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4G of Wireless Communication

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Abstract: *Since drastic development of technologies in field of communication in past 25 to 30 years, we have moved from era of analog to digital, wireless communication has also evolved from 1G to 4G. Also, with further improvements in various semiconductor and computing technologies, wireless communication & its users are curious to know what's going to be next. The current scenario of 4G states that it promises to provide promises to provide promiseable network access at high speed, at any time period, at any location and by any means. It also looks to give us an overview regarding different ways of 4G which comprises of its features, architecture and technological advancements. The main purpose of this paper is to:*
1. Study the 4G of wireless communications.
2. Provides the overview of 4G services.
3. Present the timeline of 4G standards.
Keywords: *4G, Wireless Networks and Communication, IEEE 802.11n, IEEE 802.16, IEEE 802.20, 4G Timeline.*

I. BRIEF HISTORY OF WIRELESS COMMUNICATION

In order to understand today's wireless systems & developments betterly, we will discuss about brief history of

wireless communication in this section. Although it does not cover all the inventions, discoveries & developments but it covers those which have contributed the lot to today's wireless systems *[1]*.

The existence of wireless communication started way back in ancient period. At that time modulations were done using mirrors for creating certain light on/off pattern i.e. amplitude modulation, flags were made for transmitting & receiving signals i.e. frequency modulation. This was around 150 B.C. This use of light & flags were important for important for military troops till radio transmission was developed & now a day's even sailors uses this principle whenever wireless systems failed *[1]*. The modern era of wireless communication started way back in 18 th century. At that time period Claude Chappe developed optical telegraph in 1794. After that in 1843 telegraph lines were established between Washington D.C. & Baltimore. Also, during that era in 1876, Alexander Graham Bell developed telephone. Afterwards with invention of short waves, Marconi developed first radio in 1920. Afterwards, during 1930's various TV broadcasts, modulation schemes were invented & become popular in Europe & American block *[2]*.

Afterwards, various standards such as GSM, AMPs, PSTN, DECT, CT2 etc. were developed in Japan, Europe & America. The development under this era came to known as 1G. However, with development of different frequency bands & protocols, they were incompatible with each other. The table 1 shows above explanation *[2]*.

TABLE1

SNO.	STANDARD	YEAR OF DEVELOPMENT	ACCESS TECHNIQUES	TYPE	FREQUENCY BAND (MHZ)	MODULATION
1.	GSC	1970	Simplex	Paging	Several	FSK
2.	NTT	1979	FDMA	Paging	843-925	FM
3.	NMT-450	1981	FDMA	Cellular	450-470	FM
4.	AMPS	1983	FDMA	Cellular	834-884	FM
5.	ETACS	1985	FDMA	Cellular	900	FM
6.	NMT	1986	FDMA	Cellular	890-960	FM
7.	JTACS	1988	FDMA	Cellular	860-925	FM
8.	CT2	1989	FDMA	Cordless	864-868	GFSK
9.	GSM-900	1990	TDMA	Cellular	U:890-915 D:935-960	GMSK
10.	N-AMPS	1992	FDMA	Cellular	824-894	FM
11.	DECT	1993	TDMA	Cordless	1880-1900	GFSK

In order to improve these disorders, various standards along with duplexing such as TDD, FDD; multiple access techniques such as CDMA, TDMA, GPRS, EDGE, IS-95 etc. were developed *[2]*. The development under this era came to known as 2G. The table 2 shows above explanation.

TABLE 2

SNO.	STANDARD	YEAR OF DEVELOPMENT	ACCESS TECHNIQUES	TYPE	FREQUENCY BAND (MHZ)	MODULATION
1.	GSM-1800	2000	TDMA/FDD	Cellular/PCS	D:1880-1955 U:1785-1860	GMSK
2.	IS-136	2000	TDMA/FDD	Cellular/PCS	D:869-894 U:1850-1875	QAM
3.	PDC	2001	TDMA/FDD	Cellular/PCS	D:800-825 U:1500-1525	GMSK
4.	IS-95	2001	CDMA/FDD	Cellular/PCS	D:869-894 U:1930-1955	BPSK

Afterwards with further advancements such as voice over internet protocols, multi-megabit internet access, unparalleled network capacity, various standards such as UMTS/WCDMA,

CDMA 2000, TD-SCDMA etc. were developed *[1]*. The development under this era came to known as 3G. The table 3 shows above explanation.

TABLE 3

SNO.	STANDARD	SPEED (MCPS)	ACCESS TECHNIQUES	FEATURES
1.	UMTS/WCDMA	N*0.96; N=4,8,16	CDMA/FDD, CDMA/TDD	Compatible with IS-95
2.	CDMA 2000	N*1.2288; N=1,3,6,9,12	CDMA/FDD, CDMA/TDD	Compatible with GSM
3.	TD-CDMA	1.1136	CDMA/TDD	Compatible with GSM, IS-95 & IS-136

Afterwards, with further advancements & inability of 3G to extend its features, 4G came into existence.

II. CURRENT STATUS OF 3G

Before we will start discussion on 4G, we will first lay stress on important aspects of 3G. Although, 3G is not defined by standard groups but in general, it comprises of all terms developed during IMT-2000 technology *[3]*. It defines 3G globally as technology defined for user in radio frequency band & comprises of WCDMA, CDMA 2000 & TD-CDMA.

Over the last century, there is peak development in era of wireless communication & also, over the last decades, various 3G technology utilizes more or less same tools with various combinations & variations to maximize bandwidth utilization. Also, it utilizes various access techniques OFDM, SDMA via MIMO etc. In addition to this they utilize multiplexing techniques such as WDM, modulation techniques such as QAM, MSIC etc. The fig. 1 shows how 3G has been evolved *[3]*.

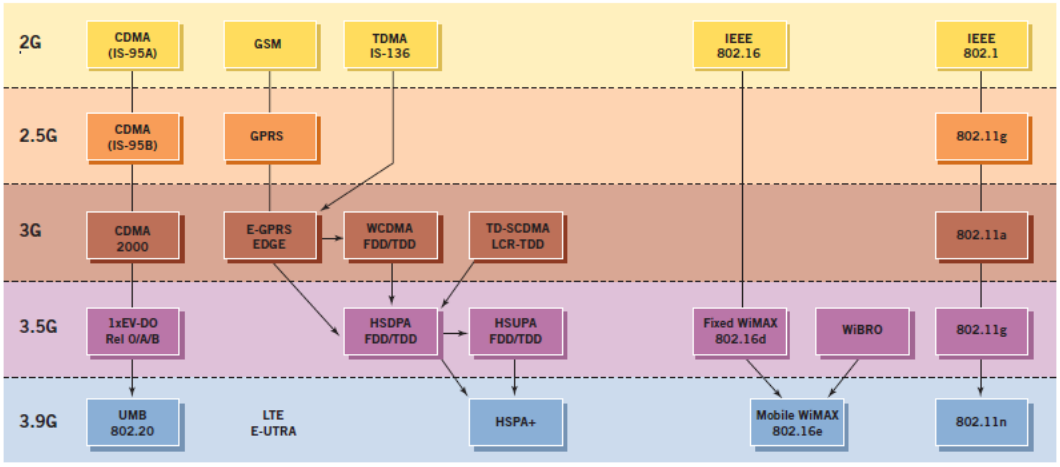

Fig. 1

III. INTRODUCTION TO 4G

It is also defined as fourth generation. It is basically an ITU specification, which is invented indeed for broad band mobile capabilities.

Using these technologies one would be able to use IP based voice, data & streaming multimedia at high speed of around 100 Mbit/sec. with high mobility & 1Gbit/sec. with low mobility *[6]*.

It is basically a packet-switching evolution of 3G which utilizes voice communication. It also provides wireless applications such as mobile web access, IP telephony, gaming services, HD mobile TV & cloud computing. Its growth period starts from 2008 with invention of WiMAX networks *[4]*.

IV. SYSTEM STANDARDS OF 4G

Although many users have marked the system services as standards for 4G but no current 4G offers the ITU's requirements.

Various system standards of 4G comprises of-

A) LTE
B) WiMAX
C) HSPA+
D) UMB
E) Wi-Fi

A) LTE

It stands for Long Term Evolution. It is basically an advancement of 3GPP to utilize WCDMA more efficiently & effectively. These services are provided by metro PCS, Verizon of U.S.A. & by November 2012 they are utilized by Ericson, Nokia & Samsung *[5]*. Using this standard one can get peak download speed of 100 Mbps & peak upload speed of 50 Mbps *[3]*.

B) WiMAX

It is basically an IEEE 802.16e standard which has been universally accepted as mobile broadband technology and it utilizes OFDMA. It is under development with main aim to fulfill IMT criteria of 1G bit/sec for stationary access and 100Mbits/sec for mobile reception. It is also known as wireless MAN *[6]*.

C) HSPA+

It is basically a widely developed 3GPP standards with maximum download speed of 672Mbits/sec and maximum upload speed of 168Mbits/sec. It utilizes CDMA, FDD and MIMO radio technology.

D) UMB

It stands for Ultra Mobile Broadband. It is an undeveloped standard for 4G project to improve CDMA 2000 standard with download speed of 275Mbits/sec and upload speed of 75Mbits/sec. It is an IEEE 802.20 standard.

E) Wi-Fi

It is an IEEE 802.11n standard which is used for setting up wireless mobile internet along with Bluetooth and Ethernet with two services namely BSS (Basic Service Set) and ESS (Extended Service Set). It also utilizes OFDM, MIMO with speeds of 288.8Mbps (using 4X4 configuration in 20 megahertz bandwidth) and 600Mbits/sec (using 4X4 configuration in 40 megahertz bandwidth) *[3]*.

V. IMPLEMENTATION OF 4G SERVICES

The 4G services are implemented using layer architecture designed by ITU. These services utilize multi core (CMT) processor with use of 4G technologies as shown in fig. 2 and fig. 3. The layer architecture comprises of 5 SS layers-

A) Fixed Layer
B) Personal Layer
C) Hotspot Layer
D) Cellular Layer
E) Distribution Layer

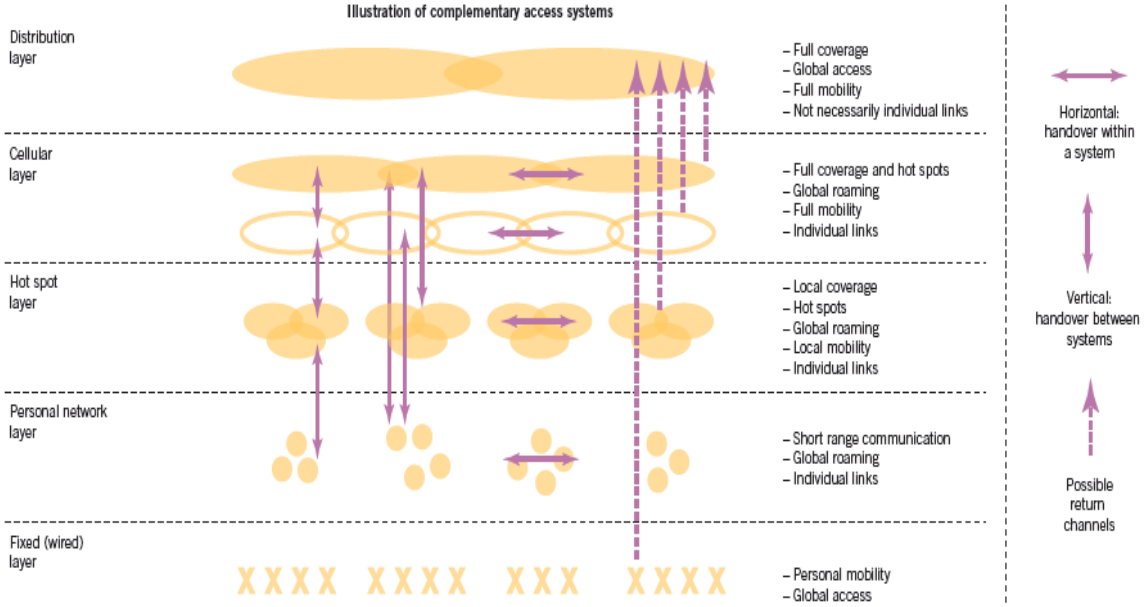

Fig. 2

A) Fixed Layer
It is used for fixed wire line networks such as DSL, optical fiber, etc.

B) Personal Layer
It is used for personal networks such as Bluetooth, smart networks, UWV, etc.

C) Hotspot Layer
It is used in restraints, coffee shops, fighter lanes, etc. along with Wi-Fi standard.

D) Cellular Layer
It is used by high speed mobile users along with WiMAX standard.

E) Distribution Layer
It is used for hand over and hand of networks which may be horizontal or vertical *[3]*.

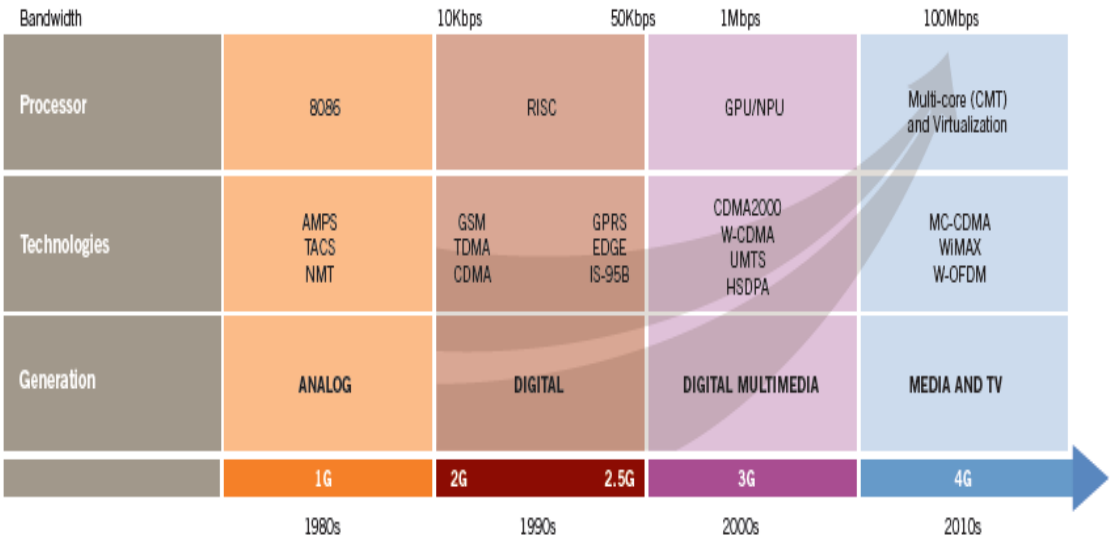

Fig. 3

VI. REQUIREMENTS FOR SETTING UP WIRELESS COMMUNICATION

Various requirements for setting up wireless communication between two or more networks depends on following characteristics of 4G which are listed below

A. Nature of services
B. Quality of services
C. Continuity and handover
D. Topology independence
E. Network detection, selection and maintenance

A. Nature of services

Since, communication between two desired points may have multicast configuration or unicast configuration. So, for using 4G services effectively & efficiently, we have to depend on the desired path which constitutes nature of services *[7]*.

B. Quality of services

In order to use system effectively & efficiently, quality of service must be improved & should be consistent for supporting system. Also, if system has better quality of service, there will be enhanced connectivity *[7]*.

C. Continuity and handover

Since, a base station uses both intra-technology & inter-technology handovers, so continuity with minimum interruption is achieved only when active services instances are maintained.

D. Topology independence

4G services available now days are independent of topology & technology limitation & looks for achieving ABC (Always Best Connected) characteristics *[3]*.

E. Network detection, selection and maintenance

Now days to set up uniform communication we lay our stress on setting up uniform process in order to define eligibility & validity of network link configuration.

VII. CHALLENGES FOR 4G

With developments in technology, the 4G can either be speed up or speed down which will automatically affect the users [3][6]. Various factors which affect 4G are

A. 5G reaching maturity and profitability
B. Improvement in radio technologies
C. Invention and implementation of IMS
D. Cost & spectrum available
E. Ownership related issues
F. Security and privacy related issues

A. 5G reaching maturity and profitability

Now days even 5G is achieving maturity with development began as early as 2012 & many countries are trying to achieve profit by covering in excess of one billions subscribers. Also, most operators are trying to set up maximum limit of 1 to 3 GB of data transfer a month *[3]*.

B. Improvement in radio technologies

With improvement & development in radio technologies such as OFDMA, SDMA, MIMO etc. are trying to match acceptable rate of coming services which are going to satisfy never ending demands of many users up to some extent.

C. Invention and implementation of IMS

With development in IMS & multiservice networking, demand for high speed access is increasing and control policy & resource utilization management are used now days to interwork IMS & non-IMS network.

D. Cost & spectrum available

While setting up communication network there are several factors such as cost & frequency spectrum available for data access cannot be ignored as they ultimately affects performance of system. If we want to fulfill needs of users we have to take them into consideration.

E. Ownership related issues

Now day's new services available depends on medium supplied by owner. So, as a result race for legalizing P2P services started which is automatically affecting system critically more *[7]*.

F. Security and privacy related issues

In order to utilize networks effectively & efficiently, there is need to setup security measure so that transmission will be safe, security attacks can be minimized & data complications can be reduced to minimize complexity as wireless networks are heterogenic in nature *[7]*.

VIII. TIMELINE OF 4G

4G growth period starts from 2008 with invention of WiMAX networks. Thereafter HSPA+, UMB & Wi-Fi came into existence. WiMAX offers IMT criteria of 1G bit/sec for stationary access and 100Mbits/sec for mobile reception. HSPA+ offers maximum download speed of 672Mbits/sec and maximum upload speed of 168Mbits/sec & utilizes CDMA, FDD and MIMO radio technology. UMB is an IEEE 802.20 standard for 4G projects to improve CDMA 2000 standard with download speed of 275Mbits/sec and upload speed of 75Mbits/sec. Wi-Fi is an IEEE 802.11n standard which utilizes OFDM & MIMO technology with speeds of 288.8Mbps (using 4X4 configuration in 20 megahertz bandwidth) and 600Mbits/sec (using 4X4 configuration in 40 megahertz bandwidth).

IX. CONCLUSION

Although 4G technologies are highly efficient, scalable and reliable. From above discussion, our major issue deals with making of high bit rates, more to users available in one base station. Now in order to serve this and increase its deficiency we have to manage frequency spectrum use very well, improve smart ratio, utilize mesh routing protocols very well so as to improve 4G.

Also, lot of research work has to be done for investigating design of standards, improve quality of services etc. So that we would be able to rectify our mistakes which we have done during 3G failure to fulfill imagination and demands of users.

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