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4g wireless technology and its standards taking consideration evolution of 4g technology

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Abstract
This is a research paper on Mobile communication play a vital l role in the data and voice network front. With the deployment of mass scale 3Gjust around the globe, new directions are already being researched. This paper addresses the fourth generation mobile communication. The Fourth Generation (4G) Mobile Communication not only emphasizes on increase in data rate and new interfaces but it also converse the advanced wireless mobile communication. The high speed wireless access the systems in an Open Wireless Architecture (OWA) platform which has become the hub of this emerging next generation mobile technology. Based on the OWA model, 4G mobile would deliver the best business to the wireless market and Asia-Pacific which happens to be the most dynamic market of new generation mobile communication with over $100 Billion businesses in the next decade. The 4G mobile technology is the intersection and convergence of wireless mobile and wireless access around the globe. Any single architecture wireless system, including 3G, HSDPA, WiMax, etc., is a transitional solution only, and will be replaced by open wireless architecture system very soon where in various different wireless standards can be integrated and converged on open platform. The advent of 4Gwireless systems has created many research opportunities. The expectations from 4G are high in terms of data rates, spectral efficiency, mobility and integration.

Keywords: EDGE, GPRS, IPV6, LTE, MIMO, GSM, OFDM, SDR, VoIP. WIMAX, wireless technologies

1. Introduction

The First generation wireless mobile communication systems were introduced in early eighties and second generations systems in the late 1980s were intended primarily for transmission of voice. The initial systems used analog frequency modulation where as the second as well as the subsequent mobile systems use digital communication techniques with time division multiplexing (TDM), frequency division multiplexing (FDM) or the code division multiple access (CDMA).

The third generation wireless systems which are just getting introduced in the world markets offer considerably higher data rates, and allow significant improvements over the 2G systems. The 3G Wireless systems were proposed to provide voice and paging services to provide interactive multimedia including teleconferencing and internet access and variety of other services.

However, these systems offer wide area network (WAN) coverage of 384 kbps peak rate and limited coverage for 2 Mbps. Hence providing broadband services would be one of the major goals of the 4G Wireless systems. A descendant to 2G and 3G aiming to provide the very high data transfer rates. This technology can provide very speedy wireless internet access to not only stationary users but also to mobile users.

This technology is expected to trounce the deficiencies of 3G technology in terms of speed and quality. 4G can be best described in one word "MAGIC", which stands for Mobile multimedia Anytime Anywhere Global mobility support, integrated wireless and personalized services 4G, short for fourth-generation wireless communication systems, has engaged the attention of wireless operators, equipment makers (OEMs), investors, and industry watchers around the world. 4G refers to the next generation of wireless technology that promises higher data rates and expanded multimedia services. Since, at this point, 4G is more of an aspiration than a standard, there is not an agreement yet on what should constitute 4G.

Since the ITU is a major force in the standardization of telecommunications technologies, it's worth looking at the ITU's performance goals for 4G:

The framework for 4G systems should fuse elements of current cellular systems with nomadic wireless-access systems and personal-area networks in a seamless layered architecture that is transparent to the user.

Data rates of 100 Mbps for mobile applications and 1 Gbps for nomadic applications should be achievable by the year 2010.

Worldwide common spectrum and open, global standardization should be pursued.

As another viewpoint, the Wireless World Research Forum (WWRF) defines a 4G network as one that operates on Internet technology, combines it with other applications and technologies such as WiFi and WiMAX, and runs at speeds ranging from 100 Mbps (in cell-phone networks) to 1 Gbps (in local WiFi networks). There is some debate among standards bodies and industry watchers as to whether WiMAX is, or will become, a full-fledged 4G technology competitive with 4G wireless.

The telecommunication companies like NTT Docomo from Japan and Sprint Nextel were also deploying 4G wireless technologies from the early 2006 along with 3G mobile technologies. The flexibility of 4G technologies to be used in combination with GSM and CDMA has provided it an edge

over other technologies. The reason is that the high broadband capability of 4G not only increases data streaming for stationary users but also for mobile users.4G can be efficiently combined with cellular technologies to make consistent use of smart phones. The digital cameras attached in smart phones can be used to establish video blogs in scattered geographical regions. This gives the manufactures the opportunity to produce more affordable user friendly 4G compatible devices. Famous iPod is one such device that supports the working of video blogs. Hence 4G is capable of providing new horizon of opportunity for both existing and startup telephone companies. Currently marketed technologies such as LTE (Long Term Evolution) and WiMAX have been around for a few years and are being marketed as 4G whilst not meeting the requirements set by the ITU. It was recently announced that these services could continue to be marketed as 4G as they are precursors to the IMT-Advanced, 4G standard whilst also operating on the same basis of technology; however, these should really be considered as "Pre-4G" or "3.9G" as they technically do not offer the required data rates of (stationary) 1Gbps.

The ITU has recognised two standards that are planned to meet the 4G IMT-Advanced requirements put forward by the two groups, 3GPP and IEEE. These are the LTE Advanced and Wireless MAN-Advanced (Wimax-Advanced) standards and will almost certainly abandon the old spread system technology found in 3G systems for OFDMA and other equalisation schemes, use MIMO technology, channel-dependant scheduling and dynamic channel allocation all technologies that are being found on new, modern wireless networking equipment.

Still 4G is not clearly defined or documented anywhere what are the basic requirements to build 4G wireless technology, like 3G is clearly defined in IMT-2000 (International Mobile Telecommunications 2000). IMT-Advanced is the closest where some of the 4G requirements can be found. For supporting *high data rate* and *high mobility* in fast moving car (60kilometers/hours) or fast moving trains (250 km/hr) and it is predicted that the new potential wireless system will support 100 Mbps on mobility and 1 Gbps approximately on without mobility at *lower cost*. This potential new wireless system could be developed by 2010. Its characteristics should be like high degree of commonality of design worldwide to provide backward compatibility, compatibility of services within IMT-Advanced and with the fixed networks, high quality, and small terminal suitable for worldwide use, worldwide roaming capability, capability to run high data rate multimedia applications within a wide range of services and terminals.

Table 1: Generations of communications

Generation	Requirements	Comments
1G	No official requirements. Analog technology.	Deployed in the 1980s.
2G	No official requirements. Digital Technology.	First digital systems. Deployed in the 1990s. New services such as SMS and low-rate data. Primary technologies include IS-95 CDMA and GSM.
3G	ITU's IMT-2000 required 144 kbps mobile, 384 kbps pedestrian, 2 Mbps indoors	Primary technologies include CDMA2000 1X/EV-DO and UMTS-HSPA. WiMAX now an official 3G technology.
4G	ITU's IMT-Advanced requirements include ability to operate in up to 40 MHz radio channels and with very high spectral efficiency.	No technology meets requirements today. IEEE 802.16m and LTE-Advanced being designed to meet requirements.

2. Evolution of 4g Technology

In order to make smooth transition from 3G to 4G the mobile communication companies are promoting Super 3G/LTE. The companies are upgrading 3G Technology by initializing the introduction of High Speed Downlink Packet Access (HSDPA) service, which increases the downlink data rate of packet services, and by finalizing specifications for High Speed Uplink Packet Access (HSUPA), which enhances uplink speed. HSDPA and HSUPA cover area by 3-4 times relative to W-CDMA and by providing the high transmission rate with low cost per bit transmission. The main objective of the Super 3G is to construct simple, low cost system by removing the complexity from wireless network and mobile handsets. The 3G provides packet and voice services separately where as Super 3G is based on ALL-IP network covering both packet and voice services. As from diagram we can infer that by the 2010 we would be able to achieve the 1 Gbps in motion at low speed and 100 Mbps at high speed. On

December 25, 2006, *NTT DOCOMO* became the first in the world to achieve a packet signal speed of *5 Gbps* in an outdoor test in a low-speed environment (10 km/h). The test was undertaken to demonstrate the expected maximum transmission speed in an actual cell environment, taking into account interference from peripheral cells.

We are steadily approaching towards 4G wireless technologies by upgrading the current 3G technology by increasing the data rate speed and by reducing the cost of transmission which is the main objective of 4G wireless technology.

3. 4G technology features

3.1 Incomparable Speed

The majority of internet users choose a particular ISP over another because of the speed it offers. Even though I've used some slow and frustrating internet connections before I've also used a lot of super fast internet connections and I'm a great fan of the 3G technology. With all I've read so far the 4G mobile internet technology will be at least 10 times faster than the 3G mobile internet technology and that alone is enough speed than any individual will need.

3.2 Advanced Security

One thing about most forms of broadband internet technology despite their great speed is their security weakness. A lot of them have one or two features that make them highly vulnerable and even though the 4G internet technology is not perfect when it comes to security it has been designed in a way that makes it cover the weakness of other technologies.

If you're an internet user concerned a lot about security, with 4G, you really have no need to worry.

3.3 Reliability and Effectiveness irrespective of the weather condition

The final thing I love the most about the 4G mobile internet technology is how reliable it is and also the fact that it isn't affected by the weather.

It can be really frustrating to be enjoying your broadband internet connection only to start experiencing problems due to harsh weather conditions. The 4G technology addresses all these and it won't in any way be affected by the weather.

3.4 Transfer Rate

One of the things that changes from each generation of computers to the next is the speed at which they can transfer and process data. For instance, a third generation computer and computer network could transfer data up to 2 megabits per second. Fourth generation computers improved on that speed, with the ability to transfer data at up to 100 megabits per second. This higher bandwidth sets these two generations apart from previous ones, which could barely transfer data fast enough for streaming video.

3.5 Wireless Technology

3G and 4G computers and computer networks are some of the first to offer truly wireless capabilities. Wireless Internet works off of radio signals, the same kind used by cell phones. 3G computers have the ability to use and receive these wireless signals and thus you can make calls over a 3G computer or you can use wireless Internet. 4G computers and their networks take this further, adding power to the amount of data that can be transferred and the additional reception that 4G systems can provide.

4. 4G wireless standards

Recently the FCC endorsed long term evolution (LTE) as the required standard for any government participating in the budding nationwide interoperable public safety wireless network. In 2007, the FCC issued a single license for all public safety agencies to jointly operate such a network within 12 MHz of spectrum in the upper 700 MHz band.

The license is held by the Public Safety Spectrum Trust, a nonprofit formed to lobby for the regulatory victories necessary to make the national network a reality. The FCC usually avoids mandating standards, but it made an exception in this case. The National Broadband Plan the FCC submitted to Congress in 2010 mandated that the public safety network be interoperable, and FCC officials said interoperability wouldn't be realistic without a single standard. LTE is popularly referred to as a 4G standard, although it doesn't actually meet the speed requirements for 4G, which are 100 Mbps for both downloads and uploads, according to the FCC's Public Safety and Homeland Security Bureau.

While LTE generates 100 Mbps for downloads, it only facilitates 50 Mbps for uploads. Nevertheless, the FCC views LTE as being close enough to 4G to make significant improvements for public safety. Of the 12 MHz the FCC designated for public safety, 10 MHz can be used for broadband. Harlin McEwen, chairman of the Public Safety Spectrum Trust, said endorsing LTE made sense because a large portion of the 700 MHz band was already occupied by AT&T and Verizon, which are deploying LTE networks.

An obstacle to deploying the network still remains, however. The bulk of public safety officials insist their current allotment of 10 MHz of broadband spectrum is not enough to give public safety the coverage it needs. They say they'll have enough spectrum if Congress gives them an additional 10 MHz of spectrum called the D Block, which is set to be auctioned to private providers. McEwen and others are lobbying Congress aggressively for the D Block, but caution that if Congress gives the D Block to public safety, it must include a funding stream to pay for local network equipment.

McEwen said giving the D Block to public safety wouldn't make sense without that funding because insufficient state and local tax revenue exists to pay for the local networks. President Barack Obama recently voiced his support for giving the D Block and equipment funding to public safety.

5. Applications of 4G

Enhanced Mobile Gaming Experience enhanced wireless capabilities that deliver mobile gaming interaction with latency less than five milliseconds. Play online multiplayer games while traveling at high speeds or sitting outside. Personal Media Repository Create a personal media repository that can be accessed from home and on the road to view photos, watch movies and listen to your personal music collection.

Virtual Presence Use hologram-generating virtual reality programs that provide an artificial presence just about anywhere [13]. For example, decide if you want to personally

respond when someone rings your front door while you are away from home. Broadband Access in Remote Locations 4G networks will provide a wireless alternative for broadband access to residential and business customers. In addition, 4G will provide the first opportunity for broadband access in remote locations without an infrastructure to support cable or DSL access.

Table 2: Comparative Study of 3G against 4G

Requirement : Architecture	3G(Including 2.5)	4G
Data Elements	voice driven.	Converged data an d voice over IP
Network Arch	Wide area cell-based	Hybrid: Integration of wireless LAN
Speed	384 Kbps to 2 M bps	20 to 100 Mbps in mobile mode.
Frequency	1800-2400 MHz	2-8 GHz
Bandwidth	5-20 MHz	100 MHz (or more)
Switching	Circuit and Pack et	Digitally packetized voice
Access Tech.	WCDMA, 1xRT T	OFDM and MC-CDMA
Forward Error Correction	Convolution rate 1/2, 1/3	Concatenated codin g scheme
Component Design	Optimized anten na design, multi-band adapters	Smarter Antennas, Software,multiband and wideband radios
IP	A number of air l ink protocols, IP 5.0	All IP (IPv6)

6. Conclusion

There has been constant development in the cellular as we have seen in 2G technology to 3G technology which includes GSM, GPRS, EDGE, CDMA, CDMA200, HSPDA, WiMAX etc. 2G only supports the voice communicate and 2.5G supports voice and data communication and 3G supports voice and data communication but at higher rate as compare to the 2.5G. But today there is high demand of multimedia applications like online video, video conferencing. And there is need of better quality of service (QoS) and device mobility from one network to network at high speed. There is strong need of technology better than 3G.

A 4G technology which is an upgraded version of 3G technology, will be introduced in the market by 2011 which will meet the needs which were not found in the 3G technology while maintaining its backward compatibility. As we have seen in the working group of 4G technology namely *3GGP, 3GGP2 and WiMAX* technologies will continue to evolve and *enhance* its capability, with a clear roadmap of reaching *1 Gbps in motion at low speed and 100 Mbps at high speed at lower cost*. The successful demonstration of the 4G technology has been done by the companies such as *NTT DoCoMo, Mobile and Nortel Networks, and Nokia Siemens Networks.*

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