Advance Physics Letter

4G Wireless Communication: A Review on Approach towards Beyond 3G Era, Architecture and Features

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Abstract — The communication industry now a day has achieved the huge of access facilities for users. The user aspects of high speed, reliability, immunity to the channel noise, large bandwidth and multipoint multiuser accessibility is highly considered and focused in communication technology of 3G operators worth keeping in mind the cost factor also. Too fast data communication is the must demand for the several sectors worldwide including medical, finance, education etc, this is carried by the aid of optical fibers using LASER communication. The highest speed of medium for communication is light and communication through optical cables has enabled users to get HD video access and high speed internet facilities. 3G proved itself a promising for such a fast vast voice, data and video transmission but the drawbacks of 3G are required to be overcome by the advantages of 4G technology. 4G model renders for the users very efficient and lightening speed multi access way of communication services. This paper describes limitations of 3G, the 4G model, advantages of 4G model over 3G, some technical challenges in the 4G model implementation for the operators and their possible solutions. Paper also gives the architecture of 4G, technology adopted for 4G wireless communication, list of services and applications of 4G to the end consumers of communication industry.

Key terms – 3G communication, 4G communication, OFDMA, LTE, WiMAX.

I. INTRODUCTION

The communication technologies are categorized in different generations according to the access facilities provided and the communication techniques used. The telecommunication era started using 1G in 1980 which uses all the systems based on analog radio signal technology having poor security and supported data bandwidth of Kbps range. 1G communication era was replaced by 2G in the year 1990 having capacity to provide rich set of services like high voice quality and global mobility which was based on the digital radio signal technology. The standards used in the era of 2G mobile communication are GPS and GPRS, but for both 1G and 2G the technology circuit switched technology was adopted and so the data rates in 1G and 2G was very low [01]. The next generation of communication technology between 2G and 3G was 2.5G based on both packet switched and circuit switched technologies which provided high data rates with low power consumptions for the need of users demanding very fast data access. GSM (Global System for Mobile communications) and CDMA (Code division multiple access) were the technologies for 2.5G architecture [1]. 2.5G is now replaced by 3G which includes the technologies of 2.5G and some other new technologies like WiMAX (Worldwide Interoperability for Microwave Access) for the enhanced data rates for the users of communication industry. The 3G communication technology is totally based on the packet switching which is capable of providing broad range of high quality services such as very fast data rates for video communication. As the 3G provided only few new features over 2G it was not as popular as 2G. The next generation of communication was to adopt the new concepts for the advancements using WiMAX technology; this is the era of 4G. "Connect anytime, anyhow, anywhere" is the main idea of this 4G technology which is beyond the imagination of end users. The 3G is a mix of circuit and packet switching network whereas 4G is only a packet switching network [2]. To achieve the highly advantageous communication facilities of the new era in 4G it is required to integrate the switching techniques those were used in the previous generations as well as some new technologies.

II. COMPARISON BETWEEN 3G & 4G TECHNOLOGY

At present 3G is the best mobile and wireless communication method when high data speeds are

required such as for video calling, video conferencing, real time applications and such others. After the success of 3G technology 4G technology is being developed. Several differences between 3G and 4G include the much faster speeds of 4G as compared to the 3G, switching technique used which is a mixture of circuit and packet switching in 3G and that is complete packet switching in 4G etc. [2].

A 4G system, in addition to the usual voice and other services of previous generations, provides mobile broadband Internet access, for example to laptops with wireless modems, to smartphones, and to other mobile devices. The two 4G candidate systems are commercially deployed which are the Mobile WiMAX standard (first used in South Korea in 2007) and the first-release Long Term Evolution (LTE) standard (in Oslo, Norway and Stockholm, Sweden since 2009) [3]. 3G is based on high capacity broadband data whereas 4G is based on internet protocol [1]. The data bandwidth of 3G is approximately 2Mbps but the 4g is having this as 200Mbps. The peak upload rate of 3G is 5 Mbps and this is 500Mbps in 4G. The peak download rate of 3G is 100 Mbps and this is 1Gbps in 4G. 3G has a frequency band of 1.8-2.5 GHz whereas 4G has a frequency band of 2-8 GHz. 3G communication is capable of providing video access to its users but 4G is capable of providing HD video access to its users [5]. Data rates of 100 Mbps are even very important advantage for a 4G user. Seamless Handover and Service Continuity is a "base station" that features intra- and inter-technology handovers, assuring service continuity with zero or minimal interruption, without a noticeable loss in service quality. Support for this function requires continuous transparent maintenance of active service instances and inclusion of various access technologies, from WiFi to OFDMA [4].

According to the ITU-Advanced specifications standards 4G networks should be able to provide 1Gbps speed for low mobility and at least 100Mbps speed of data rate for high mobility [3]. With this feature, 4G users will have access to different services, increased coverage, the convenience of a single device, one bill with reduced total access cost, and too more reliable wireless access to services even with the failure or loss of one or more networks [3].

III. THE 4G ARCHITECTURE

The WiMAX and LTE are the technologies adopted in the fourth generation wireless communication. As the WiFi suffers from the drawback of low coverage of communication network the next technology should be capable of providing a good QoS and a coverage range larger as compared to the WiFi. The WiMAX and LTE are based on point to multipoint communication and capable of serving wireless broadband services with a wider coverage. The Long Term Evolution (LTE) technology has been developed by the Third Generation Partnership Project (3GPP) as an improvement to the current Universal Mobile Telecommunications System which is sometimes called 3.9G or Super 3G [5]. Global mobility and high speed data transfer using data rates about 100Mbps are 4G era's features.

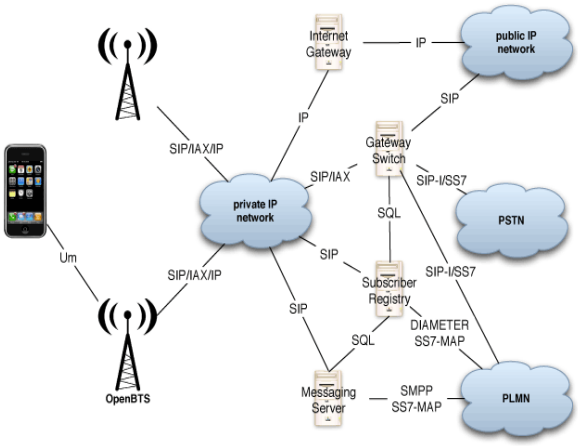

Fig .1. A 4G Architecture [6].

Both the WiMAX and LTE support Frequency-division duplex (FDD) as well as time-division duplex (TDD) systems of communication. Regarding the 4G standards, both major 3G standards bodies, which are 3rd Generation Partnership Project (3GPP) and 3rd Generation Partnership Project 2 (3GPP2), indicated that orthogonal frequency division multiple access (OFDMA) is their choice for the physical-layer transmission technology. The first standard to be deployed using the new multiplexing technique is IEEE802.16e, or known as WiMAX (Worldwide Interoperability for Microwave Access) which is adopted by the 4G [7].

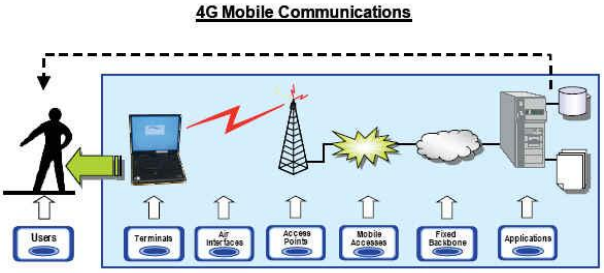

Fig.2. Mobile communication in a 4G network [2].

Above figure represents the architecture of 4G mobile communication. 4G is a multiple access technology so there are several access points for 4G end users through its network. The efficient multiple access technique adopted in the 4G is OFDMA known as orthogonal frequency division multiple access. WiMAX and LTE are the two main concepts in the 4G architecture.

IV. CHALLENGES FOR 4G

There are several factors challenging for the opportunity of the new era of communication using the 4G. The channel quality is required to be maintained at a level acceptable by the end users at operating costs [5]. Due to several users in the RF channel the interference increases. This is a key challenge for the 4G era. One another important challenge for this technology is security. The security objective is to be identified by the operators of this technology. The quality of service is also required to be maintained during the hand–off delays. The design of batteries having more backup time is also a key challenge for the 4G implementation [8]. As the number of services demands a high backup level of battery this will lead to the batteries which would increase the size. LI-ion batteries are a good solution for this type of requirement where a backup time is more according to the need of devices. Developing the new generation for a successful communication technology for the expectations of users in a cost effective manner is also a challenge for its developers. All such challenges are expected to be solved by the researchers of 4G communication so that this technology may be adopted soon by the users.

V. APPLICATIONS OF 4G

The unique application of 4G is to access multiple networks. So the user can access different mobile networks as well as wireless network simultaneously [3]. The demand of High Definition (HD) is increasing day by day more than that of the mobile network bandwidth support available. The Virtual-Presence, Virtual-Navigation, Telegeoprocessing, Telemedicine and Tele-education, and Multimedia video services are too advantageous application for the users [10]. The improvements in media communication quality have been one of the most perceptible advancements and only the perceptible advancements noted by the customers. However, current mobile terminals still have much room in terms of improving communication reality. The ultimate objective of enhanced-reality media communications is to provide a transparent environment that is indistinguishable from face-to-face communications [9]. In the 4G architecture, a single physical 4G communication device with multiple interfaces to access services on different wireless networks. As the current wireless technologies such as Bluetooth, Wi-Fi, have low data transmission speed as compared to that optical wireless communication, the data rate for optical systems is in the Gbps range [11].

The multimode device architecture may improve call completion and expand effective coverage area [8]. Now 4G technology is replacing the 2G and 3G due its increased data rates and quality of services. The speed of 4G network tested from an iPhone 5 is shown in the fig below [3]

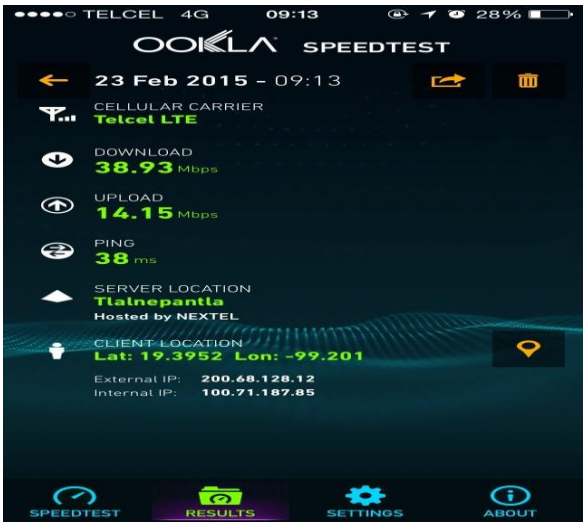

Fig.3. Telcel 4G Mexico, speed test from an iPhone 5.

VI. CONCLUSION

The need of global communication industry will lead 4G a demanding technology for the users. The optical communication will give advanced services to the end users through its high speed. This paper presented the several aspects of 4G technology. Anytime anywhere connectivity using WiMAX and LTE will prove 4G a very promising generation at cost which is affordable for users across world. High data rates of about 100Mbps will enhance the popularity of 4G wireless multiple access technology. The communication sector will have a better future of the fourth generation's wireless communication in a near future. Connectivity, cost affordability, very high rate of data and global roaming features will change the life of user bringing to a new era of wireless communication.

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