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CELLULAR AND NETWORK ARCHITECTURE FOR 5G WIRELESS COMMUNICATION NETWORKS IN MOBILE TECHNOLOGY

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***Abstract*-5G Technology stands for Fifth Generation Mobile technology. From generation 1G to 2.5G and from 3G to 5G this world of telecommunication has seen a number of improvements along with improved performance with every passing day. Fifth generation network provide affordable broadband wireless connectivity (very high speed). 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 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. In this article, we propose a potential cellular architecture that separates indoor and outdoor scenarios, and discuss various promising technologies for 5G wireless communication systems, such as massive MIMO, energy-efficient communications, cognitive radio networks, and visible light communications. The proposed network is enforced by nanotechnology, cloud computing and based on all IP Platform.**

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.

Index Terms- 5G, Telecommunication, Network Architecture, WWWW, DAWN.

I. INTRODUCTION

The 1G (First Generation) cellular systems, mainly analog system, had a bandwidth ranging from 10 to 30 KHz depending on system type and service. Offered data rates were around 10 Kbps after analog to digital conversion. Radio access scheme was FDMA and switching was all circuit, suitable for voice services. The first phase of the 2G (Second Generation) GSM systems offered a data rate up to 9.6 Kbps and increased in the second phase and phase+ to reach a peak rate of more than 300Kbps with bandwidth of 200 KHz. Switching started to be packet in addition to circuit beginning from the second phase and radio access was TDMA/FDMA. For the 3G (Third Generation) systems, the peak data rate began of 2 Mbps in the first phase and approached 50Mbps in consecutive phases at constant wide bandwidth of 5 MHz.

The approved access scheme for the 3G was CDMA and switching continued to be circuit in addition to packet. However, at the start of 3.5G, with HSDPA system, and thereafter it was focused on packet switching only. In 4G (Fourth Generation) cellular systems, peak data rates started at 100 Mbps and supposed to reach the order of more than 1 Gbps at the downlink benefiting from a variable bandwidth up to 20, 40 or even 70 MHz. Switching was approved to be packet only- all IP, and radio access changed from CDMA to OFDMA and SC-FDMA. In addition to the cellular systems, current wireless technologies include Wireless Local Area Networks (WLAN) 802.11 and Wireless Metropolitan Area Networks (WMAN) 802.16. Moreover, ad-hoc Wireless Personal Area Network (WPAN) and wireless networks for digital TV are gaining more interest. Future generations will include new systems such as broadband wireless access systems, intelligent transport systems, high altitude platform station systems and millimeter-wave Local Area Networks. Key to the future generations of mobile communications are multimedia communications, wireless access to broadband fixed networks, and seamless roaming among different systems.

Today we have different wireless and mobile technologies, which are mass deployed, such as 3G mobile networks (UMTS, cdma2000), LTE (Long Term Evolution), WiFi (IEEE 802.11 wireless networks), WiMAX (IEEE 802.16 wireless and mobile networks), as well as accompanying networks, such as sensor networks, or personal area networks (e.g., Bluetooth, ZigBee). Mobile terminals include variety of interfaces, including the GSM ones, which are based on old -fashioned circuit switching, the technology that is going into its last decade of existence. All wireless and mobile networks today are going towards all-IP principle, meaning all data and signaling will be transferred via IP (Internet Protocol) on network layer. So, we may have different Radio Access Technologies (RATs) today and new RATs in the future (e.g., LTE - Advanced), but the common "thing" for all of them is IP, which is unifying technology. The 4G term is related to available bit -rates in the access link, i.e. more than 1 Gbps is set as condition by ITU for a technology to be marked as 4G. Also, all -IP is the characteristic of 4G in the access and in the core network part, there will be no circuit - switching as it existed in 3G systems, such as UMTS. On the other side there are a lot of efforts done for separation of transport stratum and service stratum in the concepts of Next Generation Networks (NGN). Next generation of mobile and wireless networks will certainly need to fit within the NGN, because it is based on wireless and wired access possibilities, including all services and using all -IP concept. 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 that user never experienced before. The Fifth generation technologies offer 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.

II. WIRELESS AND CELLULAR SYSTEMS

A) First-Generation (1G)

The first-generation cellular systems were introduced in the beginning of 1980's where almost all of them were analog systems using the frequency modulation technique for radio transmission. Traffic was multiplexed onto an FDMA system. The needs for improved transmission quality, higher system capacity, better system coverage, more services, security and better spectral efficiency paved the way toward second generation cellular systems. 1G emerged in 1980s. It contains Analog System and popularly known as cell phones. It introduces mobile technologies such as Mobile Telephone System (MTS), Advanced Mobile Telephone System (AMTS), Improved Mobile Telephone Service (IMTS), and Push to Talk (PTT). It uses analog radio signal which have frequency 150 MHz, voice call modulation is done using a technique called Frequency-Division Multiple Access (FDMA).It has low capacity, unreliable handoff, poor voice links, and no security at all since voice calls were played back in radio towers, making these calls susceptible to unwanted eavesdropping by third parties.

Fig.1:1G Mobile

B) Second Generation (2G)

2G emerged in late 1980s. It uses digital signals for voice transmission and has speed of 64 kbps. 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. The Global System for Mobile communications (GSM) gained the most popularity as 2G digital system with data transmission up to 9.6 kbps. GSM was introduced in 1990 and then evolved in 1995 with General packet radio service (GPRS) where GPRS is a radio technology for GSM networks that adds packet-switching protocols.

Fig.2: 2G Mobile

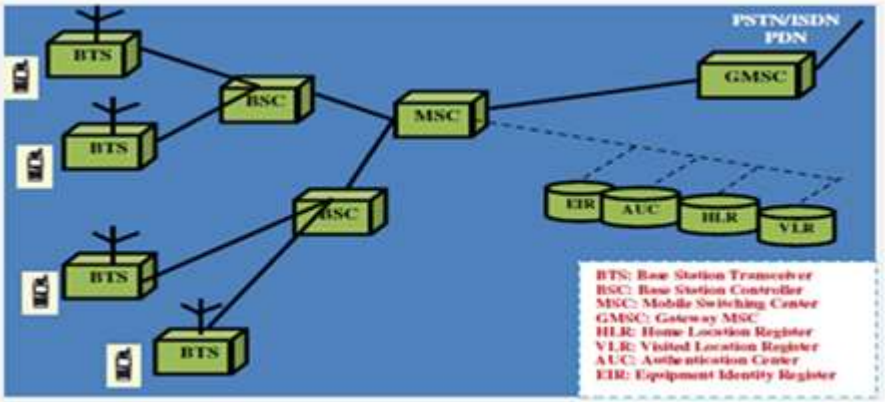

Fig.3: General GSM Network Architecture.

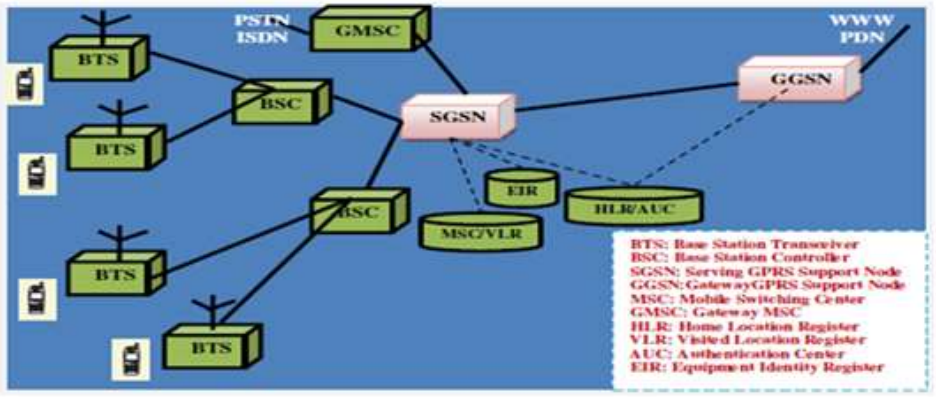

Fig.4: General GPRS Network Architecture.

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. 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.

Methods:

- UMTS
- HSDPA (High Speed Downlink Packet Access)
- HSOPA (High Speed OFDM (Orthogonal Frequency Division Multiplexing) Packet Access)

Fig.5: 3G Mobile

D) Fourth Generation(4G)

4G offers a downloading speed of 100Mbps.4G provides 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. 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.

Fig.6: 4G Mobile

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.7: 5G Mobile

III. COMPARISON OF ALL GENERATIONS OF MOBILE TECHNOLOGIES

Technology Features	**1G**	**2G**	**3G**	**4G**	**5G**
Start/ Deployment	1970 – 1980	1990 - 2004	2004-2010	Now	Soon (probably 2020)
Data Bandwidth	2kbps	64kbps	2Mbps	1 Gbps	Higher than 1Gbps
Technology	Analog Cellular Technology	Digital Cellular Technology	CDMA 2000 (1xRTT, EVDO) UMTS, EDGE	WiMax LTE Wi-Fi	WWWW(coming soon)
Service	Mobile Telephony (Voice)	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	TDMA, CDMA	CDMA	CDMA	CDMA
Switching	Circuit	Circuit, Packet	Packet	All Packet	All Packet
Core Network	PSTN	PSTN	Packet N/W	Internet	Internet

Table 1: Comparisions of Generations

IV. KEY CONCEPTS OF 5G

- Real wireless world with no more limitation with access and zone issues
- Wearable devices with AI capabilities.
- Internet protocol version 6 (IPv6), where a visiting care-of mobile IP address is assigned according to location and connected network.
- High altitude stratospheric platform station (HAPS) systems: The radio interface of 5G communication systems is suggested in a Korean research and development program to be based on beam division multiple access (BDMA) and group cooperative relay techniques.
- 5G technology offer high resolution for crazy cell phone user and bi-directional large bandwidth shaping.
- The advanced billing interfaces of 5G technology makes it more attractive and effective.
- The high quality services of 5G technology based on Policy to avoid error.
- 5G technology is providing large broadcasting of data in Gigabit which supporting almost 65,000 connections.
- The new 5G technology will take all delivery service out of business prospect.
- The uploading and downloading speed of 5G technology touching the peak.
- The 5G technology network offering enhanced and available connectivity just about the world.
- The 5G technology is providing up to 25 Mbps connectivity speed.

V. DESIGN OF 5G MOBILE NETWORK ARCHITECTURE

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. However, there should be different radio interface for each Radio Access Technology (RAT) in the mobile terminal. For an example, if we want to have access to four different RATs, we need to have four different access - specific interfaces in the mobile terminal, and to have all of them active at the same time, with aim to have this architecture to be functional.

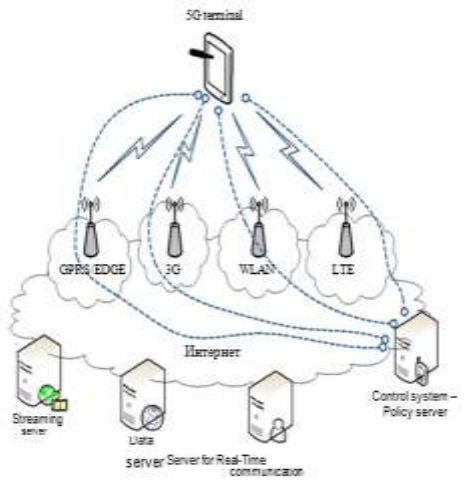

Fig.8: Functional Architecture for 5G Mobile Networks

The first two OSI levels (data-link and physical levels) are defining the radio access technologies through which is provided access to the Internet with more or less QoS support mechanisms, which is further dependent upon the access technology (e.g., 3G and WiMAX have explicit QoS support, while WLAN has not) . Then, over the OSI-1 and OSI-2 layers is the network layer, and this layer is IP (Internet Proto col) in today's communication world, either IPv4 or IPv6, regardless of the radio access technology. The purpose of IP is to ensure enough control data (in IP header) for proper routing of IP packets belonging to a certain application connections - sessions between client applications and servers somewhere on the Internet. Routing of packets should be carried out in accordance with established policies of the user.

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 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.

VII. PROGNOSIS

If a 5G family of standards were to be implemented, it would likely be around the year 2020, according to some sources. A new mobile generation has appeared every 10th year since the first 1G system (NMT) was introduced in 1981, including the 2G (GSM) system that started to roll out in 1992, and 3G (W-CDMA/FOMA), which appeared in 2001. The development of the 2G (GSM) and 3G (IMT-2000 and UMTS) standards took about 10 years from the official start of the R&D projects, and development of 4G systems started in 2001 or 2002. However, still no official 5G development projects have currently been launched. From user's point of view, previous mobile generations have implied substantial increase in peak bit rate (i.e. physical layer net bit rates for short-distance communication). However, no source suggests 5G peak download and upload rates of more than the 1 Gbps to be offered by ITU-R's definition of 4G systems. If 5G appears, and reflects these prognoses, the major difference from a user point of view between 4G and 5G techniques must be something else than increased maximum throughput; for example lower battery consumption, lower outage probability (better coverage), high bit rates in larger portions of the coverage area, cheaper or no traffic fees due to low infrastructure deployment costs, or higher aggregate capacity for many simultaneous users (i.e. higher system level spectral efficiency).

VIII. NEED FOR 5G?

The major difference, from a user point of view, between current generations and expected 5G techniques must be something else than increased maximum throughput; other requirements include:

- Lower battery consumption.
- Lower outage probability; better coverage and high data rates available at cell.
- Multiple concurrent data transfer paths.
- Around 1Gbps data rate in mobility.
- More secure; better cognitive radio/SDR Security.
- Higher system level spectral efficiency.
- Worldwide wireless web (WWWW), wireless-based web applications that include full multimedia capability beyond 4G speeds.
- More applications combined with artificial intelligent (AI) as human life will be surrounded by artificial sensors which could be communicating with mobile phones.
- Not harmful to human health.
- Cheaper traffic fees due to low infrastructure deployment costs.

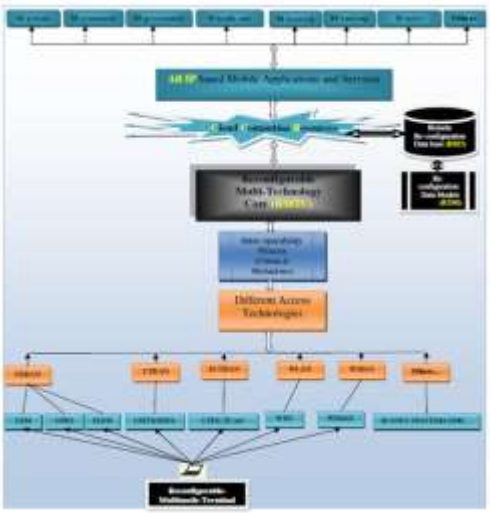

Fig.9: A proposed 5G Network Architecture

IX. CELLULAR ARCHITECRURE

A **cellular architecture** is a type of computer architecture prominent in parallel computing. Cellular architectures are relatively new, with IBM's Cell microprocessor being the first one to reach the market.

Cellular architecture takes multi-core architecture design to its logical conclusion, by giving the programmer the ability to run large numbers of concurrent threads within a single processor. Each 'cell' is a compute node containing thread units, memory, and communication. Speed-up is achieved by exploiting thread-level parallelism inherent in many applications. Cell, a cellular architecture containing 9 cores, is the processor used in the PlayStation 3. Another prominent cellular architecture is Cyclops64, a massively parallel architecture currently under development by IBM. Cellular architectures follow the low-level programming paradigm, which exposes the programmer to much of the underlying hardware. This allows the programmer to greatly optimize his code for the platform, but at the same time makes it more difficult to develop software.

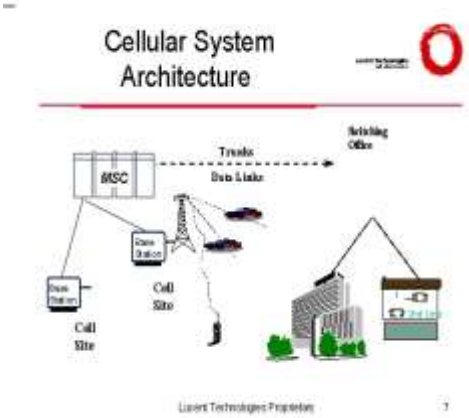

Fig.10: Cellular system Architecture

X. CONCLUTION

In this paper we have defined completely novel network architecture for such 5G mobile networks. The architecture includes introduction of software agents in the mobile terminal, which will be used for communication with newly defined nodes called Policy Routers, which shall be placed in the core network. The Policy Router creates IP tunnels with the mobile terminal via each of the interfaces to different RATs available to the terminal. The proposed architecture for future 5G mobile networks can 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. 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. There are lots of improvements from 1G, 2G, 3G, and 4G to 5G in the world of telecommunications. The new coming 5G technology is available in the market in affordable rates, high peak future and much reliability than its preceding technologies.

XI. FUTURE ENHANCEMENT

5G network technology will open a new era in mobile communication technology. The 5G mobile phones will have access to different wireless technologies at the same time and the terminal should be able to combine different flows from different technologies. 5G technology offer high resolution for crazy cell phone user. We can watch TV channels at HD clarity in our mobile phones without any interruption. The 5G mobile phones will be a tablet PC.

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