5G involves satisfying three fundamentally different requirements associated with different classes of low-data-rate services: support of a massive number of low-rate devices, sustaining a minimal data rate in virtually all circumstances, and very-low-latency data transfer. Addressing these requirements in 5G requires new methods and ideas at both the component and architectural levels, and such is the focus of a later section.

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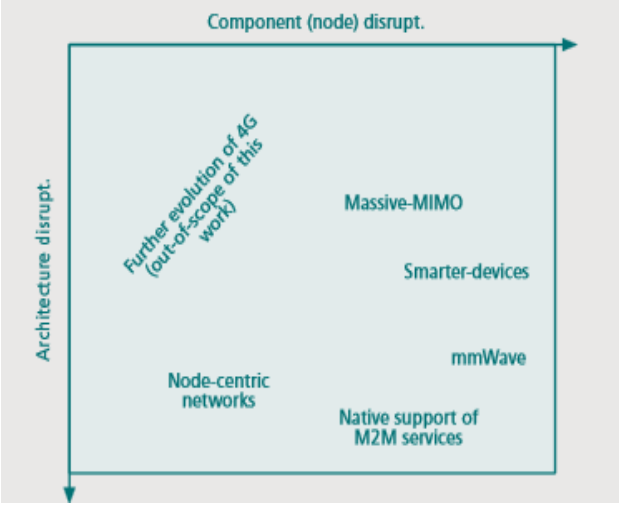


Fig.3 The five disruptive directions for 5G considered in this article, classified according to the Henderson-Clark model.

IV. 5G –ARCHITECTURE

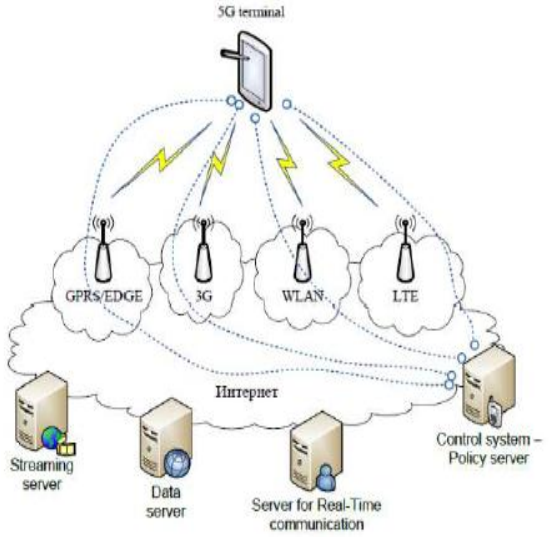


Fig.4 Functional architecture of 5G mobile network

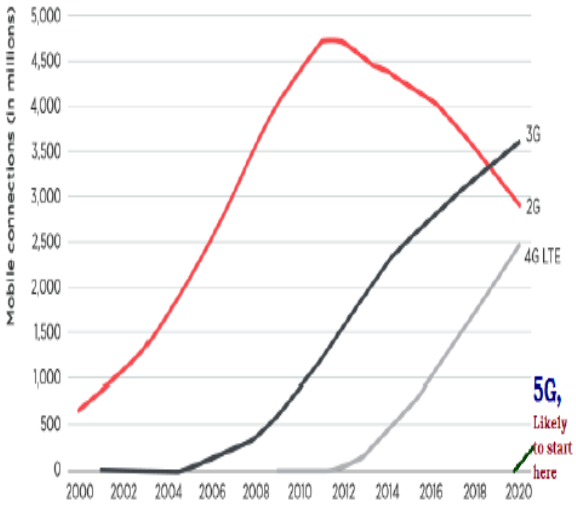
Architecture of 5G is highly advanced, its network elements and various terminals are characteristically upgraded to afford a new situation .Likewise, service providers can implement the advance technology to adopt the value-added services easily. However, upgradeability is based upon cognitive radio technology that includes various significant features such as ability of devices to identify their geographical location as well as weather, temperature, etc. Cognitive radio technology acts as a transceiver (beam) that perceptively can catch and respond radio signals in its operating environment. Further, it promptly distinguishes the changes in its environment and hence responds accordingly to provide uninterrupted quality service.

As shown in Fig.4, the system model of 5G is entirely IP based model designed for the wireless and mobile networks.

The system comprising of a main user terminal and then a number of independent and autonomous radio access technologies. Each of the radio technologies is considered as the IP link for the outside internet world. The IP technology is designed exclusively to ensure sufficient control.

5G - Time Period Required

- Normally, it is expected that the time period required for the 5G technology development and its implementation is about five years more from now (by 2020). But to becoming usable for the common people in developing countries, it could be even more.



Graph 1 − Showing the Timeline of all previous generation technologies.

V. APPLICATIONS OF 5G

Some of the significant applications are –

- It will make unified global standard for all.
- Network availability will be everywhere and will facilitate people to use their computer and such kind of mobile devices anywhere anytime.
- Because of the IPv6 technology, visiting care of mobile IP address will be assigned as per the connected network and geographical position.
- Its application will make world real Wi Fi zone.
- Its cognitive radio technology will facilitate different version of radio technologies to share the same spectrum efficiently.
- Its application will facilitate people to avail radio signal at higher altitude as well.

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VI. 5G - ADVANTAGES & DISADVANTAGES

5th generation technology offers a wide range of features, which are beneficial for all group of people including, students, professionals (doctors, engineers, teachers, governing bodies, administrative bodies, etc.) and even for a common man.

Advantages of 5G Technology: There are several advantages of 5G technology, some of the advantages have been shown in the above Ericsson image, and many others are described below –

- High resolution and bi-directional large bandwidth shaping.
- Technology to gather all networks on one platform.
- More effective and efficient.
- Technology to facilitate subscriber supervision tools for the quick action.
- Most likely, will provide a huge broadcasting data (in Gigabit), which will support more than 60,000 connections.
- Easily manageable with the previous generations.
- Technological sound to support heterogeneous services (including private network).
- Possible to provide uniform, uninterrupted, and consistent connectivity across the world.

Disadvantages of 5G Technology:
Though, 5G technology is researched and conceptualized to solve all radio signal problems and hardship of mobile world, but because of some security reason and lack of technological advancement in most of the geographic regions, it has following shortcomings –

- Technology is still under process and research on its viability is going on.
- The speed, this technology is claiming seems difficult to achieve (in future, it might be) because of the incompetent technological support in most parts of the world.
- Many of the old devices would not be competent to 5G, hence, all of them need to be replaced with new one — expensive deal.
- Developing infrastructure needs high cost.
- Security and privacy issue yet to be solved.

Table 1: Comparison In All Technologies

TECHNOLOGY / FEATURES	1G	2G	3G	4G	5G
START	1970-1980	1990-2004	2004-2010	2010-NOW	SOON (probably 2020)
DATA BANDWIDTH	2kbps	64kbps	2Mbps	1Gbps	Higher than 1Gbps
TECHNOLOGY	Analog cellular technology	Digital cellular technology	CDMA2000(1 Xrtt,EVDO) UMTS, EDGE	WiMax LTE Wi-Fi	WWWW(coming soon)
SERVICE	Mobile technology	Digital voice, SMS, higher capacity, packetized data	Integrated high quality audio, video and data	Dynamic information access, wearable devices	Dynamic information access, wearable devices with AI capabilities.
MULTIPLEXING	FDMA	TDMACDMA	CDMA	CDMA	CDMA
SWITCHING	Circuit	Circuit, packet	Packet	All packet	All packet
CORE NETWORK	PSTN	PSTN	Packet n/w	Internet	Internet

VII. 5G – CHALLENGES

Challenges are the inherent part of the new development; so, like all technologies, 5G has also big challenges to deal with. As we see past i.e. development of radio technology, we find very fast growth. Starting from 1G to 5G, the journey is merely of about 40 years old (Considering 1G in 1980s and 5G in 2020s). However, in this journey, the common challenges that we observed are lack of infrastructure, research methodology, and cost.

VIII. CONCLUSION

This article has discussed five disruptive research directions that could lead to fundamental changes in the design of cellular networks. The development of the mobile and wireless networks is going towards higher data rates and all-IP principle. Mobile terminals are obtaining each year more processing power, more memory on board, and longer battery life for the same applications. The proposed architecture for future 5G mobile networks can

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be implemented using components of the shelf (existing and standardized Internet technologies) and its implementation is transparent to the radio access technologies, which makes it very likeable solution for the next generation mobile and wireless networks.

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