The Study of the Evolution of 3g/4g Network and Their Limitations

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***Abstract*— For the past 20th century, the key technology has been information gathering, processing and distribution. This technology depends solely on the network systems. This is nothing but a grouping of systems that are controlled by a server. In business and home applications, mobile users, and in all social issues; the networks are used. To enhance the benefits of these networks, 3G/4G network systems were developed. The introduction of 3G/4G networks has brought tremendous improvement in information gathering, processing and dissemination. These include faster system connectivity, faster data sharing and downloading of large files from the internet via phones and computers. The aim of the 3G/4G networks is to improve the 2G systems.3G systems have additional standards like EDGE and CDMA rather than older systems. It has a high quality voice and video services but has limited in coverage area. Now introducing the 4G technologies to fulfil the limitations of 3G**

***Index Terms*—3G, 4G, CDMA, EDGE, GPRS, GSM, IMT, ITU, UMTS, DARPA**

I. INTRODUCTION

3G, short form of third Generation, is the third generation of mobile telecommunications technology. This is based on a set of standards used for mobile devices and mobile telecommunications use services and networks that comply with the International Mobile Telecommunications-2000 (IMT-2000) specifications by the International Telecommunication Union. 3G finds application in wireless voice telephony, mobile Internet access, fixed wireless Internet access, video calls and mobile TV.

3G telecommunication networks support services that provide an information transfer rate of at least 200 kbit/s. Later 3G releases, often denoted 3.5G and 3.75G, also provide mobile broadband access of several Mbit/s to smartphones and mobile modems in laptop computers. This ensures it can be applied to wireless voice telephony, mobile Internet access, fixed wireless Internet access, video calls and mobile TV technologies.

A new generation of cellular standards has appeared approximately every tenth year since 1G systems were introduced in 1981/1982. Each generation is characterized by new frequency bands, higher data rates and non–backward-compatible transmission technology.

Furthermore, 4G, short for fourth generation, is the fourth generation of mobile telecommunications technology, succeeding 3G and preceding 5G. A 4G system, in addition to the usual voice and other services of 3G, provides mobile ultra-broadband Internet access, for example to laptops with USB wireless modems, to smartphones, and to other mobile devices. Conceivable applications include amended mobile web access, IP telephony, gaming services, high-definition mobile TV, video conferencing, 3D television, and cloud computing.

Two 4G candidate systems are commercially deployed: 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). It has however been debated if these first-release versions should be considered to be 4G or not.

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II. HISTORICAL EVOLUTION OF 3G NETWORK

3G technology is the result of research and development work carried out by the International Telecommunication Union (ITU) in the early 1980s. 3G specifications and standards were developed in fifteen years. The technical specifications were made available to the public under the name IMT-2000. The communication spectrum between 400 MHz to 3 GHz was allocated for 3G. Both the government and communication companies approved the 3G standard. The first pre-commercial 3G network was launched by NTT DoCoMo in Japan in 1998, branded as FOMA. It was first available in May 2001 as a pre-release (test) of W-CDMA technology. The first commercial launch of 3G was also by NTT DoCoMo in Japan on 1 October 2001, although it was initially somewhat limited in scope; broader availability of the system was delayed by apparent concerns over its reliability.

The first European pre-commercial network was an UMTS network on the Isle of Man by Manx Telecom, the operator then owned by British Telecom, and the first commercial network (also UMTS based W-CDMA) in Europe was opened for business by Telenor in December 2001 with no commercial handsets and thus no paying customers. The first network to go commercially live was by SK Telecom in South Korea on the CDMA-based 1xEV-DO technology in January 2002. By May 2002 the second South Korean 3G network was by KT on EV-DO and thus the South Koreans were the first to see competition among 3G operators.

The first commercial United States 3G network was by Monet Mobile Networks, on CDMA2000 1x EV-DO technology, but this network provider later shut down operations. The second 3G network operator in the USA was Verizon Wireless in July 2002 also on CDMA2000 1x EV-DO. AT&T Mobility is also a true 3G UMTS network, having completed its upgrade of the 3G network to HSUPA.

The first pre-commercial demonstration network in the southern hemisphere was built in Adelaide, South Australia by m.Net Corporation in February 2002 using UMTS on

2,100 MHz. This was a demonstration network for the 2002 IT World Congress. The first commercial 3G network was launched by Hutchison Telecommunications branded as Three or "3" in June 2003. Emtel launched the first 3G network in Africa.

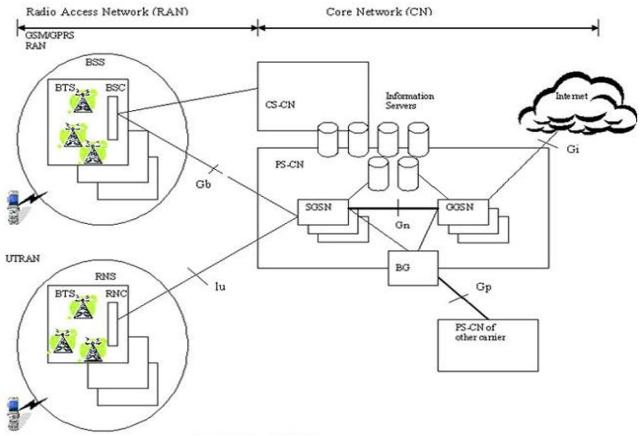

Fig.1.Architecture of 3G Network

1.1)1. Pros of 3G Networks

- 3G offers much faster data transfers, up to speeds as high as 2Mbps.
- Developers can use this network to create maps and positioning services, which are regularly accessed by the younger population.
- This network also offers powerful multimedia services, using which you can develop apps such as online billing systems, video conferencing and so on.
- Those wishing to develop visual voicemail apps will do very well to work on the 3G network.
- 3G is a preferred platform for many popular mobile phone games, especially those which contain graphics and animation.
- Advanced developers can also develop apps for mobile TV, IM and video chatting, as 3G supports all these and much more.

1.1)2. Cons of 3G Networks

- Because subscribing to 3G networks is expensive, you should understand that your clientele, though exclusive, will be limited in number. Most users prefer not to use 3G, as its cost deters them. There will still be 3G users to purchase your apps, but they will not be a concentrated part of the population.
- Also, though 3G users have the facility of enjoying video conferencing sessions with other 3G customers, they may not do too much more than that. So your sales of 3G apps may remain low-scale.
- 3G, though available in most parts of the world today, still has to catch on in some nations. Users in these locations may opt for other types of network.

III. APPLICATIONS OF 3G

The bandwidth and location information available to 3G devices gives rise to applications not previously available to mobile phone users. Some applications are:

- Mobile TV.
- Video on demand.
- Video conferencing.
- Telemedicine.
- Location-based services.
- Global Roaming.

IV. LIMITATIONS OF 3G

- With WCDMA based 3G, as the data speed increases the coverage area of the cell become smaller and smaller.
- There has been some improvement with HSPDA, but still it is impossible to connect these by wireless links in cellular technology.
- Using WCDMA cells, with increase in data rate, the speed of movement of user terminal also become lesser and lesser.
- We still have circuit voice, circuit data and packet data

V. HISTORICAL EVOLUTION OF 4G NETWORK

The 4G system was originally envisioned by the defence Advanced Research Projects Agency (DARPA). The DARPA selected the distributed architecture and end-to-end Internet protocol (IP), and believed at an early stage in peer-to-peer networking in which every mobile device would be both a transceiver and a router for other devices in the network, eliminating the spoke-and-hub weakness of 2G and 3G cellular systems. Since the 2.5G GPRS system, cellular systems have provided dual infrastructures: packet switched nodes for data services, and circuit switched nodes for voice calls. In 4G systems, the circuit-switched infrastructure is abandoned and only a packet-switched network is provided, while 2.5G and 3G systems require both packet-switched and circuit-switched network nodes, i.e. two infrastructures in parallel. This means that in 4G, traditional voice calls are replaced by IP telephony.

In 2002, the strategic vision for 4G—which ITU designated as IMT-Advanced—was laid out. In 2005, OFDMA transmission technology is chosen as candidate for the HSOPA downlink, later renamed 3GPP Long Term Evolution (LTE) air interface E-UTRA. In November 2005, KT demonstrated mobile WiMAX service in Busan, South Korea. In April 2006, KT started the world's first commercial mobile WiMAX service in Seoul, South Korea. In mid-2006, Sprint announced that it would invest about US$5 billion in a WiMAX technology buildout over the next few years ($5.85 billion in real terms). Since that time Sprint has faced many setbacks that have resulted in steep quarterly losses. On 7th May 2008, Sprint, Imagine, Google, Intel, Comcast, Bright House, and Time Warner announced a pooling of an average of 120 MHz of spectrum; Sprint merged its Xohm WiMAX division with Clearwire to form a company which will take the name "Clear".

In February 2007, the Japanese company NTT DoCoMo tested a 4G communication system prototype with 4×4 MIMO called VSF-OFCDM at 100 Mbit/s while moving, and 1 Gbit/s while stationary. NTT DoCoMo completed a trial in which they reached a maximum packet transmission rate of approximately 5 Gbit/s in the downlink with 12×12 MIMO using a 100 MHz frequency bandwidth while moving at 10 km/h, and is planning on releasing the first commercial

network in 2010. In September 2007, NTT Docomo demonstrated e-UTRA data rates of 200 Mbit/s with power consumption below 100 mW during the test. In January 2008, a U.S. Federal Communications Commission (FCC) spectrum auction for the 700 MHz former analog TV frequencies began. As a result, the biggest share of the spectrum went to Verizon Wireless and the next biggest to AT&T.[37] Both of these companies have stated their intention of supporting LTE.

In January 2008, EU commissioner Viviane Reding suggested re-allocation of 500–800 MHz spectrum for wireless communication, including WiMAX. On 15 February 2008, Skyworks Solutions released a front-end module for e-UTRAN. In November 2008, ITU-R established the detailed performance requirements of IMT-Advanced, by issuing a Circular Letter calling for candidate Radio Access Technologies (RATs) for IMT-Advanced. In April 2008, just after receiving the circular letter, the 3GPP organized a workshop on IMT-Advanced where it was decided that LTE Advanced, an evolution of current LTE standard, will meet or even exceed IMT-Advanced requirements following the ITU-R agenda. In April 2008, LG and Nortel demonstrated e-UTRA data rates of 50 Mbit/s while travelling at 110 km/h. On 12 November 2008, HTC announced the first WiMAX-enabled mobile phone, the Max 4G. In 15 December 2008, San Miguel Corporation, the largest food and beverage conglomerate in southeast Asia, has signed a memorandum of understanding with Qatar Telecom QSC (Qtel) to build wireless broadband and mobile communications projects in the Philippines. The joint-venture formed wi-tribe Philippines, which offers 4G in the country.[45] Around the same time Globe Telecom rolled out the first WiMAX service in the Philippines.

On 3 March 2009, Lithuania's LRTC announcing the first operational "4G" mobile WiMAX network in Baltic states. In December 2009, Sprint began advertising "4G" service in selected cities in the United States, despite average download speeds of only 3–6 Mbit/s with peak speeds of 10 Mbit/s (not available in all markets). On 14 December 2009, the first commercial LTE deployment was in the Scandinavian capitals Stockholm and Oslo by the Swedish-Finnish network operator TeliaSonera and its Norwegian brandname NetCom (Norway). TeliaSonera branded the network "4G". The modem devices on offer were manufactured by Samsung (dongle GT-B3710), and the network infrastructure created by Huawei (in Oslo) and Ericsson (in Stockholm). TeliaSonera plans to roll out nationwide LTE across Sweden, Norway and Finland. TeliaSonera used spectral bandwidth of 10 MHz, and single-in-single-out, which should provide physical layer net bitrates of up to 50 Mbit/s downlink and 25 Mbit/s in the uplink. Introductory tests showed a TCP throughput of 42.8 Mbit/s downlink and 5.3 Mbit/s uplink in Stockholm.

On 25 February 2010, Estonia's EMT opened LTE "4G" network working in test regime. On 4 June 2010, Sprint released the first WiMAX smartphone in the US, the HTC Evo 4G. In July 2010, Uzbekistan's MTS deployed LTE in Tashkent. On 25 August 2010, Latvia's LMT opened LTE "4G" network working in test regime 50% of territory. On November 4, 2010, the Samsung Galaxy Craft offered by MetroPCS is the first commercially available LTE smartphone. On 6 December 2010, at the ITU World Radiocommunication Seminar 2010, the ITU stated that LTE, WiMax and similar "evolved 3G technologies" could be considered "4G". On 12 December 2010, VivaCell-MTS launches in Armenia a 4G/LTE commercial test network with a live demo conducted in Yerevan.

On 28 April 2011, Lithuania's Omnitel opened a LTE "4G" network working in the 5 largest cities. In September 2011, all three Saudi telecom companies STC, Mobily and Zain announced that they will offer 4G LTE for USB modem dongles, with further development for phones by 2013. In 2011, Argentina's Claro launched a 4G HSPA+ network in the country. In 2011, Thailand's Truemove-H launched a 4G HSPA+ network with nation-wide availability. On March 17, 2011, the HTC Thunderbolt offered by Verizon in the U.S. was the second LTE smartphone to be sold commercially.

On 31 January 2012, Thailand's AIS and its subsidiaries DPC under cooperation with CAT Telecom for 1800 MHz frequency band and TOT for 2300 MHz frequency band launched the first field trial LTE in Thailand with authorization from NBTC. In February 2012, Ericsson demonstrated mobile-TV over LTE, utilizing the new eMBMS service (enhanced Multimedia Broadcast Multicast Service). On 10 April 2012, Bharti Airtel launched 4G LTE in Kolkata, first in India. On 20 May 2012, Azerbaijan's biggest mobile operator Azercell launched 4G LTE. On 10 October 2012, Vodacom (Vodafone South Africa) became the first operator in South Africa to launch a commercial LTE service. In December 2012, Telcel launches in Mexico the 4G LTE network in 9 major cities. In Kazakhstan, 4G LTE was launched on December 26, 2012 in the entire territory in the frequency bands 1865–1885/1760–1780 MHz for the urban population and in 794-799/835-840 MHz for those sparsely populated.

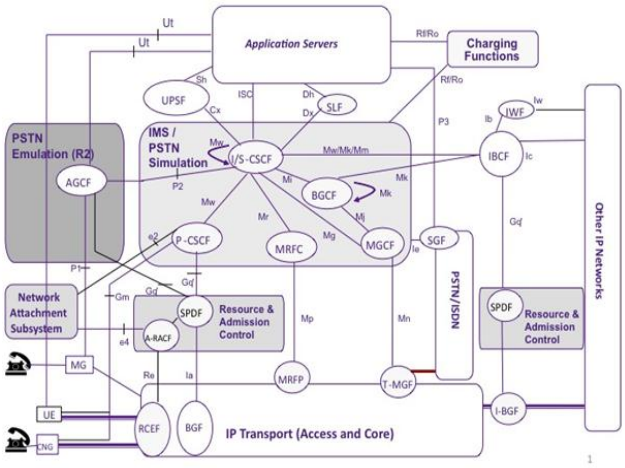

Fig.2.Architecture of 4G Network

1) Pros of 4G Networks

1. The most obvious advantage of the 4G mobile network is its amazing speed. Increased bandwidth leads to much faster data transfer speed, which is especially advantageous for mobile devices. Users of the 4G network get the advantage of superior, uninterrupted connectivity, especially for advanced tasks such as video chats and conferences. Considering the

younger generation of mobile device users, they can stream music, videos and movies at a much faster rate than ever before and can also easily share information online.

2. 4G networks offer much more coverage than other systems such as WiFi, which forces users to depend upon hotspots in each area you visit. Since 4G offers a coverage of 30 miles and more, as also overlapping network ranges, users would be assured of complete connectivity at all times.

3. One of the biggest problems with WiFi networks is that of online security. This is especially true for mobile devices. 4G networks offer complete privacy, security and safety. This is especially beneficial for corporate establishments and business persons, who hold sensitive information on their respective mobile devices.

4. 4G networks are quite affordable these days, what with pricing schemes being considerably slashed to fit users' budgets. Of course, this type of connectivity is more expensive than traditional WiFi networks, but it also has a lot more advantages to offer to users.

5. This network also offers users several options to choose from, as regards plans and equipment to connect to the 4G network. Many mobile carriers also offer special introductory offers for new customers, which works out to be very reasonable for them.

2) Cons of 4G Networks

1. Though the concept of 4G mobile networks is steadily gaining popularity, connectivity is still limited to certain specified carriers and regions. Of course, the number of cities that have 4G coverage is increasing by the day. However, it would take its own time for this network to be available in all the major cities of the world.

2. Though the hardware compatible with 4G networks is available at much cheaper rates today than earlier, the fact remains that this new equipment would necessarily have to be installed in order to supply these services. This would prove to be a cumbersome process for most mobile carriers planning to launch these services.

3. Since 4G mobile technology is still fairly new, it will most likely have its initial glitches and bugs, which could be quite annoying for the user. Needless to say, these teething troubles would be sorted out in due course of time, as well as with increase in network coverage.

4. 4G mobile networks use multiple antennae and transmitters and hence, users would experience much poorer battery life on their mobile devices, while on this network. This would mean that they would have to use larger mobile devices with more battery power, in order to be able to stay online for longer periods of time.

5. Users would be forced to make do with 3G or WiFi connectivity in the areas that do not yet have 4G mobile network coverage. While this is a problem in itself, the worse issue is that they would still have to pay the same amount as specified by the 4G network plan. This loophole has already resulted in many disgruntled customers. This situation can only be resolved once mobile carriers expand their 4G network coverage to include more regions.

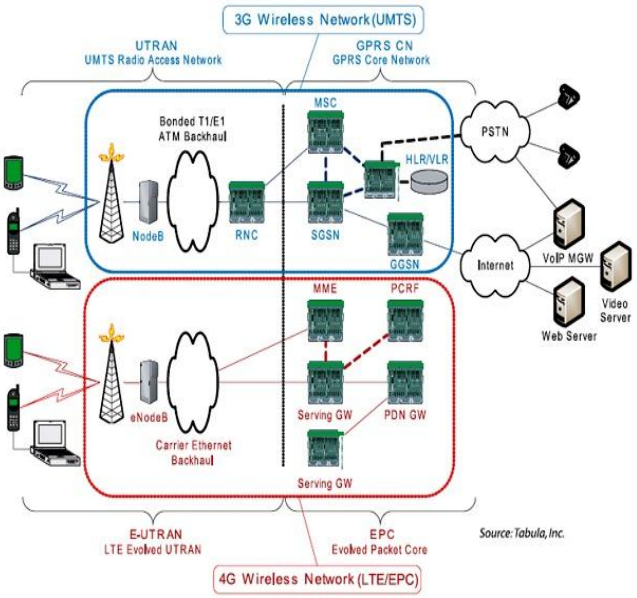

Fig.3.Wireless Transition from 3G to 4G

VI. CONCLUSION

Although network technology is evolving speedily, it would still take 3G/4G time to emerge as the most powerful and popular networks. Mobile carriers and users interested in investing in 3G/4G should do well to analyze and understand the evolutions and their pros and cons before adopting them in this new technology.

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