Volume 3, Issue 3, March 2013 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Analysis on 4G Technology

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Abstract: ***Third-generation (3G) mobile networks face a new rival: so-called 4G. And astonishingly, the new networks may even be profitable. The goal of 4G is to replace the current proliferation of core cellular networks with a single worldwide cellular core network standard based on IP for control, video, packet data, and VoIP. This integrated 4G mobile system provides wireless users an affordable broadband mobile access solution for the applications of secured wireless mobile Internet services with value-added QoS. This paper gives the reasons for the evolution of 4G, though 3G has not deployed completely. And then gives the information on the structure of the transceiver for 4G followed by the modulation techniques needed for the 4G.Later this gives the information about the 4G processing. Finally concludes with futuristic views for the quick emergence of this emerging technology.***

Keyword- We live in a world which are mostly bound without wires, i.e. nowadays wireless technology has taken an unprecedented importance over wired technology in today's era. The most important example of this is the mobile phone boom across the world; mobiles have surpassed the land line wired telephones in number.

I. Introduction

WCDMA :- Wideband Code Division Multiple Access is a third-generation (3G) wireless standard which utilizes one 5 MHz channel for both voice and data, initially offering data speeds up to 384 Kbps.
IFFT:- An IFFT (inverse fast Fourier transform) transforms the OFDM signal into an IF analog signal
Encrption:- It is the process of encoding messages (or information) in such a way that eavesdroppers or hackers cannot read it, but that authorized parties can
Congestion:- In networking , network congestion occurs when a link or node is carrying so much data that its quality of service deteriorates.
WiFi:- Wi-Fi is the name of a popular wireless networking technology that uses radio waves to provide wireless high-speed Internet and network connections. A common misconception is that the term Wi-Fi is short for "*wireless fidelity*". Wi-Fi is simply a trademarked term meaning IEEE 802.11x.
A descendant to 2G and 3G technology aiming to provide the very high data transfer rates. 4G technology provides very speedy wireless internet access to not only stationary users but also to the 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 is the short name for fourth-generation wireless, the stage of mobile communications that will enable things like IP-based voice, data, gaming services and high quality streamed multimedia on portable devices with cable modem-like transmission speeds. It's a successor to 2G and 3G wireless, whereby the first signified the shift from analog to digital transmissions, bringing data services like SMS and email to mobile phones for the first time, and the second refers to the advent of things like global roaming as well as higher data rates. Think of wireless generations as a handful of services that get faster and more feature-rich as newer technology becomes available. The 3G networks that we use today allow us to stream video, download music and files, and surf the web at average download speeds from 600Kb/s to 1.4Mb/s. With 4G you'll be able to do the same but at much faster rates, while the extra bandwidth opens the door for newer applications.

II. *Features*:

- Support for interactive multimedia, voice, streaming video, Internet, and other broadband services
- IP based mobile system.
- High speed, high capacity, and low cost per bit.
- Global access, service portability, and scalable mobile services.
- Seamless switching, and a variety of Quality of Service driven services.
- Better scheduling and call admission control techniques.
- Ad hoc and multi hop networks (the strict delay requirements of voice make multi hop network service a difficult problem).
- Avoidance or prevention of congestion.

- Seamless network of multiple protocols and air interfaces (since 4G will be all IP, look for 4G systems to be compatible with all common network technologies, including802.11, WCDMA, Blue tooth, and Hyper LAN)
- An infrastructure to handle pre existing 3G systems, along with other wireless technologies.
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III. MAGIC Of 4G Technology

So far there has been no specific definition to this successor of 2G and 3G. However it has been used often to denote a fast internet access available to mobile phone users. Moreover the distinguishing feature of high multimedia streaming and end to end IP configuration is judged to be its MAGIC enchantment. 3G utilized WiMax and WiFi as separate wireless technologies, whereas 4G technology is expected to coalesce these two technologies. Hence one can evaluate how efficient it would become when combining two extremely reliable technologies.

4G can greatly anticipate in evolving and advancing the pervasive computing. The aim of pervasive computing is to attach itself to every living space possible, so that human beings remain intact with the wireless technology intentionally and unintentionally. Therefore 4G will be able to connect various high speed networks together, which would enable each one of us to carry digital devices even in dispersed locations. The network operators worldwide would be able to deploy wireless mesh networks and make use of cognitive radio technology for widespread coverage and access.

IV. Cellular Generations (1G, 2G, 2.5G, 3G, Pre-4G And 4G)

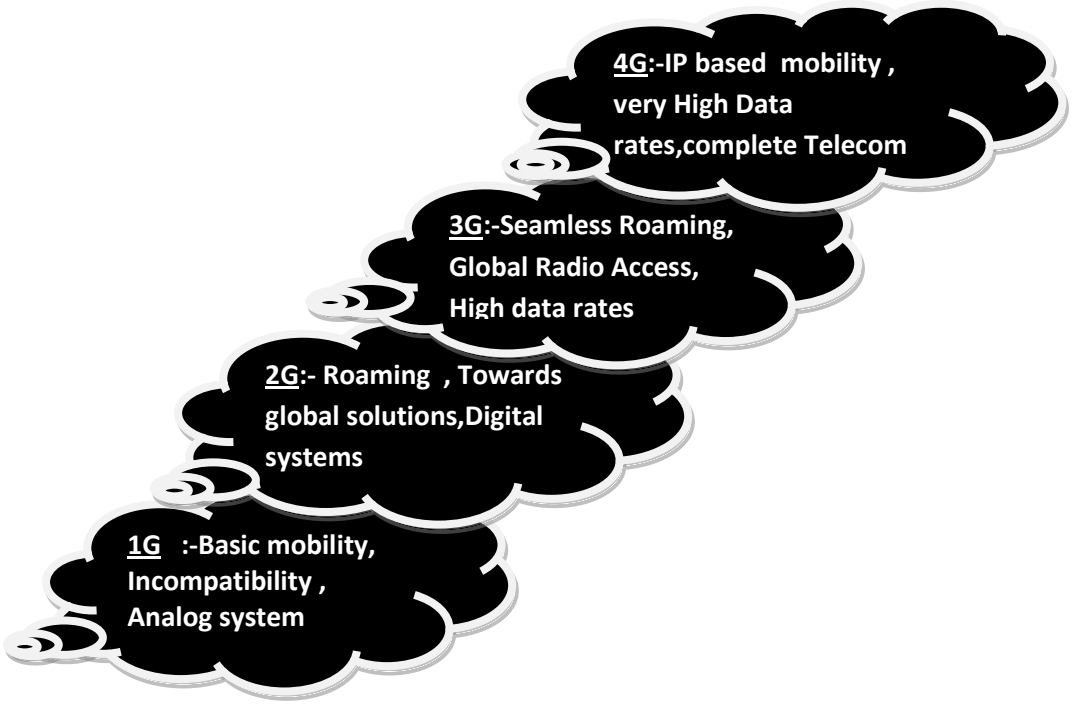


Fig: Enhancements in technology

1G is the first generation celullar network that existed in 1980s. It transfer data (only voice) in analog wave, it has limitation because there are no encryption, the sound quality is poor and the speed of transfer is only a\t 9.6kbps.

2G is the second one, improved by introducing the concept of digital modulation, which means converting the voice (only) into digital code (in your phone) and then into analog signals (imagine that it fly's in the air). Being digital, they overcame some of the limitations of 1G, such as it omits the radio power from handsets making life more healthier, and has enhanced privacy.

2.5G is a transition of 2G and 3G. In 2.5G, the most popular services like SMS (short messaging service), GPRS, EDGE, HighSpeedCircuitswitcheddata,andmorehadbeenintroduced.

3G is the current generation of mobile telecommunication standards. It allows simultaneous use of speech and data services and offers data rates of up to 2 Mbps, which provide services like video calls, mobile TV, mobile Internet and downloading. There are a bunch of technologies that fall under 3G, like WCDMA, EV-DO, and HSPA and others.

Pre-4G technologies such as mobile WiMAX and Long term evolution (LTE) have been on the market since 2006 and 2009 respectively, and are often branded as 4G. The current versions of these technologies did not fulfill the original ITU-R requirements of data rates approximately up to 1Gbps for 4G systems. Marketing materials use 4G as a description for LTE and Mobile-WiMAX in their current forms.

4G is the fourth generation of cellular wireless standards. It is a successor to the 3G and 2G families of standards. In 2008, the ITU-R organization specified the IMT-Advanced (International Mobile Telecommunications Advanced) requirements for 4G standards, setting peak speed requirements for 4G service at 100 Mbps for high mobility

communication (such as from trains and cars) and 1Gbps for low mobility communication (such as pedestrians and stationary users)

4G system is expected to provide a comprehensive and secure all-IP based mobile broadband solution to laptop computer wireless modems, smartphones , and other mobile devices. Facilities such as ultra-broadband Internet access, IP telephony, gaming services and streamed multimedia may be provided to users.

This table contains the information pertaining to the speed(uploading & downloading) of various generations and their availability in the market.

		RealWord (avg)		**Theoratical (max)**		
		Download	Upload	Download	Upload	Availabilty
2.5 G	GPRS	32-42Kbps	15Kbps	114Kbps	20Kbps	Today
2.75G	EDGE	175Kbps	30 /kbps	384Kbps	6oKbps	Today
	UMTS	226Kbps	30Kbps	384Kbps	64Kbps	Today
	W-CDMA	800Kbps	60Kbps	2Mbps	153Kbps	Today
3G	EV-DO Rev.A	1Mbps	500Mbps	3.1Mbps	1.8Mbps	Today
	HSPA 3.6	650Kbps	260Kbps	3.6Mbps	348Kbps	Today
	HSPA 7.2	1.4Mbps	700Kbps	7.2Mbps	2Mbps	Today
Pre-4G	WiMax	3-6Mbps	1Mbps	100Mbps+	56Mbps	Today
	LTE	5-12Mbps	2-5Mbps	100Mbps+	50Mbps	End 2010
	HSPA+	-----	-----	56Mbps	22Mbps	2011
	HSPA 14	2Mbps	700Kbps	14Mbps	5.7 Mbps	Today
4G	WiMax 2(802.16m)	----	-----	100Mbps mobile/1Gbps Fixed	60Mbps	2012
	Avanced LTE	-----	-----	100Mbps mobile/1Gbps Fixed		2012+

With each passing generation the technology is getting more and more advanced. It all started with 1G which dealt with minimal service which was speech, then came 2G which offered transfer of data with slow speed in addition. 3G is the current hot property in marker, with blazing data transfer speeds which includes large multimedia files.

V. Technologies used in 4G technology

A. Communication Architecture

Broadcast Layer: Fix access points (ie cell Tower) connected by fiber,microwave

By comparison, 3G or third-generation networks offer data transmission speeds averaging around 200 kilobits per second (kbps), which is significantly slower than those that 4G technology makes possible. Network connections on 4G may also be more accurate during travel when user and tower locations are at a constant rate of change .A stationary user can even see 1Gbps download speeds with 4G. Technologies that contribute to 4G include Orthogonal Frequency Division Multiplexing (OFDM), which is designed to carry more data by splitting radio signals that are broadcast over different frequencies and are immune to interference.The 4G data rates will vary depending on the number of channels that are available, and can be used. The channels that can be used will be cleaner thanks to technologies like adaptive processing, which detects interference on a channel and improves reception by actively switching channels to avoid interference. 4G networks will also use smart antenna technology, which is used to aim the radio signal in the direction of the receiver in the terminal from the base station. When teamed up with adaptive techniques, multiple antennas can cancel out more interference while enhancing the signal.

B. How OFDM works

The OFDM receiver performs functions necessary to demodulate the received signal and deliver soft information to the outer receiver for decoding .First of all the FDM part - Frequency division multiplexing is a technology that transmits several signals at the same time over a single transmission path, in a medium such as a cable or wireless system. Each signal is transmitted inside its own unique frequency range (the carrier frequency) which is then modulated by the data that is needed to be transmitted.

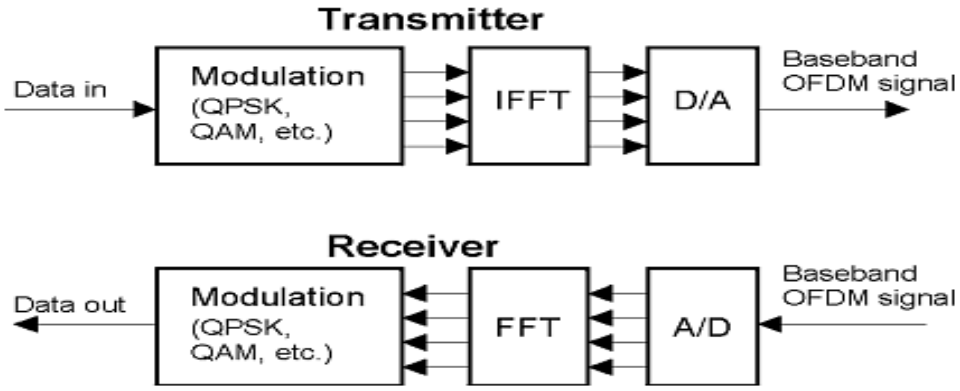
The transmitter modulates the data and transfers it to Inverse Fast Fourier Transform and then conversion is performed on it which produces the result in the form of OFDM signals.

The receiver then further converts OFDM signal from analog to digital and the Fast Fourier Transform provides input to modulation techniques and then the resultant data is produced as shown in the figure above.

An OFDM transmitter accepts data from an IP network, converting and encoding the data prior to modulation. An IFFT (inverse fast Fourier transform) transforms the OFDM signal into an IF analog signal, which is sent to the RF transceiver. The receiver circuit reconstructs the data by reversing this process. With orthogonal sub-carriers, the receiver can

separate and process each sub-carrier without interference from other sub-carriers. More impervious to fading and multi-path delays than other wireless transmission techniques, ODFM provides better link and communication quality

Orthogonal FDM's spread spectrum technique spreads the data over a lot of carriers that are spaced apart at precise frequencies. This spacing provides the "orthogonality" in this method which prevents the receivers/demodulators from seeing frequencies other than their own specific one. The main benefit of OFDM is high spectral efficiency, but with OFDM you also get; high resiliency to RF interference, and the multi-path distortion is lower. This is handy because in a standard terrestrial broadcasting situation there are high amounts of multipath-channels (e.g. the signal that was sent arrives at the receiving end using multiple paths of different lengths). Since the various versions of the signal interfere with each other, known as inter symbol interference (ISI) it becomes incredibly hard to extract the original information.



VI. Strengths of 4G

- The network operators worldwide would be able to deploy wireless mesh networks and make use of cognitive radio technology for widespread coverage and access.
- Elaborating more on its goals, 4G should use enhanced security measures and the data transfer speed should be high to meet requirements and increase efficiency for users.
- It should also reduce blips in transmission when a device moves between areas covered by different networks. 4G mobile networks must also use a network based on the IP address system, same as is used for the Internet.
- Unlike the previous generation of mobile technologies 4G will be intensively used for Internet access on computers as well as carrying cell phone communications.
- People who reside in areas having high 4G coverage can use it for broadband connection directly. It can also be used for accessing the Internet on the move without having to be in a wireless hotspot.
- The key entities in a 4G set up are the user, mobile terminal, paging agent, access router, QoS broker, AAAC System, Network Management System etc. One of the main advantages of a 4G network is its network interoperability.
- 4G visions take into account installed base and past investments
- Strong position of telecom vendors in the marketplace.
- Faster data transmission and higher bit rate and bandwidth, allow more business applications and commercialization
- Has advantage for personalized multimedia communication tools

VII. Weaknesses of 4G

- Although the speed and just overall quality of web-based applications would improve, it would not occur without a fee. Most companies such as Sprint are trying to limit the fee as much as possible starting at a “ten dollars a month service fee to use the HTC Evo on a 4G network. This fee is not unusually high, but with a reduction in fee comes a cheap deployment of this technology which means that it is expected to disrupt broadband access alternatives such as DSL and cable modems. This is because it is cheaper to deploy and covers such a wide bandwidth in the network.
- Also, since people are being connected to a variety of devices while using 4G, each person needs to be aware of the security threats they are opposing on themselves. As mentioned earlier, this is a problem because each person may be connected to many devices using 4G therefore increasing their risk of receiving a virus attack.
- Research will have to be done in order to figure out how much more battery life a phone must be able to hold in order to participate on a 4G network as well. “The big challenge in bringing 4G to the market will be using the right applications’ processors as well as modem and power management technologies to deliver the performance, size and battery life that consumers demand”. This may be a con since the battery life and the processors may

have to be changed greatly, therefore causing 4G technology to cost more for the company that acquires their phones with this network.

- Some research may be required in figuring out exactly how much more at risk a person is for using a 4G mobile phone of receiving viruses and tracking cookies through this IP-address system.

5G technologies are also being planned upon. This technology will be intelligent and will interconnect the entire world without limits (Jarrett, 2006). This technology could be further researched to help understand qualities of 4G technology that may need to be changed.

VIII. Applications

- **Telegeoprocessing** :- You will be able to see the internal layout of a building during an emergency rescue. This type of application is some time referred to as "telegeoprocessing".A remote database will contain the graphical representation of streets, buildings and physical characteristics of a large metropolis. Blocks of this database will be transmitted in rapid sequence to a vehicle, where a rendering program will permit the occupants to visualize the environment ahead. They may also 'virtually' see the internal layout of buildings to plan an emergency rescue or engage hostile elements hidden in the building.
- **Telemedicine :-** A paramedic assisting a victim of a traffic accident in a remote location could access medical records (X-rays) and establish a video conference so that a remotely based surgeon could provide 'on-scene' assistance.
- It is assumed that the next generation of wireless applications and services, such as e-readers, mobile IPTV, mobile marketing and geo-targeted advertising, location-based mobile applications embedded in social networking are likely to become the key applications in the upcoming 4G apps space.

Conclusion

The 4G revolution still awaits India. Drastic changes and improvements from 3G technology need to be a priority and, before they're addressed, there are many gray areas for 4G. But if done intelligently and thoroughly, 4G holds enormous potential for India and can really create a boom in the IT industry, key to the Indian economy. Hence the evolution from 3G to 4G will be stimulated by services offering enhanced quality, requires increased bandwidth, needs elevated sophistication of large-scale information provisions and must have improved customization capabilities to support myriad user demands.*"The development in day-to-day communication after 3G is not just an 4G EVOLUTION,it's the REVOLUTIONISATION in the world of technology."*

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