THIRD GENERATION WIRELESS SYSTEMS

WHITE PAPER

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1. ABSTRACT

This paper introduces third generation systems and presents a historical overview of its evolution while discussing other technological trends of the past and the present in this wireless industry. It also examines how third generation systems can be successfully implemented to address the growing demand for wireless multimedia services. Different types of third generation technologies, their performance, operational features, technical air interfaces, implementations, applications and implications have been discussed too. It concludes with a brief insight about the future of third generation systems.

2. KEYWORDS

2G, 2.5G, 3G, 4G, Wireless, Third Generation Systems, M-Commerce, 3GPP, 3GPP2, AMPS, EDGE, GPRS, GSM, HSCSD, IMT-2000, TDD, TDMA, WCDMA, UMTS, UWC-136

3. INTRODUCTION TO THIRD GENERATION SYSTEMS (3G)

The third generation wireless technology, also known as 3G, is a term used to define a collection of standards and technologies defined by international organizations, to improve performance, quality and efficiency of wireless systems. They offer enhancements to current applications, including greater data speeds, increased capacity for voice and data and the advent of packet data networks versus today's switched networks. [2]

Third Generation systems will upgrade wireless communications into an on-line, real-time connectivity that can be accessed via mobile devices that are stationary or in motion. It will also allow an individual to have immediate access to location-specific services that offer information on demand. Wireless data services are expected to see the same explosive growth in demand that Internet services and

wireless voice services have seen in last few years. As shown in Figure 1, an analysis carried on by EMC Database group shows wireless subscriber will increase to a count of 1800 million by the year 2005.

4. EVOLUTION OF THIRD GENERATION SYSTEMS

The third generation systems passed through a regular phase of evolution, from first, second to third generation. The first generation of mobile phones consisted of the analog models that emerged in the early 1980s. During the second generation of digital mobile phones appeared about ten years later along with the first digital mobile networks. During this the mobile telecommunications industry experienced exponential growth both in terms of subscribers as well as new types of value-added services. Mobile phones rapidly became the preferred means of personal communication, creating the world's largest consumer electronics industry. The third generation brought with it a revolution in mobile communication enabling high speed data connectivity and improving the performance and quality of applications, thus making communication faster and richer.

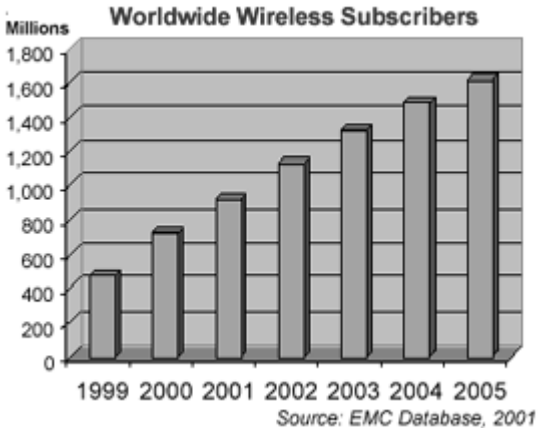

Figure 1 Wireless Subscribers Expected by 2005

4.1. FIRST GENERATION SYSTEMS

The first generation of wireless mobile communications was based on analog signaling. Analog systems, implemented in North America, were known as Analog Mobile Phone Systems (AMPS), while systems implemented in Europe and the rest of the world were typically identified as a variation of Total Access Communication Systems (TACS). Analog systems were primarily based on circuit-switched technology and designed only for voice (not data). [1]

The most successful analog systems are based on the following First Generation standards, all of which are still in demand today:

Nordic Mobile Telephone (NMT) was the first commercially available analog system, introduced in Sweden and Norway in 1979.

Advanced Mobile Phone Service (AMPS) was launched in 1982. This has proven to be the most successful analog standard of all. AMPS networks are widely deployed and can be found on all continents.

Total Access Communications System (TACS) was originally specified for the United Kingdom and is based on AMPS. The original TACS specification was extended and is known as ETACS. ETACS is primarily deployed in Asia Pacific regions.

4.2. SECOND GENERATION SYSTEMS

Since First generation systems were typically limited in capacity, the second generation (2G) appeared about 10 years later, with the first digital mobile, circuit-switched networks. These systems provide better voice quality, higher capacity, lower power requirements and global roaming capabilities. They are also digital systems therefore they can also transmit data over an air link. Circuit-switched cellular data is now the most widely used wireless data service. However, the effective data rates of 2G circuit-switched wireless systems are still too slow to facilitate comfortable Internet access. They can handle some data capabilities such as fax and short message service at the data rate of up to 9.6 kbps, but it is not suitable for web browsing and multimedia applications

Cellular systems use three different techniques for sharing an RF (radio frequency) spectrum: FDMA (Frequency Division Multiple Access), TDMA (Time Division Multiple Access), and CDMA (Code Division Multiple Access). Each of this technology is discussed in detail below:

4.2.1. TDMA

TDMA that stands for Time Division Multiple Access is a time-sharing technology that allows three calls to use the same frequency at the same time. Each call is assigned a small

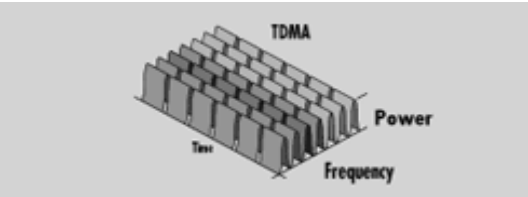

Figure 2: TDMA waveform

time slot during which it has use of the full channel. All the calls then rotate through the channel in a

circular manner. Voice and/or data is stored and then sent in packets based on when the time slot for the call emerges, as shown in the Figure 2. This pattern then repeats for all the calls, but the time slots are so narrow that it is very difficult to detect any delay at all. TDMA-based networks generally have a capacity of around 1,000 calls at once whereas an analog-based network can only handle about 100 at once. The maximum throughput of TDMA is 9.6 Kbps, as shown in Table 1.

4.2.2. CDMAone

CDMA that stands for Code Division Multiple Access was developed by Qualcomm for military private conversation systems. It assigns a unique code to each call in the system and takes advantage of using a low power signal across a wide frequency width so a call can move from frequency to frequency without losing its identity or attracting interference, as shown in Figure 3. CDMA makes use of whatever bandwidth is available, and thus CDMA-based networks are able to handle 10,000 calls per frequency at one time. Analog systems have a capacity of approximately 100 calls at once.

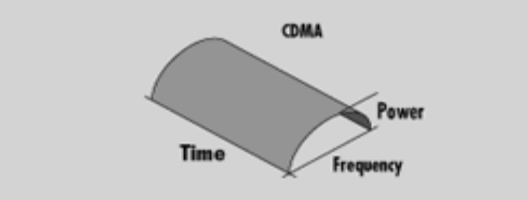

Figure 3: CDMA/CDMAone waveform

4.2.3. FDMA

FDMA stands for frequency division multiple access. It is used exclusively for analog cellular systems, even though in theory FDMA can also be used with digital. Essentially, FDMA splits the allocated spectrum into many channels, as shown in Figure 4. In current analog cell systems, each channel is 30 kHz. When a FDMA cell phone establishes a call, it reserves the frequency channel for the entire duration of the call. The voice data is modulated into this channel's frequency band (using frequency modulation) and sent over the airwaves. At the receiver, the information is recovered using a band-pass filter. The phone then uses a common digital control channel to acquire channels.

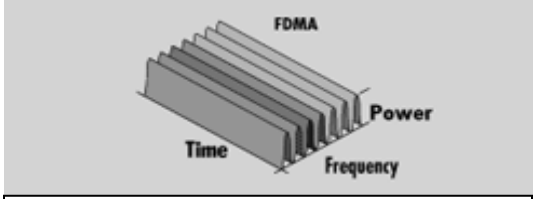

Figure 4: FDMA waveform

4.2.4. GSM

This stands for Global Standard for Mobile Communications. It was originally developed in Europe and really takes pieces from both CDMA and TDMA. GSM separates calls into their own time slots, like TDMA, but also assigns a unique code to each call – like CDMA. GSM does allow 8 to 10 time slots per channel though, and operates at 900 MHz and 1800 MHz. The PCS networks that employ GSM technology operate at 1900 MHz. It was first implemented in 1991, are now operating in about 140 countries and territories around the world. An estimated 248 million users now operate over GSM systems. As shown in the Figure 5, 60% of total wireless users operate on GSM. The maximum throughput of GSM is also 9.6 Kbps, as shown in Table 1.

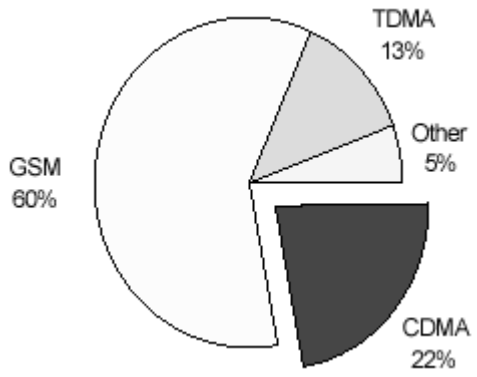

Figure 5: World Market Share: Expected by 2005

4.3. SECOND (2G+) GENERATION SYSTEMS

As stated in a previous section, the virtual explosion of Internet usage has had a tremendous impact on the demand for advanced wireless data communication services. However, the effective data rate of 2G circuit-switched wireless systems is relatively slow -- too slow for today's Internet. As a result, GSM, PDC and other TDMA-based mobile system providers and carriers have developed 2G+ technology that is packet-based and increases the data communication speeds to as high as 384kbps. These 2G+ systems are based on the following technologies: High Speed Circuit-Switched Data (HSCSD), General Packet Radio Service (GPRS) and Enhanced Data Rates for Global Evolution (EDGE) technologies.

4.3.1. HSCSD - High Speed Circuit-Switched Data

HSCSD is one step towards 3G wideband mobile data networks. This circuit-switched technology improves the data rates up to 57.6kbps by introducing 14.4 kbps data coding

and by aggregating 4 radio channels timeslots of 14.4 kbps.

4.3.2. GPRS - General Packet Radio Service

GPRS is an intermediate step that is designed to allow the GSM world to implement a full range of Internet services without waiting for the deployment of full-scale 3G wireless systems. GPRS technology is packet-based and designed to work in parallel with the 2G GSM, PDC and TDMA systems that are used for voice communications. GPRS uses a multiple of the 1 to 8 radio channel timeslots in the 200kHz-frequency band allocated for a carrier frequency to enable data speeds of up to 115kbps. The data is sent in packets and transported over Public Land Mobile Networks (PLMN) using an IP backbone so that mobile users can access services on the Internet, such as SMTP/POP-based e-mail, ftp and HTTP-based Web services.

4.3.3. EDGE – Enhanced Data Rates for Global Evolution

EDGE technology is a standard that has been specified to enhance the throughput per timeslot for both HSCSD and GPRS. The enhancement of HSCSD is called ECSD, whereas the enhancement of GPRS is called EGPRS. In ECSD, the maximum data rate will not increase from 64 kbps due to the restrictions in the A interface, but the data rate per timeslot will triple. Similarly, in EGPRS, the data rate per timeslot will triple and the peak throughput, including all eight timeslots in the radio interface, will exceed 384 kbps. [1]

Technology	G	Trans-mission	Max. throughput
TDMA	2G	Circuit	9.6 Kbps
GSM	2G	Circuit	9.6 Kbps
IS-95A	2G	Circuit	14.4 Kbps
GPRS	2.5G	Packet	115 Kbps
EDGE	2.5G	Packet	384 Kbps
CDMA2000	3G	Packet	2.4 Mbps
WCDMA	3G	Packet	2.4 Mbps

Table 1 Maximum throughput of each technology

4.4. THIRD GENERATION SYSTEMS (3G)

3G wireless systems represents the convergence of various 2G wireless telecommunications systems into a single global system that includes both terrestrial and satellite components.

One of the most important aspects of 3G wireless technologies is its ability to unify existing cellular standards, such as CDMA, GSM, and TDMA

under one umbrella. The following

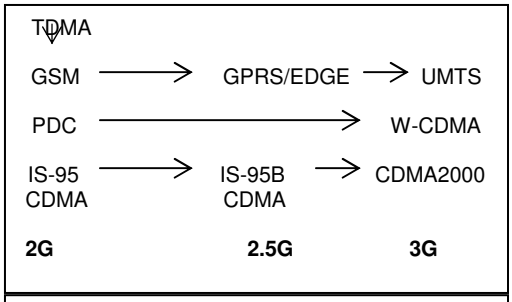

Figure 6: Convergence from 2G to 3G

three air interface modes accomplish this result: wideband CDMA, CDMA2000 and the Universal Wireless Communication (UWC-136) interfaces. Figure 6 shows the graphical evolution of these technologies from 2G and 2.5G technologies. Each of this is discussed below in detail:

4.4.1. W-CDMA

W-CDMA that stands for Wideband-CDMA was introduced for the first time in 1999 by UMTS, aimed to be used as mode of third generation of mobile technology (3G). W-CDMA can be deployed very cost effectively and with little need for additional resources to the existing 2G network infrastructures of the GSM standard which is already been used in Europe and throughout the rest of the world. Mobile telephones and other devices used in W-CDMA mode will be able to use GSM, GPRS or EDGE, which ensures a seamless transition within the existing networks. W-CDMA attains its high performance by transmitting signals from the various services which require variable data rates by assigning bandwidth on demand. Each signal is coded, and then modulated and distributed across a 5 MHz transmission bandwidth, as shown in Table 1. The frequency band is available to all subscribers simultaneously. The coding identifies the signals destined for the each individual subscriber. The codes act as a filter or encryption system which only extracts the data destined for a particular subscriber from this enormous volume of Data. All other users that do not have the appropriate codes will only receive the sum total of all signals in the form of undefined noise. This way of distributing across a wide frequency band helps to prevent disruption that might be caused due to overlapping frequency fading.

4.4.2. CDMA 2000

CDMA2000 is derived from IS-95 (Interim Standard No 95) that was published in 1993 by the North American trading organization; It is based on a narrow band (1.25 MHz channel bandwidth), as shown in Table 1. Although a multi-carrier CDMA that is able to handle multiple

Sequences, IS-95 carriers was originally suggested within the framework of IMT-2000, only the single carrier solution of the cdma2000 family has remained, The first step takes the form of 1xRTT (called cdma2000 1x) a slightly improved variant of IS-95 including the integration of a packet-switching core network which delivers similar performance to GPRS. Since the data throughput did not meet the 3G guidelines, the HDR (High Data Rate) system proposed by Qualcomm in 1998 was introduced as an evolution phase and was accepted as a standard known as cdma2000 1xEV-DO in August 2001. 1xEV-DO is designed especially for data services that are not runtime critical, and requires a separate frequency band. This means that transmission capacities are reserved exclusively for data, even if there is no need, which can be a waste of radio resources. In order to eliminate this problem, the new version, cdma2000 1xEV-DV, is designed to handle both voice traffic and data on a single frequency bandwidth. Only this second stage of evolution can be compared to W-CDMA.

In order to support higher bandwidth channels, CDMA2000 has defined two configuration options: Direct Spread (DS) and Multi-carrier (MC). The DS option is similar to IS-95B and uses the entire bandwidth to spread the data for radio transmissions. In the MC option, user data is encoded as a single stream and de-multiplexed into multiple streams. Each stream carries part of the user data using a different carrier frequency signal, hence the name Multi-carrier. The receiver will multiplex the received signals together before demodulation is carried out. Both the DS and MC options are available in the forward link only. The reverse link supports only the DS option. [4]

4.4.3. TD-SCDMA

TD-SCDMA that stands for Time Division– Synchronous Code Division Multiple Access has developed from GSM in China by two organizations, The China academy of Telecommunication Technology and Siemens Corporation in 1998. It uses the existing GSM infrastructure and allows upgrade to 3G systems by upgrading the hardware and equipments on the base stations. It combines TDMA and TDD to provide data overlay in existing GSM network.

TD-SCDMA is a fast alternative to regular 2G/2.5G wireless systems in China. It offers packet data speed up to 384 kbps. The radio channels which are 1.6Mhz in bandwidth and depends on the smart antenna, spatial filtering and joint detection techniques to yield several times more spectrum efficiency than GSM. It uses 5 milisecond frame, which is further sub divided into seven time slots. These slots can be assigned to single high data users or many slower users. Since it uses FDD technique for transmission, time slows within single slots can be used for both forward as well as backward transmission.[2]

5. NEED FOR 3G

Telecommunications service providers and network operators are embracing the recently adopted global third generation (3G) wireless standards in order to address emerging user demands and to provide new services. The concept of 3G wireless technology represents a shift from voice-centric services to multimedia-oriented (voice, data, video, fax) services. In addition, heavy demand for remote access to personalized data is fueling development of applications, such as the Wireless Application Protocol (WAP) and multimedia management, to complement the 3G protocols. Complementary standards, such as Bluetooth, will enable interoperability between a mobile terminal (phone, PDA etc.) and other electronic devices, such as a laptop/desktop and peripherals, providing added convenience to the consumer and allowing for the synchronization and uploading of information at all times. According to Lehman Brothers, approximately 50 percent of current voice services subscribers are expected to use wireless data services by 2007, instead of 25 percent as previously forecast1. Demand for voice services has traditionally been a market driver. However, demand for data services has emerged as an equally significant market driver. Up until recently, data traffic over mobile networks remained low at around 2% due to the bandwidth limitations of the present second-generation (2G) wireless networks.

The third generation of mobile communications will greatly enhance the implementation of sophisticated wireless applications. Users will be able to utilize personal, location-based wireless information and interactive services.

6. FEATURES OF THIRD GENERATION SYSTEMS

Third generation systems were developed while meeting the following needs and they later became features of emerging wireless systems:

- 3G systems are globally recognized and they comply with international standards to offer globalization.
- They work, enable quick time-to-market needs and meet industry expectations
- They offer spectrum flexibility and efficiency in speed and cost
- They can be offer access via broad range of competitively-priced devices for end users (consumers, enterprises)
- They can be used to develop broad range of applications for end users.
- Migration from existing wireless systems to 3G systems is seamless and cost effective

7. TECHNICAL AIR INTERFACE

	GSM	GPRS	CDMA IS-95A	CDMA IS-95B	CDMA2000	WCDMA
System Generation	2G	2.5G	2G	2.5G	3G	3G
Base System	TDMA	GSM	CDMA	IS-95A	IS-95B	GPRS/EDGE
Frequency Band	1900 mHz	1900 mHz	1900 mHz	1900 mHz	+5MHz	+5MHz
Carrier Channels	200 kHz	200 kHz	1.25 MHz	1.25 MHz	1.25 MHz	1.25 MHz
Users per Channel	8	8	64	64	100-350	100-350
Data Transfer Rate	9.6 kbps	115 kbps	14.4 kbps	64 kbps	2.4 Mbps	2.4 Mbps

8. SYSTEM ARCHITECTURE

The network architecture for a cdma2000 network (defined in 3GPP2) is shown in the Figure 7.[4]

Current services (voice and circuit-switched data) are supported via base station subsystem BSS and network subsystem NSS. The BSS consists of the base transceiver station BTS that handles the radio

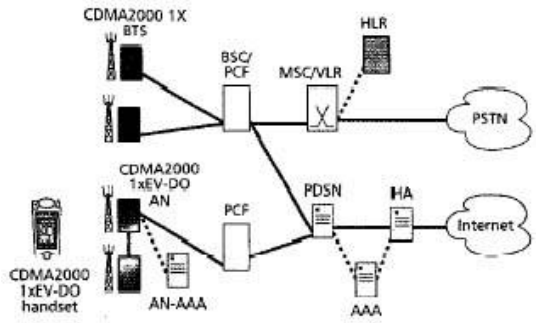

Figure 7: CDMA Wireless System Architecture [4]

physical layer and the base station controller BSC that deals with the radio resource management and handover. The NSS for circuit switched CS services consists of the mobile switching center MSC, the visitor location register VLR integrated in the MSC and the home location register HLR.

This architecture provides packet-switched services over the regular GSM radio, as shown in the Figure 7. An entirely new functional network entirely, the packet control unit PCU is required with the BCC to manage packet segmentation, radio channel access, automatic retransmission and power control. The major new element introduced by GPRS is an NSS that processes all the data traffic. In the packet domain, packet data switching node PDSN is used for mobility management.

9. IMPLEMENTATION / MIGRATION

The rapid and efficient deployment of new wireless data and Internet services has emerged as a critical priority for communications equipment manufacturers. Network components that enable wireless data services are fundamental to the next-generation network infrastructure.

9.1. Internetworking with 2G and 2G+ Wireless Networks

The existence of legacy networks in most regions of the world highlights the challenge that communications equipment manufacturers face when implementing next-generation wireless technology. Compatibility and internetworking between the new 3G wireless systems and the old legacy networks must be achieved in order to ensure the acceptance of new 3G wireless technology by service providers and end-users.

The existing core technology used in mobile networks is based on traditional circuit-switched technology for delivery of voice services. However, this traditional technology is inefficient for the delivery of multimedia services. The core switches for next-generation of mobile networks will be based on packet-switched technology which is

better suited for data and multimedia services.

2G GSM networks have many components like BTS, BSC, MSC/VLR and HLR/AuC/EIR, combined together to form the complete wireless system. The interfaces between BTS, BSC and MSC/VLR elements are circuit-switched PCM.

On the other hand, GPRS technology adds a parallel packet-switched core network. The 2G+ network consists of BSC with packet interfaces to SGSN, GGSN, HLR/AuC/EIR. The interfaces between BSC and SGSN network elements are either Frame Relay and/or ATM so as to provide reliable transport with Quality of Service (QoS).

Third generation wireless technology introduces new Radio Access Network (RAN) consisting of Node B and RNC network elements. The third generation core network consists of the same entities as GSM and GPRS: 3G MSC/VLR, GMSC, HLR/AuC/EIR, 3G-SGSN, and GGSN. IP technology is used end-to-end for multimedia applications and ATM technology is used to provide reliable transport with QoS. 3G wireless solutions allow for the possibility of having an integrated network for circuit-switched and packet-switched services by utilizing ATM technology. The BSC may evolve into an RNC by using add-on cards or additional hardware that is co-located. The carrier frequency (5Mhz) and the bands (2.5 to 5Ghz) are different for 3G wireless technology compared to 2G/2G+ wireless technology. Evolution of BSC to RNC requires support for new protocols such as PDCP, RRC, RANAP, RNSAP and NBAP. Therefore, BTS' evolution into Node B may prove to be difficult and may represent significant capital expenditure on the part of network operators.

MSC evolution depends on the selection of a fixed network to carry the requested services. If an ATM network is chosen, then ATM protocols will have to be supported in 3G MSC along with interworking between ATM and existing PSTN/ISDN networks.

The evolution of SGSN and GGSN to 3G nodes is relatively easier. Enhancements to GTP protocol and support for new RANAP protocol are necessary to support 3G wireless systems.

ATM protocols need to be incorporated to transport the services. The HLR databases evolve

into 3G-HLR by adding 3G wireless user profiles. The VLR database must also be updated accordingly. The EIR database needs to change to accommodate new equipment that will be deployed for 3G wireless systems. Finally, global roaming requires compatibility to existing deployment and graceful fallback to an available level when requested services are not available in the region.

10. SIGNAL PROCESSING

Signal processing is the process of converting analog signals into digital format suitable for transmission. The digital signal received is then converted back into analog signal. As shown in Figure 8, encoders are used to convert the signals into digital formats, while decoders are used on the receiver end to convert receiving digital signals back to analog format.

Following five major factors controls the quality and performance of signal processing:

Quality: The quality of the processed signal should be as good as the quality of Wire line.

Complexity: The encoding/decoding should be done so that it can be implemented on small Wireless devices.

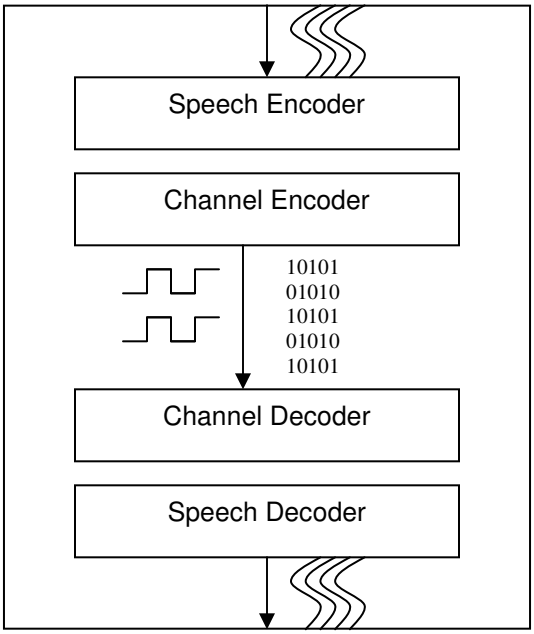

Figure 8: Block diagram of signal processing

Bit Rate: The bit rate should be minimized to maximize system capacity

Delay: The delay of signal processing should be moderate due to the codec frame size and system delays

Robustness: It should be robust enough to operate properly in noisy environments with channel errors

Flexibility: It should be flexible enough to be accommodated in different applications and devices.

10.1. SPEECH CODING of 3G

As shown in Table 3, the speech coding techniques of 3G

technologies, cdma2000 and WCDMA differ from each other.

3GPP2/CDMA2000	3GPP/WCDMA
Variable Bit-Rate Codecs Using this technique the encoder will attempt to allocate approximately the same number of bytes per frame.	**Fixed-Rate Speech Codecs** This technique attempts to give each frame the optimum number of bytes, while still meeting set constraints (such as the overall data rate of the transmission, and the maximum peak data rate).
Treats all bits equally It uses a Fixed Channel Coding Scheme and thus assumes all bits are equally important.	**Doesn't treat all bits equally** It tailors the Channel Coding to each particular speech codec by coding the perceptually most important bits more heavily.

Table 3: Speech Coding Properties of 3G

11. CONCERNS ABOUT 3G

While third generation systems has a lot to offer and organizations, operators and consumers have a lot to look forward to, yet there are many concerns that still need to be addressed before the implementation begins globally. Some of these problems are technical that will hopefully be solved with time, but others are political yet more critical. The next section, discusses few of the most important problems that third generation is expected to face once the deployment begins:

11.1. Implementation Cost

There are two type of costs involved in the deployment of third generation system. One is related to the acquisitions of licenses and the other is the cost involved in the equipment and hardware installations, required to enable the transmission for high speed data and voice.

The government and authorities are giving away licenses for spectrum that is required for 3G technologies at a very higher rate. Different telecom organizations are looking

forward to acquiring these licenses, and those who have succeeded simply became victim of higher fees. For example, LG Telecom agreed to pay the South Korean government about $900 million for its 3G license. this will compel them to increase the rates for usage, thus the demand at consumer level with decrease. Furthermore, with the passage of time, when the hype of 3G will start to settle and many organizations get involved, these companies will find themselves in a very difficult position to manage the finances. That might let them towards greater financial crises. Telecom organizations keeping in mind these threats might not want to acquire 3G in first place, since existing 2.5G does to great extent fulfill the very purpose of end users.

Huge Cost is also involved in the installation of equipment and hardware required to deploy third generation technology. Many 3G technologies claim to offer simple upgrade over 2.5G equipments, but its not that simple. In any case, whether it's CDMA2000 or WCDMA, great deal of antennas, hardware at base stations, internetworking and software are required. Third generation system works well when there are small cells because the range of radio transmission reduces the higher frequencies. Similarly, 3G technologies use modulation and power management techniques that require short distance. The cost involved in this whole upgrade process is quite huge as compared to the transition that took place from 2G to 2.5G. Telecom organizations have to consider and analyze this level of investment, and might come to conclusion that it's not worth at this time, since existing technologies are already helping them serve their customers with great satisfaction and applications.

11.2. Security and Privacy

One of the biggest concerns a consumer and organizations have today is the privacy and security of their content. There are many solutions available for current networked communication and can be deployed for third generation systems also. But this deployment means huge cost and efforts from telecom industry, and thus will again simply increase their investments for third generation systems. If they decide not to offer this feature, then the threat involved in using this new technology is simply unavoidable.

11.3. Data Delivery

One of the most important features of third generation technology is its capabilities to work with data. There will be intensive data sets, such as those used in images, videos and other multimedia applications. This will let 3G achieve its goal of taking mobile devices beyond voice communication to a new era of content delivery. At the same time, it will raise great concerns by the telecom industry. Initially the amount of data transfer speed they would be able to offer will be approx. 56 Kbits/second. And even that depends upon the motion of mobile device and its distance from base station when the demand of cellular devices will increase; it will require great deal of handling by the base stations and might end up affecting the performance of regular voice transmission.

CDMA200 does offer an alternative by putting content and the voice on different channels, thus making them independent of each other. This will successful address the issue of keeping the regular voice transmission consistent, even when data delivery is slow.

11.4. Content

It is very important for consumer to access interesting or important content when purchasing any new mobile devices. Therefore, if the authors fail to provide what is desired by the consumer, there is a great risk of failure for the whole technology. The issue is whether content providers will be able to offer compelling material and whether users will want to bother accessing it over wireless, rather then traditional wireline, networks. For example, user might prefer buying a car on regular internet, but would be more interested to find out about weather, nearby restaurants and news from their mobile devices.

11.5. Applications

With the introduction of such technologies there need to be some driving force that should convince users to go for it! Applications usually plays the part of that driving force, because they are either solution to the problems consumer faces in their daily life or help them improve the quality of their living. For instance, network brought many killer applications on door step from purchasing vacation packages to architect ring the buildings.

Similarly, consumers will be looking forward to applications that will make

difference in their life, before upgrading their devices and services from satisfying 2.5G to 3G. There are lots of talks going about the new killer applications but none came into market yet. For instance, while emerged with GPRS, devices using 3G would be able to help consumers

12. APPLICATIONS OF 3G

There are thousands of applications for wireless devices, if the major constraints of speed, performance and consistency are resolved. This is where third generation systems jumps in. They address the issue of speedy data transfer and consistent connection, thus opening door to new era of applications and usage for mobile devices. e.g. from tracking location of other users to making financial transactions, from playing multiplayer games to video conferencing, and from information retrieval to education and training.

The paper discusses few major applications of wireless devices, equipped with third generation system services:

12.1. m-Commerce

find directions from their current position, locate their friend's position and look for nearby theatres. There is a great deal of efforts that need to be put in this area, as soon as the 3G comes up, as they will help people transition from old service to new one.

m-Commerce that stands for Mobile Commerce, can be defined as set of transactions between a wireless device and service provider (or merchants) that results in the transfer of value in exchange for information, services, or goods. Just like eCommerce, where merchants do business with their clients using computer and wired internet, in m-Commerce same business is carried on using mobile devices and wireless networks. For example, users can buy movie tickets using its mobile device. Movie listing and information will be sent to user and they can make the payments using their credit card. Similarly, user can access their financial details by accessing their bank accounts and can make payments and other transactions directly from their cell phones.

As compared to e-Comernce, m-Commerce is newly born technology and there are many concerns that need to be addressed. For instance

the security of transactions, display of goods and information on small devices, connection consistency, unauthorized wireless intrusion and so on.

In past, wireless devices weren't used for any commerce, because data exchange was very much limited to short messaging services. With the introduction of third generation system, this area is expected to grow exponentially, thus offering consumers ability to make any financial transactions using their cell phones or other small wireless devices.

12.3. Multiplayer Gaming

Mobile devices currently available offer many games but none of them supports multi-players. Reason being, multi player games require lot of speedy data transfer between the two players. The wireless technologies in past couldn't support that much bit rate and thus users were limited to single player games. With the introduction of third generation systems, devices would be able to communicate with each other on runtime, thus allowing even more then one user to connect and play against each other. Not to forget, gaming holds a big share in today's consumer market.

12.2. Video Conferencing

Communication has always been limited to either text (simple data) or voice conversation in past and telecom industry just kept promising to offer video conferencing. This can be now made possible with the arrival of third generation systems. Initially, due to speed limit on wireless transmission, its not going to be a smooth video conversation, but as the 3G systems will evolve and improve, consumers will be able to communicate with each other using their mobile device while watching each others on runtime videos, without any flickering. This will be a major leap in communication and would offer consumers with a solid reason to switch to 3G services.

12.4. Web browsing

Even though consumers would prefer to browse the internet using their desktops and notebook, but in many cases, they wouldn't mind accessing information on their small handy devices! For instance, while looking for bus schedule, checking

latest news or getting latest scores, they can use their wireless devices.

In second generation systems, a new protocol was introduced to offer a compact version of websites to mobile users. It is called WAP that stands for Wireless Application Protocol. Unfortunately, it required organizations and service provider to develop smaller versions of their websites, which meant lot of rework. At the same time, the visibility of WAP pages was very small and browsing them was not user friendly.

Now, the wireless devices are equipped with micro version of regular web browsers. They strip off the complicated content from the website and display the content and images in a very sophisticated manner, reflecting the features and functionality of original web browsers. Consumers are using those devices for accessing websites only when they are connected via WLAN, but third generation systems will offer them same connection to internet globally.

13. CONCLUSION

In spite of all the concerns discussed above, sooner or later, third generation systems will be deployed. Telecom industry is putting a lot of effort into making this happen and co-operating with manufacturers to develop devices that will support third generation services. Initially, it should be implemented in regions where there is more demand for data, like businesses campuses and urban areas. It might expand and replace all the existing wireless networks. Industry is well aware about the fact that implementation of 3G wireless systems raises a critical issue i.e. of successful backward compatibility to air interfaces as well as to deployed infrastructures, so they make sure that transition to the third generation systems is cost effective and beneficial both for them and the consumers.

In the past few years, technology has merged as a major role player in all fields of life. It evolved from impossible to possible and is still striving for improvement. With that in mind, it is possible that in next few years the consumers will soon be offered the third generation system services and communication over mobiles devices which will be as fast and rich as what is provided by the wired internet today.

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16. ACRONYMS

Term	Description
2G	Second-generation
3G	Third-generation
3GPP	Third-generation Partnership Project
3GPP2	Third-generation Partnership Project 2
AMPS/D-AMPS	Advanced Mobile Phone System
ARIB	Association of Radio Industries and Broadcasting
EDGE	Enhanced Data Rates for GSM Evolution and TDMA-136
ETSI	European Telecommunications Standards Institute
FDD	Frequency Division Duplex
GPRS	General Packet Radio Services
GSM	Global System for Mobile communication
HSCSD	High-speed Circuit-switched Data
IMT-2000	International Mobile Telecommunication-2000
ITU-R	International Telecommunication Union- Radio Communications
NMT	Nordic Mobile Telephone
PDC	Personal Digital Communication
TACS	Total Access Communications System
TDD	Time Division Duplex
TDMA	Time Division Multiple Access
TIA	Telecommunications Industry Association
SDO	Standards Development Organization
WCDMA	Wideband Code Division Multiple Access
UMTS	Universal Mobile Telecommunications System
UWC-136	Universal Wireless Communications