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RESEARCH ARTICLE

Architectural Shift from 4G to 5G Wireless Mobile Networks

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Abstract— Due to the ever increasing user demand for higher data rate and seamless communication through their mobile devices the current wireless mobile networks need to be upgraded to support such high requirements. The current fourth generation wireless mobile network (4G) based on All-IP Network architecture provides high data rates, low latency and low-cost implementation. But there are few specific user applications that require very high data rate and uninterrupted access to the internet. A sophisticated modern mobile technology termed the fifth generation wireless mobile network (5G) is proposed for the future. 5G will make use of Flat-IP Network architecture which will not only provide very high data rates but also provides increased spectrum efficiency, average cell throughput and supports ubiquitous computing. In this paper we discuss this evolution of wireless mobile network technology specifically the shift in the architecture from 4G to 5G to achieve a full real wireless world.

Keywords— 4G, 5G, Architecture, Transition

I. INTRODUCTION

Over the last few decades wireless communication has seen a great advancement in technology. The telecommunication industry started with 1G also known as AMPS(Advanced Mobile Phone System) which was a form of analog communication. To overcome the drawbacks of 1G a new technology called 2G also known as GSM(Global System for Mobile communication) was developed. It was the first digital communication technique. A more advanced form of 2G with higher data rate called 3G(UMTS, CDMA2000) was developed. Now the most recent technology is 4G(Mobile WiMax, LTE) with even more improved data rates and efficiency. To overcome the limitations of 4G and create a real wireless world a new wireless technology is proposed for the future called 5G.

4G is short for Fourth (4th) Generation Technology. 4G Technology is basically the extension in the 3G technology with more bandwidth and services offers in the 3G. Fourth generation (4G) technology will offer many advancements to the wireless market, including downlink data rates well over 100 megabits per second (Mbps), low latency, very efficient spectrum use and low-cost implementations. With impressive network capabilities, 4G enhancements promise to bring the wireless experience to an entirely new level with impressive user applications, such as sophisticated graphical user interfaces, high-end gaming, high- definition video and high-performance Ad hoc and multi hop networks (the strict delay requirements of voice make multi hop network.[1] The 4G integrates three standards (WCDMA, CDMA and TD-SCDMA) of 3G into MC-CDMA.[2]

A key change in 4G is the abandonment of circuit switching. 3G technologies use a hybrid of circuit switching and packet switching. Circuit switching is a very old technology that has been used in telephone systems for a very long time. The downside to this technology is that it ties up the resource for as long as the connection is kept up. Packet switching is a technology that is very prevalent in computer networks but has since appeared in mobile phones as well. With packet switching, resources are only used when there is information to be sent across. The efficiency of packet switching allows the mobile phone company to squeeze more conversations into the same bandwidth. 4G technologies would no longer utilize circuit switching even for voice calls and video calls. All information that is passed around would be packet switched to enhance efficiency. [3] Still with 4G there are some drawbacks namely the power consumption is still more, the spectrum efficiency is not up to the mark, etc. With the increasing demands for higher data rates a new and more advanced technology called 5G is developed. It will provide many features like ubiquitous computing, seamless wireless network, etc. along with improved data rates.

5G Technology stands for 5th Generation Mobile technology. It has changed the means to use cell phones within very high bandwidth. 5G technology has extraordinary data capabilities and has ability to tie together unrestricted call volumes and infinite data broadcast within latest mobile operating system. 5G has a bright future because it can handle the best technologies and offer priceless handsets to their customers[4]. There are two views of 5G systems: evolutionary and revolutionary. In evolutionary view the 5G (or beyond 4G) systems will be capable of supporting WWWW(World Wide Wireless Web) allowing a highly flexible network such as a Dynamic Adhoc Wireless Network (DAWN). In this view advanced technologies including intelligent antenna and flexible modulation are keys to optimize the adhoc wireless networks. In revolutionary view, 5G systems should be an intelligent technology capable of interconnecting the entire world without limits. An example application could be a robot with built-in wireless communication with artificial intelligence[5].

II. ARCHITECTURE OF 4G MOBILE NETWORK

The requirements of a 4G core network are:

1. The ability to handle a very high level of multimedia traffic.
2. Advanced mobility management (this involves location management and managing hand-overs)
3. Diversified radio access support (this refers to support for features like various QoS levels and transmission speeds, independent uplink and downlink capacity).
4. Seamless service: the delivery of data must be smooth and not be affected by any transitions in the user's situation:
-Network-seamless
-Terminal-seamless
-Content-seamless

5. Support for a diverse range of applications - i.e support structure for wireless ASPs (Application Service Providers), who are third-party providers of high-level services similar to ASPs in the wired Internet today).

The IP core network will be based on IPv6 (IP Version 6) instead of IPv4. This is more conducive to a large number of devices with IP addresses and also supports mobility far better than its predecessor. The IP core will most likely be implemented using ATM (Asynchronous Transfer Mode) - an evolutionary step from the Frame Relay based 3G core.

The Core network may be viewed as consisting of 3 layers - the Transport Network, the Service Middleware and the Applications. The Transport Network is the actual network interconnection and will be configured by routers, as with any IP network.

The Service Middleware is at the hardware and software level (hence the name, middleware). This will be implemented in Servers running specialised software. On one side, this will provide application support with such functions as billing, media conversion, location registration, billing and so on. Known as the Service Support Layer this also provides an API (Application Programming Interface) through protocols such as JAIN and Parlay which are in the process of being standardised. On the other side, the Service Middleware will perform network and transport management with functions like RRM (Radio Resource Management), MM (Mobility Management), C/SM (Call and Session Management).

The Core Network is inherently network-seamless since it is based on IP, the most universal Network layer protocol. Also, nodes can be configured to allow connectivity with other types of networks. The Service Middleware provides the content-seamless and terminal-seamless service. Location Management keeps track of the whereabouts of any mobile device and its movement characteristics. Thus, media conversion can take place when necessary according to the user's current situation and preferences. For example, the video resolution may be automatically reduced when user changes from a large-screen terminal (stationary location) to a smaller screen (on the move). Another example is the conversion from real-time video to audio when the user has to drive a vehicle.[6]

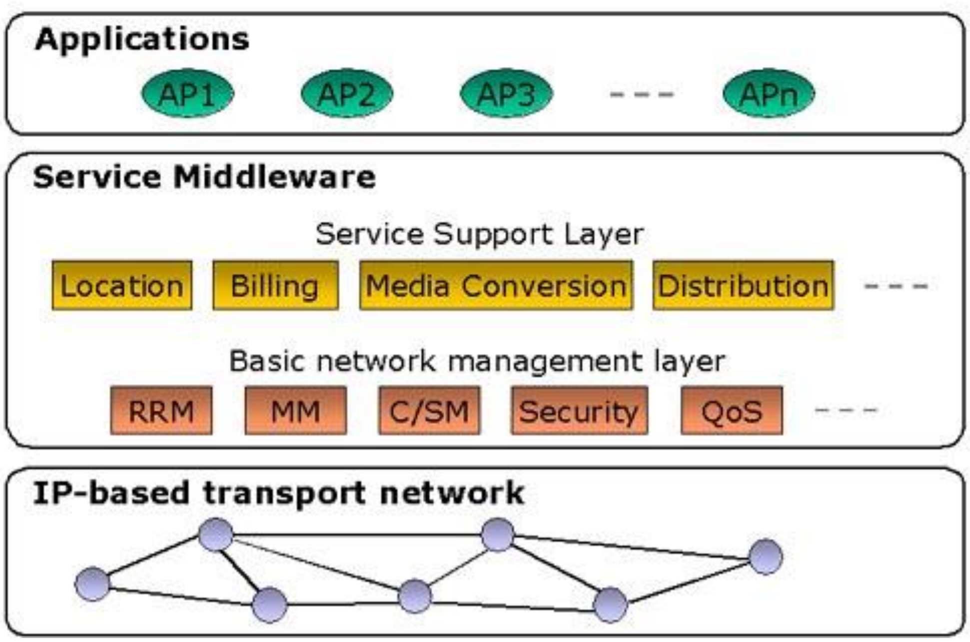

Fig.1 Layered view of the IP-based Core Network in 4G

Fig.2 provides a high-level functional representation of a LTE/4G network. This network is composed of three major sub-networks: the Evolved Universal Terrestrial Radio Access Networks (eUTRAN),which provides the air interface and local mobility management of the user equipment (UE), the evolved packet core (EPC), and the broadband backhaul network that provides the aggregation of cell traffic and transport back to the EPC. The 3GPP LTE standards defined the EPC as a set of logical data and control plane functions that can be implemented either as integrated or as separate network elements. The four EPC functions are: the Serving Gateway (SGW), the Packet Data Network Gateway (PGW) that supports the data or bearer traffic; and the Mobility Management Entity (MME) and the Policy Charging and Rules Function (PCRF) which support the dynamic mobility management and policy control traffic. The backhaul network either is owned by the wireless operator or is leased from a third party backhaul access provider. Any number of transport technologies can be used for backhaul including packet microwave, packet optical, Carrier Ethernet, IP/MPLS, GPON and xDSL.[7]

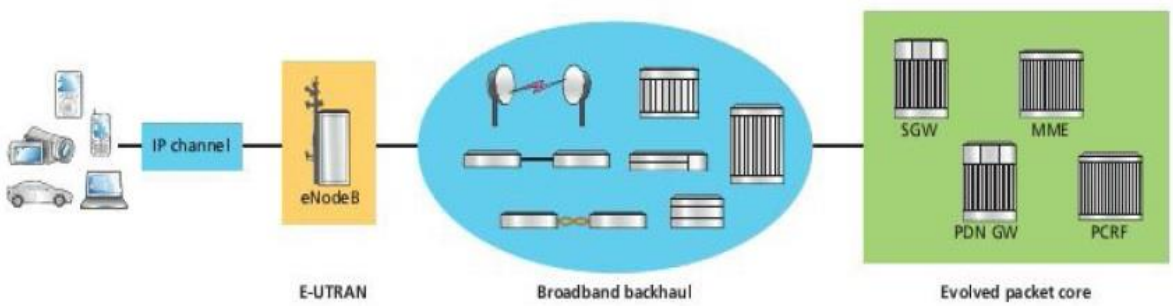

Fig2. 4G architechture

III. TRANSITION

The All-IP Network (AIPN) is an evolution of the 3GPP system to fulfill the increasing demands of the cellular communications market. It is a common platform valid for all sorts of radio access technologies. AIPN focused primarily on the enhancements of packet switched technology but now it provides a continued evolution and optimization in terms of both performance and cost. The key benefits of AIPN architecture includes a variety of different access systems‘ provision, lower costs, universal seamless access, and increased user-satisfaction and reduced system latency. But with the advantages of IP come some dangers: as data flow more freely and the internet is open not only to developers but also to all manner of criminals and viruses, developers and operators face new security challenges which should be solved properly.[8] Hence the 5G RAN (radio access network) technology should be a dynamic mesh network based on IP backhaul. In 5G networks there could be many types of base station including UDN (user densification network), massive MIMO (multiple-input multiple-output), traditional macro, and D2D. These various base stations will coordinate with each other horizontally more often than they do in 4G networks, and so will require a dynamic and adaptive wireless mesh network.[9]

In contrast to 4g 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 will be able to combine different flows from different technologies. 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.[10]

IV. ARCHITECTURE OF 5G MOBILE NETWORK

Figure 3 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. 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.

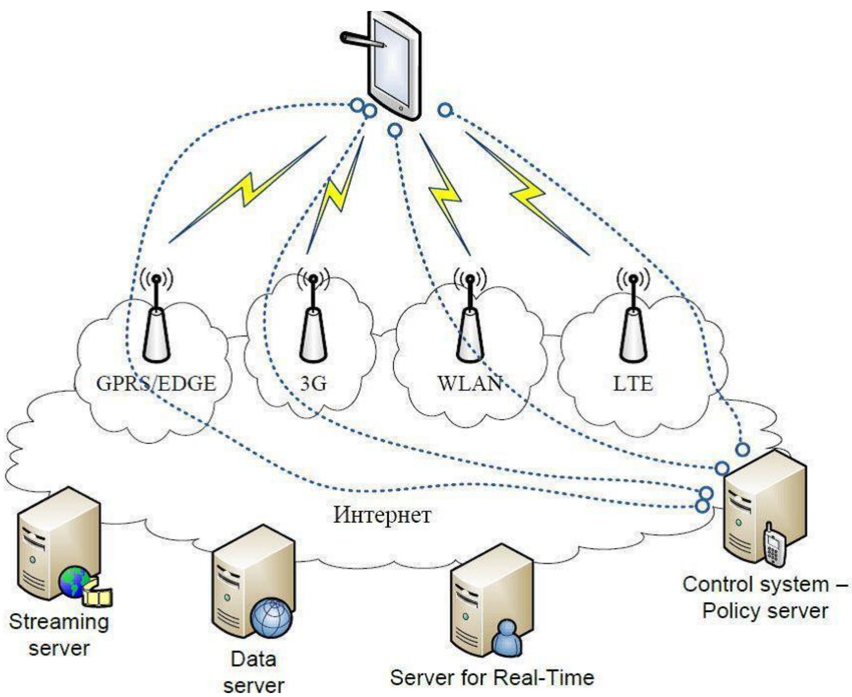

Fig.3 Functional Architecture for 5G Mobile Networks

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.

Application connections are realized between clients and servers in the Internet via sockets. Internet sockets are endpoints for data communication flows. Each socket of the web is a unified and unique combination of local IP address and appropriate local transport communications port, target IP address and target appropriate communication port, and type of transport protocol. Considering that, the establishment of communication from end to end between the client and server using the Internet protocol is necessary to raise the appropriate Internet socket uniquely determined by the application of the client and the server. This means that in case of interoperability between heterogeneous networks and for the vertical handover between the respective radio technologies, the local IP address and destination IP address should be fixed and unchanged. Fixing of these two parameters should ensure handover transparency to the Internet connection end-to-end, when there is a mobile user at least on one end of such connection. In order to preserve the proper layout of the packets and to reduce or prevent packets losses, routing to the target destination and vice versa should be uniquely and using the same path. Each radio access technology that is available to the user in achieving connectivity with the relevant radio access is presented with appropriate IP interface. Each IP interface in the terminal is characterized by its IP address and netmask and parameters associated with the routing of IP packets across the network. In regular inter-system handover the change of access technology (i.e., vertical handover) would mean changing the local IP address. Then, change of any of the parameters of the socket means and change of the socket, that is, closing the socket and opening a new one. This means, ending the connection and starting e new one. This approach is not-flexible, and it is based on today's Internet communication.

In order to solve this deficiency we propose a new level that will take care of the abstraction levels of network access technologies to higher layers of the protocol stack. This layer is crucial in the new architecture.

To enable the functions of the applied transparency and control or direct routing of packets through the most appropriate radio access technology, in the proposed architecture we introduce a control system in the functional architecture of the networks, which works in complete coordination with the user terminal and provides a network abstraction functions and routing of packets based on defined policies. At the same time this control system is an essential element through which it can determine the quality of service for each transmission technology. He is on the Internet side of the proposed architecture, and as such represents an ideal system to test the qualitative characteristics of the access technologies, as well as to obtain a realistic picture regarding the quality that can be expected from applications of the user towards a given server in Internet (or peer).

The network abstraction level would be provided by creating IP tunnels over IP interfaces obtained by connection to the terminal via the access technologies available to the terminal (i.e., mobile user). In fact, the tunnels would be established between the user terminal and control system named here as Policy Router, which performs routing based on given policies. In this way the client side will create an appropriate number of tunnels connected to the number of radio access technologies, and the client will only set a local IP address which will be formed with sockets Internet communication of client applications with Internet servers. The way IP packets are routed through tunnels, or choosing the right tunnel, would be served by policies whose rules will be exchanged via the virtual network layer protocol. This way we achieve the required abstraction of the network to the client applications at the mobile terminal. The process of establishing a tunnel to the Policy Router, for routing based on the policies, are carried out immediately after the establishment of IP connectivity across the radio access technology, and it is initiated from the mobile terminal Virtual Network-level Protocol. Establishing tunnel connections as well as maintaining them represents basic functionality of the virtual network level (or network level of abstraction).[11]

V. CONCLUSION

In this paper, we have discussed the transition of wireless mobile networks from the current 4G mobile network to the future 5G wireless mobile network. The evolution from 4G to 5G is necessary as the future mobile devices will have very high computing and memory capabilities and thus will support applications which will require very high data rates, the current network architecture of 4G mobile networks will not be able to provide these high data rates necessary for these applications, thus a complete architectural change is necessary. This new architecture can be seen in the 5G wireless mobile network. The 5G mobile network offers very high data rates as compared to the current 4G networks. Along with the high data rates 5G also offers low power consumption in mobile devices and also supports ubiquitous computing wherein the user is connected to many access technologies simultaneously like WiFi or 5G networks and the user can therefore move from the range of one access technology to another without loss of internet access. Thus as the 5G mobile network has several advantages over 4G mobile network, the current network architecture of 4G mobile network should be replaced by a more flexible 5G mobile network architecture having better features and capabilities than its current counterpart.

References

[1] Gautam, Priya, et al. "Review Paper on 4G Wireless Technology."

[2] Gani, Abdullah, et al. "Multi-bandwidth data path design for 5G wireless mobile internets." *WSEAS Transactions on Information Science and Applications* 6.2 (2009): 159-168.

[3] FAGBOHUN, Olumuyiwa Oludare. "Comparative studies on 3G, 4G and 5G wireless technology."

[4] Bhalla, Mudit Ratana, and Anand Vardhan Bhalla. "Generations of mobile wireless technology: A survey."*International Journal of Computer Applications*5.4 (2010).

[5] Akhtar, Shakil. "2G-4G Networks: Evolution of technologies, standards, and deployment."*Encyclopedia of Multimedia Technology and Networking, Ideas Group Publisher http://faculty. uaeu. ac. ae/s. akhtar/EncyPaper04. Pdf*(2009).

[6] http://services.eng.uts.edu.au/~kumbes/ra/4G/4g02a.html#archOp

[7] Kumar, Arun. "Comparision of 3g Wireless Networks and 4g Wireless Networks." *International Journal of Electronics and Communication Engineering* 6.1 (2013): 1-8.

[8] Hossain, Saddam. "5G Wireless Communication Systems." *American Journal of Engineering Research (AJER) e-ISSN*: 2320-0847.

[9] http://wwwen.zte.com.cn/en/press_center/news/201406/t20140623_425167.html

[10] FAGBOHUN, Olumuyiwa Oludare. "Comparative studies on 3G, 4G and 5G wireless technology."

[11] Tudzarov, Aleksandar, and Toni Janevski. "Functional architecture for 5G mobile networks."*International Journal of Advanced Science and Technology*32 (2011): 65-78.

