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A Review on 4G Communication Network

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Abstract

The development of broadband wireless access technologies in recent years was the result of growing demand for mobile internet and multimedia application. With the growing user demands, the third generation (3G) network faces various limitations with respect to its bandwidth, data rate, etc. which cannot accommodate the future multimedia environment. This has given rise to the fourth generation network which tries to accommodate all the shortcomings of the 3G network with its unique needs and aspirations. This review paper describes the 4G network in detail along with its scope in the ever growing communication industry..

Keywords:4G (Fourth generation), CDMA, Wi-Max, Security and MIMO.

Introduction

The ability to communicate with people on the move has evolved remarkably since Guglielmo Marconi first demonstrated radio’s ability to provide continuous contact with ships sailing the English channel. That was in 1897, and since then new wireless communication methods and services have been adopted enthusiastically by people throughout the world. The commercial proliferation of cellular voice and limited data service has created a great demand for mobile communications and computing. Wireless communication is enjoying its fastest growth period in history due to enabling technologies which permit wide spread deployment. In 1946, the first public mobile telephone service was introduced in 25 major American cities. Each system used a single powered transmitter and large tower in order to consider distances of over 50km in a particular market. Historically, growth in mobile communications field has come slowly and has been coupled closely to technological improvements.[5]

TABLE I

Some of the present wireless digital communication systems are as follows:

APPLICATIONS	EXISTING STANDARD/TECHNOLOGY USED
Mobile telephony (digital cellular telephony)	GSM, CDMA

Wireless LAN/MAN/WAN	IEEE 802.11 [Wi-Fi].802.16 [WIMAX].etc.
Personal area communication	Bluetooth
Wireless local loops	DECT.C orDECT, CDMA, GSM
Mobile satellite communication, global communication	Iridium. UMTS. GPS
Digital video broadcast, DTH through satellite	DVB
Mobile adhoc networks	All WLAN/WMAN standards and Bluetooth
Digital audio broadcast, HD radio	DAB

Major changes that took place in the 1g to 3g wireless communication systems:

First Generation [1G] Systems:

- Complete analog systems mainly dealing with audio (except television with analog video)
- Analog mobile phone systems (AMPS)

Second generation [2G] Systems:

- Partially analog and digital systems where audio and images were communicated.

- Bit rate was very low around 10 to 50 kbps

Third Generation [3G] Systems:

- Fully digital systems with audio, image and video
- Tremendous rise in the bit rate, of the order of 2 to 20 Mbps, in Wi-Fi and WiMAX even up to 54 Mbps.

Characteristics of fourth generation [4g] technology:

- Overcoming the shortcomings in the 3G network, 4G provides mobile ultra-broadband internet access, example, in laptop with USB, in wireless modems etc.
- 4G network works faster, is comparatively more expensive and is covered in less area than the 3G network.
- 4G devices also have 3G support.
- They have speed as high as 100 Mbps and users in strongly supported areas have speed ranging from 15 to 20 Mbps. The speed generally varies depending on its distance from the transmission tower.
- The 4G systems have speed, are fully digital anywhere anytime and converged wireless communication is expected with total multimedia.
- They are more advanced in technology than all the previous generations and are a multistand wireless system with Ad Hoc networking.

Technology used in 4g network

- MIMO - Minimum antenna configurations.
 - For the BS - a minimum of 2 Tx and 2 Rcv antennas
 - For the MS - a minimum of 1 Tx and 2 Rcv antennas
- MIMO Techniques -
 - Beam forming – makes use of multiple antennas to steer or focus signal in a particular direction. Can reduce adjacent site self-interference & add reach.
 - SU-MIMO (Single User MIMO)
- Transmitting parallel & unique data streams in the same frequency-time resource to a single user. (Spatial Multiplexing)
- Improves individual users throughput.
 - MU-MIMO (Multiple User MIMO)
- Transmitting parallel & unique data streams in the same frequency-time to multiple users. (Spatial multiplexing)
- Improves sector/site capacity throughput.
 - STBC - Space Time Block Coding
- The simplest of the STBCs transmits multiple copies of a single data stream across a number of antennas

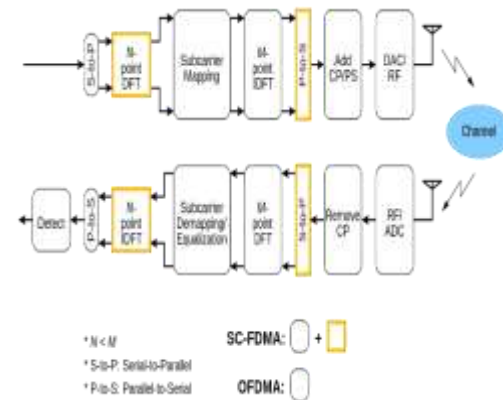
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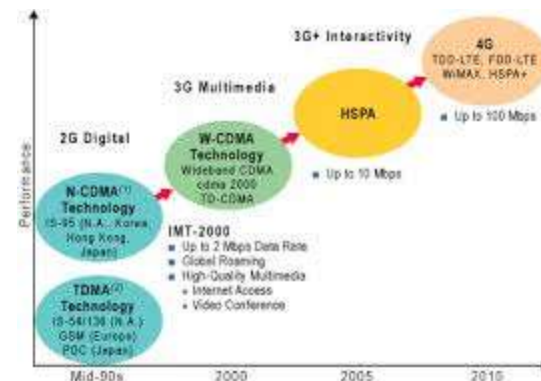
which improves the SNR of the received data to improve the reliability of data-transfer.

OFDMA – Orthogonal Frequency Division Multiple Access. (LTE DL only, WiMAX UL and DL).

- Two types of sub-carrier permutations.
 - Contiguous subcarriers grouped into logical sub-channels (Used in LTE & WiMAX sub channels).
 - Pseudo-random subcarriers grouped into logical sub channels (Used in WiMAX FUSC and PUSC).

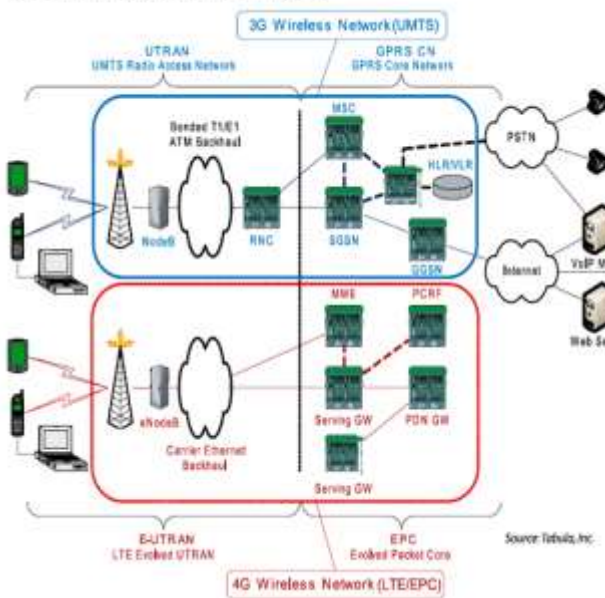


- SC-FDMA – Single Carrier Frequency Division Multiple Access. (LTE UL only)
 - Low peak-to-average power ratio conserves mobile battery life.
- ACM – Adaptive Coding and Modulation
 - Changing the coding (1/2, 2/3, 3/4) and modulation schemes (BPSK, QPSK, 16 QAM, 64QAM) based upon current RF conditions
- HARQ - Hybrid automatic repeat request
 - The most common versions use transmissions with incrementally more redundant error-detecting codes such as cyclical redundancy checking and forward error correction bits.



Technology	1G	2G	2.5G	3G	4G
Design Began	1970	1980	1985	1990	2000
Implementation	1984	1991	1999	2002	2010?
Services	Analog voice	Digital voice	Higher capacity, packetized data	Higher capacity, broadband data up to 2Mbps	Completely IP based, speed up to hundreds of MBs
Standards	NMT, AMPS, Hicap, CDPD, TACS, ETACS	GSM, iDEN, D-MPS	GPRS, EDGE etc.	WCDMA, CDMA 2000	Single standard
Data Bandwidth	1.9 kbps	14.4 kbps	384 kbps	2 Mbps	200 Mbps
Multiplexing	FDMA	TDMA, CDMA	TDMA, CDMA	CDMA	CDMA?
Core Network	PSTN	PSTN	PSTN, packet network	Packet network	Internet

Figure 3. Wireless Network transition from 3G to 4G



Challenges faced in 4G

Expectations from 4G

Today’s market demands value added services. With the success of 3G network, user expectation with 4G have shot up by a hundred fold. The dream of internet-style functionality via wireless communication is expected to surpass that available in 3G.

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The expected applications to be available in 4G include:

4G network should handle broadcast quality data loads over much cheaper, faster and in more number of mobile communication networks. Eg. One developer nomad innovations offers a WiMAX based modem that attaches to the back of a professional video camera, obviating the need for satellite connectivity in the field.

Cloud computing should be more safe, authentic, dependable, impregnable and more operative.

Large files should be transferred in less time and applications developed for mobile users should have maximum compatibility with the network.

In mobile gaming, multi-player games can be played at a high speed.

The cameras installed in traffic light can be deployed with 4G network thus increasing the law and order in the city.

4G network will provide broadband access (even in remote areas).

Conclusion

For the 4G network to be a success, the coverage area has to be maximum along with its capacity. Over the past few years the use of internet has changed considerably from user to user and is still ever-changing. Keeping this in mind the 4G network should fulfil the demands of shared channels, since they allow substantial number of simultaneous users to be served with satisfactory perceived speeds. Thus, for it to be a complete success it has to meet the criterion set by the user only then will it prove to be a complete winner!

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