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A Comparative Study of Different Generations of Communication Networks

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Abstract: 5G Technology stands for Fifth Generation Mobile technology. From generation 1G to 2.5G and 3G to 5G the world of telecommunication has seen a number of significant improvements. Fifth generation network provide affordable broadband wireless connectivity at very high speed. The paper throws light on different 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 Adhoc 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. Wire-less system designers have been facing the continuously increasing demand for high data rates and mobility required by new wireless applications and therefore has started research on fifth generation wireless systems that are expected to be deployed beyond 2020. The main features in 5G mobile network is that user can simultaneously connect to the multiple wireless technologies and can switch between them. This forthcoming mobile technology will support IPv6 and flat IP.

Keywords: 5G, World Wide Wireless Web, Dynamic Adhoc Wireless Networks (DAWN), Real Wireless Communication.

I. INTRODUCTION

Wireless communication has started in early 1970s. In next four decades, a mobile wireless technology has evolved from 1G to 5G generations. Fifth generation technology offer very high bandwidth and various new advanced features which makes it most powerful and in huge demand in the future. Now days different wireless and mobile technologies are present such as third generation mobile networks (UMTS-Universal Mobile Telecommunication System, cdma2000), LTE (Long Term Evolution), WiFi (IEEE 802.11 wireless networks), WiMAX (IEEE 802.16 wireless and mobile networks),as well as sensor networks, or personal area networks (e.g. Bluetooth, ZigBee). Mobile terminals include variety of interfaces like GSM which are based on circuit switching. All wireless and mobile networks implements all- IP principle, that means all data and signaling will be transferred via IP (Internet Protocol) on network layer.

Fifth generation technology provide facilities like camera, MP3 recording, video player, large phone memory, audio player etc. that user never imagine and for children rocking fun with Bluetooth technology and Piconets. The fifth generation wireless mobile multimedia internet networks can be completely wireless communication without limitation, which makes perfect wireless real world – World Wide Wireless Web (WWWW). Fifth generation is based on 4G technologies. The 5th wireless mobile internet networks are real wireless world which shall be supported by LASCDMA (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[1].

Fig. 1wireless mobile communication

Fifth generation technologies offers tremendous data capabilities and unrestricted call volumes and infinite data broadcast together within latest mobile operating system.

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Fifth generation should make an important difference and add more services and benefits to the world over 4G. 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

II. 5G MOBILE NETWORKS

5G is being developed to accommodate the QoS and rate requirements set by forthcoming applications like wireless broadband access, Multimedia Messaging Service (MMS), HDTV content, Digital Video Broadcasting (DVB), minimal services like voice and data, and other services that utilize bandwidth. [8]The definition of 5G is to provide adequate RF coverage, more bits/Hz and to interconnect all wireless heterogonous networks to provide seamless, consistent telecom experience to user. In 5G, each network will be responsible for handling user mobility, while the terminal will make the final choice among different wireless/mobile access network providers for a given service. Such choice will be based on open intelligent middleware in the mobile phone. Now, we will go through all OSI layers Table1 in the 5G mobile terminal design [7].

TABLE 1 OSI LAYERS USED IN THE 5G MOBILE TERMINAL DESIGN

Application layer	Application (services)
Presentation layer	
Session layer	Open Transport Protocol
Transport layer	
Network layer	Upper Network layer
	Lower Network layer
Data Link layer	Open wireless Architecture
Physical Layer	

A. Physical/Mac Layers

Physical and Medium Access Control layers i.e. OSI layer 1 and OSI layer 2, define the wireless technology. For these two layers the 5G mobile networks is likely to be based on Open Wireless Architecture.

B. Network Layer

The network layer will be IP. The IPv4 (version 4) is worldwide spread and it has several problems such as limited address space and has no real possibility for QoS support per flow. These issues are solved in IPv6, but traded with significantly bigger packet header. Then, mobility still remains a problem. There is Mobile IP standard on one side as well as many micro-mobility solutions (e.g., Cellular IP, HAWAII etc.). All mobile networks will use Mobile IP in 5G, and each mobile terminal will be FA (Foreign Agent), keeping the CoA (Care of Address) mapping between its fixed IPv6 address and CoA address for the current wireless network. However, a mobile can be attached to several mobile or wireless networks at the same time. In such case, it will maintain different IP addresses for each of the radio interfaces, while each of these IP addresses will be CoA address for the FA placed in the mobile Phone.

The fixed IPv6 will be implemented in the mobile phone by 5G phone manufactures. The 5G mobile phone shall maintain virtual multiwireless network environment. For this purpose there should be separation of network layer into two sublayers in 5G mobiles i.e. Lower network layer (for each interface) and Upper network layer (for the mobile terminal). This is due to the initial design of the Internet, where all the routing is based on IP addresses which should be different in each IP network world-wide. The middleware between the Upper and Lower network layers shall maintain address translation from Upper network address (IPv6) to different Lower network IP addresses (IPv4 or IPv6), and vice versa [3].

C. Open Transport Protocol (Ota) Layer

The mobile and wireless networks differ from wired networks regarding the transport layer. In all TCP versions the assumption is that lost segments are due to network congestion, while in wireless networks losses may occur due to higher bit error ratio in the radio interface. Therefore, TCP modifications and adaptation are proposed for the mobile and wireless networks, which retransmit the lost or damaged TCP segments over the wireless link only. For 5G mobile terminals, it is suitable to have transport layer that is possible to be downloaded and installed. Such mobiles shall have the possibility to download (e.g., TCP, RTP etc. or new transport protocol) version which is targeted to a specific wireless technology installed at the base stations. This is called here Open Transport Protocol - OTP.

D. Application Layer

Regarding the applications, the ultimate request from the 5G mobile terminal is to provide intelligent QoS management over variety of networks. Today, in mobile phones the users manually select the wireless interface for particular Internet service without having the possibility to use QoS history to select the best wireless connection for a given service. The 5G phone shall provide possibility for service quality testing and storage of measurement information in information databases in the mobile terminal. The QoS parameters, such as delay, jitter, losses, bandwidth, reliability, will be stored in a database in the

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5G mobile phone with aim to be used by intelligent algorithms running in the mobile terminal as system processes, which at the end shall provide the best wireless connection upon required QoS and personal cost constraints.

With 4G, a range of new services and models will be available. These services and models need to be further examined for their interface with the design of 4G systems. The process of IPv4 address exhaustion is expected to be in its final stages by the time that 4G is deployed. Therefore, IPv6 support for 4G is essential in order to support a large no. of wireless- enabled devices. IPv6 removes the need for NAT (Network Address Translation) by increasing the no. of IP addresses. With the available address space and number of addressing bits in IPv6, many innovative coding schemes can be developed for 4g devices and applications that could help in

III. FUNCTIONAL ARCHITECTURE FOR 5G MOBILE NETWORKS

Figure 5 shows the system model that proposes design of network architecture for 5G mobile systems, which is all-IP based model for wireless and mobile networks interoperability. The system consists of a user terminal (which has a crucial role in the new architecture) and a number of independent, autonomous radio access technologies. Within each of the terminals, each of the radio access technologies is seen as the IP link to the outside Internet world.

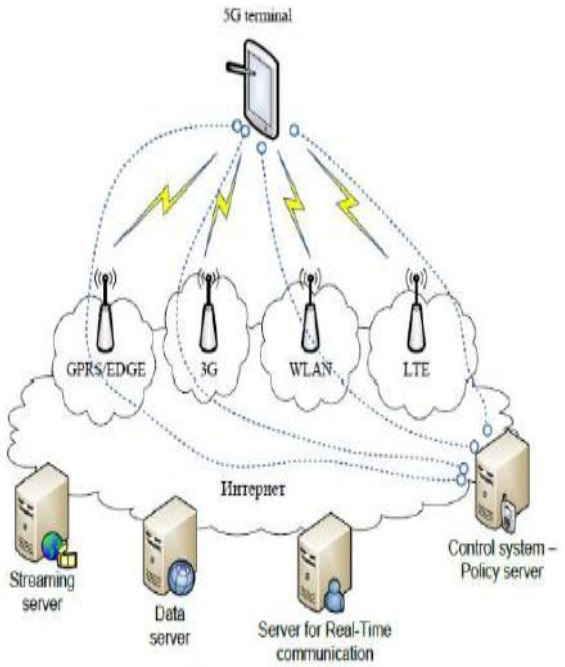

Fig.2: Functional architecture for 5G mobile networks

IV. 5G ARCHITECTURE –THE NANOCORE

The 5G architecture uses Noncore which is an association of Nanotechnology, Cloud Computing and IP Platform,radio access technologies [2]. These technologies have their own influence on exiting wireless network which prepares them as 5G.

Data sharing in 5G network is very easy. It omits the condition of putting both mobile face to face so that data could be shared. But 5G Bluetooth technology removes this condition and data could be transferred if it is shared in the range of 50m. It is not far away when we see the global mobiles all over the world. A user can move everywhere in the world by holding just 5G mobile network. All the roaming would be exempt from the tariff plans [9].

The rates of the call would not be different area to area. 5G enabled smart phones will be a great challenge to laptops due to the extraordinary features offered. With thousands of mobile applications a user will do on his laptop with improve facilities.

The tables II, describes the comparison of each generation's technology and the changes which has come up for improvements. Nanotechnology is an application of nanoscience to control process on nanometer scale (0.1 to 100nm). The term "nanotechnology" was introduced by Nori Taniguchi in 1974 at the Tokyo international conference on production engineering.

Nanotechnology has shown its impact on both mobile as well as the core network. Powerful computation and communication are ready to serve the users in an intelligent way. With nanotechnology, mobile phones can act as intelligent sensors that have applications in many industries like in transportation, medicine, safety and communications [4].

Nano equipment (Ne):

In 5G Nancore, the mobiles are known as NanoEquipment as they are stimulated with nanotechnology. Mobile devices along with intelligence, lodged in the human environment, create a new platform that enables ubiquitary sensing, and communication. The main tasks of the Nano Equipments are [5]

- Self-Cleaning –the phone cleans by itself.
- Self-powered –the phone derives its energy/power from the sun, water, or air.
- Sense the environment –A phone will tell you about the weather, the amount of air pollution present, etc.
- Flexible –bend but not break.
- Transparent –"see through" phones.

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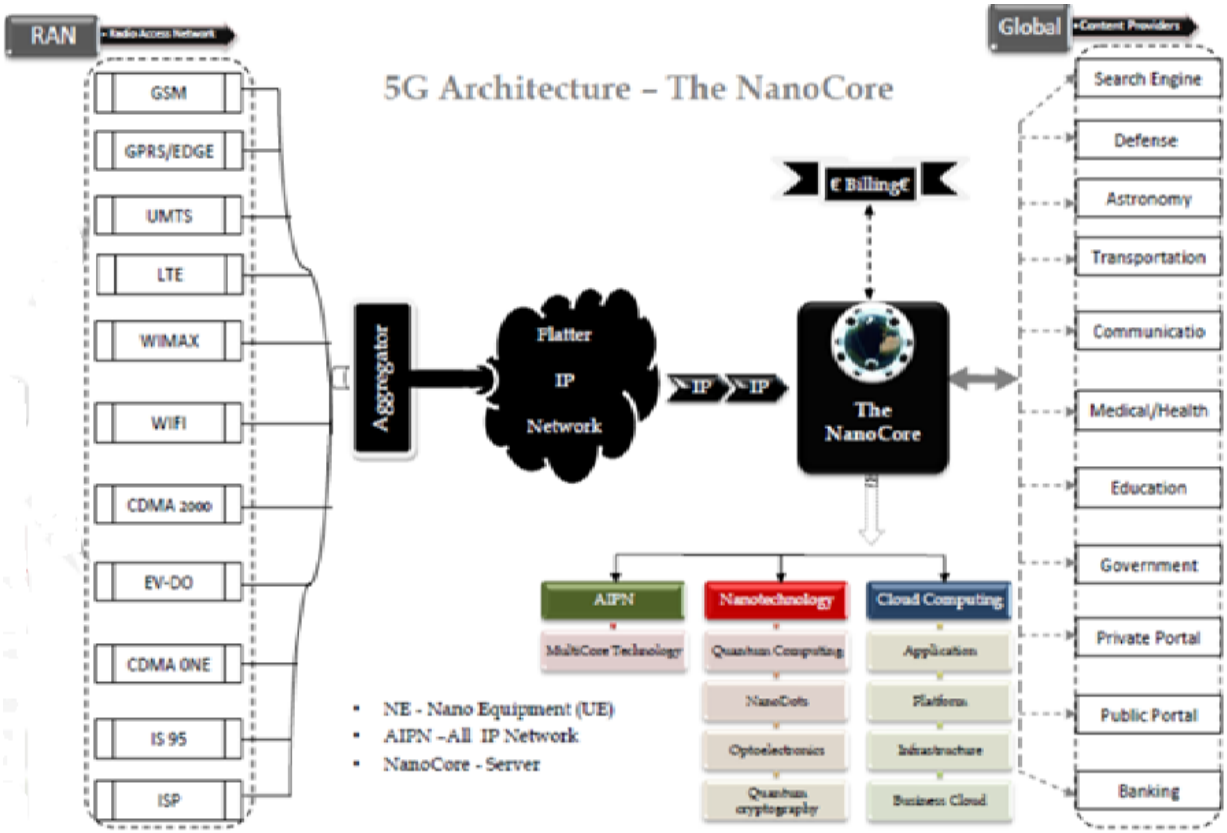

Fig.3: The NanoCore architecture for 5G mobile networks

V. EVOLUTION OF WIRELESS TECHNOLOGIES

A. First Generation (1g):

Mobile communication has become more popular in last few years due to fast revolution in mobile technology.

Fig. 4 I[st] Generation

This revolution is due to very high increase in telecoms customers. This revolution is from 1G- the first generation, 2G- the second generation, 3G- the third generation, and then the 4G- the forth generation,5G-the fifth generation[2].

B. Second Generation (2g):

2G emerged in late 1980s. It uses digital signals for voice transmission and has speed of 64 kbps.

Fig. 5 II[nd] Generation

It provides facility of SMS (Short Message Service) and use the bandwidth of 30 to 200 KHz. Next to 2G, 2.5G system uses packet switched and circuit switched domain and provide data rate up to 144 kbps. E.g. GPRS, CDMA and EDGE.

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C. Third Generation (3g):
It uses Wide Brand Wireless Network with which clarity is increased. The data are sent through the technology called Packet Switching. Voice calls are interpreted through Circuit Switching. Along with verbal communication it includes data services, access to television/video, new services like Global Roaming.

Fig. 6 III[rd] Generation

It operates at a range of 2100MHz and has a bandwidth of 15-20MHz used for High-speed internet service, video chatting.3G uses Wide Band Voice Channel that is by this the world has been contracted to a little village because a person can contact with other person located in any part of the world and can even send messages too.

D. Fourth Generation (4g):
4G offers a downloading speed of 100Mbps.4G provides same same feature as 3G and additional services like Multi-Media Newspapers, to watch T.V programs with more clarity and send Data much faster than previous generations. LTE (Long Term Evolution) is considered as 4G technology.

Fig. 7: IV[th] Generation

4G is being developed to accommodate the QoS and rate requirements set by forthcoming applications like wireless broadband access, Multimedia Messaging Service (MMS), video chat, mobile TV, HDTV content, Digital Video Broadcasting (DVB), minimal services like voice and data, and other services that utilize bandwidth.

E) Fifth Generation(5g):
5G is the name currently being given to the next generation of mobile data connectivity that will come after the last drop has been ringed from 4G.It will provide unbelievably fast broadband speeds, but more importantly it will have enough capacity wherever you go to perform every function you want it to without a drop in speed or connection, no matter how many people are connected at the same time. It represents the wireless telco echo system beyond LTE/EPC. It aims to provide a new radio access network with ultra capacity, low delay and energy efficiency for an extremely high number of devices and applications. 5G represents the complete echo system: core network, convergence with 3rd party wireless, fixed and satellite backhaul, management, supporting the convergence of 4G legacy wireless and the efficient end-to-end application delay. The new 5G Radio Access Network (RAN) wants to use more efficiency the radio resources by enlarging its spectrum in very dense areas> 66Hz, and with better spectral efficiency <66 Hz**.**

Fig. 8 V[th] Generation

VI. CONCEPTS FOR 5G MOBILE NETWORKS

The 5G terminals will have software defined radios and modulation schemes as well as new error-control schemes that can be downloaded from the Internet. The development is seen towards the user terminals as a focus of the 5G mobile networks. The terminals will have access to different wireless technologies at the same time and the terminal should be able to combine different flows from different technologies. The vertical handovers should be avoided, because they are not feasible in a case when there are many technologies and many operators and service

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providers. In 5G, each network will be responsible for handling user mobility, while the terminal will make the final choice among different wireless/mobile access network providers for a given service. Such choice will be based on open intelligent middleware in the mobile phone

TABLE 2 COMPARISON OF GENERATION [6]

Technology features	1G	2G	3G	4G	5G
Start / deployment	1970-1980	1990-2004	2004-2010	Now	SOON(Probably2020)
Data Bandwidth	2kbps	64KBPS	2Mbps	1Gbps	Higher than 1Gbps
Technology	Analog cellular technology	Digital cellular technology	CDMA2000(1X RTT,EVDO) UMTS, EDGE	Wimax LTE Wi-Fi	WWWW(Coming soon)
Service	Mobile telephony (Voice)	Digital voice SMS, Higher capacity	Integrated high quality audio video and data	Dynamic information access Wearable devices	Dynamic information access Wearable device with AI capabilities
multiplexing	FDMA	TDMA, CDMA	CDMA	CDMA	CDMA
Switching	Circuit	Circuit, packet	Packet	All packet	All packet
Core network	PSTN	PSTN	Packet network	Internet	Internet

VII. CONCLUSION

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. 5G include latest technologies such as cognitive radio, SDR, nanotechnology, cloud computing and based on All IP Platform. It is expected that the initial Internet philosophy of keeping the network simple as possible, and giving more functionalities to the end nodes, will become reality in the future generation of mobile networks, here referred to as 5G.

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