A STUDY ON THIRD GENERATION MOBILE TECHNOLOGY (3G) IN INDIA

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Abstract

The rapid development of mobile telecommunications was one of the most notable success stories of the 1990s. The 2G networks began their operation at the beginning of the decade (the first GSM network was opened in 1991 in Finland),and since then they have been expanding and evolving continuously, In September 2002 there were 460 GSM networks on air worldwide, together serving 747.5 million subscribers. In the same year that GSM was commercially launched, ETSI had already started the standardization work for the next-generation mobile telecommunications network. This new system was called the Universal Mobile Telecommunications System (UMTS). The work was done in ETSI's technical committee Special Mobile Group (SMG). SMG was further divided into subgroups SMG1-SMG12 (SMG5 was discontinued in 1997),with each subgroup specializing in certain aspects of the system. The 3G development work was not done only with in ETSI.

Keywords: 1G,2G,3G, Wireless Mobile Communication, Smartphones, Mobile internet, Wireless

Introduction

A new generation of cellular standards has appeared approximately every tenth year since 1G systems were introduced in 1979 and the early to mid 1980s.Each generation is characterized by new frequency bands, higher data rates and non-backward-compatible transmission technology. The first 3G networks were introduced in 1998 and 4G networks in 2008.

Several telecommunications companies market wireless mobile internet services as 3G,indicating that the advertised service is provided over a 3 G 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 200kbit/s (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 services often denoted as 3.5 G and 3.75G,also provide mobile broadband access of several Mbit/s to smartphones and mobile modems in laptop computers.

3G technology in India

In 2008, India entered the 3G arena with the launch of 3G enabled Mobile and Data services by Government owned Bharat Sanchar Nigam Ltd. (BSNL). Later MTNL launched 3G in Delhi and

Mumbai. Nationwide auction of 3G wireless spectrum was announced in April 2010.The first private sector service provider that launched 3G services is Tata DoCoMo, on November 5, 2010. And the second is by Reliance Communications, December 13, 2010. Bharti Airtel launched their 3G services on 24 January 2011 in Bangalore and also launched in Delhi & Jaipur on March 4, 2011. Aircel also launched 3G in Kolkatta in the month of February. Other providers like Vodaphone, Idea and others launched 3G services in first quarter of 2011.Telecom Regulatory Authority of India (TRAI) also recommended auctioning 200 MHz for broadband wireless access services like Worldwide Interoperability for Microwave Access (WiMAX) and has proposed a national frequency management board to oversee spectrum availability and its efficient use. The allocated spectrum would be enough for the next two years. TRAI would recommend freeing up more spectrums for those who lose out in this auction.

The following standards are typically branded 3G:

- 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 (Wideband Code Division Multiple Access).
- The TD-SCDMA radio interface was commercialized in 2009 and is only offered in China.
- The latest UMTS release, HSPA+, can provide peak data rates upto 56 Mbit/s in the downlink in theory (28 Mbit/s in existing services) and 22 Mbit/s in the uplink.

Break-up of 3G systems:

These are evolutionary standards (EDGE and CDMA) that are backward- compatible extensions to pre-existing 2G networks as well as revolutionary standards that require all new network hardware and frequency allocations. The cell phones use UMTS in combination with 2G GSM standards and bandwidths, but do not support EDGE. The latter group is the UMTS family, which consists of standards developed for IMT-2000, as well as the independently developed standards DECT and WiMAX, which were included because they fit the IMT-2000 definition. While EDGE fulfils the 3G specifications, most GSM/UMTS phones report EDGE ("2.75G") and UMTS ("3G") functionality.

Features

I. **Data rates :** In market implementation, 3G downlink data speeds defined by telecom service providers vary depending on the underlying technology deployed; upto 384 kbit/s for WCDMA, upto 7.2 Mbit/s for HSPA and a theoretical maximum of 21.6 Mbit/s for HSPA+ (technically 3.5G, but usually clubbed under the trade name of 3G). Compare data speeds with 3.5G and 4G.

II. **Security:** 3G networks offer greater security than their 2G predecessors. By allowing the UE (User Equipment) to authenticate the network it is attaching to, the user can be sure the network is the intended one and not an impersonator.3G networks use the KASUMI block cipher instead of the older A5/1 stream cipher. However, a number of serious weaknesses in the KASUMI cipher have been identified. In addition to the 3G network infrastructure security, end-to-end security is offered when application frameworks such as IMS are accessed, although this is not strictly a 3G property.

III. **Applications of 3G:** The bandwidth and location information available to 3G devices gives rise to applications not previously available to mobile phone users. Some of the applications are:

- Global positioning system (GPS)
- Location based services
- Mobile TV
- Telemedicine
- Video conferencing
- Video on demand

Evolution

Both 3GPP and 3GPP2 are working on the extensions to 3G standards that are based on an all-IP network infrastructure and using advanced wireless technologies such as MIMO. These specifications already display features characteristic for IMT-Advance I (4G), the successor of 3G. However, falling short of the bandwidth requirements for 4G (which is 1 Gbit/s) for stationary and 100 Mbit/s for mobile operation), these standards are classified as 3.9G or Pre-4G.

3GPP plans to meet the 4G goals with LTE advanced, whereas Quaimm has halted development of UMB in favor

of the LTE family . On 14 December 2009, Telia Sonera announced in an official press release that "We are very proud to be the first operator in the world to offer our customers 4G services". With the launch of their LTE network, initially they are offering Pre-4G (or beyond 3G) services in Stockholm, Sweden, Oslo and Norway.

Evaluation of Mobile Generation

The nomenclature of the cellular wireless genetrations (G) generally refers to a change in the fundamental nature of the service, non-backwards compatible transmission technology, and new frequency bands. New generations have appeared about every ten years since the first move from 1981 analog (1G) to digital (2G) transmission in 1992. This was followed, in 2001, by 3G multi-media support, spread spectrum transmission and peak throughputs of 200kbit/s; and in 2011 by 4G,which refers to all-IP switched networks, mobile ultra-broadband (gigabit speed) access and multi-carrier transmission.

a) **First Generation:** The first generation of mobile cellular telecommunication systems appeared in 1980's. The first generation was not the beginning of mobile communications, as there were several mobile radio networks in existence before them, but they were not cellular systems either. The capacity of these early networks was much lower than that of cellular networks, and the support for mobility was weaker. In mobile cellular networks the coverage area is divided into small cells, thus the same frequencies can be used several times in the network without disruptive interference. This increases the system capacity. The first generation used analog transmission techniques for traffic, which was almost entirely voice. There was no dominant standard but several competing ones. The most successful standards were Nordic Mobile Telephone (NMT), Total Access Communication System (TACS) and Advanced Mobile Phone Service (AMPS).

b) **Second Generation:** The second generation (2G) mobile cellular systems use digital radio transmission for traffic. Thus, the boundary line between first and second generation systems is obvious: it is the analog/digital split. The 2G networks have much higher capacity than the first generation systems. One frequency channel is simultaneously divided among several users (either by code or time division). Hierarchical cell structures – in which the service area is covered by macrocells, microcells, and picocells- enhance the system capacity even further.

There are four main standards for 2G systems:

- Global system for Mobile (GSM) communications and its derivatives.
- Digital AMPS (D-AMPS).
- Code division multiple access (CDMA) IS-95.
- Personal digital cellular (PDC).

c) **Generation 2.5 :** "Generation 2.5" is a designation that broadly includes all advanced upgrades for the 2G networks. These upgrades may in fact sometimes provide almost the same capabilities as the planned 3G systems. The boundary line between 2G and 2.5G is a hazy one. It is difficult to say when a 2G becomes a 2.5G system in a technical stage. Generally, a 2.5G GSM system includes at least one of the following technologies: high-speed circuit- switched data (HSCSD), General Packet Radio Services (GPRS) and Enhanced Data Rates for Global Evolution (EDGE). An IS-136 system becomes 2.5G with the introduction of GPRS and EDGE, and an IS-95 system is called 2.5G when it implements IS-95B, or CDMA2000 IXRTT upgrades.

Proposals for 3G standard

There have been (and still are) several competing proposals for a global 3G standard. Below, these are grouped based on their basic technology,WCDMA, advanced TDMA, hybrid CDMA/TDMA, and orthogonal frequency division multiplexing (OFDM). 1.3.1 WCDMA by

definition, the band width of a WCDMA system is 5MHz or more, and this 5MHZ is also the nominal bandwidth of all 3G WCDMA proposals. This bandwidth was chosen because:

- It is enough to provide data rates of 144 and 384 Kbit/s (these were 3G targets),and even 2 Mbit
- /s in good conditions.
- Bandwidth is always scarce, and the smallest possible allocation should be used, especially if the system must use frequency bands already occupied by existing 2G systems.
- This bandwidth can resolve more multipaths than narrower bandwidths, thus improving performance.

d) Advanced TDMA : Serious research was conducted around advanced TDMA systems in the 1990's . For some time, The European 3G research was concentrated around TDMA systems, and CDMA was seen only as a secondary alternative. However, in the IMT-2000 process the UWC-136 was the only surviving TDMA 3G proposal, and even that one had backing only in North America. As of 2002, UWC-136 was no longer supported even by UWCC, but North American TDMA and GSM operators have decided to adopt the WCDMA system, that is, IMT-Ds as their 3G technology.

e) Hybrid CDMA/TDMA : This solution was examined in the European FRAMES project. It was also the original ETSI UMTS radio interface scheme. Each TDMA frame is divided into eight time slots and within each time slot the different channels are multiplexed using CDMA. This frame structure would have been backward compatible with GSM. This particular ETSI proposal is no longer supported. However, the UTRAN TDD mode is actually also a hybrid CDMA/TDMA system. A radio frame is divided into 15 time slots, and within each slot different channels are CDMA multiplexed.

f) OFDM : It is based on a principle of multicarrier modulation, which means dividing a data stream into several bit streams (subchannels), each of which has a much lower bit rate than the parent data stream. These substreams are then modulated using codes that are orthogonal to each other. Because of their orthogonality, the subcarriers can be very close to each other (or even partly overlapping) in the frequency spectrum without interfering each other. And since the symbol times on these low bit rate channels are long, there is no intersymbol interference (ISI). The result is a very spectrum- efficient system.

g) IMT-2000 : IMT-2000 is the "umbrella specification" of all 3G systems. Originally it was the purpose of the International Telecommunication Union (ITU) to have only one truly global 3G specification, but for both technical and political reasons this did not happen. In its November 1999 meeting in Helsinki, the ITU accepted the following proposals as IMT-2000 compatible:

- IMT Direct spread (IMT-DS; also known as UTRA FDD).
- IMT Multicarrer (IMT-MC: also known as CDMA2000).

- IMT Time code (IMT-TC; also known as UTRA-TDD/TD-SCDMA "narrowband TDD".
- IMT single-carrier (IMT-SC; also known as UWC-136).
- IMT Frequency time (IMT-FT; also known as DECT).

The number of accepted systems indicates that the ITU adopted a policy that no serious candidate should be excluded from the new IMT-2000 specification. Thus, the IMT-2000 is not actually a single radio interface specification, but a family of specifications that technically do not have much in common.

Evolution of Mobile Technology:

1) **GSM :** Global System for Mobile Communication GSM (4) is the legacy network of the evolution to the third generation (3G) technologies Universal Mobile Telecommunication System (UMTS), also known as WCDMA, and High Speed Packet Access (HSPA). Commonly referred to as the GSM family of technologies, the following diagram represents the evolution from second generation (2G) GSM and General Packet Radio System (GPRS) to 3G Enhanced Data for GSM Evolution (EDGE),UMTS and HSPA.
   The oldest member of the GSM family of technologies is GSM itself; a digital or Personal Communication System (PCS), 2G technology that provides voice and circuit-switched data services. There are several reasons why GSM is so popular among operators and their customers:
   - Clear voice quality.
   - International roaming.
   - Spectral flexibility.
   - Tight security.
   - Data support.
   - Subscriber Identity Module(SIM) cards.
2) **Femtocells :** They are low power wireless access points- originally called Access Point Base Stations- that operate in licensed spectrum to connect standard mobile devices to a mobile operator's network using the customer's DSL or cable broadband connection. A Femtocell is a scalable, multi-channel, two-way communications device that incorporates key elements of a mobile radio access network into a compact device – about the size of the typical desktop WiFi router – and can be deployed in a home or office.
3) **FMC :** Fixed Mobile Convergence is a technology trend towards seamless connectivity between fixed and wireless telecommunications networks. FMC impacts almost all communications and information industries, promising great changes to the way customers consume communication services – anytime, anywhere and from any device. It is comprised of four key components – service, terminal, network and industry convergence – all of which are interrelated and critical to the success of the others. Simply put, the aim

is to provide both fixed and mobile telephony services with a single device or phone that can switch back and forth seamlessly.

4) **HSPA+ :** High Speed Packet Access Plus is also known as HSPA Evolution and Evolved HSPA.HSPA+ was first standardized in 3GPP Release 7 and standardization has continued through a Release. HSPA+ will apply some of the techniques developed for Long Term Evolution (LTE) and allow operators to extend the life of their HSPA networks.
5) **IMS :** The IP Multimedia Subsystem is an architectural framework for delivering internet protocol (IP) multimedia services. It was originally designed by the wireless standards body 3rd Generation Partnership Project (3GPP), as a part of the vision for evolving mobile networks beyond GSM. IMS applications can reside either in the operators network or in third party networks.
6) **LTE :** Long Term Evolution is a radio platform technology that will allow operators to achieve even higher peak throughputs than HSPA+ in higher spectrum bandwidth. Work on LTE began at 3GPP in 2004, with an official LTE work item started in 2006 and a completed 3GPP Release 8 specification in March 2009. Initial deployments of LTE began in late 2009.
7) **MIMO :** Multiple-input Multiple- output, MIMO, is an antenna technology – sometimes called smart antenna technology- that is used both in transmission and receiver equipment for wireless radio communication. MIMO uses multiple antennas to send multiple parallel signals from transmitter. MIMO can be used to advance such applications as:
    - Streaming video, music video surveillance.
    - Voice over Internet Protocol (VoIP)
    - Video conferencing.
    - Interactive gaming.
    - Mobile TV.
8) **SAE/EPC :** System Architecture Evolution/ Evolved Packet Core System Architecture Evolution is synonymous with Evolved Packet Core (EPC). SAE/EPC is defined by 3GPP in Release 8 (Rel-8) as an entirely new core network with a flatter all-IP architecture enabling a higher data rate, lower latency packet-optimized system that supports multiple radio- access technologies, focusing on the packet-switched domain, with the assumption that the system will support all services- including voice- in this domain.
9) **Evolution (EDGE) :** Evolution also called as Evolved EDGE or EDGE II, is an upgraded version of EDGE technology that was ratified by the 3GPP in Release 7 (Rel-7). It applies many of the techniques employed in HSPA+ to lower latency and increase the speed of EDGE, A key part of the evolution of EDGE is the utilization of more than one radio frequency carrier. This is designed to overcome the inherent limitation of the narrow channel bandwidth of GSM.
    - CDMA2000 IXEV-DO_launched in 2002, is a Evolution Data Optimized of the CDMA2000 standard, capable of delivering peak forward link data rates of 2.4 Mbit/s, or rates comparable to wired broadband.

- CDMA2000 IXEV-DO Rev. A- It is a significant evolutionary step in the CDMA2000 IXEV-DO progression. Launched in 2006,EV-DO Rev. It provides a peak forward link data rate of 3.1 Mbit/s.

10) TD-SCDMA : Time Division Synchronous Code Division Multiple Access (TD-SCDMA**)** is a 3G mobile telecommunications standard, being pursued in China by the Chinese Academy of Telecommunications Technology(CATT), Datang and Siemens AG, in an attempt to develop home-grown technology and not be "dependent on western technology" . Technical high lights of TD-SCDMA-TDSCDMA uses TDD, in contrast to the FDD scheme used by W-CDMA.

Conclusion: 3G telecommunication networks support services that provide an information transfer rate of at least 0.2 Mbit/s. Later 3G releases, often denoted 3.5G and 3.75G, also provide mobile broadband access of several Mbit/s to smart phones and mobile modems in laptop computers. This ensures it can be applied to wireless voice telephony, mobile internet access, fixed wireless internet access, video calls and mobile TV technologies. 3G technology is considered to be the evolution of existing mobile communications. In the light of the discussion in this paper, there is strong evidence to suggest that the main outcome of using 3G networks and services will be to get access to the same services with faster data connection speed. Furthermore, it seems that the success of 3G lies in its ability to serve not only mobile users but in providing access to the internet with data cards inserted in laptops. Thus, 3G networks will serve the same purpose as LAN and WLAN networks. In terms of business opportunities, telecommunication companies main source of income is still coming from voice-centric services.

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