T.C.
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EVOLUTION OF MOBILE TECHNOLOGIES FROM 3G - 5G NETWORKS

(M. Sc. Thesis)

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COMPLIANCE WITH SCIENTIFIC ETHICS

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EVOLUTİON OF MOBİLE TECHNOLOGİES FROM 3G - 5G NETWORKS

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KISA ÖZET

Kablosuz iletişim, insanların Kablosuz Ağ olarak bilinen bir ağ aracılığıyla belirli bir sinyali bir yerden diğerine ve bir cihazdan diğerine iletmek için kullandıkları görünmeyen bir spectrum dalgası olan elektromanyetik dalgaları kullanır. 1G, sesli aramayı aktarmak için analog sinyali kullandı. 2G, ses ve verileri aktarmak için dijital sinyali kullanan bu teknolojinin gelişmiş kopyasıdır. 3G'de görüntülü aramalar, küresel dolaşım ve İnternet aktarımı gibi veri hızları arttı. 4G, multimedya ve daha yüksek veri hızlarını kullanması ile karakterize edildi. 5G sistemi daha geniş bir kapsama sahip olacak, çünkü tüm kablosuz, hücresel ve İnternet ağları, kullanıcının istediği zaman bağlanabileceği bir çatı altında işlev görecek.

Bu tezde, gelişmiş ve gelişmekte olan ülkeler (Irak, Birleşik Arap Emirlikleri, Pakistan ve Avrupa) arasında sırasıyla alan, nüfus, ekonomik durum, internet servis politikaları ve mobil şebekelerindeki gelişme temel alınarak karşılaştırma yapılmıştır. Irak mobil ağları pazarında devlet şirketi ile iletişim kurmak ve Irak hükümetlerinin mali gelir oranını artırmak için geleceğe dair bir çözüm önerildi.

Ayrıca, Irak'taki mobil ağlar hakkında kısa bir tanıtım ve çok sayıda bilgi içeren bir vaka çalışması yapılmıştır. Dahası, bu vaka çalışmasında, projede karşılaşılan bazı engeller ve bu engellerin üstesinden gelmek için bazı çözümler önerilmiştir.

Anahtar Kelimeler: 1G, 2G, 3G, 4G, 5G, kablosuz iletişim, mobil kablosuz ağlar.

EVOLUTION OF MOBILE TECHNOLOGIES FROM 3G - 5G NETWORKS

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ABSTRACT

Wireless communication uses electromagnetic waves, an invisible spectrum of waves that humans have used to transmit specific signals from one place to another and from one device to another through a network known as the Wireless Network. The 1G used the analog signal to transfer the voice call. The 2G is the developed copy of this technology which used the digital signal to transfer voice and data. In the 3G the rates of data like video calls, global roaming and the Internet transfer has been increased. The 4G is characterized by its use of multimedia and higher data rates. The 5G system will have a wider coverage because all wireless, cellular, and Internet networks will function under one roof where the user can be connected at any time.

In this thesis, a comparative has been done between developed and developing countries (Iraq, UAE, Pakistan and Europe) respectively, based on the area, population, economic situation, internet service policies and development mobile networks. It has been suggested a future solution to involve the state company for communication in the Iraqi mobile networks market to raise the proportion of the financial income of the Iraqi governments.

Also a case study has been done containing a brief introduction and lot of information about the mobile networks in Iraq. Furthermore, it contained some obstacles which faced these projects and gives some solutions to overcome these obstacles.

Keywords: 1G, 2G, 3G, 4G, 5G, wireless communications, mobile wireless networks.

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Evolution of mobile technologies from 3G - 5G networks

CHAPTER 6

CONCLUSIONS, DISCUSSION AND RECOMMENDATIONS

LIST OF ABBREVIATIONS

0G : Zero Generation

1G : First Generation

1xEV-DO : Evolution-Data Optimized

2G : Second Generation

3G : Third Generation

3gpp : 3rd Generation Partnership Project

4G : Fourth Generation

5G : Fifth Generation

AMPS : Advanced Mobile Phone System

AMTS : Advanced Mobile Telephone System

ARP : Autoradiopuhelin, "car radio phone”

ATM : Asynchronous Transfer Mode

AuC : Authentication Center

BF : Beam forming

BS : Base system

BSC : Base Station controllers

BSS : Base Station System

BTS : Base Terminal Station

CCITT : Consultative Committee for International Telephony and Telegraphy

CDMA : Code Division Multiple Access

cdmaOne : Code Division Multiple Access One

CI : Context Information

CMC : Communication and Media Commission

CS : concurrence throughout

DSL : Digital Subscriber Line

du : du Telecom Company in UAE

DVB : Digital Video Broadcasting

EDGE : Enhanced Data Rates for the evolution of GSM

EIR : Equipment Identity Register

EPC : Evolved Packet Core

EU : Europe

E-UTRAN : Evolved UMTS Terrestrial Radio Access Network

FAB : Frequency Allocation Board

FDI : Foreign Direct Investment

FDMA : Frequency Division Multiple Access

FTTH : Fiber to the home

GGSN : Gateway GPRS Support Node

GPRS : General Packet Radio Services

GPS : Global Positioning System

GSM : Global System for Mobile Communications

HLR : Home Location Register

HSDPA : High Speed Download Packet Data

HSPA : High Speed Packet Access

HSUPA : High Speed Uplink Packet Data

IA : Initial access

IEEE : Institute of Electrical and Electronics Engineers

IMEI : International Mobile Equipment Identity

IMT-2000 : International Mobile Telecommunications 2000

IMTS : Improved Mobile Telephone Service

IPTV : Internet protocol Television

ISDN : Integrated Services Digital Network

ISP : Internet Service Provider

ITPC : Iraqi Telecommunications and Post Company

ITU : International Telecommunications Union

JDC : Japanese digital cellular

LAN : Local Area Network

LDI : Long-Distance and International

LL : Local Loop

LTE : Long-Term Evolution

MAN : Metropolitan Area Network

MCP : Mobile Cellular Policy

ME : Mobile Equipment

MIMO : Multiple Input, Multiple Output

MME : Mobility Management Entity

MMS : Multimedia Messaging Service

MS : Mobile Station

MSC : Mobile Switching Center

NTC : National Telecommunication Corporation

MTS : Mobile Telephone System

NMT : Nordic Mobile Telephone

NSS : Network Switching Subsystem

OFDM : Orthogonal Frequency Division Multiplexing

OLT : Norwegian for Offentlig Landmobil Talefoni

OMC : Operations and Maintenance Center

PAN Personal Area Network

PCS : Personal Communications Service

PDC : Personal Digital Cellular

PMD : Polarization mode dispersion

PSTN : Packet Switched Telephone Network

PSS : Personal Search Syndication

PTA : Pakistan Telecommunication Authority

PTC : Pakistan Telecommunication Corporation

PTCL : Pakistan Telecommunication Company Limited

PTT : Push To Talk

RF : Radio Frequency

RNC : The Radio Network Controller

RSRP : Reference signal received power

SCIS : State Company for Internet Services

SGSN : Serving GPRS Support Node

SGW : Serving Gateway

SIM : Subscriber Identity Module

TACS : Total Access Communication System

TDMA : Time Division Multiple Access

TRA : Telecommunications Regulatory Authority

UAE : United Arab Emirates

UMTS : Universal Mobile Telecommunications Service

UMTs : Universal Mobile Telecommunications System

VTC : Video Teleconferencing Communication

VLR : Visitor Location Register

VoIP : Voice Internet protocol

WAN : Wide Area Network

WCDMA : Wideband

Wi-Fi : Wireless Fidelity

WiMAX : Worldwide Interoperability for Microwave Access

WISP : Wireless Internet Service Provider

WLL : wireless local loop

WLAN : Wireless Local Area Network

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CHAPTER 1

1.1. Introduction

The word communications means communicate of two parties, the first is a transmitter and the other is a receiver and the center-carrier's network exists between them [1].

Communications systems emergenced in the eighteenth century as a telegraph, then years later, the telephone usage has begun in the early nineteenth century [2]. As a result of the Second World War, the armies need to communicate between the countries, so the interest of research in communication fields witnessed a significant evolution in the means of communication where wires used to transmit the signal for long distances as well as wireless communications emerged [3]. The technical development of communicative devices such as the optical fiber, satellites, and the internet made the world as a small village [4].

The process of sending data (audio, image or video) cannot be carried out only after a data processing operation (encryption data), the adaptation of the sending data within transmitter system and converting it to an electronic signal then sending it to the other terminal. After the arrival of this data to the consignee, the electronic signal processed (decryption data) and converted to identical form to the transmitted data (voice or image or visible) [5].

Generally, wireless communication is transferring the information from one point to another without using wires not just for a short distance (TV remote) but also for long distances (thousands of kilometers or more). Wireless communications include many types like fixed-line (radios) or mobile (mobile phones) [6].

The first successful experiment of Mr. Guglielmo Marconi to send the first radio signals at a distance of 3 kilometers was in 1895 then, Mr. William Hudson was able in 1896 to get a patent for a system of wireless transmitter. While the first experience of wireless transmitter between the two states, France and England was in 1899; and laid the foundation to the experience of wireless communications, mainly based on the wireless communications spectrum [7].

Wireless is the word to describe the term for connections that use electromagnetic waves (center carrier) between the transmitter and receiver (without wires). It is a type of communication that uses radio waves of low energy to transfer data between devices.

Advantages of wireless networks [7]:

1. Fast and easy transfer of data between different devices.
2. Fast installation and simple because didn't need connections and cables.
3. Flexible installation so that it can be placed in places where wired networks are difficult to install.
4. Lower in cost than wired networks [5].

Disadvantages of wireless networks:

1. Low speed Internet because it is more susceptible to interference and jamming with radio waves.
2. Speed is affected, with no stable signal.
3. The wireless communication devices consume much more energy than normal organs because they need more energy to help reverberate in the spread in the air.
4. Needed to install equipment on the roofs of tall buildings to enhance the signal in the coverage area (coverage area between 150 m - 500 m) where these devices affect health. [5].

Types of wireless networks:

1. PAN (Personal Area Network).
2. WLAN (Wireless Local Area Network).
3. MAN (Metropolitan Area Network).
4. WAN (Wide Area Network).

1. PAN: The distance for this type of network no more than 10 meters. connect with devices using radio waves. This type of network is used to connect two computers, telephone or a computer with a fax or printer. For example, Bluetooth technology.

   The Bluetooth is a method of wireless communication via short-range radio frequency (RF). It forms a personal network with limited distance (1-100 m). Because the small size Bluetooth has been added in most devices that require data exchange for short distances. This process requires little energy. Bluetooth is connected through frequency (2.45 GHz) by wireless broadcast and using the frequency hopping technology so as not to interference between the waves when you find more than one Bluetooth. By changing the frequency value 1600 times per second using 79 frequency randomly. So, the possibility of interference from two devices Bluetooth is impossible [8].
2. WLAN: It is one of the most widely, used wireless networks using (IEEE 802.11) and frequency (2.4.3.6.5 GHz). Can transmit data up to (10000 Mbps). For example, Wi-Fi.

   Wi-Fi: It is a wireless network through which it can connect to more than one device, such as computers, mobile or any device that can connect wirelessly to this network. This is called Wi-Fi and is the acronym for Wireless Fidelity. The frequency of this network (RF) (5GHz) to prevent interference and interconnection of networks between them because the frequency (2.4 GHz) is used by most electronic devices that connect wireless networks. Coverage of this type of wireless network is 100-200 m. These networks operate within the coverage area, such as a home, institution, airport or building [9].
3. MAN: A wireless network that covers more space than Wi-Fi. For example, a number of buildings or a city, the network is designed to transfer data within larger geographical areas. For example, WiMAX.

   WiMAX is the technology of wireless broadband, the word "Worldwide Interoperability for Microwave Access". This technology is similar to Wi-Fi but differs from it, in the area of coverage so that WiMAX has more coverage space than Wi-Fi, and faster than Wi-Fi with a speed of 70 Mbps. A license must be obtained from the authority for frequencies. This license gives the freedom to work without sharing and connecting information without noise. While both

Bluetooth and Wi-Fi does not require a license, broadband wireless networks were used by telecommunications companies in 1990. The aim was to make the network fast, reliable and low-cost, and to deliver services to cities, major corporations and universities such as the Internet. Special standards have been set for this type of network, where one station can provide services to user groups. This type of network has disadvantages such as signal interruptions in certain weather conditions such as rain. This technology operates at a frequency (2-11 GHz or 10-66 GHz) and uses the IEEE 802.16d or IEEE 802.16e standard. This technique sends data from one device to another, transmitting radio waves (RF) where these waves are encrypted to protect the data. This mode of transmission shall be by towers where each tower covers an area of 50 Km. [10].

4. WAN is used in long distances where this network covers one or more cities. This network includes the use of satellites as well as telephone lines. The utility of this network is the fast and secure transfer of data between different nodes. Companies, organizations with branches in different parts of the world are benefiting from this network because it allows them to communicate with their employees and customers. The speed of this network (2-650 Mbps).

   The characteristics of this network:

   - Unlimited network size as well as an unlimited number of connected devices.
   - The data transfer rate is low.
   - This network is not affected by any malfunctioned device.
   - Setting up a network of this kind is very expensive.
   - This network needs devices to reduce the rate of error in data transmission.
   - Economic and political factors determine the mechanism of this network [11].

Cellular network: It is one of the types of wireless networks have been designed to connect cell phones with each other through this network in and out (provided the availability of international roaming) their countries. This network is a group of cells, so called the cellular network [12].

1.2. Cellular telephone networks

In the evolution of wireless communications, which requires the use of the frequency spectrum and wireless communications technology development arrangement techniques, for example, to use frequencies efficiently and use these contacts is the latest cellular phones and the Internet, using radio waves [12].

Inventing the telephone (wired) for the first time was in 1876 by the scientist Alexander Graham Bell. In 1892 the radio was invented by the scientist Nikolai. The mobile device is similar to radio work, but it is a degree of accuracy and complexity so that the mobile phone network at its inception was based on the idea of the radio network [7].

The use of the radio network in the field of wireless communications is Walkie-talkie devices as an example of such; a device to send and receive voice conversations (Half Duplex) meaning one person speaks (sending or receiving) and the other listens (one for sending frequency and receiving). And the evolution of wireless communications technology has been used technology (Full Duplex) a possibility to talk and listen at the same time (frequency for sending and another frequency for receiving) [13].

The interest on the wireless communications began in the 1970s, the last decades started wireless communications design according to the generation where every generation has a data transfer speed of service and other services type [14].

1.3. Mobile phone network

Mobile phone (cell phone) that regions divided into cells (7 cells) are a hexagonal shape and each cell have a specific frequency.

Each cell contains a device to strengthen the signal hanging on the tower, each tower contains three devices to strengthen the signal, an angle between a device and another 120 degrees, therefore the devices broadcast 360 degrees. The same frequencies of these cells (7 cell) again can be used by a neighboring group. So the cells neighboring cannot have the same frequency [14]. The mobile phone network will be explained in detail in Chapter 3.

1.4. Radio frequencies

The radio frequencies that are used in cellular networks vary according to regions of the world, which are classified according to the standards organization ITU (Asia, Africa, Europe, and America). The first frequency used in the United States use the system

(AMPS) a frequency of 800 MHz. In northern Europe, the system (NMT-450) is used and a frequency of 450 MHz. With the increase of the number of subscribers when the cellular phones are becoming affordable and more popular, it is necessary to develop the cellular network.

The development of a network (NMT-450), which operates in Europe and Japan to operating at 900 MHz, and after an increase in the number of the network is to use the frequency 1800 MHz. In the United States, the development of frequency to become (IS-95) in the system (CDMA), known then turned to the (IS-136) which uses (TDMA) technology and replaced to (PCS) frequency 1900 MHz system.

Generally, low frequencies provide coverage over large areas, while high frequencies provide more services for a small space. The frequencies used in the world now are (850, 900, 1800, 1900) MHz [19].

1.5. Thesis organization

This thesis covers sex chapters. Chapter one included the introduction, deffinitions about cellular network (cellular telephone networks, mobile phone networks, and radio frequencies) and literature review. The second chapter is talking about general information from zero generation to fifth generation. Chapter three contain the mobile network architecture for the first, second, third, fourth, and fifth generation and comparatives between the second and third generation, third and fourth generation, and between fourth and fifth generation. The fourth chapter included a comparrative between the developed countries (europe) and the developing countries (UAE, Pakistan and Iraq). Chapter five contains a case study as comparative analysis of intial access technologies in 3G to 4G networks for Iraq. The sixth chapter holds the thesis conclusion.

1.6. Literature review

This section, discussing the previous studies of the mobile evolution technologies from 1G - 5G networks.

A study done by Ali Akkaya., [15] named “An end-to-end QoS architecture for all-IP 4G mobile networks”, discussed the quality of radio signal and high Encryption by studying the architecture of the fourth generation in broadband, also studying the shape

of the signal sent between a number of towers and the possibility of adding IP to get an end-to-end QoS architecture for all IP.

A study done by Hüseyin TÜRKER., [16] named “Next generation on mobile networks 3G to 4G (LTE) exchange requirements and compatibility”, which discussed the evolution of cellular networks and access to mobile broadband through the study of architecture 3G, 4G and how can develop the 3GPP in 3G to access Long Term Evolution (LTE) technology in 4G as well as the development of (LTE) to access WiMAX technology in 4G.

A study done by Rawat, N., [17] named “Future and Challenges of 4G Wireless Technology”, that discussed the Evolution in the world of wireless and cellular communications especially 4G. The development process of (LTE) and WiMAX technology and its accompanying evolution in this generation has led to the foundation of the 5G standards that will start operating in 5G by 2020. The 5G standard is to assemble all wireless and cellular networks and make them as a single network. The satellite network and 5G network together, that is standard in 6G (satellite roaming network).

A study done by Sharma, P., [18] named “Evolution of mobile wireless communication networks-1G to 5G as well as future prospective of next generation communication network”. Which discussed the standards and technological foundations that will be in 5G. Makes all wireless cellular networks as one network, that enable the subscriber to communicate with the network at any time and place (low probability of interruption interconnection with the network). Low battery consumption rate as well as low connection charges.

A study done by Dhiraj D. & Rushikesh Shete., [19] named “A Review on 4.5G Technology”, that discussed the evolution of all wireless communications cellular networks from 1G to 4G. This study focused on the development of 4G technology to access large transfer of data in Gbps by giving an IP for every phone by using IPV6 technology, as well as makeing all wireless and cellular networks under one network.

A study done by Mohammad Meraj & Dr. Sumit Kumar., [20] named “evolution of mobile wireless technology from 0G to 5G”, that discussed the generations started from wireless communication,1G to 5G, also discussed the standards and techniques which will be added to 5G through the evolution of 4G. giving all IP for every phone by using

IPV6 technology, as well as make all wireless and cellular networks under one umbrella.

CHAPTER 2

GENERAL INFORMATION

2.1. Zero Generation (0G)

Referring to the (0G) mobile radio telephone system and the cellular system; the system of analog signals, where the system works on any half-duplex system and when someone who speaks and the other listens. This technology used basic voice communication. The use of this system as a service business is part of the public telephone network, which is not a closed system. The mobile radio networks preceded the mobile phone technology called (1G), it is a closed network for example a police radio or taxi dispatch system [14]. Techniques used in (0G) is to Push To Talk (PTT), Improved Mobile Telephone Service (IMTS), Mobile Telephone System (MTS), Advanced Mobile Telephone System (AMTS) and Norwegian for Offentlig Landmobil Talefoni (OLT).

Examples of (0G) applications:

1. Run first commercial mobile phone service (MTS) in the United States in 1942 by the Motorola Company.
2. First communication system for mobile phone in Europe (Norway) in 1966.
3. System Autoradiopuhelin (ARP) was started in Finland use first portable mobile phone networks [19].

2.2. First Generation (1G)

Is the first type of wireless communication technology. This generation appeared in 1980s and used by analog communication technology and the difference between it and the main systems that were prevalent is the cellular technology innovation, and communication between its facilities have only my voice [20].

First Generation (1G) technique has been divided the land area into small segments, each sector called cell, by a wireless network covered this cell, (the radio transmitter & receiver in the same tower) the same frequency is used several times. This will lead to the use of the large spectrum, which leads to increase the system's ability to receive a large number of users [18].

The most popular techniques of (1G) were Advance Mobile Phone Service (AMPS), Nordic Mobile Telephone (NMT) and Total Access Communication System (TACS). Called cells Base system (BS); where each call allocates a specialization pair of channels (information transfer between the wired parts) as well as using Packet Switched Telephone Network (PSTN) [21].

The development of the first system, cell phone connects several countries in 1981, like Finland countries, Sweden, Denmark, and Roger (Scandinavia). Nine systems were used in Uriah (communaction analog systems) are exposed with each other and cause difficulties between the borders. However, the Scandinavian countries and the support of government used standard (NWT) where the first to put cellular standards and this led the European countries to focus and develop the next generation using digital rather than analog.

In 1983, the first regional Bell operating commercial cellular service company was in the United States use the standard (AMPS); where the used frequency (800MHz) using a technique (FDMA) technology to transmit information.

In the United Kingdom used (TACS) in 1985 as a national standard adopted as a standard (AMPS) using (FDMA) within the frequency band (800MHz) [21].

2.3. Second Generation (2G)

In 1981, was the launched of (2G) second-generation wireless communications technology and the use of this generation of digital encryption technology for calls, in addition to providing data start SMS text messaging services; then, it was possible to provide picture messaging and multimedia messaging services [19].

European use of a unified standard for mobile phone (GSM) Global System for Mobile communications which has been used throughout Western Europe and through the use of technology (TDMA) Multiple Access Time Division where this standard of millions of users in Europe, movement between its countries and the phone was still connected

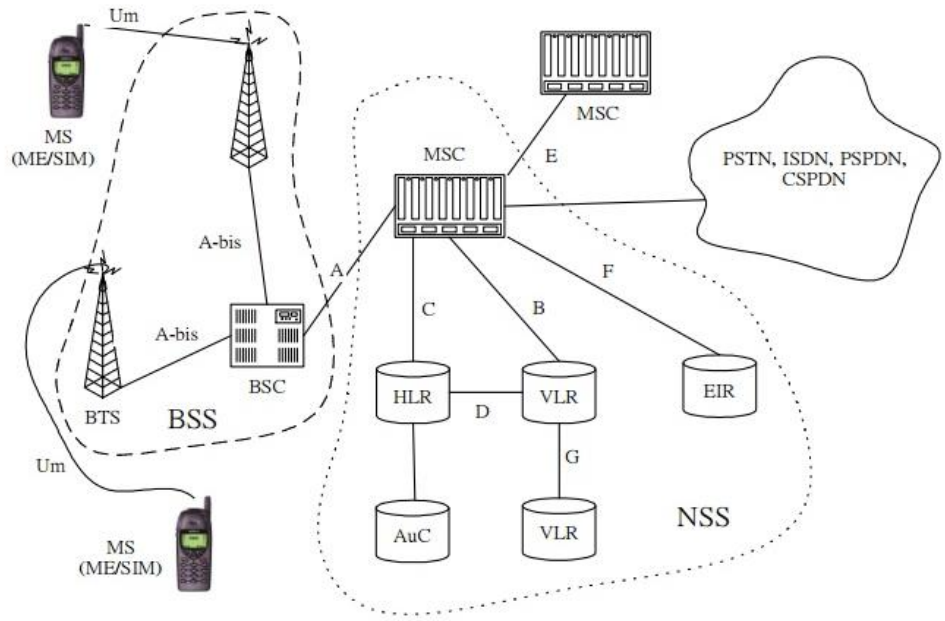

Figure 2.1. GSM system architecture

and can communicate with anyone in their countries. Figure 2.1. GSM system architecture [22].

The figure above shows many Terminologies (MS, BSS, NSS, MSC, and PSTN) now description details terms:

- MS: Mobile Station that content
    1. ME: Mobile Equipment.
    2. SIM: Subscriber Identity Module [23].
- BSS: Base Station System that content
    1. BTS: Base Terminal Station, antennas and channels known ubiquitous in this field. The BTS contains a transmitter / receiver which will give mobile device (mobile) radio signal that would be sent and received by the BTS. The BTS Model covers an angle of 120 degrees; we need to 3 BTS's to cover 360 degrees.
    2. BSC: Base Station controllers, which manages and controls the unit or most of the “BTS” usually controls the run from 20 to 30 units of the BTS, deals with the preparation of a radio channel, and system frequency hopping. The delivery of the cell to another in the sense to give a new frequency when changing his cell location [23].

- NSS: Network Switching Subsystem is considered the center of the network where the bills systems and service direct connection to the networks want to achieve contact with it. That content:
    1. MSC: Mobile Switching Center, Functions include center switches: tackle the appeal, management channel link radio logically required during appeals, management system signaling between the base station system and the center of the switch to stretchers, - processing registration of the site and ensure interaction between MS and VLR, controls the Manipulator between BSS, Mobile Gateway central automatic telephone exchanges KLR to interrogate and VLR, the exchange of information referring entities other systems [23].
    2. HLR: Home Location Register is a permanent record of the reservation settings for each participant to enable the network to control the call for private subscribers.
    3. VLR: Visitor Location Register is a database that contains temporary information about all users of the network database, and integrates sometimes in the mobile service switching center [23].
    4. EIR: Equipment Identity Register is a data base for each mobile device, which is a number that is placed inside the device by the manufacturer, where each device in the world has a special number; which is called International Mobile Equipment Identity (IMEI).
    5. AuC: Authentication Center, this is a security center for the network, which gives orders to allow the Mobile (mobile) using the Network [23].

While the United States used the standard (CDMA) Code Division Multiple Access - (IS-95A) either Japan used the standard (PDC) Personal Digital Cellular (PDC) use a technique (TDMA).

According to the standards of (ITU), the term 2.5G is considered unofficial in marketing unlike generations (1G, 2G, 3G, 4G, 5G). In wireless 2G system, GSM technology, CDMA is used together (TDMA), but in the 2.5G GSM, CDMA used (GPRS) General Packet Radio Services and Enhanced Data Rates for the evolution of GSM (EDGE) in CDMA. Table 2.1 frequency 2G, data rate in this generation shows [24].

Use of the (2G) in most countries of the world as Europe and the Americas, Japan, India and Australia; but the difference was in technology:

Table 2.1. Frequency 2G

No.	Generation	Data rate
2G	GSM	10 kbps
2G	CDMA	10 kbps
2.5G	GPRS	~ 50 kbps
2.5G	EDGE	~ 200 kbps

- Technology (TDMA) first set up in Europe has also been used in North America, where this technique accounted for about 80% of the total subscribers who use this technique.
- Technology (CDMA), which is also called (cdmaOne, IS-95) was used in the parts of Asia and Mexico and Americas, India, where Australia has this technology accounted for about 17% of the total subscribers who use this technique.
- Technology (PDC), known as (JDC) Japanese digital cellular relied on technology (TDMA) basis for its work and was limited for use in Japan [25].

2.4. Advantages and disadvantages of this generation

Advantages

- Difficult to eavesdrop on calls and to use digital encryption.
- Increase the sound and reduce noise quality.
- Radio signals using less energy than those that were used in the first generation.

Disadvantages

- Dropping the call when using high frequencies in less populated places was this problem by using relatively lower frequencies [26].

2.5. Third Generation (3G)

In 2003, a mobile radio network compatible with standards and specifications (ITU) and was used IMT-2000 system. This generation is known as 3G [19].

In this generation, it was possible to access to the Internet via mobile phone, access to the fixed wireless Internet, video calls, mobile TV as well as voice calls.

Table 2.2. Frequency 3G

No.	Generation	Data rate
3G	WCDMA/UMTS	384 kbps
3G	CDMA 2000	384 kbps
3.5G	HSDPA/ HSUPA	5-30 Mbps
3.5G	Ix EVDO	5-30 Mbps

The back of a generation unofficial (3.5G), use this generation of the following techniques:

- Universal Mobile Telecommunications Service (UMTS) was developed in 2001 from the three-generation partnership project by (3gpp) has used this technique in 2003 in Europe and was completed updated of its network in 2010.
- Wideband (WCDMA) network was first created by the transportation company Aochuhayo Japanese were out commercially and widely used in Japan in 2001 and was completed to update all of the network in Japan in 2006 [27].

- In 2006, its name was used technique for High Speed Download Packet Data (HSDPA) is part of the third generation (3.5 G) used in Africa.
- High Speed Packet Access (HSPA), it is a protocol through which the Internet can be used in mobile phones. The (HSPA) contains two protocols, the first protocol (HSDPA) and the second (HSUPA). The first is a special packet (Downlink) data, and the second is a special package (Uplink). This protocol was used in 2010. [14].
- 1xEV-DO (EVDO), is a 3G standard for CDMA networks. It focuses on get high speed data to CDMA networks [28]. Table 2.2. Frequency 3G, data rate in this generation shows.

Advantages

- High-speed communications network compared to (2G).
- It was possible to make video calls and multimedia messaging.
- The use of applications such as more social applications and more.
- Wages licenses to provide services [14].

Disadvantages

- Some states launched a third-generation service, but have not updated third-generation network and the user therefore has a loss to third-generation services in addition to that there will be a high cost for these services [14].

2.6. Fourth Generation (4G)

It is the next generation after 3G, compatible with the standards and requirements set by the (ITU) where the speed limit of data reach to (100 Mpbs). This generation is, 4G. The 4G is developed, to correspond with the quality of service as well as the applications for wireless entry of broadband in addition to the multimedia messaging service, video chat, TV mobile High Definition, Digital Video Broadcasting (DVB) In addition to basic services such as voice and data, which are used bandwidth.

The 4G two techniques are used (LTE) and (WiMAX); the following are explanation of these techniques [29]:

- WiMAX

  That is a wireless broadband technology, similar to Wi-Fi but different from the speed and distance it covers. The technique is divided into two types, the first type fixed connections, which is between buildings and fixed places, while the second type supports mobility and roaming.

  The WiMAX network consists of a tower, that tower is similar to the tower in mobile networks, but covers a larger area of the cellular network is up to (50 Km). This tower contains antennas that send the signal to the user. The modem is a device that receives the signal from the antennas, where this device converts the received signal to information.

  The tower connects to an Internet service provider with a high-capacity cable. This technology has high data exchange speeds of up to 280 Mpbs, each channel is equipped with a maximum of 100 users and frequency (1.75-20 MHz). This technique is known as high encryption and has low penetration potential [30].

- LTE

  That is another technique of 4G technology and is the acronym for long term evolution. The technology is a broadband wireless network, providing high data transfer speeds when compared to 3G. One of the advantages of LTE is the

possibility of transmitting video using digital television broadcasting using IPTV protocol. The OFDM technique is used as the abbreviation of orthogonal frequency division multiplexing. The OFDM process consists of dividing the channel into many sub channel as well as dividing the carrier into several sub carriers and sending it through a single band [29].

The LTE network is made up of two main components, the E-UTRAN and EPC; the E-UTRAN consists of a transmitter and receiver stations sophisticated, which is different from earlier second-generation stations 2G and third 3G, where they are more complex than its predecessor operations to transfer user data is processed and converted and do broadcast some of the messages to control, whereas the EPC the basis of the network and the performance process, which is the center of communication with other networks. This is the basis of the difference between a 2G network as well as a 3G network. This leads to a need for two separate networks are Circuit-switched which are used to transmit voice and Packet-switched and which are used to transmit data, while in the LTE we need not only to a single network is Packet-switched IP-based Internet Protocol, and this is what made the network a flat structure with a smaller number of components, to enjoy fast High [29].

One of the most important features of the LTE network is that it uses OFDM and another MIMO technology. The MIMO mean multi-input multiple output interface that uses more than one transmitter and receiver at the same time and from one station. This process increases the sending and receiving of data, with speed Downlink (100-300 Mpbs) and speed Uplink (50-86 Mpbs). This technology uses bandwidth (1.25 - 20 Mpbs).

It is worth mentioning that there are other criterion of a rival of LTE, it has many versions, and recent versions of it are included among the fourth generation standards, a standard WiMAX (digital character 802.16 by Organization IEEE), which is considered a very strong contender for the LTE in specifications.

Table 2.3. Frequency 4G

No.	Generation	Data rate
4G	LTE	100-200 Mbps
4G	WiMAX	100-200 Mbps

But most telecom companies have used LTE technology because the infrastructure is available and it came from the development of the GSM network, while WiMAX came as a copy of an upgraded wide-ranging of the Wi-Fi [31]. Table 2.3. Frequency 4G, data rate in this generation shows.

2.7. Fifth Generation (5G)

The fifth generation (5G) wireless systems, this comes after the fourth generation within the international standards for wireless communication. The new generation will be faster peak Internet connection speeds [32]. The development of cellular networks technically and quickly will change the form of technologies used in previous generations 3G, 4G [19].

The development of cellular networks technically and quickly, will change the form of technologies used in previous generations 3G, 4G. In 2013, the test of the South Korean Samsung 5G networks at the speed 1 GB per second, which means the ability to download high-definition with less than one-minute film, the 5G networks that will reach a top speed of 800 GB per second also download 33 HD film in one second [14].

The 5G network use about 2020, then from now to 2020, it will increase the number of callers during this period to 100 billion users. This requires that a 5G network has been designed to accommodate more than that number of users [32].

MIMO technology is a multiplexing and receiving technology at the same time and from one station. This technology will be adopted by companies that test and develop 5G networks. it this technology provides high speeds for data loading [19].

The Table 2.4 below displays the description of the generations [14] [16] [18] (1G, 2G, 3G, 4G, and 5G) type of technology …etc.

Table 2.4. Description of the generations

Parameters	1G	2G	3G	4G	5G
Introduced in year	1980s	1993	2001	2009	Soon probably 2020
Technology	AMPS ,NMT, TACS	IS-95, GSM	IMT2000, WCDMA	LTE, WiMAX	Not Yet
Access system	FDMA	TDMA, CDMA	CDMA	CDMA	Not Yet
Data Bandwidth	2kbps	64kbps	2Mbps	1 Gbps	Higher than 1Gbps
Switching type	Circuit switching	Circuit switching for Voice and Packet switching for Data	Packet switching except for Air Interface	Packet switching	Packet switching
Speed (data rates)	2.4 kbps - 14.4 kbps	14.4 Kbps	3.1 Mbps	100 Mbps	Probably Gigbits
Special Characteristic	First wireless communication	Digital version of 1G	Digital broadband, speed increments	Very high speeds, All IP	WWW(coming soon)
Features	Voice only	Multiple users on single channel	Multimedia features, Video Call	High Speed, real time streaming	Very High Speed, real time streaming
Supports	Voice only	Voice and Data	Voice and Data	Voice and Data	Voice and Data
Internet service	No Internet	Narrowband	Broadband	Ultra Broadband	Super Ultra Broadband
Bandwidth	Analog	25 MHz	25 MHz	100 MHz	800 MHz
Operating frequencies	800 MHz	900MHZ, 1800MHz 800MHz	2100 MHz	850 MHz, 1800 MHz	1000 MHz
Band type	Narrow band	Narrow band	Wide band	Ultra Wide Band	Very High Speed Broadband
Carrier Freq.	30 KHZ	200 KHz	5 MHz	15 MHz	100-300 MHz

CHAPTER 3

MOBILE NETWORK ARCHITECTURE

3.1. Architecture of GSM (2G) Network

This chapter will display the explanation of the transmission process and receipt for communications in the cellular phone network in detail to the GSM network (2G) and then the additions that have been in generations (3G, 4G), which will be revealed in (5G); and below is the Architecture of GSM (2G) Network 3.1. [33].

Mobile Station (MS): is a mobile radiotelephone operator within a wireless system that includes transceivers installed in vehicles and as well as handheld units. When you run a mobile device (MS) connected with the (BTS) located in your area (the network in your area or case of roaming or network services used in another country). The (BTS) broadcast (send) frequencies to enable MS to pick up the strongest signal. MS contains Mobile Equipment (ME), Subscriber Identity Module (SIM) [23].

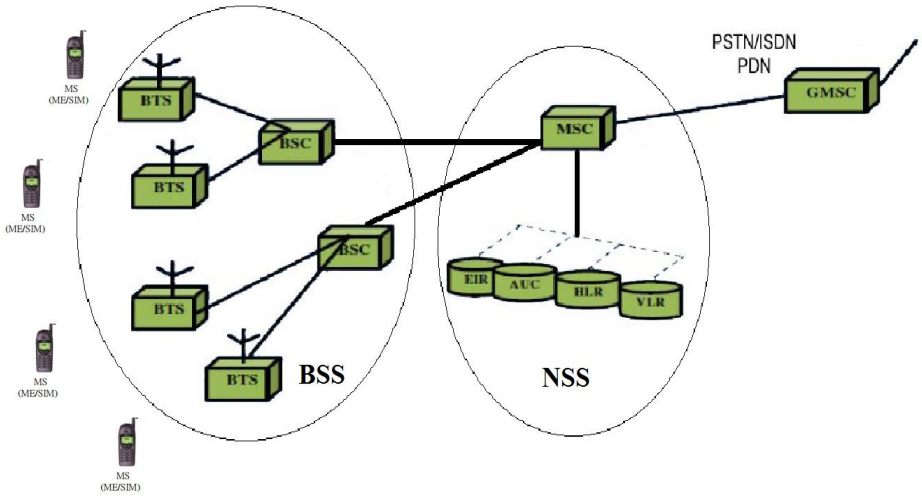

Figure 3.1. Architecture of GSM (2G) Network [33].

Figure 3.2. Evolution of the mobile device

ME: All mobile phones are connected to the wireless network through radio or satellite waves. At the end of 1989, Nokia launched its first mobile device weighing 800 g. Even at the end of the 1990's, the use of mobile devices began by users. Most mobile phones provide voice communications; it extended from 1973-1995.With the development of cellular telephone networks, cellular phone devices evolved became a digital cellular phone. From 1996 and later it became the name of the devices to smartphones [34].

Smartphone, have an operating system such as (ios, windows, and Android) multi-tasking. It includes music and video players, cameras, Bluetooth, the possibility of connecting the phone to the Internet through Wi-Fi or SIM card and other applications. Figure 3.2. Evolution of the mobile device.

- SIM: Subscriber Identity Module: Subscriber Identity which is about an integrated a small segment, read by a mobile device, the SIM contains the user's identity, phone number, location, data network license, personal security key and contact lists, text messages, and also includes features safety authentication and encryption to protect data and prevent eavesdropping. SIM card operates on voltages 5, 3 and 1.8 volt. It has different data capability ranging from 32K to 128K. SIM will be three types of Standard, Micro and Nano. The Figure below shows the types of SIM 3.3. [23].

Figure 3.3. Kinds of SIM

Base Station System (BSS): Sets of devices that are used to provide the necessary radio coverage of connecting terminals where this part takes to process the radio link between the radio sources and cells broadcast management. It is also called Radio Networking which is an essential part of its work from Mobile Phone network connecting GSM network with MS through electromagnetic waves where this part consists of [23]:

- **BTS**: Base transceiver station (cell) is the part where the process of transmission and reception waves between the antenna and (MS). In each tower, mostly three antennae and the angle between the antennae is 120 degrees. This means the tower covers 360 degrees. The communication process (MS) with the antenna is via electromagnetic waves. When running (MS) based mobile device to search for electromagnetic waves so that the access to it, after verification of data and shared information through the SIM connection is complete. The time of the search process and connect these to be in seconds. Below the types of BTS antenna. 3.4. [35].

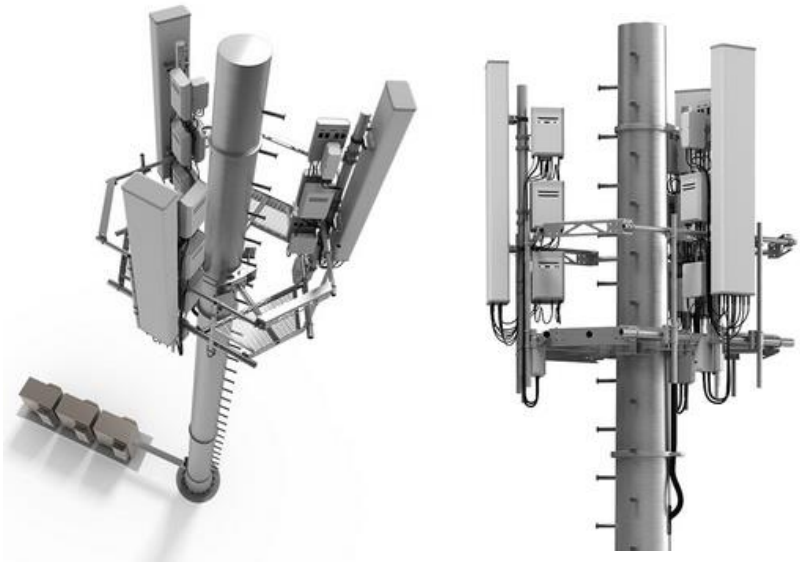

Figure 3.4. Type of BTS antenna.

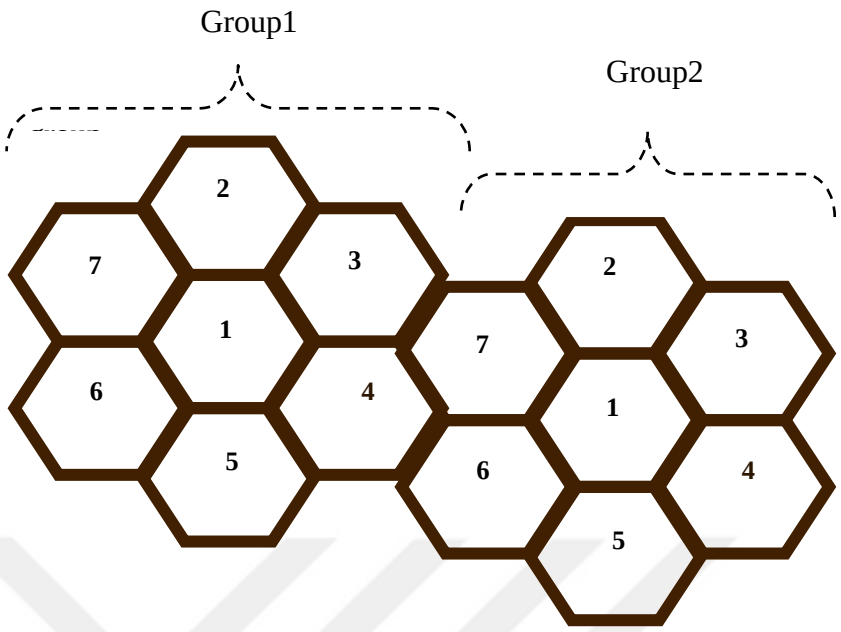

Figure 3.5. Group of cells.

Cell coverage in a circle shape, but is irregular in form. This cell coverage is affected by the terrain. The coverage area is polygon-shaped and is closer to the shape of the cell (Beehive), i.e. Hexagonal. Therefore, the position of the transmitters in the hexagonal form is number less, a small cost compared to the shape of the square cell or triangle [36].

The cell is a Base Station (Transmitter) having several RF channels. The Hexagonal shape. Coverage area, each cell covers a limited number of Mobile Subs within the cell boundaries. Normally, the region is divided (7) cell, every cell has a frequency. It can be used same frequencies of these cells (7) cell again by a neighboring group, so the cells neighboring cannot have the same frequency. The group of cells showed in Figure 3.5 [36].

3.2. GSM Frequencies:

Uplink is defined as the frequency to send your signal from (MS) to (BSS). The transmission from (BSS) to (NSS) is called the same name. Downlink is defined as the frequency of sending a signal from (BSS) to (MS). The transmission from (NSS) to (BSS) is called the same name. Channel spacing the distance between the frequency of the channels of transmission or reception. The smaller the distance between channels the smaller the number of channels.

Table 3.1. GSM Frequency [37].

Freq. Range	GSM 900	GSM 1800	GSM 1900
Uplink Freq.	890 - 915 MHz	1710 - 1785 MHz	1850-1910 MHz
Downlink Freq.	935 - 960 MHz	1805 - 1880 MHz	1930 -1990 MHz
Bandwidth	25 MHz	75 MHz	60 MHz
Channel Spacing	200 KHz	200 KHz	200 KHz
No. of channel	124	374	299

There is a relationship between channel spacing to get the most out of the spectrum and get the best sound. GSM 900 divides the bandwidth of this type to 124 channels. GSM 1800 divides the bandwidth of this type 374 channels. GSM 1900 divides the bandwidth of this type 299 channels [38]. See the Table 3.1.

- **BSC**: Base Station Controller: it is to control the range of (BTSs), as well as management of the electromagnetic wave sources and the allocation of channels of communication between (BSTs) [23]. Below is the BSC device and BTSs. Figure 3.6.
- **Network Switching Subsystem (NSS):** It is the main part of the network, where billing systems and routing service are on the same network and other networks consists of the following parts [23]:

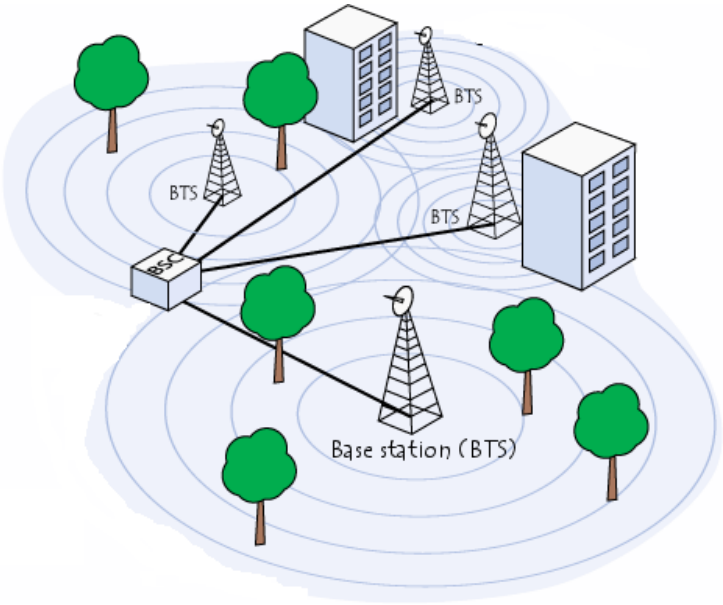

Figure 3.6. BSC device and BTSs

Figure 3.7. Mobile Switching Center (MSC)

- **MSC:** Mobile Switching Center, It works like a BIX usual (in the wired telephone system), besides; it provides all the functions needed by mobile, including, show in the below. Figure 3.7.:
  - Registration, MS in the network. (If known the MS).
  - Authorization, MS use the network. It is called Authentication. (If MS have authorized).
  - Update the MS site in the network. It is called Updating Location.
  - Delivery between BTS's and Handovers.
  - Directing or diverting the connection to roaming subscribers.
  - Connection with fixed local networks such as PTSN or ISDN [23].
  - The language of communication between these services in the network is the reference system Signaling System number 7 (SS7) [23].
  - This center is the system that deals with all (BSC's).
- **HLR:** Home Location Register is a permanent record in which the settings are reserved for each subscriber to enable the network to control the private connection of the subscriber, for example, the subscriber has calls or has a waiting service. HLR Provides a log store where the current MS location [23].

- **VLR:** Visitor Location Register is a temporary record in which you save the necessary settings to run the MS, the mobile always speaks to the VLR, each MSC contains VLR [23].
- **AuC:** Authentication Center is a security center for the network that gives MS commands using the network [23].
- **EIR:** Equipment Identity Register is an information base for the mobile device, which is a number placed inside the device by the manufacturer and each device in the world has a special number (IMEI) International Mobile Equipment Identity and this record contains three sections, White list is the authorized device using the network, Black List is the unauthorized device using the network and Gray List which is not from the other lists. IMEI this is a special number for each ME device placed by the manufacturer. This number is sent with every ME connection to the network [23].

The Gateway Mobile Switching Center (GMSC) :is a function that directs calls from outside the cellular network when a subscriber connects from outside the cellular network to a subscriber within the cellular network or when a subscriber connects from within the cellular network to a subscriber from outside the network [39].

2.5G is an informal term according to the ITU standards, was invented only for marketing purposes. Below is architecture of GSM (2.5G) Network in Figure 3.8.

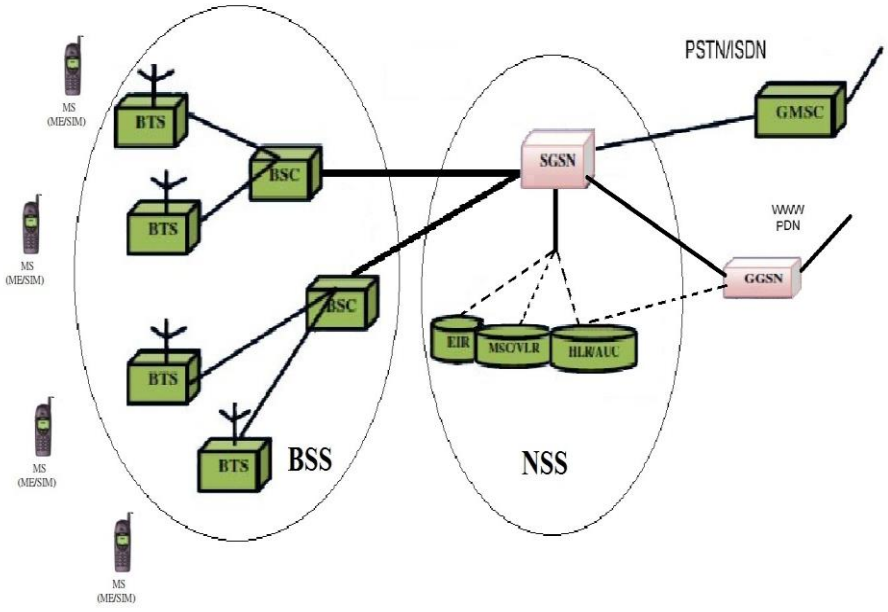

Figure 3.8. Architecture of GSM (2.5G) Network.

Serving GPRS Support Node (SGSN) was added to the (NSS) and Gateway GPRS Support Node (GGSN) was added. (BSS) and (MS) did not change in general (changed in frequencies sent and received only, but the mobile device has been added software that works on receiving the Internet, playing audio and video files, Camera ...etc.) [39].

- **General Packet Radio Service (GPRS):** A technique for transmitting data to the general packet of radio, providing data for speeds up to 111 Kbit/s. Most important features of this technology, transfer of information in a packet which contributes to access to a greater volume of information and faster and at a much lower cost compared to the way data transfer in 2G [14].
- **Serving GPRS Support Node (SGSN):** SGSN and GGSN work in conjunction with GPRS. As SGSN works with MSC, Benefits from it to give the subscriber a default IP. This works when there is data sent from one subscriber to another. The cost is calculated based on this transmission only [33].
- **Gateway GPRS Support Node (GGSN**) acts as an intermediary between wireless networks (GPRS) and other networks such as the Internet and private networks [33].

3.3. Architecture of UMTS (3G) Network

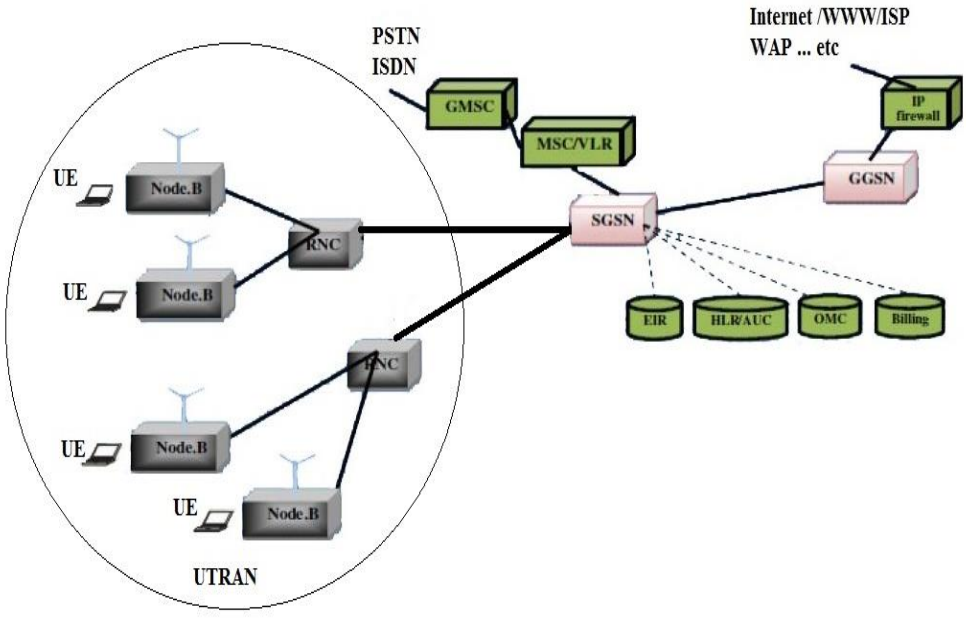

Figure 3.9. Architecture of UMTS (3G) Network.

Universal Mobile Telecommunications Service (UMTS) which was developed in 2001 from the three-generation partnership project by (3gpp) had used this technique in 2003 in Europe and was completed updated of its network in 2010. The Frequency of this generation in most of the world (Asia, Africa, and Europe) used the frequency 2100 MHz, while America and Latin America used the frequency of 1900 MHZ. Below the Architecture of UMTS (3G) Network Figure 3.9 [33].

Universal Terrestrial Radio Access Network (UTRAN) is a term used for equipment that connects mobile devices to the public network or the Internet, using UE, Node B, and RNC.

- **User equipment (UE)**: Any device connected with the final broadcast devices in the 3G network called the (UE), where it can be a mobile phone or a laptop computer provider with a mobile broadband adapter [40].
- **Node B:** It is responsible for the radio link between the fixed part of the network and the mobile phone. Node B Part of the base station in UMTS. Node B corresponds to BTS (base transceiver station) in GSM [40].
- **The Radio Network Controller (RNC):** It is a controller base station. It provides wireless source management, handling control and connectivity between Media Gateway and packet switching [40].

Operations and Maintenance Center (OMC): The operations and maintenance center in mobile networks is responsible for operating and maintaining the network [39].

3.4. Architecture of LTE (4G) Network

The fourth-generation is developed for compatibility with the quality of service and rates set by applications such as wireless broadband access, MMS, video chat, mobile TV, HDTV, DVB, and smaller services such as voice, data, and the used bandwidth [41]. Below is the architecture of LTE network Figure 3.10 [33].

- **e-Node.B**: is one of the important parts in the 4G network, also known as E-UTRAN. Its work is similar to the work of RNC in 3G, and BSC in 2G. All e-node B are connected to each other through interface X2. The benefit of X2 is to base stations collaboration with each other to find the next base station that can capture your conversation seamlessly without interruption and without notice (when talking in a moving car) [42].

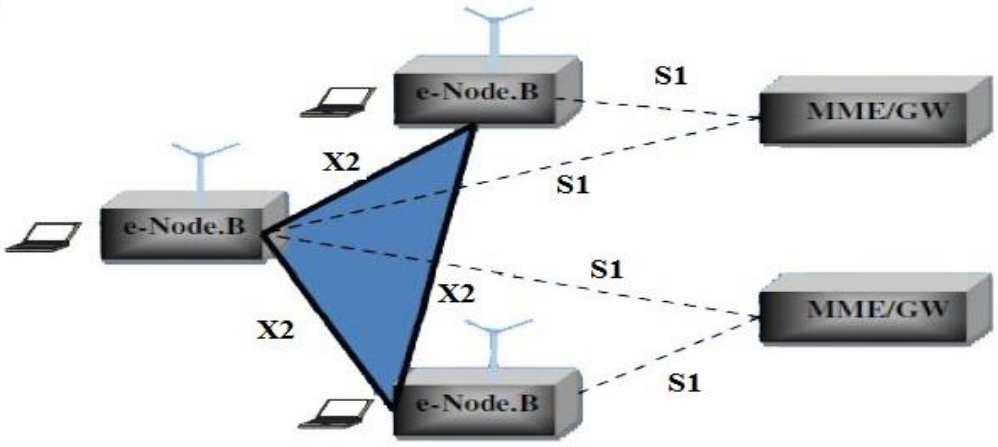

Figure 3.10. Architecture of LTE (4G) Network.

- **Mobility Management Entity (MME):** is responsible for managing the network and its subscribers, which is support in the quality of service, encryption algorithm and protection. MME is associated with (e-Node.B) interface (S1) [42].
- **Serving Gateway (SGW)**: It is the termination point of the packet data interface towards E-UTRAN. When terminals move across e-Node.B in E-UTRAN [42].

3.5. Architecture of (5G) Network

The fifth-generation mobile phone or is so-called fifth-generation wireless systems as proposed by ITU. In 2012, began embarked on a program to develop “5G” and setting for research that is emerging around the world, and begin work 5G in 2020. Figure 3.11 [44].

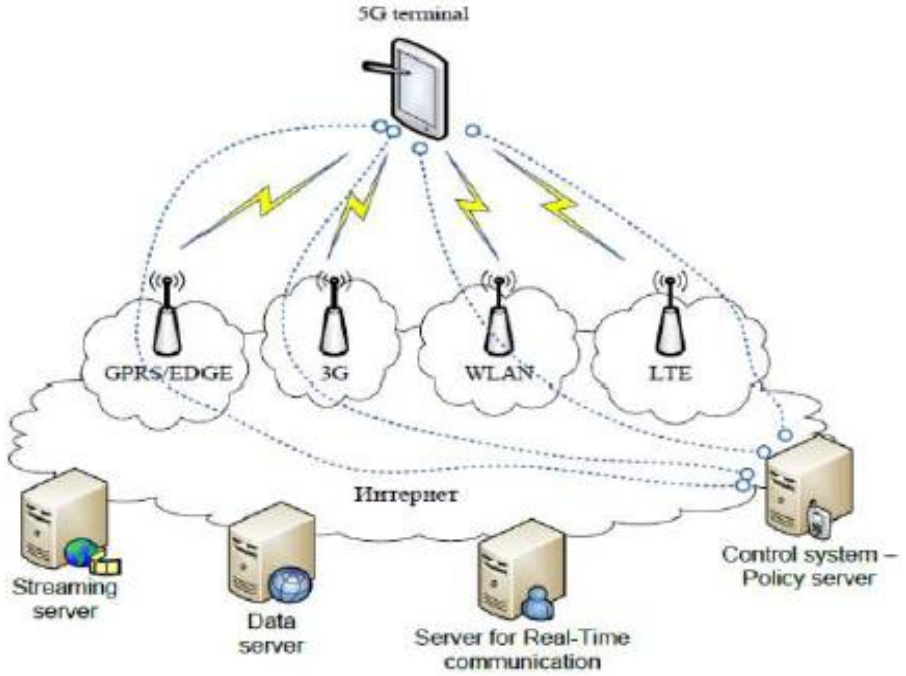

Figure 3.11. Architecture of (5G) Network

The first chip designed by Qualcomm is designed in 2016. The X50 5G is called a modem where it supports 28 GHz operations with 800 MHz bandwidth support and is designed to support maximum load speeds of 35.46 gigabits per second [45].

It is planned to make 5G the highest capacity of current 4G and higher density of mobile broadband users and higher reliability [46].

Features of this generation (default)

- High speed, high capacity, data availability in Gbps.
- High quality in watching TV HD and other media.
- Data transfer faster than previous generations.
- Large phone memory, connection speed, sound and picture clarity [47].

More international companies have worked in research and development to 5G; the companies are Huawei, Nokia, and Samsung. In 2013, Samsung Company tested 5G networks at 1 GB/s, which means that a high-resolution movie can be downloaded in less than one minute [48].

CHAPTER 4

COMPARRATIVE BETWEEN THE DEVELOPED COUNTRIES (EUROPE) AND THE DEVELOPING COUNTRIES (UAE, PAKISTAN AND IRAQ)

4.1. People and the economy

Pakistan

Pakistan is located in south of Asia, it is bordered to the south by the Arabian Sea and the Gulf of Oman and from the east and south-east bounded by the subcontinent of India, the north-east is bordered by China, and from the west and south west it shares its borders with Afghanistan and Iran. Its area is (881.913) km^2 and its population is of about (201 995 540) million; [49] Pakistan is considered one of the developing countries [50]. Figure 4.1. displays the location of Pakistan:

Figure 4.1. Location of Pakistan

Pakistan is considered one of the richest regions in the world for the period from the beginning of the Gregorian calendar until the 18th century. Pakistan has a big economy of the gross domestic product, it lost this advantage because of social instability; by the end of this situation, and Pakistan has a high potentiality to become the largest economies in the world [49].

Its economy is composed of:

1. Agriculture: produces annually about (21.5914 million) tons of wheat (2005), which is more than the production of both Africa and South America.
2. Cotton (Pakistan is the fifth country in the world which produces it).
3. Leather.
4. Fuel extraction.
5. Mining.
6. Textile industry: Pakistan is the eighth largest producer of textile industries in Asia.
7. TV industry.
8. IT: (the fastest growing sector in Pakistan in the evaluation and development of information and communication technology as Pakistan is ranked 111 out of 144 in 2014).
9. Internet: Best states that recorded high growth in the spread of the Internet as the number of Internet users (20) million. Increase the growth of Pakistan's exports of telecommunications services, computer and information technology, this growth is considered much better than its counterpart in China [49].

UAE

Figure 4.2. Location of UAE.

United Arab Emirates is located in the east of Arabian Peninsula in the west-south of Asia, overlooking the southern shore of the Arabian Gulf. It has a common maritime border from the west-north with the state of Qatar, from the west a land border with Kingdom of Saudi Arabia and with Oman from east-south. Its area is (83.600) km^2 and its population is (8.264.000) and its population density of (110) inhabitants / km [51]. UAE is one of the developing countries [50]. Figure 4.2. displays the location of UAE.

The United Arab Emirates was established in 1972 (seven-emirate federation). In the 1930s, the oil exploration teams conducted preliminary studies on the existence of oil in this region. Oil was discovered in 1958 and a foreign company was prerogative to extract and export oil and started in 1962. With the increase in oil imports, the UAE government started implementing large projects such as housing, building schools and hospitals paving the way for more development in other fields [51].

Europe

Figure 4.3. Location of Europe

Europe is one of the world's continents, bordered on the north by the Arctic, from the East by Asia, from the south by the Mediterranean and by the Atlantic Ocean from the west. The area of Europe is about (10,180,000) km^2 and population (742,452,000). Europe consists of about fifty countries (the European Union was founded in 1993) [52]. Figure 4.3 shows the location of Europe.

Industrial and economic growth began in continent of Europe, specifically in Britain, and it spread throughout Europe in the late 18th century. After the outbreak of the First World War, this growth disrupted. With the end of the war, countries began to work to restore industrial and economic growth, but this growth did not last because of World War II. Western Germany, Britain, France and Spain could recover their industrial and economic growth rapidly in the early 1950s after the end of the war. Their industries developed in the fields of the automobile industry, aircraft, military industries, telecommunications, agriculture and others [52].

4.2. Telecommunications policy, infrastructure and development

Pakistan

Pakistan gained independence from India and became an independent state on August 14, 1947; in this period, the communications infrastructure has been established only in two cities Karachi and Lahore, the population of the two cities reached to (35) million people and the number of subscribers to phone was (12,436) or one phone for every 3,000 people.

In order to know how Pakistan reached such a degree of a sophisticated communications system, The historical development of telecommunications in this country. Began in first Telegraph Act 1885, a law that gave the right to the state to give license to companies or individuals to provide telecommunications services under the lightning, this law was amended and renamed Wireless Telegraph Act in 1933, with addition accountable any company or person from possessing any wireless device without a license. In 1991, was the enactment of the Pakistan Telecommunication Corporation (PTC) and this law was amended in 1996, the text of the amendment on the establishment of the Pakistan Telecommunication Authority and the National Authority for Communications and whose job is to promote high-quality contacts and determine the cost of telecommunications services and protect the interests of subscribers. In 2000, the Pakistani government set up the first special policy information technology functions of the infrastructure development and training of human resources capacity [53].

In 2003, the Pakistani government lifted the restrictions on fixed terrestrial communications and allowed private companies to work instead of PTCL and thus, ensured the improvement of services, especially in rural areas, as well as put the details of the license fee [54].

In 2004, the Pakistani government placed its Mobile Cellular Policy (MCP) and the objectives of this policy promote the efficient use of spectrum and options for increasing mobile cellular services clients competitive and reasonable price in addition to encouraging private investment in the telecommunications sector (mobile cellular) and gave the rights and obligations of the mobile cellular operators as fair competition between cellular and fixed-line operators; hence, is the establishment of an effective regulatory system [55].

In 2004, the Pakistani government puts its policy in the Internet broadband services and identified to be the high-speed as well as any reasonable prices for businesses and citizens and under the re-organization of communications in Pakistan Act in 1996, divided the telecommunications sector into four sections [55]:

- National Telecommunication Corporation (NTC).
- Pakistan Telecommunication Company Limited (PTCL).
- Frequency Allocation Board (FAB).
- Pakistan Telecommunication Authority (PTA) [53].

The following is the description in details:

- National Telecommunication Corporation (NTC): The basis of communication in any country is the infrastructure where the cables and copper networks, microwave, under Telecommunications Regulatory Act phrase was preparing a plan to modernize the network and make fibre optic, set up a transit network, billing systems, and services data network. This network has been updated under the above law and with the help of private companies [55].
- Pakistan Telecommunication Company Limited (PTCL): This Company provides telephone services and the Internet represents the backbone of the company's infrastructure for communications in Pakistan [56].
- Frequency Allocation Board (FAB): This body issuing licenses spectrum for broadcasts of radio and TV, wireless operators, public and private companies, as well as wired and wireless networks and communication systems providers [57].
- Pakistan Telecommunication Authority (PTA): It is responsible for monitoring telecommunications in Pakistan for private communications operating in Pakistan, a cellular phone company, Internet service providers, company’s prepaid cards [58].

The Pakistani government gave licenses to private companies (investors) to work in the telecommunications sector and divided Pakistan into (14) regions, the licensing section into three types [59]:

- Local Loop (LL), the field of operation of fixed telephone network and wireless local area network wireless local loop (WLL). A number of companies licensed to work in these type (6) companies [59].

Table 4.1. Frequency used in mobile network in Pakistan

Frequency	Protocol	Class
900 MHz	GSM/GPRS/EDGE	2G
1800 MHz	GSM/GPRS/EDGE	2G
2100 MHz	UMTS/HSDPA/HSPA+/DC-HSPA+	3G
1800 MHz	LTE	4G

- Long-Distance and International (LDI), the field of its work the Internet network using optical fibre network and connect Pakistan with neighbouring countries. A Number of companies licensed in these type (6) companies [59].
- The Cellular mobile network started in mid-1990, where it was a very limited use by the rich and the elite. At the end of 1992, another cellular mobile network started at work in Pakistan [60].

The number of users increased in 1993 reached to (200,000) thousand users. Mobile cellular policy was approving due to the (MCP) in 2004. Six companies became cell phone competition which has led to a proliferation of cell phone networks extensively with the low prices of their services as the number of users reached to (86,698,075) million users in 2008 [60]. Table 4.1 displays the frequencies that have been used in the generations (2G, 3G, and 4G) [61].

UAE

In 1976, Telecommunications was established in UAE as the Emirates Telecommunications. Telephone establishment is responsible for the processing of these services, this institution continued to work until 2006.

In 2003, a private Telecommunications Regulatory Authority (TRA) was established in Emirates. In 2006, the first mobile phone service was established and the Internet Company was known as (du) and published its services all over the Emirates. In the free zone, it became known as Emirates Integrated Telecommunications Company [62].

The telecom companies in the UAE are Etisalat and (du). Etisalat is the first government company was established in the UAE in 1976, initially operating in fixed lines. In 1982, Etisalat had established the first mobile telephone network in the Middle East. The GSM network was used in 1994. It was able to operate outside the UAE in Saudi Arabia, Sudan, India, and Indonesia. 3DTV has been provided through Fiber Optic Network, thus making UAE the fifth country in the world to offer this service [63].

Table 4.2. Frequency used in mobile network in UAE

Frequency	Protocol	Class
900 MHz	GSM/GPRS/EDGE	2G
1800 MHz	GSM/GPRS/EDGE	2G
2100 MHz	UMTS/DC-HSPA+	3G
1800 MHz	LTE	4G
2600 MHz	LTE	4G

The Table 4.2. displays the frequencies that have been used in the generations of (2G, 3G, and 4G) [64] [65].

Europe

The term (mobile phone) was called the phones found in cars. The first mobile phone experiment was conducted in the United States in 1920 (between Boston and New York) where there were problems with structure, roaming, and handover. In 1973, Motorola Company solved these problems by a cellular patent. It was the first mobile phone service in America in 1978. Each city was considered a cell.

In Europe the situation was different. Sweden was the first country to use an automatic system and established a team called Nordic Mobile Telephone Group (NMT), which standardizes cellular analog standards for Nordic countries. Used of roaming between its countries (Sweden, Finland, Norway, Denmark and Iceland) 1981-1988 [66].

From 1990 – 2000, the telecommunications service industry has grown rapidly after the bank's financing in the EU for the telecommunications sector to improve and provide basic infrastructure (Fixed line and mobile network) to connect the EU parts at home and abroad, as a result of the competitiveness, the European market has improved [67].

The EU fixed line rate is 48 lines per 100 people. This rate increased to 65 lines per 100 people in 1995. In 2000, each person has a fixed telephone. The prevalence of the mobile network was about 42% at the end of 1995, becoming 100% in 2000. The EU works on digitization documents and transactions and becomes 100% in 2000 [67]. The Table 4.3 shows the frequencies that have been used in the generations of (2G-4G) [68].

Table 4.3. Frequency used in mobile network in Europe

Frequency	Protocol	Class
900 - 1800 MHz	GSM	2G
2100 MHz	UMTS	3G
800 -1800 - 2600 MHz	LTE	4G

4.3. Networks Mobile phone in Iraq

Figure 4.4. Location of Iraq

In this section, a comparison between the development of networks (wired, wireless, cellular and Internet) systems in Iraq, Pakistan, UAE and Europe, also comparing the evolution of mobile phone networks in Iraq.

Iraq is a state located on the western side of Asia surrounded by Turkey to the north, to the east by Iran, on the south by Saudi Arabia and Kuwait and to the west there is Syria and Jordan. The total area is about (438.317) km and a population of (37.547.686) [69] with a population density of (84) to the square kilometer [70]. Figure 4.4 shows the location of Iraq.

Iraqi state Company of Telecommunications and Post (ITPC) has been established in 1919 [71] and continue working as a part of the Iraqi ministry of communications after that the State Company for Internet Services (SCIS) has been established in 2000 [72] to take in charge of all the internet services in Iraq. In 2004 (after the war) (ITPC and SCIS) have been separated from the ministry of communication and based a new ministry concerning all the telecommunications and internet services in Iraq.

Table 4.4. Frequency used in mobile network in Iraq

Frequency	Protocol	Class
900 MHz	GSM/GPRS/EDGE	2G
1800 MHz	GSM	2G
2100 MHz	UMTS	3G

Table 4.5. Frequency use in Pakistan, UAE, Europe and Iraq for mobile network

Frequency	Pakistan	UAE	Europe	Iraq	Class
900 MHz	GSM/GPRS/EDGE	GSM/GPRS/EDGE	GSM	GSM/GPRS/EDGE	2G
1800 MHz	GSM/GPRS/EDGE	GSM/GPRS/EDGE	GSM	GSM	2G
2100 MHz	UMTS/HSDPA/HSPA+/DC-HSPA+	UMTS/DC-HSPA+	UMTS	UMTS	3G
800 MHz	-	-	LTE	-	4G
1800 MHz	LTE	LTE	LTE	-	4G
2600 MHz	-	LTE	LTE	-	4G

Communication and Media Commission (CMC) has been established in 2004 to organizing the media and telecommunication institutions in Iraq [73]. A (CDMA) Sim Card wireless communications have been issued by ITPC named as Al-watania. 2007 was the year where a license has been given to three (private) mobile phone companies, Zain, Asia and Korek, to start a ((2G) GSM) to work in Iraq, [74] also they gained a license for (3G) in 2015. Table 4.4 shows the frequencies that have been used in 2G and 3G generations. Table 4.5 shows the frequencies use in Pakistan, UAE, Europe and Iraq for mobile network.

Networks

The communications networks in Iraq (ground, wireless) are old and have not been updated since the end of the 80's to the end of 2004, as well as the lack of a mobile phone networks until 2004. This led to almost stop the communications in Iraq.

It is possible to develop the telecommunications network in Iraq by granting licenses to several companies (investment) to establish a fiber optic network instead of the old copper cable network (just like what has been done in Pakistan, UAE and Europe).
The table 4.5 shows the year of transition of the cellular network for Pakistan, UAE, Europe and Iraq.

Table 4.6. Year of transition of the cellular network

Country	2G	3G	4G	5G
	Year	Year	Year	Year
Pakistan	1992	2007	2014	Till now
UAE	1994	2009	2012	Till now
Europe	1981	1998	2008	Till now
Iraq	2004	2015	Till now	Till now

The above table shows the how much Europe Precedes UAE and Pakistan not to mention Iraq in all networks generations. Advantages and disadvantages of using 4G in Iraq, 4G users can handle the Internet at high speeds and the user will be able to watch movies on mobile without cutting. For mobile gaming enthusiasts 4G can share their gaming partners with high-quality graphics without waiting for a download period.

Advantages

- Support for interactive multimedia, voice, streaming video, Internet, and other broadband services
- Low cost per bit, and high capacity.
- Service portability, Global access and scalable mobile services.

Disadvantages

- Battery usage is more.
- Needs complex hardware.

4.4.Technical Communications policy between developed and developing countries

Fixed line, mobile telephone and internet services

Fixed and wireless in the Pakistan, the figure below shows the rate of subscribers that increased in the cellular network significantly, from (18%) in 2001 to (40.4%) in 2014. The rate of Internet usage increased to (32%) in 2014, while it was (8%) in 2001. Increased by a small percentage, Fixed line subscribers in 2014 (9.8%), while it was (1%) in 2001. Figure 4.5. shows the charts for mobile cellular telephone subscription and fixed telephone [75].

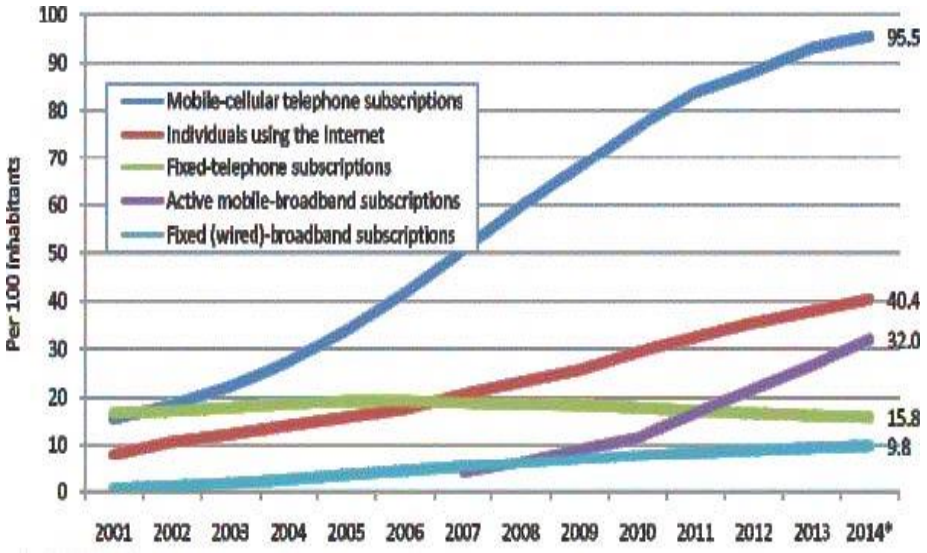

Figure 4.5. Fixed and wireless in the Pakistan [75]

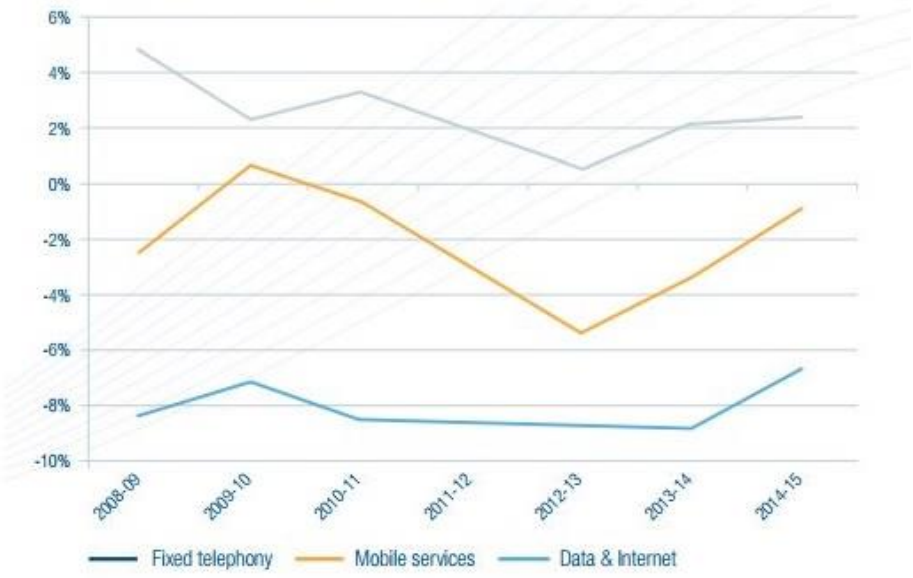

Figure 4.6. Fixed and wireless in the Europe [76]

Fixed and wireless in the Europe, the figure below shows the rate fixed line, mobile subscribers and internet services, in Europe from 2008-2015. Figure 4.6. shows charts for fixed line, mobile subscribers and internet services [76].

Fixed and wireless in the UAE, the figure below shows the number of subscribers in the fixed line, mobile telephone and internet services, and penetration rate to fixed line, mobile telephone and internet services from 2011-2014. Figure 4.7 displays charts for fixed line, mobile telephone and internet services [71].

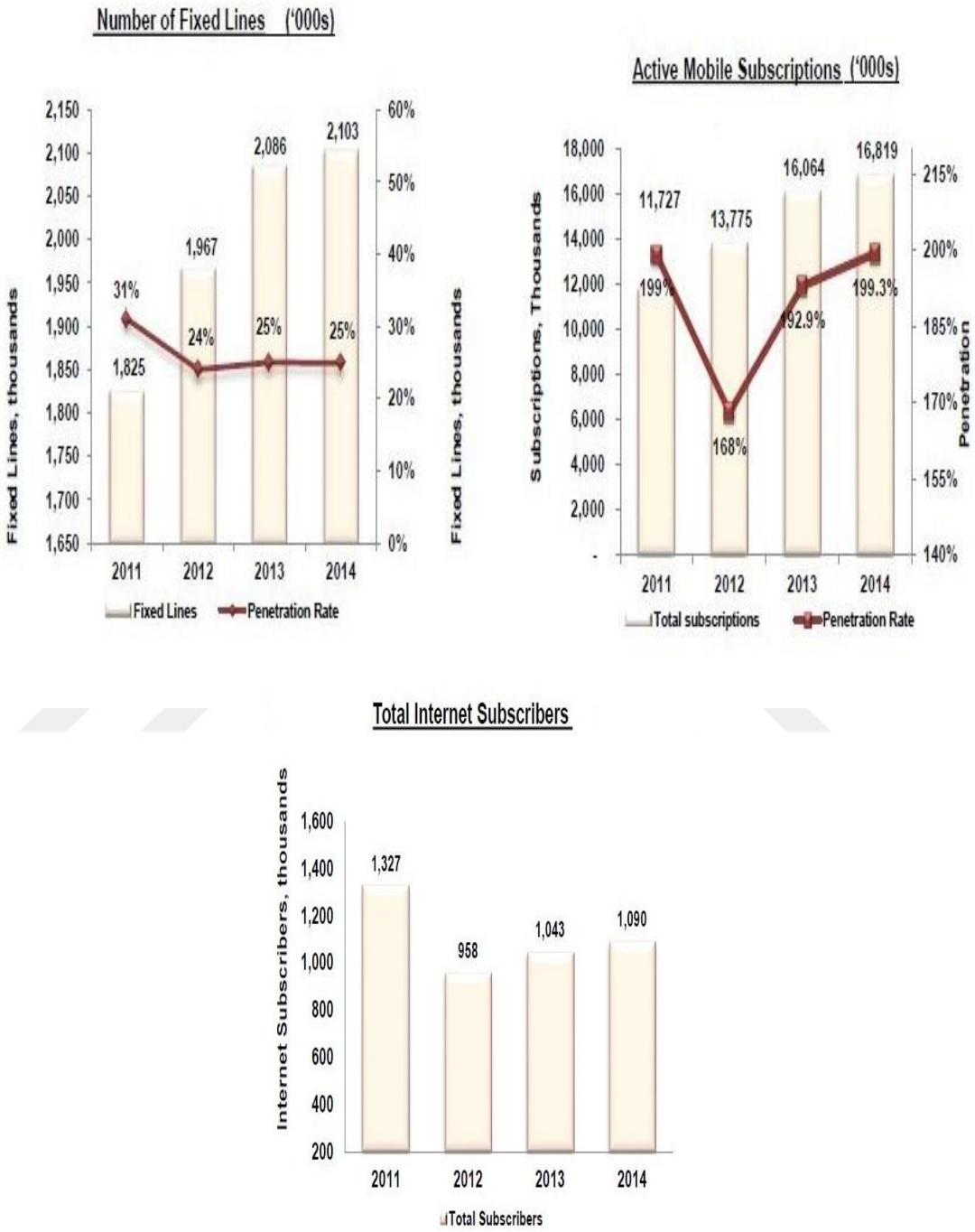

Figure 4.7. Charts for fixed line, mobile telephone and internet services UAE [71]

Investment

Investment in Pakistan, the figure below shows the rate of Foreign Direct Investment (FDI) that yellow color in the field of telecommunication and (FDI) that green color in all field totals, and Figure 4.8 displays the Foreign Direct Investment in Pakistan [75].

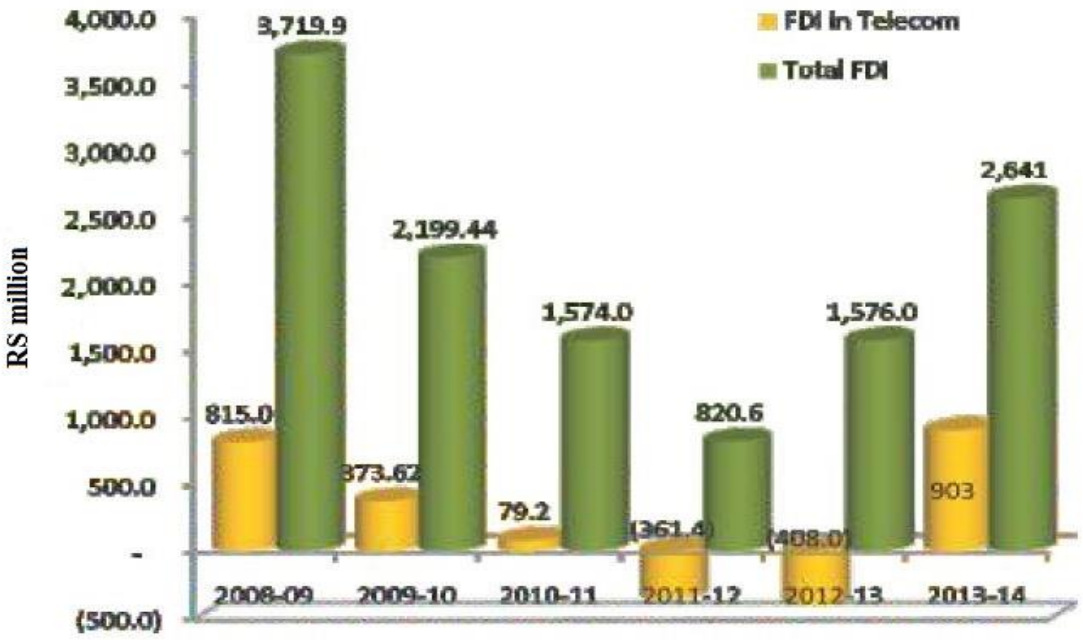

Figure 4.8. Foreign Direct Investment in Pakistan [75]

Figure 4.9. Investment in Europe [76]

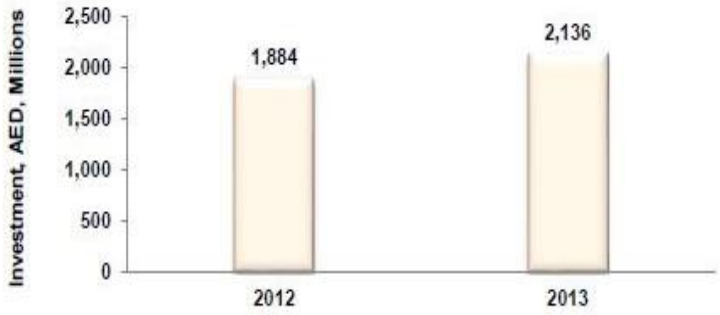

Figure 4.10. Total Capital Investment in UAE [78]

Investment in Europe, the figure below shows the rate of investment in Europe (EU-28) and European Telecommunication Network Operators Association (ETNO) perimeter, compared to US and Japan, and Figure 4.9 displays the Foreign Direct Investment in Europe [76].

As for the investment in UAE, the Figure 4.10 shows the rate of investment in UAE, the increased investment in 2013 reached to (2,136) compared with (1,884) in 2012, and the Figure 4.10 displays the investment in UAE [78].

Revenues

Revenues in Pakistan, the figure below shows the rate of telecom revenues which were (333.8) in 2008-09 and (355.6) in 2009-10, and became (465.6) Rs. Million in 2013-14, and the Figure 4.11 displays the revenues in Pakistan [75].

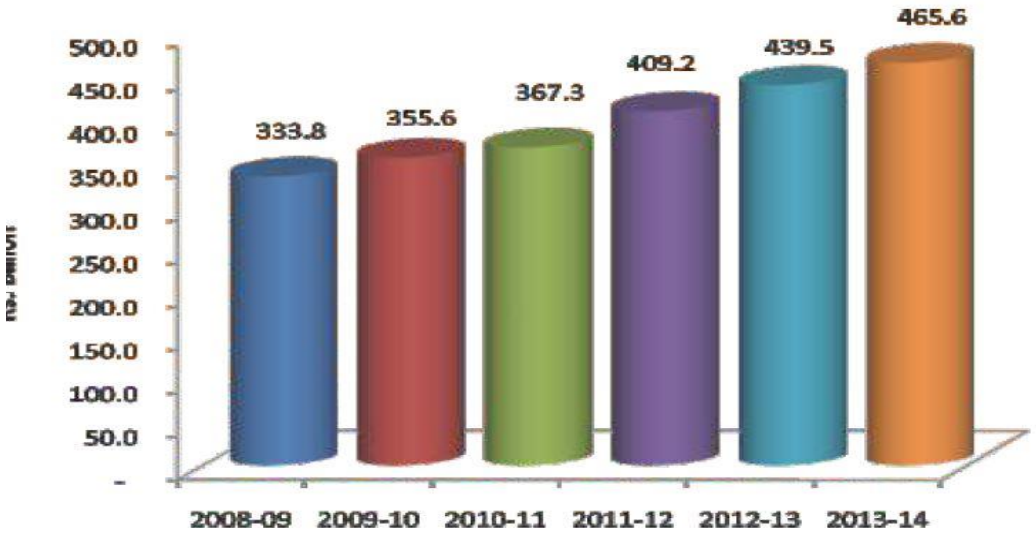

Figure 4.11. Revenues in Pakistan [75]

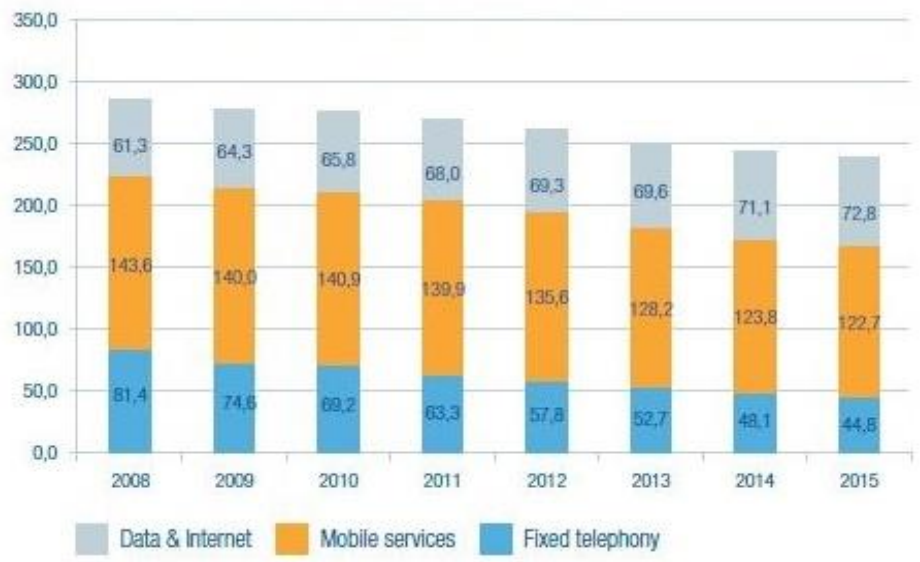

Figure 4.5. Revenues in Europe [76]

The Figure 4.12 shows the rate of telecom service revenues in Europe (incl. Turkey, excl. Georgia, Russia, Ukraine, and EUR), which includes fixed and mobile telephone revenues as well as Internet service charges for the period (2008-2015) [76].

As for the revenues in UAE, the figure below shows the rate of telecom revenues in UAE which includes fixed and mobile telephone revenues as well as Internet service charges for the period (2011-2014), and the Figure 4.13 displays revenues in UAE [77].

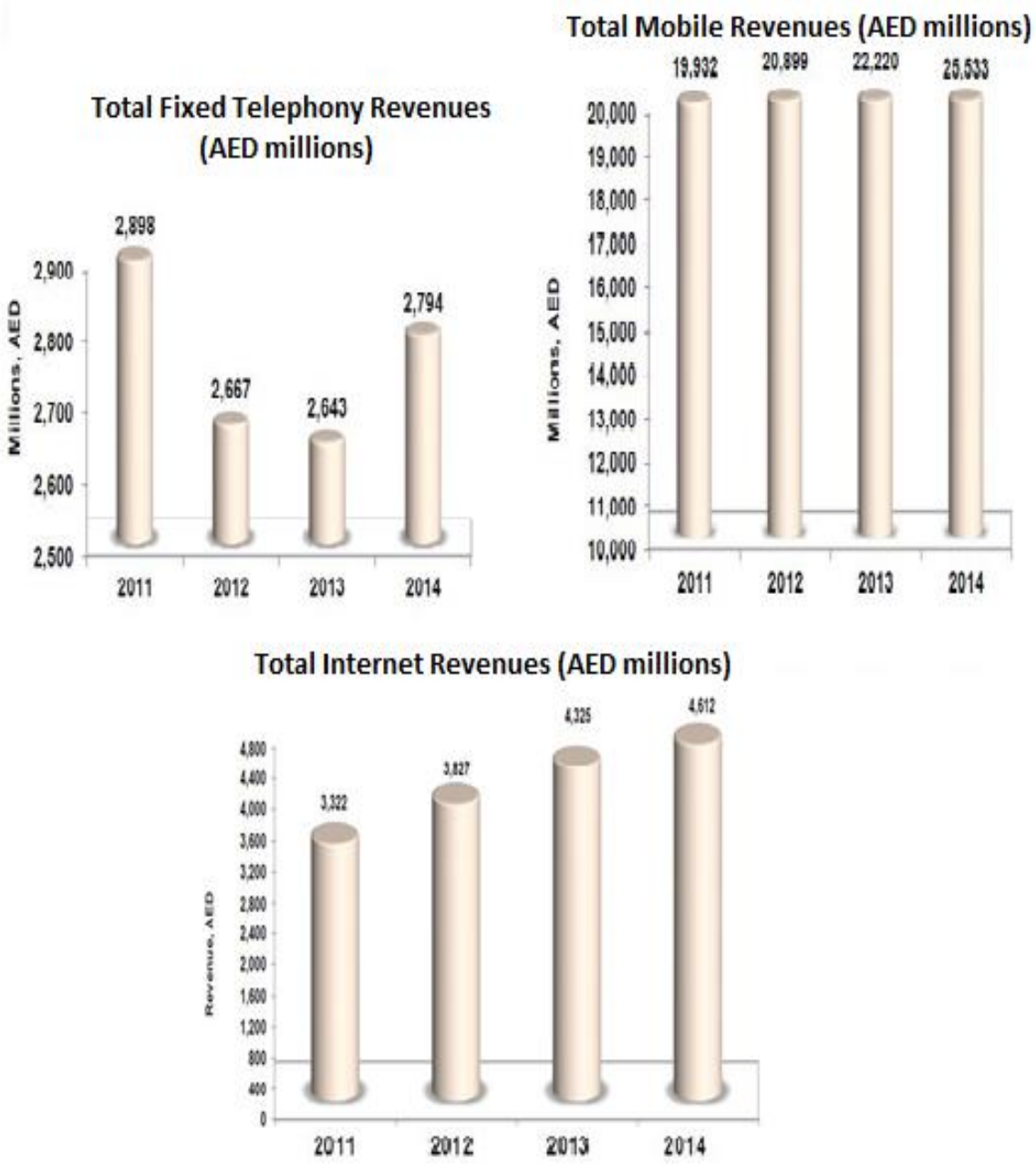

Figure 4.6. Revenues in UAE [77]

4.5. Development of telecommunications infrastructure in the UN report

The development of telecommunications infrastructure (wireless, cellular and cellular networks and Internet use) is one of the most important points that the UN has focused since 2003 on the classification of countries within the e-government development plan. Pakistan has set up 30 countries in the world to provide an online level for disadvantaged groups and levels in the 2014 UN report. Pakistan has launched a literacy program using text messaging by SMS, reaching the fourth phase in 2013, benefiting 4,000 women. The sequence of Pakistan is 158 within the e-government development index and 97 in the electronic participation index. Pakistan's sequence is 159 within the e-government development index and 114 in the e-participation index in the 2016 United Nations report [79] [80].

UAE is ranked 12th worldwide for the online services index in the UN report 2014, which is among the (50) countries in the world with electronic participation, and the (36) in the world in the Service Delivery Index for Older Persons. UAE is ranked 32th in the e-Government Index, (13) within the electronic participation index. UAE's ranking in the United Nations' 2016 report rose to 29th in the e-government index and fell to 32th in the e-participation index [79] [80].

The EU countries will be at the top of the list of nations in 2014-2016, because the first point the Completed of telecommunications and mobile networks as well as internet networks using fiber optic. The second point is the provision of services over the Internet and the third point is human capacity (population of Europe is about 750 million people). These three points are the most important points that the United Nations is focusing on to assess the level of countries in the field of e-government [79].

CHAPTER 5

CASE STUDY: VIEW ON THE IRAQI COMMUNICATIONS AND MOBILE NETWORKS OBSTACLES AND SOLUTIONS

The Iraqi state company for communication (ITCP)has been established in 1919, which specialized in all communications forms, wired, wireless, and postal services, as part of the Iraqi Ministry of Transportation until 2003 [71]. While the Iraqi state company for Internet services (SCIS) was founded in 2000 it was also a part of the Iraqi Ministry of Transportation [72]. After 2003 these companies became part of the Iraqi Ministry of Communications.

The ministry of communication with its all companies has 22,000 employees. ITCP is responsible for the operation and management of 1.9 million PSTN, also it has a fiber optics lines which consider as the backbone for all Iraqi microwave networks. The company also offers a CDMA fixed local loop serving 200,000 Iraqi subscribers [71].

SCIS is responsible for Internet subscribers and Internet connections in Iraq and provides broadband wireless Internet access to government agencies, DSL and Internet services, as well as IP address services.

In 2004, the Communication and media Committee (CMC) was established. This body gave license to operate three private companies in the field of mobile communications in 2007 which are working on GSM, 2G, and 3G technologies in 2015. These companies are Asiacell, Zain Iraq, and Korek telecom as shown in Table 5.1.

Table 5.1. Compared between Asiacell, Zain Iraq, and Korek telecom

Company	Zain Iraq	Asiacell	Korek telecom
Subscribers (M)	12.7	9	6
Operates technology	3.9G	3.9G	3.9G
number of subscribers	39%	38%	23%

- **Zain Iraq:** is one of the mobile phone companies operating in Iraq, where the number of subscribers until 2016 (12.7) million subscribers and 39% of the number of subscribers compared to other companies. It operates according to 3.9G technology [80].
- **Asia Cell:** is one of the mobile phone companies operating in Iraq, where the number of subscribers until 2016 (9) million subscribers and 38% of the number of subscribers compared to other companies. It operates according to 3.9G technology [81].
- **Korek telecom:** is one of the mobile phone companies operating in Iraq, where the number of subscribers until 2016 (6) million subscribers and 23% of the number of subscribers compared to other companies. It operates according to 3.9G technology [82].

The Ministry of Communications has implemented giant projects in the form of investment, including Access Network for the transmission of video call, voice and data, high-quality television channels, games, and optical fiber project. This project extended from the north region of Iraq to the south region to provide telecommunications and Internet services. The aim of this project is to connect Iraq with its neighboring countries through the submarine cables, which will be reflected on the Internet prices available to citizens in Iraq through the FTTH project and a speed of (13 Mbps) to deliver Internet, VoIP services, and television services to every house in Iraq using an optical fiber network. This network will be secured, protected, and owned by the Ministry of Communications, as well as the completion of LTE and IPV6 which are two important projects in the field of mobile phone networks [71].

The LTE network can also be used to operate 4G in Iraq through ITCP after completing some technical procedures including getting frequency. The 4G supports the ITU standards under IMT-2000, and the network supports file download speeds of up to 100 Mbps compared to only 21 Mbps in 3G, making it suitable for all types of downloading for different Types of applications and services [71].

Table 5.2. Strategic plan for telecommunications for the period 2015-2018

No.	Indicator	Current situation	Targeted situation 2017
1	Fixed phone line per 100 persons	8.6	25
2	Mobile phone subscriber per 100 persons	3.76	100
3	Computers per 100 persons	1.5	5
4	Internet subscribers per 100 persons	14.0	20
5	Internet subscriber for broadband per 100 persons	6.3	10
6	20 Hour per month services costs for internet in US dollar	8.0	4
7	100 minutes per month cost for mobile phone services in US dollar	5.0	3

Table 5.2 shows the strategic telecommunications plan for the period of 2015-2018. The Ministry has set up this plan for the development of the telecommunications sector in terms of number of fixed lines, number of mobile subscribers, number of computers, and the number of participants in the ordinary and broadband Internet service with the cost of using 100 minutes per month through mobile phone.

The number of Internet servers reached 26 domains, the registered domains within the Iraqi code were 960 domains in 2014 according to the statistics of the CMC [73]. The children category users' percentage of other Internet categories users is of 74% This indicates the acceptance of the Iraqi society to upgrade and communicate with the external environment [73].

5.1. Iraqi 3G and 4G network differences

The most important differences between 3G network used in Iraq and 4G networks (LTE) which is being executed by Huawei company over steps since 2012 which covered all Iraqi regions as the ITU standards in the network Architecture, the working companies in Iraq used Wide area cell-based while the 4G network will use Hybrid: Integration of wireless LAN (WiFi, Bluetooth) and wide area.

Also, the used speed now is 384 Kbps to 2 Mbps, while when the 4G service begins the speed will be 20 to 100 Mbps in mobile mode. Furthermore, for the other characteristics (Frequency Band, Bandwidth, Switching Design Basis, and Access Technologies). Show in Table 5.3.

Table 5.3. Comparism between 3G and 4G in Iraq

Requirement architecture	3G	4G
Network Architecture	Wide area cell-based	Hybrid: Integration of wireless LAN (WiFi, Bluetooth) and wide area
Speeds	384 Kbps to 2 Mbps	20 to 100 Mbps in mobile mode
Frequency Band	Dependent on country or continent (1800-2400 MHz)	Higher frequency bands (2-8 GHz)
Bandwidth	5-20 MHz	100 MHz (or more)
Switching Design Basis	Circuit and Packet	All digital with packetized voice
Access Technologies	W-CDMA, 1xRTT, Edge	OFDM and MC-CDMA (Multi Carrier CDMA)

5.2. Iraqi Ministry of Communication Projects

- **The microwave project:** This dynamic project started in 2008 and finished in 2012 which represents the link unit affecting the reality of the national communication work as it provides additional capabilities supporting the project of the national optical communication and a reserve available when needed in emergencies [71].
- **The National Project for optical Communications**: This project has been done and starts running in 2012 which based on the establishment of optical communication stations covering all the provinces of Iraq and interconnected through the national network of optical cables, this network extends for thousands of kilometers, the project is one of the largest and important projects in terms of capacity, which the transfer of telephone traffic and Internet packages done by it, this services satisfying the needs of ITCP. This project also supports the operations of other projects that have been operated such as the International Access Gates Project, fixed lines Pre-payment project, public fixed lines, Optical access networks for cabins and houses using the optical fiber cables. [71]
- **The National Data Transformation Project:** This project started to run in 2013 which consists of main stations spread in Baghdad and other governorates. It provides services to the International Access Gates project, the next generation operators project, and the optical access networks projects in all of Iraq. ITCP has given a special importance for this project as it works concurrently with the projects mentioned above and those projects cannot work without it [71].

- **Optical Access Gates Project:** This project is one of the most important strategic projects of ITPC, through which the international telephone traffic issued by the users of (Asia cell - Zain - Cork telecom) and by the subscribers of national fixed lines and wireless phones through connecting the national optical network with the gates This project has been officially launched on 12/3/2012 [71].
- **Closed Circuit Project (VTC):** VTC started to work in 2008 which is a system that provides video conferencing services through a secure video conferencing network, providing services to interested parties by providing it to communication stations that are usually connected to the network's main server. The service is provided through a network of High security and stability, the system provides the possibility of teleconferencing between the beneficiaries and within a closed and visible circle, which reduces the time necessary for travel for meetings. The system provides these services to facilitate the process of communication and business meetings by providing audio and visual communications effectively without geographical restrictions [71].
- **LAN Project:** This is a project that was implemented at the Ministry of Communications headquarters, started to work in 2010. It connects all computers via servers and provides internet and e-mail services to the Ministry. This project is considered the main building block for e-government [71].
- **Iraqi satellite project:** Iraqi satellite project is a future project will provide many services to Iraq, including satellite communications services and satellite television broadcasting services for satellite channels and develop the scientific and research side and strengthen the security aspect [71].

5.3. Obstacles that faced the communications field in Iraq and its solutions

5.3.1. Obstacles

- The number of national calls in 2001 reached (7430 calls) while in 2003 (zero call) according to the Central Bureau of Statistics data and granting licenses - or perhaps without licenses - to private companies to sell calling cards in the markets by landline as an alternative.

- Mobile licenses have been granted to several companies. These companies have relied heavily on employees of the same government telecommunications sector and have continued to use the Ministry of Communications infrastructure.
- The work on the government mobile phone project, which was started after 2003 was stopped and however a lot of communication towers were established.
- The Communications and media committee (CMC) was formed in 2004 and the mobile and wireless companies were linked to it, and the Ministry of Communications (the competent authority) has nothing to do with mobile phone companies, either technically or financially.
- The door opened widely for the private Internet offices in all parts of Iraq without control and involvement of the ministry of communications in this project, which almost canceled the role of Internet service company.
- The delay in repairing the damage caused to the telecommunications sector by the events in 2003.
- The door opened widely for the foreign post companies like (DHL), which hampered the role of Iraqi postal services and reduced their desires to a minimum, where postal items in 2001 were (2856836) and in 2007 fell to (12390), and the percentage of empty postal mailboxes in 2007 was more than 85%.
- Many communications infrastructures (especially networks) are being destroyed for lack of coordination projects.
- The allocation of small amounts to the telecommunications sector from the amounts of the investment budget of ministries and development projects in the provinces, where the percentage of what was monitored for the telecommunications sector in one of the provinces, for example during the years (2006-2007-2008) was less than (1%).
- Mobile phone companies are contracted by GSM technology, which is a second generation (2G) technology for communication. It is an old technology that has been disposed of in many countries. Most of the neighboring countries are now using the 3.9G technology called CDMA2000, others used 4G technology called LTE. While in many developed countries, the 5G technology is being developed, noting that some of these companies (including Zain, for example) are working with technologies that are more developed in other countries.

5.3.2. Solutions

- Linking fixed mobile licenses and all communications to the Ministry of Communications technically and financially. Or to at least involve this Ministry in this regard, which will have reflected positively on the provision of large sums to the state budget, keeping abreast of the development in the telecommunications sector through the supervision of a specialized body to work, developing the rest of the telecommunications sector, taking advantage of excess profits and providing great job opportunities.
- Increasing the budget for the Ministry of Communications to help it finished its Communication Projects.
- Compel existing mobile and wireless companies to develop communication technologies to keep pace with current developments.
- Reduce the prices of calls and messages of mobile and fixed (wireless) and start working by the seconds system.
- Government involvement in the telecommunications sector through partnership with the same existing companies or establishing a new state company to compete with these companies.
- Developing the work of the SCIS and opening offices to suit the size of the demand for its services.
- Setting some standards for the work of the private Internet services offices and urging them to provide better services.
- Developing the government postal service to attract citizens to benefit from their services.

CHAPTER 6

CONCLUSIONS, DISCUSSION AND RECOMMENDATIONS

The technological development reached its highest level ever. This development covered all aspects of life, including in the field of communications, which contributed to the convergence of distances and access to others in the easiest ways and the best means of communication. Communications are divided into two main types: telecommunications, depending on the environment used to transmit information and communications between different locations. Wired connections rely on wires to transmit data, such as terrestrial telephones that use wires.

The other type of communication is wireless communications, which uses air as a transmission medium for data as in limited home uses through Bluetooth technology, which is limited frequency. In the cases of wireless Internet and cellular communications there are towers tracking companies that provide wireless telecommunications service using electromagnetic waves, the methodology of linking different sites. The development of mobile communication networks made mobile an essential part of our daily lives.

Generations of the cellular phone network, 1G commercially appeared in the 1980s where the analog wireless signal and data transfer speeds (10 Kbps) services of this generation were used to transmit voice calls only. 2G is Distinguished from 1G by converting the wireless signal to a digital that was used commercially in 1992. This generation used several standards including (TDMA), (GSM) and (CDMA). 3G was based on ITU standards, which was commercially used in 2001. (CDMA2000) and (UMTS) Data Transfer Speed (384 Kbps). The services of this generation include the transfer of voice calls as well as the transfer of video calls, downloading data, music, pictures, and messages beside, the possibility of used the Internet and exchange of

Email messages. Using (HSDPA / HSUPA and Ix EVDO), the data transfer speed is between (5-30 Mbps).

The 4G used (LTE, WiMAX) technology, which was commercially used in 2012 and is a new technology used in broadband wireless communications. The technology provides high data transfer speeds ranging from 5-200 Mbps, which is faster than 3G.

The term 5G is used to denote a future stage of cellular communication standards. This term is used in the papers and projects under test. Korean companies have tested this generation and have been able to transmit 1Gbps data, which will be commercially available in 2020. One of the criteria for this generation is the ease of access to applications as well as games through (IP) and this generation provides a large bandwidth bidirectional and better than previous generations for interconnect of all wireless and cellular technology in the world under one umbrella. It will be highly reliable, with low battery power consumption, low fees and the use of the World Wide Wireless Web (wwww), it will be for each phone (IP) within (IPV6) technology.

A comparative based on area, population, economic situation, and internet service policies between developing countries (UAE, Pakistan), developed countries (Europe) and the republic of Iraq has been taken.

As shown in the previous table (4.5.), Europe (Sweden, Finland, Norway, Denmark and Iceland) starts using the first cellular network in 1981, while Pakistan, UAE and Iraq began using the cellular communications network in 1992, 1994 and 2004 respectively. For the third generation of mobile networks 3G, Europe starts to use this networks in 1998, but Pakistan, UAE and Iraq developed their systems to work on 3G in 2007, 2009 and 2015 respectively. After 10 years (in 2008) till now, Europe began to use the fourth generation of mobile networks 4G. On the other hand, UAE starts using the 4G systems in 2012 preceding Pakistan by two years and both still using this technology nowadays. Europe, UAE and Pakistan are planning to use the fifth generation 5G technology by the year 2020 which will lead to a huge impact on the development of telecommunications infrastructure according to UN reports. For Iraq no farther development has been done on its mobile networks system where they are still using the third generation technology 3G.

In Iraq although the idea of processing and applying the mobile networks has been discussed in the 80’s and 90’s of the previous century, but the high cost of the Iraq - Iran war have clouded the future of mobile networks.

A case study for 3G, 4G, and future 5G mobile networks in Iraq has been done. This case study compared and illustrated the differences between these mobile networks.

Also discussed the advantages of executing 5G systems and the future threats that may face it when it applied in Iraq.

In general, the Iraqi government should involve the ministry of communication in the Iraqi mobile networks for ability to access the 5G technology in two ways:

The first one is a direct transformation of 3G technologies into 5G technology without using 4G technology.

The second way is to switch from 3G technologies to 4G technologies, which will be operational during the next 2 years. After completing the requirements of 5G technology, Iraq will be to operate the 5G technologies in the future.

The first method requires the presence of technical devices and technical staff which have the ability to implement the requirements of the 5G technology, the most important requirements is to connect all wireless networks, cellular networks and Internet together under one umbrella with the presence of the IPV6 technology (give a certain IP for each device), also with the presence of devices which have the ability to work with the 5G technology. At present, this is not possible because of the lack of network connectivity with each other, as well as the lack of completion of the IPV6 technology, furthermore, the devices that will work on 5G technology are not currently present in the mobile phones markets.

6.1. Future View

- The development of the telecommunications sector and the mobile phone network in Iraq should be started with giving the ability and the chance for ITPC to inter the Iraqi mobile networks market and competing the private companies by utilization the LTE networks and transform it to used it as 4G generation, also use it with the IPV6 to be the core for the 5G generation. The 5G system will have a wider coverage because all wireless, cellular, and Internet networks will function under one roof where the user can be connected at any time. In the future, each phone will own (IP) from IPV6 (unlimited IP) technology and that will let him gain a highly increase in the data rate about five times more than 4G.
- Using the second method of the previous section in Iraq will be the best choice according to the existence of the LTE network [72] which is one of the 4G

technologies according to ITU standards as well as IPV6 technology, which will be operational during the next two years. Where after completing the requirements of 5G technology, Iraq will be able to operate the 5G network with his technical staff where they will connect all wireless and cellular networks as well as Internet networks together and within five years after the operation of 4G technology.

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