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Development of Field Propagation Model for Urban Area

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LIST OF ABBREVIATIONS

1G	First Generation wireless technology
2G	Second Generation wireless technology
3G	Third Generation wireless technology
1xDV	3G Extension of IS-95B: shared data and voice
1xDO	3G Extension of IS-95B: data only
1xEV	3G Extension of IS-95B: data with circuit-switched voice
1xRTT	3G Extension of IS-95B: one RF channel
ACELP	Adaptive Code Excited Linear Prediction
ADPCM	Adaptive Digital Pulse Code Modulation
AM	Amplitude Modulation
AMPS	Advanced Mobile Phone Service
BCCH	Broadcast Control Channel
BCH	Bose Chaudhuri Hocquenghem *also* Broadcast Channel
BoD	Bandwidth on Demand
BPSK	Binary Phase Shift Keying
BS	Base Station
BTS	Base Transreceiver Station
CC	Convolution Code
CB	Citizens Band
CDMA	Code Division Multiple Access
CEPT	Conference of European Postal and Telecommunications Administrations
COST	Cooperative for Scientific and Technical Research
CT2	Cordless Telephone 2
CTIA	Telephone Industry Association
COST WI	COST Walfisch Ikegami
DCS	Digital Cellular System
DECT	Digital European Cordless Telephone
DQPSK	Differential Quadrature Phase Shift Keying
DS-CDMA	Direct-Sequence Code Division Multiple Access
EDGE	Enhanced Data Rate For GSM Evolution
EIRP	Effective Isotropic Radiated Power
EFR	Enhance Full Rate
ELF	Extremely Low Frequency
ETACS	Extended Total Access Communication System *also* European Total Access Cellular System
ETSI	European Telecommunications Standard Institute
EURO-COST	European Cooperative for Scientific and Technical Research
EHF	Extremely High Frequency
F/TDMA	Hybrid FDMA/TDMA
FDD	Frequency Division Duplex
FDMA	Frequency Division Multiple Accesses
FL	Forward Link
FM	Frequency Modulation
FR	Full Rate

GAN	Global Area Network
GMSK	Gaussian Minimum Shift Keying
GFSK	Gaussian Frequency Shift Keying
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	Global System for Mobile Communications
HF	High Frequency
HO	Hand Over
HR	Half Rate
HSCSD	High Speed Circuit Switched Data
HSPDA	High Speed Downlink Packet Access
HSPA	High Speed Packet Access
HSUPA	High Speed Uplink Packet Access
iDEN	Integrated Digital Enhanced Network
IMT	International Mobile Telecommunications
ITU	International Telecommunication Union
ITU-R	ITU’s Radio communications sector
IS-54	EIA Interim Standard for U.S. Digital Cellular with Analog Control Channel
IS-95	EIA Interim Standard for U.S. Code Division Multiple Access
IS-136	EIA Interim Standard136 –USDC with Digital Control Channel
ISDN	Integrated Services Digital Network
JTACS	Japanese Total Access Communication System
LF	Low Frequency
LOS	Line of sight
LTE	Long Term Evolution
MSE	Mean square error
MF	Medium Frequency
MS	Mobile Station
NIDS	Network Intrusion Detection System
NMT	Nordic Mobile Telephone
NLOS	Nonlineofsight
NTACS	Narrowband Integrated Services Digital Network
NTT	Nippon Telephone and Telegraph
OVSF	Orthogonal Variable Spreading Factor
PABX	Private Access Business Exchange
PDC	Personal Digital Cellular
PCNs	Personal Communication Networks
PN	Pseudo Noise
PCS	Personal Communication System
PSI-CELP	Pitch Synchronous Innovation CELP
QCELP	Quadrature Code Excited Linear Prediction
QoS	Quality of Service
QPSK	Quadrature Phase Shift Keying
RAN	*Radio Access Network*
RCELP	Residual Code Excited Linear Prediction
RL	Reverse Link

RPE-LTP	Regular Pulse Excited Long Term Prediction
SDCCH	Stand-alone Dedicated Control Channel
SQI	Speech Quality Index
SHF	Super High Frequency
TACS	Total Access Communication System
TCH	Traffic Control Channel
TDD	Time Division Duplex
TETRA	Terrestrial Trunked Radio
UHF	Ultra High Frequency
UMTS	Universal Mobile Telecommunication System
VHF	Very High Frequency
VLF	Very Low Frequency
VSELP	Vector Sum Excited Linear Prediction
WCDMA	Wideband CDMA
WiMAX	Worldwide Interoperability for Microwave Access
WARC	World Allocation Radio Conference

CHAPTER 1

INTRODUCTION

In current era the wireless communication is spreading throughout the world rapidly. The wireless technology has covered each and every area in day to day life. This chapter discusses the historical overview and outline of the thesis along with expected outcome of the research work carried presently.

1.1 HISTORICAL OVERVIEW

Wireless communication is one of the most dynamic and vibrant areas of technology development in the communication field today. To give better understanding, it may be revert from literature of old days that the first outcome of communication started with origin of radio in the year 1680 by Newton's theory of composition of light. According to Newton, light is a composition of various colours and his theory brings the importance of light as a research area of study for many scientists. Later on in 1873, James Clerks Maxwell gave many laws to explain electro magnetism as a result of Poisson’s equation using electrostatics, Gauss law equation using magneto statics, Ampere’s law equation using electrodynamics, and Faraday law equation using magneto-dynamics. After his research, in the year 1888, Heinrich Rudolf Hertz practically verified the electromagnetism phenomena which Maxwell obtained mathematically [164].

Four years later, in the year 1892, A British scientist Sir William Crookes published a paper on telegraphic communication over long distances using tuned circuits. With the help of Crookes work, Gugliemo Marconi established a radio link over a distance of a small number of miles in 1895. It is the first revolution to the mobile radio industry. The communication with people on the move was made possible by this radio link. Two way radio communication links at frequencies of 30 to 40 MHz were designed from the middle of 1930s [174]. The radio communication gradually increased to include the metric, decimetric and centimetric wavelengths from the year 1930 to 1960 [187]. From the year 1970 frequency modulation was introduced in communication. The analog cellular systems were first developed by Bell Laboratories [186]. In 1979, an effort was made to launch and install first cellular system, i.e. Advanced Mobile Phone Service (AMPS) started at Chicago. Then in 1980 the High Capacity Mobile Telephone System (HCMTS) launched at Tokyo and the Nordic Mobile Telephone (NMT) launched in 1981 at Scandinavia. France's Radiocom 2000 was operational in 1985, similar to United Kingdom's Total Access Communication System (TACS) and Germany's C 450 systems [209]. In the early days of 1990s, low cost cordless system and it got remarkable growth rates. Among these systems cellular played an important role in such growth process, especially after the invention of international digital standards like Global System for Mobile Communications (GSM) and Code division multiple access (CDMA) system (IS-95) [184].

In general, the cellular systems in operation are divided into two categories: the first-generation analog systems and the second generation digital systems. At present, one can observe the quick growth of different types of wireless communication systems for example personal fixed & mobile, and land & satellite. These systems utilize a frequency band from 500 MHz up to 3 to 10GHz. The IMT-2000 third generation cellular mobile system was introduced in 2002.This system relies on cellular techniques and reuses the basic concepts of architecture, functionality and services of these systems [70], [187]. Generation wise the wireless communication is as shown in figure 1.1. The first-generation (1G) mobile systems were analogue, and commissioned in the 1980s. In the 1990s, second-generation (2G) digital mobile systems such as the GSM came in existence. The GSM standard is tremendously triumphant, providing the national as well as international coverage. So, GSM is nowadays the foremost mobile communication system [163].

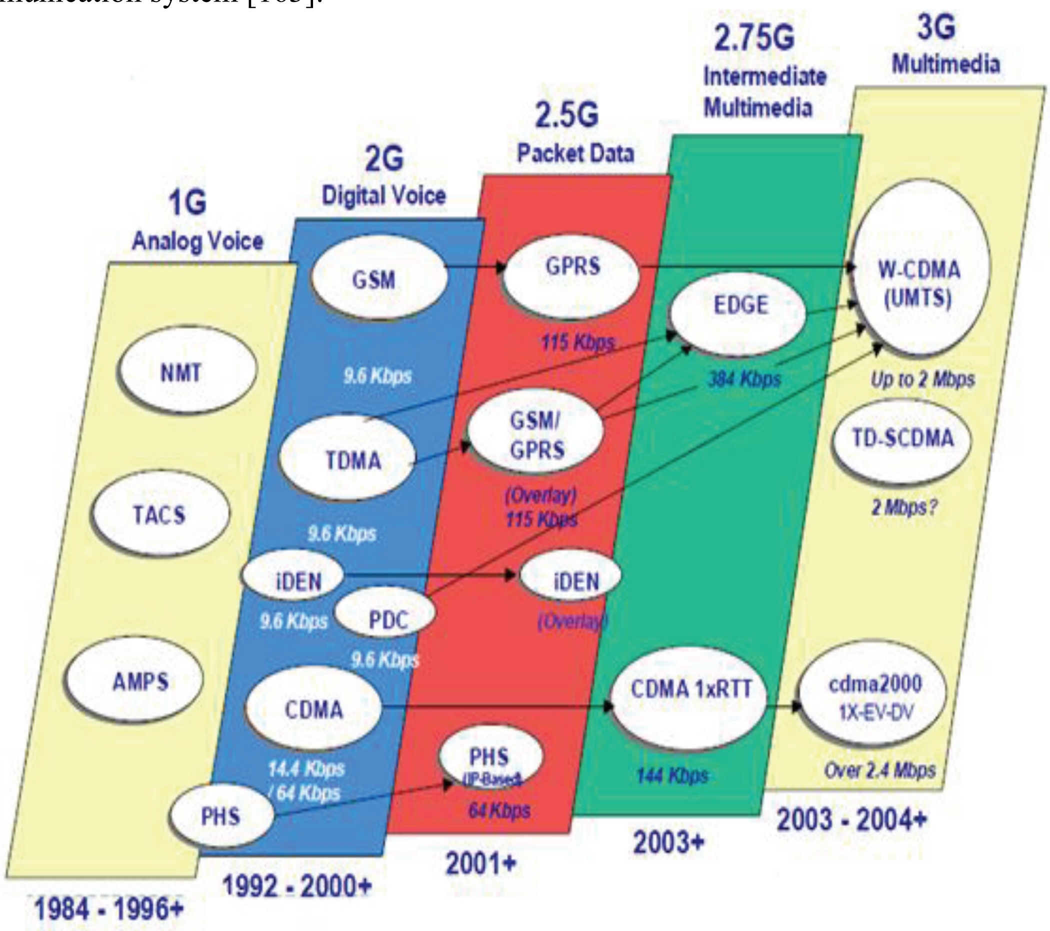

Figure 1.1 Year Wise Development of Wireless Communication

Wireless communication has gained incredible growth in the last few years. The first mobile contributions took place in the early 1980s, and the industry was blooming by 1987. However, the traditional phone technology was analogue. The business take-off by GSM (digital) technology occurred in 1992. In early 1991 hardly one in every thousand people had a mobile phone. But till the end of 2001, approximately 17% people got access of the mobile phone [106]. Within this period the number of countries using a mobile network increased tremendously from 3% to more than 90%. In 2002 the number of mobile subscribers leaves behind the number of fixed-line subscribers. Mobile subscribers outnumbered by 7% fixed line subscribers: Mobile subscribers (million): 1,157 and Fixed lines (million):1,083. Since 2002, the fixed line technology declined, getting closer to the edge of obsolescence. The growth of mobile subscribers is depicted in figure 1.2. It is assumed that this growth will continue to rise, and by 2015 every person will have mobile subscription [163].

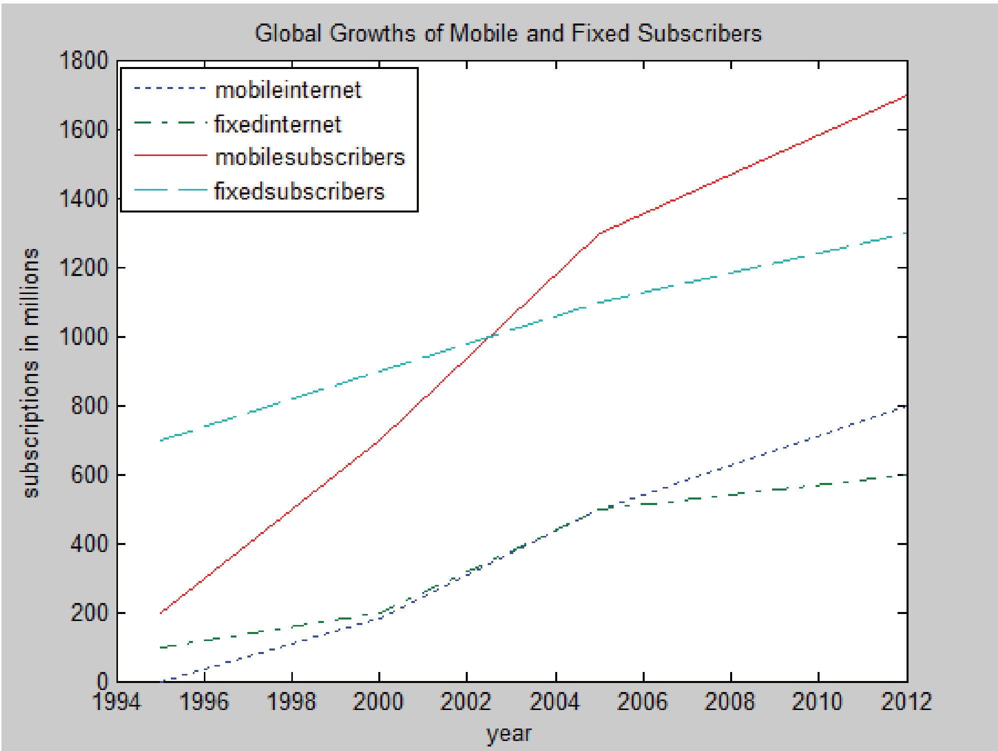

Figure 1.2 Global Growths of Mobile Subscribers

Other than mobile phone communications, Wireless Local Area Networks (WLANs), which came into existence in 1997 only, have also gained tremendous growth. The quick propagation of WLAN hotspots in public places like airport terminal has been amazing. In fact, WLANs have reached into homes, with the help of Digital subscriber line (DSL) and cable access modems resulting in the scenario where number of wireless Internet subscribers will go beyond the number of wired internet users in near future and shown in figure 1.2. The growth of wireless data systems is also seen in many new standards which have recently been developed or are currently under development [163]. Both 1G and 2G systems were intended mainly to offer voice applications, and to support circuit-switched services [167]. However, GSM provides data communication services to users, but the data rates are restricted to only a few tens of kbps. In contrast, WLANs which were designed to offer fixed data network extension in the beginning provide Mbps data transmission rates. The WLAN standard – IEEE 802.11, known as Wi-Fi, was commissioned first time in 1997 and it offered 2 Mbps. Since then the standard has grown numerous times and keeps on increasing as per user requirement for higher bit-rates as shown in Table 1.1. Now days, WLANs can offer up-to 54 Mbps for the IEEE 802.11a/g, and Hiper LAN2 standards operating in the 2.4 GHz and 5 GHz license-free ISM bands. Though, WLANs are not able to provide the kind of mobility, which mobile systems can do [5], [163].

Table 1.1 Evolutions of the WLAN Standards

Year of Establishment	Standard of WLAN Standard	Frequency	Modulation	Bit rate
1997	IEEE 802.11	2.4 GHz	Frequency Hopping and direct spread spectrum	2 Mbps
1998	ETSI Home RF	2.4 GHz	Wideband Frequency Hopping	1.6 Mbps
1999	IEEE 802.11b	2.4 GHz	Direct Sequence Spread spectrum	11 Mbps
1999	IEEE 802.11a	5 GHz	OFDM	54 Mbps
2000	ETSI Hiper LAN2	5 GHz	OFDM Connection oriented	54 Mbps
2003	IEEE 802.11g	2.4 GHz	OFDM Compatible with 802.11a	54 Mbps

Wireless communication should be designed to attain high capacity with limited radio spectrum and it is possible by the Cellular radio concept, which is discussed in the following section.

1.2 CELLULAR RADIO CONCEPT

The concept of cells was introduced in early 1947 by Bell Laboratories in the US; they also gave a detailed proposal for a “High-Capacity Mobile Telephone System" integrating the cellular concept submitted by Bell Laboratories to the FCC in 1971. Still the first AMPS system was set up in Chicago in 1983 [56]. The old system was able to attain a large coverage by means of a simple, high power transmitter in a cell. Base station (BS) was put on the top of mountains or tall towers, so that it could cover a large area. The next Base station BS was put so far away that interference was not a concern. Wireless radio services just in terms of spectrum use alone pretence a much more difficult problem [33]. Severely, it bounds the number of users that could communicate at a time. These were noise-limited systems as numbers of users were limited. The Bell mobile system in New York City in the 1970s was able to communicate a maximum of twelve calls at a time over an area of thousand square miles [125], [186]. The number of calls a mobile wireless system can handle at the same time is essentially determined by the total spectral allocation for that system and the bandwidth needed for transmitting signals used in managing a call. Cellular systems can handle a large number of users over a large geographic area within a limited frequency spectrum. High capacity is attained by using the concept of cell which is a small geographic area and for each cell a single base station is used. Using this concept the same radio channels can be reused by another base station situated some distance away. The entire coverage area can be partitioned into several cells [14]. A cell corresponds to the covering area of single BS transmitter or a small collection of many transmitters. The size of a cell is determined by the transmitter's power.

In this way a single, high power transmitter (large cell) is replaced by many low power transmitters (small cells) which cover only one cell area (a small portion of the service area) as shown in figure 1.3. For mobility a sophisticated switching technique called handoff is used which helps in establishing a call un-interrupted when the user shift, from one cell to another.

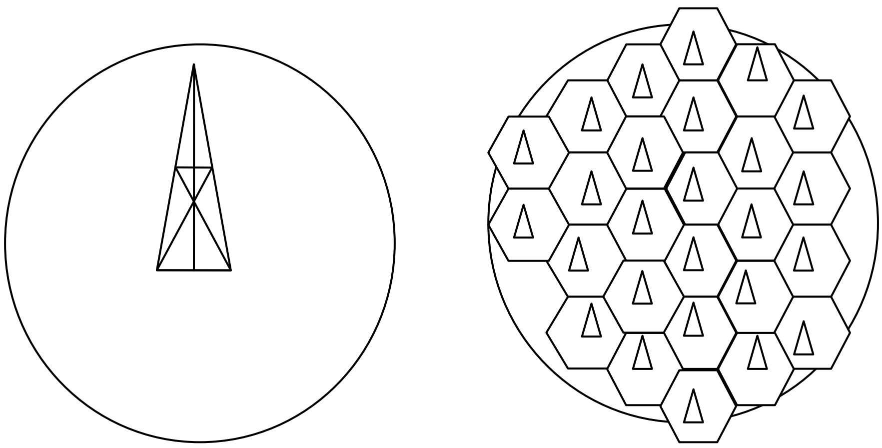

Figure 1.3 Illustrations Showing the Importance of Accurate Coverage Estimation in Cellular Networks as Compared to Early Land to Mobile System

Basic cellular system consists of mobile stations, base stations, and a mobile switching centre (MSC). Mobile switching centre (MSC) is also referred as mobile telephone switching office (MTSO) which manages the activities of the base stations and also connects the entire cellular system to the public switched telephone network (PSTN) [230]. It handles all billing and system maintenance functions. Each communication takes place via radio waves with one of the base stations and for the complete duration of call the mobile station may be handed-off to any number of base stations [231]. Mobile station consists of three units, first one is transceiver, second is an antenna, and third is control circuitry. Among all mobile users in the cell Base stations work as a bridge and helps in connecting the concurrent mobile calls via telephone lines or microwave links to the MSC. It contains a number of transmitters and receivers which concurrently manage full duplex communications. In general it has towers to support numerous transmitting and receiving antennas [232]. Cellular concept also depends on an intelligent allocation and reusability of channels all over a coverage region. These systems are sometimes referred as narrow band systems as these use the concept of frequency reusability. The frequency reuse concept is given in the following section.

Figure1.4. First Generation Cellular Phone of 1924

1.2.1 Frequency Reuse

Cellular notion depends on an intelligent allocation and reusability of channels all over a coverage region. These systems are sometimes referred as narrow band systems as these use the concept of frequency reusability. A group of radio channels are assigned to each cellular base station (BTS) to be utilized within a cell. The design process contains selecting and assigning channel groups to all cellular BTS within a system [80]. Consider a cellular system has a total of S duplex channels available for use. If each cell is allocated a group of k channels, where $k< S$, and if the S channels are divided among N cells into unique and disjoint channel groups which each have the same number of channels, the total number of available radio channels can be expressed as

$$S= k N \qquad (1)$$