Wireless Systems "Advanced 4G Technology"

D.HariPrashanth

Abstract- The recent revolution created by 3G technology paved the world to enter into a new fastest communication and fully flexible environment of internet at high speed. Now its time for even advanced technology for future generations called as the 4G technology. The components of 4G Technology, advanced materials used in it, mode of communication, upgraded versions of previously used components in 3G, and also the advantages of the 4G systems were about to be discussed.

Index Terms- 1) Introduction 2) Overview of 3G 3) Components used in 3G 4) Evolution Of 4G 5) Advantages of 4G 6) Components Of 4G 7) OFDMA 8)MIMO 9) Smart Antennas 10)SDR(Software Defined Ratio) 11) IP v6.0 12) Spectral efficiency 13) Working Of 4G 14) Conclusion.

---

1. Introduction:

The recent advancements in the communication technologies with special reference to the wireless communication technology has paved the way for faster, more reliable modes of data transfer and communication means. And now it's time for the deployment of even advanced wireless communication system called as **4G (4th generation)** technology which was yet to emerge within months/years.

4G technology offers high rate of data transfer at low cost than in 3G and also accessing applications with a high degree of customization and personalisation of user applications.

2. Overview of 3G:

G or **3rd generation mobile telecommunications** is a generation of standards for mobile phones and mobile telecommunication services fulfilling the **International Mobile Telecommunications-2000 (IMT-2000)** specifications by the International Telecommunication Union. Application services include wide-area wireless voice telephone, mobile Internet access, video calls and mobile TV, all in a mobile environment.

Several telecommunications companies market wireless mobile Internet services as *3G*, indicating that the advertised service is provided over a 3G wireless network. Services advertised as 3G are required to meet IMT-2000 technical standards, including standards for reliability and speed (data transfer rates). To meet the IMT-2000 standards, a system is required to provide peak data rates of at least 200 Kbit (about 0.2 Mbit/s). However, many services advertised as 3G provide higher speed than the minimum technical requirements for a 3G service. Recent 3G releases, often denoted 3.5Gand 3.75G, also provide mobile broadband access of several Mbit/s to smart phones and mobile modems in laptop computers.

3. Components of 3G:

- the UMTS system, first offered in 2001, standardized by 3GPP, used primarily in Europe, Japan, China (however with a different radio interface) and other regions predominated by GSM 2G system infrastructure. The cell phones are typically UMTS and GSM hybrids. Several radio interfaces are offered, sharing the same infrastructure:

- The original and most widespread radio interface is called W-CDMA.
- The TD-SCDMA radio interface was commercialised in 2009 and is only offered in China.
- The latest UMTS release, HSPA+, can provide peak data rates up to 56 Mbit/s in the downlink in theory (28 Mbit/s in existing services) and 22 Mbit/s in the uplink.

- the CDMA2000 system, first offered in 2002, standardized by 3GPP2, used especially in North America and South Korea, sharing infrastructure with the IS-95 2G standard. The cell phones are typically CDMA2000 and IS-95 hybrids. The latest release EVDO Rev B offers peak rates of 14.7 Mbit/s downstream.

The above systems and radio interfaces are based on kindred spread spectrum radio transmission technology. While the GSM EDGE standard ("2.9G"), DECT cordless phones and Mobile WiMAXstandards formally also fulfil the IMT-2000 requirements and are approved as 3G standards by ITU, these are typically not branded 3G, and are based on completely different 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 backwards compatible transmission technology. The first release of the 3GPP Long Term Evolution (LTE) standard does not completely fulfillthe ITU 4G requirements called IMT-Advanced. First release LTE is not backwards compatible with 3G, but is a pre-4G or 3.9G technology, however sometimes branded "4G" by the service providers. Its evolution LTE Advanced is a 4Gtechnology. WiMAX is another technology verging on or marketed as 4G.

4. Evolution of 4G:

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 whereas 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.

5. Components of 4G:

There are some components which makes the successful 4G systems they are:

a) OFDMA
b) MIMO
c) IPv6.0
d) Spectral efficiency of 4G
e) SDR(Software Defined Ratio)
f) Smart antennas

6. OFDMA(Orthogonal Frequency Demux):

It captures entire energy because of capability to absorb high no. of OFDM signal subcarriers. In OFDM, as long as guard interval is long enough, all inter-symbol-interference is absorbed

And Multipath self-interference does not affect OFDM, only a few tones are affected or lost in OFDM while compared to CDMA in 3G. Implementation of equalization, interference cancellation, and adaptive antenna array algorithms is simpler in OFDM.

7. MIMO(Multi Input Multi Output):

To improve the communication performance between sender and receiver, the multiple antennas are used at both transmitter and receiver end. The signal transmitted by m antennas and signal received by n antennas and the processing of the received signal may produce significant performance improvement such as ***range***, ***quality of received signal*** and ***spectrum efficiency***.

8. Smart Antennas:

There are two types of smart antennas which are switched beam smart antennas and adaptive array smart antennas. Switched beam systems have several available fixed beam patterns which help in making decisions as to which beam to access at any given point of time based on the requirements of the system. While adaptive arrays allow the antenna to steer the beam to any direction of interest while simultaneously nulling interfering signals.

9. SDR(Software Defined Ratio):

A basic SDR produces a radio that is capable of receiving and transmitting a different form of radio protocol (sometimes referred to as a waveform) as per the needs just by ***running different software***. A SDR will allow increasing network capacity at specific time.

10. IPv6.0:

4G wireless technology will be using mobile IPv6 which allows assigning more number of addresses than IPv4. In IPv6 each device have ***own IP address***. User can keep their IP address even if user changes the access point..

11. Spectral Efficiency in 4G:

The 4G wireless technology bandwidth efficiency will be measured in terms of spectral efficiency. Spectrum efficiency describes that the amount of information that can be transmitted over a given bandwidth in a specific communication system. It is a measure of how efficiently a limited frequency spectrum is utilized by the physical layer protocol, and sometimes by the media access control (the channel access protocol). Clearly the bit rate should be associated with an amount of spectrum. For mobile use, a good target is a network performance of 5 bit/s/Hz, rising to 8 bit/s/Hz in nomadic use.

12. Brief Note on Working Of 4G:

a. Based on an all-IP packet switched network.
b. Peak data rates of up to approximately 100 Mbit/s for high mobility such as mobile access and up to approximately 1 Gbit/s for low mobility such as nomadic/local wireless access, according to the ITU requirements.
c. Dynamically share and use the network resources to support more simultaneous users per cell.
d. Scalable channel bandwidth 5–20 MHz, optionally up to 40 MHz
e. Peak link spectral efficiency of 15 bit/s/Hz in the downlink, and 6.75 bit/s/Hz in the uplink (meaning that 1 Gbit/s in the downlink should be possible over less than 67 MHz bandwidth).
f. System spectral efficiency of up to 3 bit/s/Hz/cell in the downlink and 2.25 bit/s/Hz/cell for indoor usage.
g. Smooth handovers across heterogeneous networks.
h. Ability to offer high quality of service for next generation multimedia support.

13. Advantages of 4G:

4G technology offers high rate of data transfer at low cost than in 3G and also accessing applications with a high degree of customization and personalisation of user applications,

The user will be able to receive HD streaming of video, and the data range of 4G will be 100M/bits and 1G/bits. Broadband applications may be like wireless broadband access, Multimedia Messaging Service (MMS), video chat, mobile TV, HDTV content, Digital Video Broadcasting (DVB) demands high data rate

and the quality of service(QoS) but this type of data rate and QoS are not available in 3G technology.

The main objective of 4G technology is going to be based on OFDMA (Orthogonal Frequency Division Multiple access) modulations with MIMO (Multiple Input Multiple Outputs) and other smart antennae enhancements.

14. Conclusion:

4G technologies was still at research stages in many of the countries however companies like NTT Do Como, Mobile and Nortel Networks, and Nokia Siemens Networks successfully demonstrated the working of 4G. This technology will be deployed in the world market soon.

Details about Author:
D.HariPrashanth,
M.S.SoftwareEngg,
VIT UNIVERSITY, Vellore.
INDIA.

Residence address:
105,RoyanKuttai Street,
Big Kanchipuram,
Tamil nadu-631502.
Email: hprashanth610@gmail.com
Ph: +91-9789640904.