

A Review Paper on the Deeper Aspects of 5G

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Abstract—This paper aims at diving into the deeper aspects of evolving 5G wide area radio access wireless technology. Recent arena of wireless communication deals in terms of providing high data rate, low latency, high QOS etc. and 5G proves itself an ideal case on all these fronts. Hence, by means of this paper we have attempted to throw the insights of 5G for clear and sheer understanding of its technological aspects.

Index Terms—5G; network architecture; OWA; protocol stack; QOS; why 5G?

I. INTRODUCTION

5G has come through the continuous evolution of 1G, 2G, 2.5G, 3G and 4G^[1]. 5G is a packet switched wireless system with wider area coverage and high throughput. Simply saying-5G technologies will provide consumers with the same abilities of 4G, but with more power and features in hand held phone^[1]. The 5G wireless mobile internet networks are real wireless world which shall be supported by LAS-CDMA (Large Area Synchronized Code-Division Multiple Access), OFDM (Orthogonal frequency-division multiplexing), MCCDMA(Multi-Carrier Code Division Multiple Access), UWB(Ultra-wideband), Network-LMDS(Local Multipoint Distribution Service), and IPv6^[2]. The 5G technology provides the mobile phone users more features and efficiency. A user of mobile phone can easily hook their 5G technology gadget with laptops or tablets to acquire broadband internet connectivity. High resolution is offered by 5G for extreme mobile users, it also offers bidirectional huge bandwidth, higher data rates and the finest Quality of Service (QoS)^[5].

5G, which is being called the Real world wireless or WWW that is World Wide Wireless Web, allows complete wireless communication with almost no limitation, Multi-Media Newspapers, watch TV programs with the clarity as to that of an HD TV.^[1]There are two views of 5G systems: evolutionary and revolutionary. In the evolutionary view the 5G (or beyond 4G) systems will be capable of supporting the www allowing a highly flexible network such as a Dynamic Ad-hoc Wireless Network (DAWN). In this view, advanced technologies including intelligent antenna and flexible modulation are keys to optimize the ad-hoc wireless networks. In revolutionary view, 5G systems would be an intelligent technology capable of interconnecting the entire world without limits. An example application could be a robot with in-built wireless communication with artificial intelligence^[4].The 5G MasterCore is a convergence of Parallel Multimode (PMM), Nanotechnology, Cloud Computing, and

All IP Platform also 5G-IU technology. These technologies have their own impacts on existing wireless networks which make them into 5G^[5].

Fifth generation should be more intelligent technology that interconnects the entire world without limits. This generation is expected to be released around 2020. The world of universal, uninterrupted access to information, entertainment and communication will open new dimension to our lives and change our life style significantly^[2]. Thus the 5G is the future of the world for instance proving itself a biggest achievement in the field of wireless communication when implemented.

II. ARCHITECTURE OF 5G

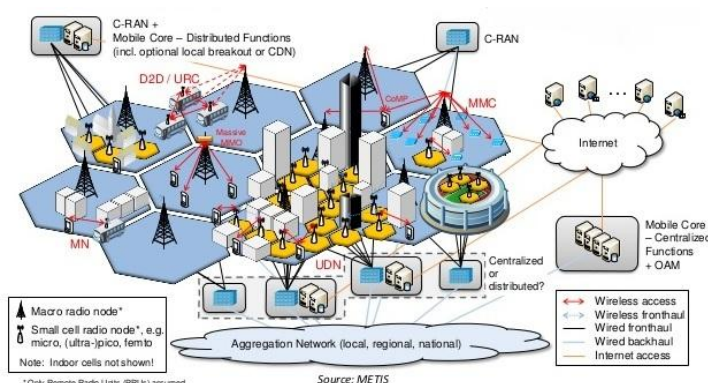


Figure 1: METIS E2E Reference Network (Courtesy: METIS-“Mobile & wireless communication enablers for the twenty-twenty information society”)

Fig. 1 introduces an E2E reference network that is used when functional placement within the network topology is discussed. This reference network shows how the different types of sites are located along the access, aggregation and core networks within a typical telecom operator system.

The model includes devices, e.g., terminals and D2D groups, antenna sites, e.g., small cells, relay nodes, cluster nodes, as well as radio base station (RBS) sites. In addition, data centers with data processing and storage capabilities at access and aggregation level are depicted.

In principle, NFs can be deployed at all those sites in a flexible architecture, but finally, it strongly depends on the underlying service/use case requirements. Important requirements include latency and throughput on the input and output interfaces, time synchronization (e.g., on radio time slot level) and scaling of processing (e.g., relation to U-Plane throughput).^[9]

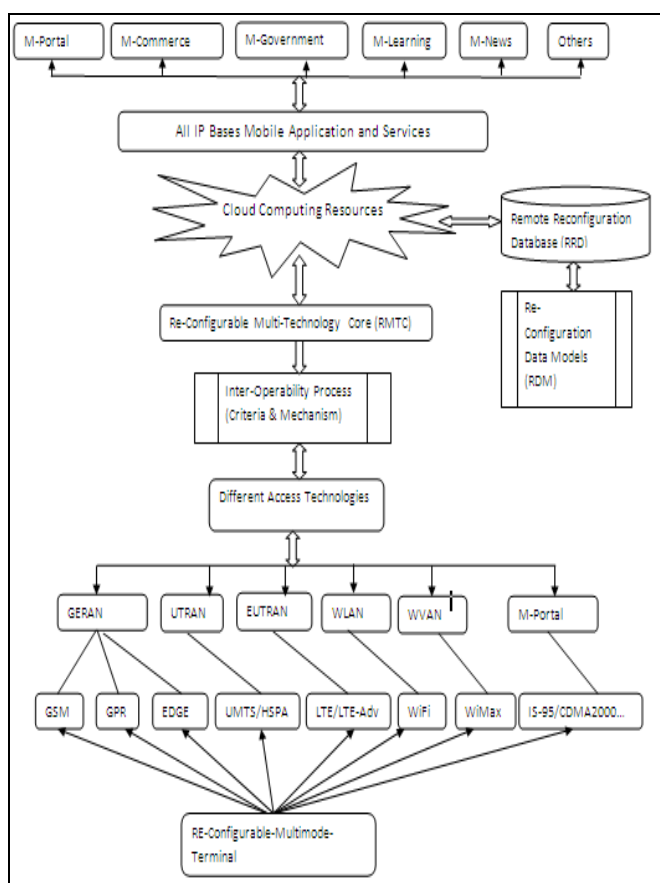


Figure 2: Flowchart of Architecture

Fig. 2 shows that Fifth generation mobile systems model is all-IP based model for wireless and mobile networks interoperability. AIPN uses packet switching and its continuous evolution provides optimized performance and cost. In fifth generation Network Architecture consist of a user terminal (which has a crucial role in the new architecture) and a number of independent, autonomous radio access technologies (RAT). In 5G Network Architecture all IP internet access. CCR links the Reconfigurable Multi Technology Core (RMTC) with remote reconfiguration data from RRD attached to Reconfiguration Data models (RDM). The main challenge for a RMTC is to deal with increasing different radio access technologies. The core is a convergence of the nanotechnology, cloud computing and radio, and based on All IP Platform.

Core changes its communication functions depending on status of the network and/or user demands. RMTC is connected to different radio access technologies ranging from 2G/GERAN to 3G/UTRAN and 4G/EUTRAN in addition to 802.11x LAN and 802.16x WMAN. Other standards are also enabled such as IS/95, EVDO, CDMA2000...etc. Interoperability process-criteria and mechanisms enable both terminal and RMTC to select from heterogeneous access systems^[6].

III. WHAT IS NEW IN 5G

1. Spectrum extension; millimeter waves; cell densification; increases spectrum efficiency; advance antennas; 3D beam-forming techniques ;new electronics components; backhaul optimization;D2D;moving networks(vehicle based cells)

2. Combination of 4G,3G,WIFI,& new radio access to create an integrated & dynamic radio access network; connectivity management mechanisms.
3. Ultra-low latency; Software-defined networks; Decoupling functional architecture from the underlying physical infrastructure; Network intelligence closer to users; MEC (mobile edge computing) ,D2D
4. Millimeter waves for front –haul & backhaul; New operation mechanisms for dense networks; Pooling of base station processing; On-demand consumption ;massive machine communications; Power amplifiers; DSP(digital signal processing) – enabled optical transceivers; Harvesting ambient energy; Optimization of sleep mode switching
5. Physical channel authentication; Virtualised authentication
6. New waveform; Cell densification; much less signaling traffic & no synchronization; RAN architecture
7. Software-defined networks; Network function virtualization; Decoupling functional architecture from the underlying physical infrastructure; APIs

IV. WHY 5G?

- Very High speed, high capacity, and low cost per bit ^[7].
- It supports interactive multimedia, voice, video Internet, and other broadband services, more effective and more attractive, and have Bi-directional, accurate traffic statistics ^[7].
- 5G technology offers Global access and service portability.
- It offers the high quality services due to high error tolerance.
- It is providing large broadcasting capacity up to Gigabit which supporting almost 65,000 connections at a time.
- More applications combined with artificial intelligent (AI) as human life will be surrounded by artificial sensors which could be communicating with mobile phones ^[6].
- 5G technology use remote management that user can get better and fast solution.
- The uploading and downloading speed of 5G technology is very high.
- 5G technology offer high resolution for crazy cell phone user and bi-directional large bandwidth shaping ^[8].
- 5G technology offer transporter class gateway with unparalleled consistency ^[8].

V. FEATURES IN 5G

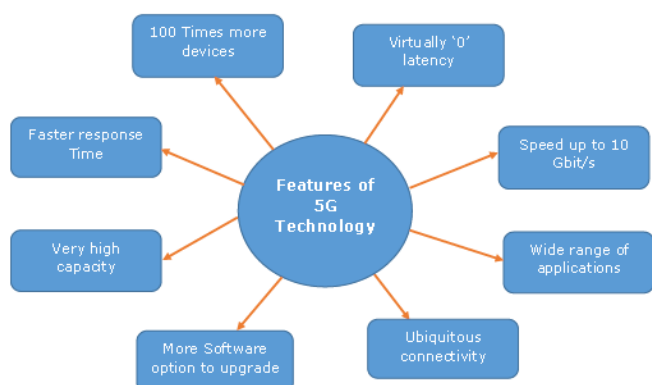


Figure 3: Features of 5G technology

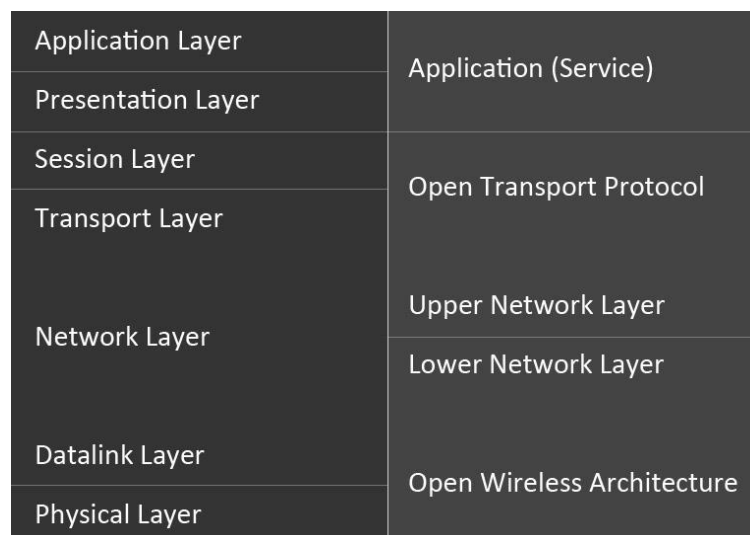


Figure 4: Comparison with OSI model

- a) 5G technology offer high resolution for crazy cell phone user and bi- directional large bandwidth shaping.
- b) The advanced billing interfaces of 5G technology makes it more attractive and effective.
- c) 5G technology also providing subscriber supervision tools for fast action.
- d) The high quality services of 5G technology based on Policy to avoid error.
- e) Technology is providing large broadcasting of data in Gigabit which supporting almost 65,000 connections.
- f) 5G technology offer transporter class gateway with unparalleled consistency.
- g) The traffic statistics by 5G technology makes it more accurate.
- h) Through remote management offered by 5G technology a user can get better and fast solution.
- i) The remote diagnostics also a great feature of 5G technology.
- j) The 5G technology is providing up to 25 Mbps connectivity speed.
- k) The 5G technology also support virtual private network.
- l) The new 5G technology will take all delivery service out of business prospect.
- m) The uploading and downloading speed of 5G technology touching the peak.
- n) The 5G technology network offering enhanced and available connectivity just about the world. ^[1]

VI. PROTOCOL STACK OF 5G

Open Wireless Architecture (OWA):

Physical layer + Data link layer = OWA

- a) OSI layer 1, i.e. Physical layer & OSI layer 2, i.e. Data link layer define the wireless technology.
- b) For these two layers the 5G mobile network is likely to be based on Open Wireless Architecture (OWA).

Network Layer:

- a) All mobile networks will use mobile IP.
- b) Each mobile terminal will be FA (Foreign Agent).
- c) A mobile can be attached to several mobiles or wireless networks at the same time.
- d) The fixed IPv6 will be implemented in the mobile phones.
- e) Separation of network layer into two sub-layers:
 1. Lower Network Layer
 2. Upper Network Layer

Open Transport Protocol (OTP):

Transport layer + Session layer = OTP

- a) Wireless network differs from wired network regarding the transport layer.
- b) In all TCP versions the assumption is that lost segments are due to network congestion.
- c) In wireless, the loss is due to higher bit error ratio in the radio interface.
- d) 5G mobile terminals have transport layer that is possible to be downloaded & installed which is based on Open Transport Protocol.

Application Layer:

Presentation layer + Application layer = Application layer (5G)

- a) Provides intelligent QOS (Quality of Service) management over variety of networks.
- b) Provides possibility for service quality testing & storage of measurement information in information database in the mobile terminal.
- c) Select the best wireless connection for given services.
- d) QOS parameters, such as, delay, losses, BW, reliability, will be stored in DB (Database) of 5G mobile. ^[1]

VI. PRACTICAL APPLICATIONS OF 5G



Figure 5: Various social Applications of 5G (Courtesy: European Commission)

eHealth: Telesurgery made international news in 2001 when the first transatlantic surgical procedure took place between New York City and Strasbourg. This remote surgery experiment required extremely expensive high capacity leased lines. Commands triggered in the US were controlling surgery devices in France, with some small delay. 5G will make this scenario much easier and also mobile. 5G specificities will make the command-response time close to zero and provide the practitioner with great operation comfort and accuracy. In the near-future, a patient who needs an urgent or specific operation could be operated by a practitioner remotely located.

Connected homes: Our future homes will be full of connected devices, not only providing information on their environment, but also communicating with each other. A smart thermostat may "talk" to a smoke detector, so that the combined information can provide more reliable information in the event of a fire at home. In case no one is present, this information can be remotely communicated to mobile devices and bring the fire brigade to the rescue. Homes are expected to become massive sources of information and data will be transferred to mobile devices for remote monitoring, control and eventual decision. The operations rapidly exhaust spectrum and capacity resources of existing networks. 5G can support such connected home scenarios, whilst bringing down the service costs.

Secure transport: Vehicles become more secure thanks to ICT integration. They will soon be able to communicate with the outside world. Imagine you are driving on a motorway on a rainy day and behind a truck. Your visibility is extremely limited. If the truck in front of you has a camera, your car could hook into the truck driver's view of the road ahead and give you added information, greatly improving your driving comfort and security. This performance requires instantaneous transmission of images between the truck and your car, which is not possible with our current networks.

Smart grids: Utility infrastructures increasingly rely on wireless communication to support their activities. They are often located in rural or remote areas, and thus wireless connectivity to ensure low cost monitoring. Capacity is critical

to support applications such as video surveillance and broadband mobile data. And the latency – the time interval between stimulation and response – should be very low to react quickly in case of problem. Once again 5G can bring solutions where existing systems cannot.

Entertainment: With 5G, you will be able to use great new apps, even in crowded places. Imagine you are watching a football match in a stadium with 50,000 people around you. If 5G connectivity is installed, you can play and replay interesting phases of the game from different viewing angles and with high definition on your mobile phone or tablet. This is made possible thanks to the use of higher frequency bands currently unexploited for broadband communications. Whoever tried to connect to the Internet in a conference room with more than 200 persons has experienced loss of connectivity due to the instability of WiFi access networks.^[1]

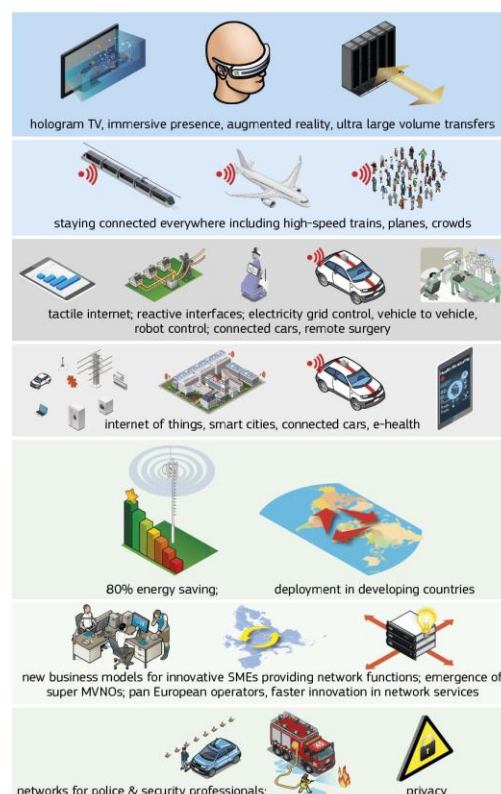


FIGURE 6: Daily life Applications of 5G (Courtesy: European Commission)

VII. CONCLUSION

After having a deeper insight of the scopes and applications as well as various other highly convenient aspects of 5G, it clearly shows the calling of future and it is 5G which will provide an enormous shift in the wireless world. So 5G will come up with a new way of transformation and will connect the world in a much smoother way and provide the user a larger space to explore the 5G wireless services.

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