Wireless Mobile Communication - A Study of 3G Technology

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---ABSTRACT---

Third Generation (3G) mobile devices and services will transform wireless communications in to on-line, real-time connectivity. 3G wireless technology will allow an individual to have immediate access to location-specific services that offer information on demand. Mobile phones are rapidly becoming the preferred means of personal communication, creating the world's largest consumer electronics industry. Wireless data services are expected to see the same explosive growth in demand that Internet services and wireless voice services have seen in recent years. 3G is a wireless industry term for a collection of international standards and technologies aimed at increasing efficiency and improving the performance of mobile wireless networks. 3G wireless services 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. This white paper presents an overview of current technology trends in the wireless technology market, a historical overview of the evolving 3G technologies and its characteristics, benefits. In next subsections makes an examination of 3G wireless technology standards to address the growing demand for 3G services. That is adoption of 3G across globe and in India. In last section we also show the future technologies beyond third generation wireless technology.

Keywords – **1G, 2G, 3G, Wireless Mobile Communication.**
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1. INTRODUCTION

Mobile communication allows transmission of voice and multimedia data via a computer or a mobile device without having connected to any physical or fixed link. Mobile communication is evolving day by day and has become a must have for everyone. Mobile communication is the exchange of voice and data using a communication infrastructure at the same time regardless of any physical link. Mobile communication technologies not only benefit businesses to perform their operation faster and efficiently but also raising the standard of human lives. Mobile communication or mobile computing is just the two different names for the ability to use the mobile technology while on the move, most of the portable computers and computing equipment which are particular for the use in stationary place or configuration.

If we talk about the mobile communication technologies we can count on many mobile technologies available today such as 2G, 3G, 4G, WiMAX, Wibro, EDGE, GPRS and many others. Mobile computing or mobile communication technologies based on different security standards and as well as the transmission protocol behind it. In this section we have discussed in detail about 3G technologies. If you want augmented bandwidth, multiple mobile applications and clarity of digital signals, then 3G (Thrid Generation Technology) is our gateway. The use of 3G technology is also able to transmit packet switch data efficiently at better and increased bandwidth. 3G mobile technologies proffers more advanced services to mobile users. It can help many multimedia services to function. The spectral efficiency of 3G technology is better than 2G technologies. Spectral efficiency is the measurement of rate of information transfer over any communication system.

3G, short for "Third Generation Wireless," is the next generation high-speed mobile system based on GSM. GSM technology was able to transfer circuit switched data over the network. 3G supports broadband, packet-based transmission of voice, text, multimedia, and video data at rates from 384 kbps to 2 Mbps. At the heart of 3G is the aim to provide mobile users, wherever they may be, with the same high speed services offered by broadband. With 3G, the mobile user can access high speed internet, videoconferencing, and basic video/TV services. 3G can support a minimum of 2 Mbps for stationary or slow-moving users (walking) and 384 kbps for fast-moving vehicles (in an auto or train). Compare this to rates of 9.6-40 kbps for 2G and 2.5G systems.

3G was developed to address the ever-growing consumer demand for mobile network capacity and services. From the youth-inspired excitement for SMS to a need for seamless connectivity to the corporate network while traveling, consumers have embraced the benefits of mobility. 3G is a technology for mobile service providers. Mobile services are provided by service providers that own and operate their own wireless networks and sell mobile services to end users. Mobile service providers use licensed spectrum to provide wireless telephone coverage over some relatively large contiguous geographic service area. Today it may include the entire country. From a user's perspective, the key feature of mobile service is that it offers ubiquitous and continuous coverage. To support the service, mobile operators maintain a network of interconnected and overlapping mobile base stations that hand-off customers as those customers move among adjacent cells. Each mobile base station may support users up to several kilometers away. The cell towers are connected to each other by a backhaul network that also provides interconnection to the wire line Public Switched Telecommunications Network (PSTN) and other services. The mobile system operator owns the end-to-end network from the base stations to the

backhaul networks to the point of interconnection to the PSTN. Third Generations (3G) mobile technologies will support higher bandwidth digital communications. To expand the range and capability of data services that can be supported by digital mobile systems, service providers will have to upgrade their networks to one of the 3G technologies which can support data rates of from 384Kbps up to 2Mbps.

2.   EVOLUTION OF 3G TECHNOLOGY

Mobile communications systems revolutionized the way people communicate, joining together communications and mobility. A long way in a remarkably short time has been achieved in the history of wireless. Evolution of wireless access technologies is about to reach its fourth generation (4G). Looking past, wireless access technologies have followed different evolutionary paths aimed at unified target: performance and efficiency in high mobile environment. The first pre-commercial 3G network was launched by NTT DoCoMo in Japan, branded as FOMA. It was first available in May 2001 as a pre-release (test) of W-CDMA technology. The first commercial launch of 3G was also by NTT DoCoMo in Japan on 1 October 2001, although it was initially somewhat limited in scope; broader availability of the system was delayed by apparent concerns over its reliability. The second network to go commercially live was by SK Telecom in South Korea on the CDMA-based 1xEV-DO technology in January 2002. By May 2002 the second South Korean 3G network was by KT on EV-DO and thus the Koreans were the first to see competition among 3G operators. The first European pre-commercial network was an UTMS network on the Isle of Man by Manx Telecom, the operator then owned by British Telecom and the first commercial network (also UTMS based W-CDMA) in Europe was opened for business by Telenor in December 2001 with no commercial handsets and thus no paying customers. The first commercial United States 3G network was by Monet Mobile Networks, on CDMA2000 1x EV-DO technology, but this network provider later shut down operations. The second 3G network operator in the USA was Verizon Wireless in October 2003 also on CDMA2000 1x EV-DO. AT&T Mobility is also a true 3G UMTS network, having completed its upgrade of the 3G network to HSUPA. The first pre-commercial demonstration network in the southern hemisphere was built in Adelaide, South Australia by m.Net Corporation in February 2002 using UMTS on 2100 MHz. This was a demonstration network for the 2002 IT World Congress. The first commercial 3G network was launched by Hutchison Telecommunications branded as three in March 2003. Emtel Launched the first 3G network in Africa. By June 2007, the 200 millionth 3G subscriber had been connected. Out of 3 billion mobile phone subscriptions worldwide this is only 6.7%. In the countries where 3G was launched first – Japan and South Korea – 3G penetration is over 70%. In Europe the leading country is Italy with a third of its subscribers migrated to 3G. Other leading countries by 3G migrations include UK, Austria, Australia and Singapore at the 20% migration level. A confusing statistic is counting CDMA2000 1x RTT customers as if they were 3G customers. If using this definition, then the total 3G subscriber base would be 475 million at June 2007 and 15.8% of all subscribers worldwide.

The mobile communications industry has evolved in three stages, and correspondingly three generations of mobile phones have emerged. Each one has provided more flexibility and usability than the previous ones. Generations are named as First Generation, Second Generation and Third Generation. Fig 1 shows wireless standards evolve towards 3G technology
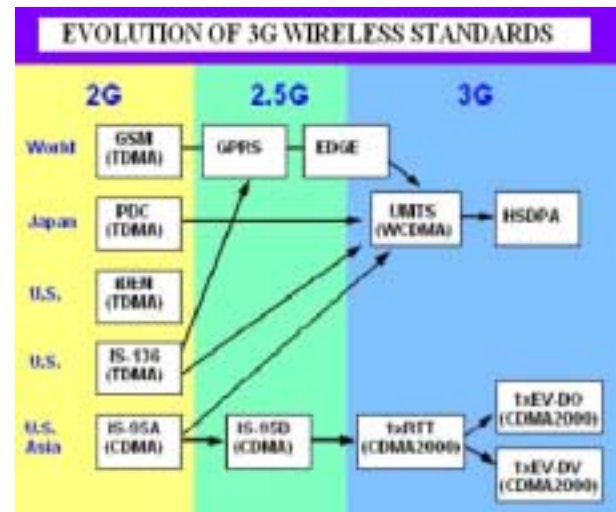

Figure: 1 Evolution of 3G Wireless Standards

Let's have a quick glance on these generations.

1st Generation: Analog phones helped to make voice calls inside one's country without roaming facilities.

2nd Generation: Digital mobile phone systems added fax, data and messaging capabilities as well as voice telephone service in many countries offering worldwide roaming.

3rd Generation: Multimedia services add high speed data transfer to mobile devices, allowing new video, audio and other applications (including Internet services) through mobile phones.

Table 1 below shows comparative analysis of these generations of mobile communication.

Table 1: Comparison of Wireless Generations

Generation (1G,2G,3G,4G,5G)	Definition	Throughput/Speed	Technology
1G	Analog	14.4 Kbps (peak)	AMPS, NMT, TACS
2G	Digital Narrow band circuit data	9.6/14.4 Kbps	TDMA, CDMA
2.5G	Packet Data	171.2 Kbps(peak)	GPRS
		20-40 Kbps	
3G	Digital Broadband Packet Data	5.1 Mbps (peak)	CDMA 2000
		500-700 Kbps	(1xRTT, EVDO)
			UMTS, EDGE

3. FEATURES OF 3G TECHNOLOGY

3G technologies make use of Time Division Multiple Access (TDMA) and Code Division Multiple Access (CDMA). 3G technologies make use of value added services like mobile television, GPS (Global Positioning System) and video conferencing. The basic feature of 3G Technology is fast data transfer rates. However this feature is not currently working properly because, ITU 200 is still making decision to fix the data rates. It is expected that 2mbit/sec for stationary users, while 348kbits when moving or traveling. ITU sell various frequency rates in order to make use of broadband technologies. Network authentication has won the trust of users, because the user can rely on its network as a reliable source of transferring data.3G technology is much flexible, because it is able to support the 5 major radio technologies. These radio technologies operate under CDMA, TDMA and FDMA. CDMA holds for (International Mobile Telecommunication) IMT-DS (direct spread), IMT-MC (multi carrier). TDMA accounts for IMT-TC (time code), IMT-SC (single carrier). FDMA has only one radio interface known as IMT-FC or frequency code. Third generation technology is really affordable due to the agreement of industry. This agreement took place in order to increase its adoption by the users. 3G system is compatible to work with the 2G technologies. 3G technologies hold the vision that they should be expandable on demand. The aim of the 3G is to allow for more coverage and growth with minimum investment. High Bandwidth, Higher Speed, Price, Always Online Devices, Associated Costs, Power Requirements, Functions, Getting Information, all these characteristics of 3G technologies are look at more in next sections.

3.1. High Bandwidth- The measure of transmission capacity is one of the selling points of 3G. This allows you quick and easy access to all of your favorite online multimedia and Internet tools, just like you were at home on a computer. You can pay bills, book dinner reservations, update social networking pages and check emails, all on-the-go.

3.2. Higher Speed- With 3G technology, you get to enjoy data transmission speed leading up to 2Mbps, considering that you have a phone in stationary mode. It also gives you high degree of connectivity and higher networking, plus resistance to noise. The technology has enhanced the bit rate, allowing service providers to give high speed internet facilities, higher call volumes and host of the multimedia applications that can be given to the customers. All the services can be given to the customers based on the data quantity transmitted and not on the time used for the service. The services rendered to clients are cheaper overall.

3.3. On Price- Despite the new speeds and features of 3G technology, the prices of handsets and mobile units are relatively the same. The most recent models, however, may be priced higher compared to those featuring 2.5G.

3.4. Always-Online Devices- Another feature of 3G technology is that it can utilize packet-based Internet protocol connectivity. This means your mobile device will always be online and ready for Internet access. However, you will not actually pay for the connection until you start sending or receiving data packets, such as sending an email or looking at a webpage.

3.5. Power Requirements- In addition to being more expensive, 3G handsets also require more power than most 2G models.

3.6. Associated Costs- To support 3G technology, updates need to be made to the current cellular infrastructure. According to 3G Internet, this means installing new 3G equipment at ideally every current cellular base station and acquiring new frequencies for 3G transmissions.

3.7. Getting Information- This is one of the best features of 3G technology. You can also watch the latest news and headlines, getting data like the weather, sports and economic details. You get to acquire the latest scores in an ongoing cricket match and other favorite sports.

The most significant features offered by third generation mobile technologies are the momentous capacity and broadband capabilities to support greater numbers of voice and data customers - especially in urban centers - plus higher data rates at lower incremental cost than 2G.

3G uses 5 MHz channel carrier width to deliver significantly higher data rates and increased capacity compared with 2G networks. The 5 MHz channel carrier provides optimum use of radio resources for operators who

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have been granted large, contiguous blocks of spectrum. On the other hand, it also helps to reduce the cost to 3G networks while being capable of providing extremely highspeed data transmission to users. It also allows the transmission of 384kbps for mobile systems and 2Mbps for stationary systems. 3G users are expected to have greater capacity and improved spectrum efficiency, which will allow them to access global roaming between different 3G net workings.

The main characteristics of 3G are to provide mobile multimedia services at transmission rate of 144kbps at the high speed 384kbps at the speed of walking 2Mbps indoors. This theoretical maximum (2Mbps) is close to the speed of LAN connections that many households nowadays have. In addition, 3G networks can offer faster data transmission than the slowest.

4. PROPOSED BENEFITS OF 3G TECHNOLOGY

Third-generation, or 3G, technology is a wireless network technology that is commonly utilized in smart phones like iPhones and Blackberries. While its predecessor, second-generation (2G) technology, was formulated around voice applications (like talking, call-waiting and voicemail), 3G technology puts a strong emphasis on Internet and multimedia services, such as web browsing, video conferencing and downloading music. And while there are several advantages to 3G, the technology also comes with its disadvantages.

While on the road, a manager can conduct a teleconference with colleagues to discuss an upcoming presentation. He can download the latest version; make edits online, all while talking. Users can take advantage of mobile video on demand to watch news, sports highlights, and video clips anytime on their mobile devices. 3G gives mobile staff access to critical applications like Customer Relationship Management (CRM) applications. For example, field engineers can view a customer's profile from the road, update their files, and even close the trouble ticket while on site. Sales people can create and place orders while still at the customer's location. 3G-enabled vehicles are beginning to enter the market. These provide access to traffic-view cameras, Internet access, gaming, and video-streaming. You can perform all those functions that you perform at present with your mobile devices but at much higher speed than before. It provides you with faster connectivity, faster internet access, and music entertainment with improved quality. The benefits are immense. You can avail the benefits of video calling. You can call you friend and have a video call facility. The clarity is better and the facility can be enjoyed as long as both of you are using the 3G technology.

You can use your mobile phone as a modem for your computer and mail the important documents. Downloading games and songs is much faster with this technology. You can download your favorite games in your mobile and start playing. You can also download the music videos or simply the songs. The technology enable for much faster download. Hence it will take only few minutes to download movie clips or albums. You can also view the news headlines get information about the evening weather so that

you can plan your party. You can find out the latest baseball score and any latest news about your favorite sport. The 3G phones with their advanced feature will also enable you to watch exciting highlights of your favorite sport. With the increased speed and improved quality of the services provided in the 3G phones, you can view the movie clips and the music videos with clearer picture than with the 2.5G technology mobiles.

The 3G technology provide you with the data transmission speed of up to 2Mbps when you are using the phone in stationary mode. It also provides high degree of connectivity and increased networking and most importantly the resistance to noise. The technology has in fact increased the bit rate thus enabling the service providers to provide high speed internet facilities, increased call volumes and host of the multimedia applications to their customers. The bandwidth and location information available to 3G devices gives rise to applications not previously available to mobile phone users.

Mobile TV– A provider redirects a TV channel directly to the subscriber's phone where it can be watched.

Video on demand– A provider sends a movie to the subscriber's phone.

Video conferencing– Subscribers can see as well as talk to each other.

Tele-medicine– A medical provider monitors or provides advice to the potentially isolated subscriber.

Location-based services– A provider sends localized weather or traffic conditions to the phone, or the phone allows the subscriber to find nearby businesses or friends.

All these services can be provided to the customers on the basis of the amount of data they transmit and not on the time for which they use the service thus making the services cheaper for us. What next? Just get the 3G mobile and mail your friends, enjoy the video clips before deciding for the movie, download games.

5. ADOPTION OF 3G TECHNOLOGY

3G was relatively slow to be adopted globally. In some instances, 3G networks do not use the same radio frequencies as 2G so mobile operators must build entirely new networks and license entirely new frequencies, especially so to achieve high-end data transmission rates. Other delays were due to the expenses of upgrading transmission hardware, especially for Universal Mobile Telecommunication System (UMTS), whose deployment required the replacement of most broadcast towers. Due to these issues and difficulties with deployment, many carriers were not able to or delayed acquisition of these updated capabilities. In December 2007, 190 3G networks were operating in 40 countries and 154 HSDPA networks were operating in 71 countries, according to the Global Mobile Suppliers Association (GSA). In Asia, Europe, Canada and the USA, telecommunication companies use W-CDMA technology with the support of around 100 terminal designs to operate 3G mobile networks. Roll-out of 3G networks was delayed in some countries by the enormous costs of additional spectrum licensing fees. The license fees in some European countries were particularly high, bolstered by government auctions of a limited number of licenses and

sealed bid auctions, and initial excitement over 3G's potential. The 3G standard is perhaps well known because of a massive expansion of the mobile communications market post-2G and advances of the consumer mobile phone. An especially notable development during this time is the smartphone (for example, the iPhone, and the Android family), combining the abilities of a PDA with a mobile phone, leading to widespread demand for mobile internet connectivity.3G has also introduced the term "mobile broadband" because its speed and capability makes it a viable alternative for internet browsing, and USB Modems connecting to 3G networks are becoming increasingly common.

6.   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 Vodafone, Idea and others launched 3G services in first quarter of 2011.

People in India are looking forward to more information, faster data access and multimedia services through their mobile phones. 3G technology is here to turn this dream into reality. It's a technology anxiously awaited by telecom operations and subscribers in India.

According to Telecom Regulatory Authority of India a total of 32.5 MHz was making available for allocation. 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.

TRAI has recommended auctioning radio frequencies for 3G telecom services at a reserve price of Rs 1,050 crore (Rs 10.50 billion) to companies who are seeking to offer nationwide high-speed Internet and streaming video. The base price for spectrum in cities like Mumbai and Delhi and Category A telecom circles is Rs 120 crore (Rs 1200 million); in cities like Chennai and Kolkata and Category B circles Rs 80 crore (Rs 800 million); and in all other cities Rs 15 crore (Rs 150 million). TRAI has recommended three sets of frequency bands – 450 MHz, 800 MHz and 2.1 GHz. For CDMA players like Reliance and Tata Teleservices 1.25 MHz each is offered. CDMA operators are free to bid both in the 2.1 GHz and the 450 MHz bands, but they will be allocated spectrum only in one. The pricing of these two bands is linked to the auction in the 2.1 GHz band.

CDMA operators will pay the same as the second-highest GSM bidder. And if there is more than one claimant in the 450 MHz band, the reserve price will be half of that arrived at in the 2.1 GHz band. Another rider is that if the highest bid is a quarter more than the lowest, the lowest bidder has to raise its bid to 75 per cent of the winning bid. But CDMA operators are likely to face problems. Operating 3G services on 450 MHz is a problem because we they do not have dual-band phones that work both in 450 MHz and in 800 MHz (the band in which CDMA operates in India).

3G spectrums has been provided to GSM players like BSNL, MTNL, Bharti, and Vodafone and some international companies have also shown interest to carry out an interface check on a non-commercial basis ahead of the start of 3G mobile services. Trial spectrum has been given for a period of one month. This will be only 1/1000th of the actual 3G spectrum capability. Apart from PSU majors, spectrum for carrying out 3G trials has been given to all those who have applied under the National Frequency Allocation Plan on the 2.1 GHz band. GSM players operate on 900 MHz and 1,800 MHz, while CDMA players operate on 800 MHz. While Tatas have welcomed TRAI's Rs 1,400-crore (Rs 14 billion) base price for a nationwide rollout of 3G services, the rest of the players find the price too exorbitant. Bharti-Airtel is disappointed with the pricing as they were expecting it to be Rs 300-400 crore (Rs 3-4 billion). The reserve price is a disincentive for telecom companies in India. Bharti has appealed to lower the prices especially for rural penetration. The Cellular Operators Association of India and the Association of Unified Service Providers of India are studying TRAI's recommendations and have not given their comments. Japan was the first country to introduce 3G on a large commercial scale. In 2005, about 40 per cent of subscribers used only 3G networks. It is expected that during 2006 the subscribers would move from 2G to 3G and upgrade to the next 3.5 G level. The success of 3G in Japan also shows that video telephony was the killer application for 3G networks. Downloading music was the biggest draw in 3G services.

7.   FUTURE OF 3G TECHNOLOGY

The future of 3G is impressive—in fact, it's already here!
HSDPA- (High-Speed Downlink Packet Access) is an evolution of Wideband Code Division Multiple Access (WCDMA), optimized for packet switched data applications. HSDPA provides impressive enhancements over WCDMA on the downlink (also referred to as the forward link) promising 14.4 Mbps peak data rate, resulting in a better enduser experience. Subscribers with HSDPA service are able to receive emails with large attachments, surf the web or download multimedia or text files faster than ever. HSUPA will provide end users with a DSL-like experience and enable lower latency services such as VoIP, multiplayer interactive gaming, push-to-talk and more. The first HSUPA (High-Speed Uplink Packet Access) deployment was in 2007.

7.1 CDMA2000 1xEV-DO- Launched in 2002, CDMA2000 1xEV-DO is a Evolution Data Optimized of the CDMA2000 standard, capable of delivering peak forward link data rates of 2.4 Mbps, or rates comparable to wired broadband.

7.2 CDMA2000 1xEV-DO Rev. A- It is a significant evolutionary step in the CDMA2000 1xEV-DO progression. Launched in 2006, EV-DO Rev. A provides a peak forward link data rate of 3.1 Mbps and a peak reverse

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link rate of 1.8 Mbps. In addition, EV-DO Rev. A incorporates comprehensive improvements to the air link that reduce call set up times, decrease transmission delays and enable greater service control. These enhancements, combined with the increased data rates, enable network operators using EV-DO Rev. A to offer richer, more interactive applications and services such as wire line-quality Voice over Internet Protocol (VoIP), low-latency push-to-talk, online gaming, video on demand and video messaging, as well as the ability to upload large data files.

7.3 EV-DO Rev. B- EV-DO Rev. B, a further development on the CDMA2000 roadmap beyond Rev. A, offers multichannel capabilities, which allow network operators to aggregate multiple 1.25 MHz channels simultaneously and increase data rates dramatically. The first implementation of Rev. B will support up to 9.3 Mbps on the forward link and 5.4 Mbps on the reverse link (the standard, at its theoretical limit and aggregating 20 MHz of spectrum, allows up to 75 Mbps on the forward link and 27 Mbps on the reverse link) One of the chief advantages of Rev. B is that it puts the control for scaling bandwidth into the network operators' hands, allowing operators to tailor their systems to the spectrum they have available. Rev. B's flexibility will enable significant capacity and performance improvements, while protecting CDMA2000 operators' current investments in networks and devices.

7.4 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 highlights of TD-SCDMA- TD-SCDMA uses TDD, in contrast to the FDD scheme used by W-CDMA. By dynamically adjusting the number of timeslots used for downlink and uplink, the system can more easily accommodate asymmetric traffic with different data rate requirements on downlink and uplink than FDD schemes. Since it does not require paired spectrum for downlink and uplink, spectrum allocation flexibility is also increased. Also, using the same carrier frequency for uplink and downlink means that the channel condition is the same on both directions, and the base station can deduce the downlink channel information from uplink channel estimates, which is helpful to the application of beam-forming techniques.

8. CONCLUSION

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. Moreover, as long as the price of the network time is high in 3G, operators cannot wait fast diffusion of data centric mobile services. According to mobile operators, 3G is needed in congested places where the demand on current mobile networks exceeds the capacity. On this basis, future research that identifies additional factors or views the factors presented in different light would contribute to the understanding of 3G acceptance. Thus, a natural extension of this study is the collection of primary data about the use and acceptance of 3G services in both consumer and business markets.

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