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Broadband Internet Wireless Performance Evaluation

Hussin Al Elwani Abdussalam, Ayiman Rajab Qashout, Ahmed Alarbi Bashir Amer

Lecturer, Department of Computer Science, Higher Institute for Comprehensive Careers, Tarhuna, Libya

Assistant Lecturer, Department of Computer Science, Libyan Authority for Scientific Research, Tripoli, Libya

Lecturer, Department of Computer Science, Higher Institute for Comprehensive Careers, Tarhuna, Libya

ABSTRACT: The telecommunication industry is finding itself most affected by what is happening. The underlying human behavioral trait responsible for this unprecedented but welcomed activity is the need for communication. Because the telecommunication industry is now more mature than ever, trying to find new solution and technologies, new ways to add value to their existing products and services, to gain competitive advantage and to increase customer loyalty. The aim of this study is to define and compare the parameters and measures of the current wireless broadband internet service system used in Tripoli, Therefore the data used in this study will be drawn from two Libyan companies namely LIBYANA and AL MADAR operators. Measures and parameters of OFDM modulation used by each company will be involved in the study's data. In same time, MATLAB software application will be used for the implementation of simulation model design.

I. INTRODUCTION

The telecommunication industry is finding itself most affected by what is happening. The underlying human behavioral trait responsible for this unprecedented but welcomed activity is the need for communication. Because the telecommunication industry is now more mature than ever, trying to find new solution and technologies, new ways to add value to their existing products and services, to gain competitive advantage and to increase customer loyalty.

Nowadays, many WIRELESS technologies are used for a multiple of applications. WIMAX stands for “worldwide Interoperability for Microwave Access”. It is a telecommunication technology that provides for the high speed wireless transmission of data using a variety of transmission modes. Due to the increasing pressure of rapid technological development and intensifying competition, transmission setting is now changing dramatically whereby the effects of revolution are felt in approximately every sector. Advanced communication technologies will undoubtedly be the pivotal force shaping societies and economics over the future.

Even though the term Broadband does not have a specific definition because every country has different characteristics of a broadband connection but in general broadband is defined as the on demand, reliable and high speed internet connectivity. Broadband access provides faster web surfing makes download files more quickly and allows multimedia applications like real-time audio, video streaming, multimedia conferencing and interactive gaming. The broadband connection can also used as voice telephony through the use of the Voice over Internet Protocol (VoIP) technology. According to organizations like International Telecommunication Union (ITU) or other international regulators, the downloading speed fall in the category of Broadband connections if it is within the range of 256 Kbps to 2 Mbps or higher. Therefore, in regard to these points, the formal definition would be that it is [3] Broadband connection is an always-on the data connection side that is able to support various interactive services and that has the capability of a minimum download speed of 256 Kbps.” A remarkable growth in wireless and broadband technologies has emerged in recent years. These technologies benefited from the rapid market adoption. Figure 1 indicates the of the broadband and wireless technologies' rate of growth around the world in recent years.

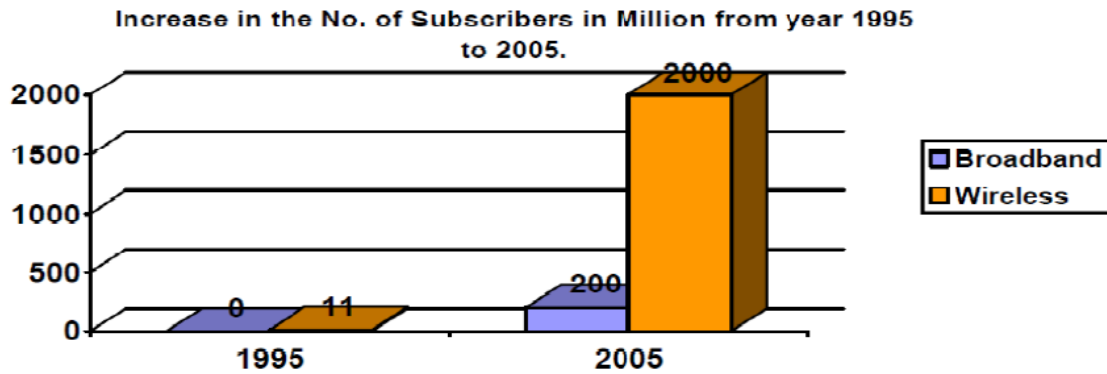


Figure 01: Increases in number of subscriber in millions from year 1995 to 2005

II. PROBLEM STATEMENT

Telecommunication consists of the integration of image, voice, video, data and wireless communication technologies in one hand with microelectronic technologies and PC to assist communication between people or to deliver information, entertainment and other services to people. Due to their mobility around the globe, people need communication to support their mobility. Communication represents a convergence of these technologies into networks and systems that serve people in the four corners of the globe. Although wireless connectivity is spreading rapidly but it is becoming much more complicated and complex to providing service on the many levels available to wireless users which use multiple devices. This is mainly attributed to some issues such as technical issues (modulation issues, bit error rate, fading, Delay Distortion, Attenuation, and signal to noise ratio) [10, 11] As an illustrative case, Tripoli (Libya) wireless' users encounter difficulties and problems to access the wireless network, in addition to the obstacles and barriers related the connectivity. The raisons thereby, might be within telecommunication companies which are facing those technical issues.

Therefore, To challenging this situation and overcoming barriers to access using a handheld, portable or fixed device is the matte of this study which will investigate the most appropriate measures that the Libyan telecommunication companies need in order to create a "Universal Always Best Connected Communication", a solution that makes communicating affordable regardless of the connection options available to the user in Tripoli.

III. RESEARCH OBJECTIVE

This study aims:

- Propose a simulating model design for wireless broadband internet network to implement WiMAX at Tripoli area in Libya which ensure the providing of high-speed data transmission.
- To define and compare the parameters and measures of the current wireless broadband internet service system used in Tripoli by some Libyan telecommunication companies.
- To determine and evaluate most suitable performance parameters of models can be used by thus companies.

IV. THE SCOPE OF THE RESEARCH

The aim of this study is to define and compare the parameters and measures of the current wireless broadband internet service system used in Tripoli, Therefore the data used in this study will be drawn from two Libyan companies namely LIBYANA and AL MADAR operators. Measures and parameters of OFDM modulation used by each company will be involved in the study's data. In same time, MATLAB software application will be used for the implementation of simulation model design.

V. THE SIGNIFICANCE OF THE STUDY

This study will provide a preliminary design (OFDM) using simulink which can serve Tripoli's telecommunication companies to reach high-speed internet service with greater distance. This would be certainly useful and profitable for both users and operators. However, the successful conduction of the objective of this study will ensure Universal Always Best Connected Communication area on Tripoli. This study can also serve as a foundation for other studies related to similar.

VI. LITERATURE REVIEW

This section reviews the current literature to discover specific information in order to apply them in the context of this research and serve as assistance in the later simulation design and experiment phase. The scope of the literature review involves projects outcomes, research studies and any others literature deemed to be of use.

6.1 Concepts and definitions**6.1.1 Wireless Technology**

There are many wireless technologies used nowadays for different applications. Wireless radio communications, for instance, are based on transmission of radio waves through the air. Radio waves between 30 MHz and 20 GHz are used for data communication. However, ranges lower than 30 MHz could support data communication. These waves are typically used for FM and AM radio broadcasting, because they reflect on the earth's ionosphere to extend the communication. Water vapor may absorb radio waves over 20 GHz which makes them unsuitable for long distance communication [1]. The radio transmission system contains both transmitter and a receiver. Transducer, oscillator, modulator, and antenna are the main components of a radio transmitter. The information to be transmitted is converted to an electrical signal by a transducer which might be microphone or camera. An oscillator produces the frequency that is used to carry the signal, a modulator embeds the voice or data signal into the carrier frequency, while the antenna is used to radiate an electrical signal into space in the form of electromagnetic waves [2]. Additionally, a radio receiver consists of an antenna, an oscillator, a demodulator, and an amplifier. The antenna captures radio waves and changes them into electrical signals. The oscillator engender electrical waves at the carrier frequency that is used as a reference wave to extract the signal. The demodulator detects and restores modulated signals. Finally, the amplifier augments the received signal that is typically very weak.

6.1.2 WIMAX

WiMAX (or Worldwide Interoperability for Microwave Access) is also known as "Last Mile" broadband wireless access technology. It is based on Wireless Metropolitan Area Networking (WMAN) standard which has been developed by the IEEE 802.16 group and it is adopted by European Telecommunication Standard Institute (ETSI) in High Performance Radio Metropolitan Area Network, i.e., the HiperMAN group. The main purpose of WiMAX is to offer broadband facilities by using wireless communication [15]. as depicted in Figure 2, WiMAX provides an alternate and better solution compared to cable, DSL and Wi-Fi technologies. Compared to WLANs, WMANs cover a much greater distance and connect buildings to one another over a broader geographic area. The improvement of WiMAX technology such as the current 802.16d and 802.16e in the near future) will further facilitate mobility and reduce reliance on wires for connections. WiMAX is the new short hand term for IEEE standards 802.16, also known as Air Interface for fixed broadband Wireless Access Systems. The original version of the 802.16 standard, approved by the New York based IEEE in 2002, has operated in the 10 to 66 GHz frequency band while requiring line of sight towers [15]. The 802.16a extension, ratified in March 2003, does not necessitate line of sight transmission and permits use of lower frequencies (2 to 11 GHz), many of which are unregulated. It boasts a 31 mi range and 70 Mbps data transfer rates that can support thousands of users. Additional 802.16 standards are in the works.

- 802.16b - Quality of service.
- 802.16c - Interoperability, with protocols and test-suite structures.
- 802.16d - Fixing thing not covered by 802.11c, which is standard for developing access points.
- 802.16e - support for mobile as well as fixed broadband.

The key features of WiMAX are summarized in the following text:

- New standard for BWA.
- WiMAX is similar to Wi-Fi.
- Higher power increases distances.

- Miles versus hundreds of feet.
- Spectrum efficient.
- Flexible.
- Metropolitan area access technology.
- Better security, authentication, and protection against theft of service.
- Possibility of using both licensed and unlicensed frequencies.
- Quality of service.
- Triple play enabler.

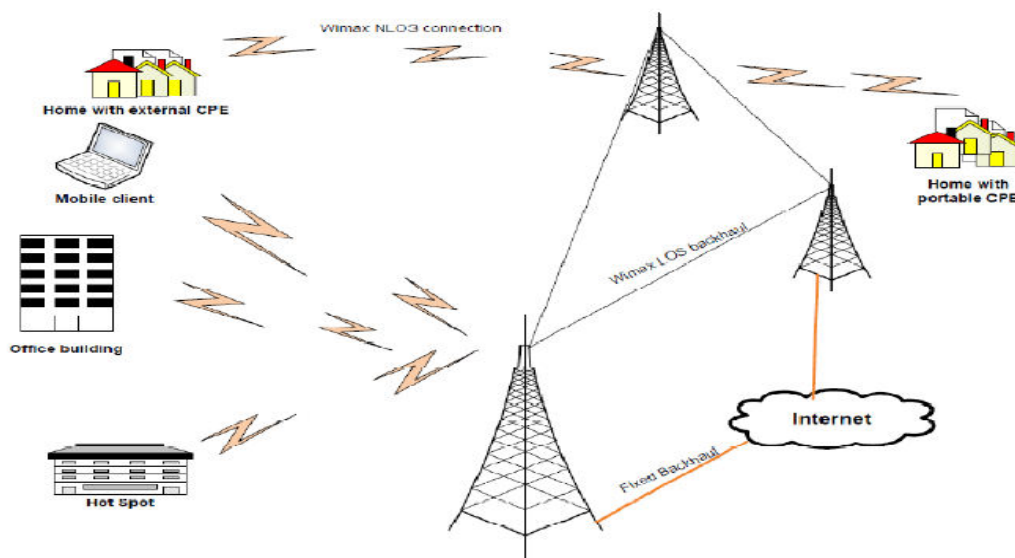


Figure 02: WiMAX Overview

6.1.3 Issues of Wireless Networks

There are various issues and obstacles that impede the implementation and the utilization of wireless networks. Therefore, many challenges are yet to be overcome. These issues are both common and specific depending on the type of wireless network. Some of the common factors include electromagnetic interference and physical obstacles that limit coverage of wireless networks; others are more specific, such as standards, data security, throughput, ease of use, etc.

6.2 WiMAX Network Architecture

WiMAX Forum Network Group (WiMAX NWG) has developed the network architecture of WiMAX to ensure interoperability among different vendors and their equipments. As depicted in Figure 6, the network architecture is based on the IP network service model and supports fixed, nomadic and mobile standards of WiMAX. The network architecture of WiMAX is logically into among three parts [8]:

- The device called Mobile Stations (MS) is used by the subscribers to access the network.
- Access Service Network (ASN) consists of Base Stations (BS) or a group of base stations through ASN gateways that connects with the core network.
- Connectivity Service Network (CSN) provides the IP connectivity and in charge with the entire core IP network functions.

Access Service Network:

The ASN contains BS and the Access Service Network gateways (ASN-GW), while the CSN comprises a number of network functions and provides IP connectivity to the mobile stations. below are discussed the details of these entities.

Mobile Stations (MS):

Devices used by subscribers to utilize different services offered by the WiMAX operators. The subscriber unit is either a portable, mobile terminal or a fixed terminal.

Base Stations (BS):

The base station is responsible for handoff decisions, Quality of Service (QoS) policies enforcements, DHCP proxy, session managements and radio resource management. It is also responsible for providing the air interface to the subscriber units.

Access Service Network Gateway (ASN-GW):

Access Service Network Gateway (ASN-GW) performs as layer 2 traffic aggregation point and acts within the Access Service Network (ASN). It is responsible for radio resource management, intra-ASN location management and paging, admission control, security issues like AAA, mobility management, encryption, QoS and routing to CSN.

Connectivity Service Network (CSN):

The CSN contains the Network Service Provider (NSP) that make available IP connectivity to ASN, Application Service Provider (ASP) responsible for providing value added services like multimedia applications using IP Multimedia Subsystem (IMS), the Authentication Authorization and Accounting (AAA) servers for users, devices and specific services. CSN also comprises the mobile IP home agent that carries the subscriber database. The other networks are interconnected with CSN through gateways (the other network may be PSTN or 3GGP etc).

CSN is also responsible for the management IP address mobility and roaming between different network service providers.

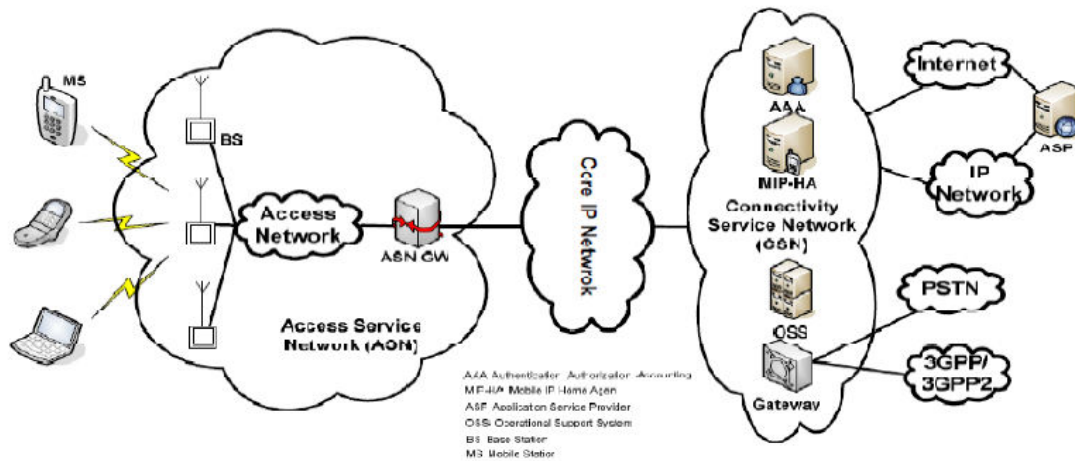


Figure 03: MiMAX Network Architecture.

6.3 Advantages of WiMAX Technology

WiMAX has been standardized with different goals as depicted in Figure 4 [9].

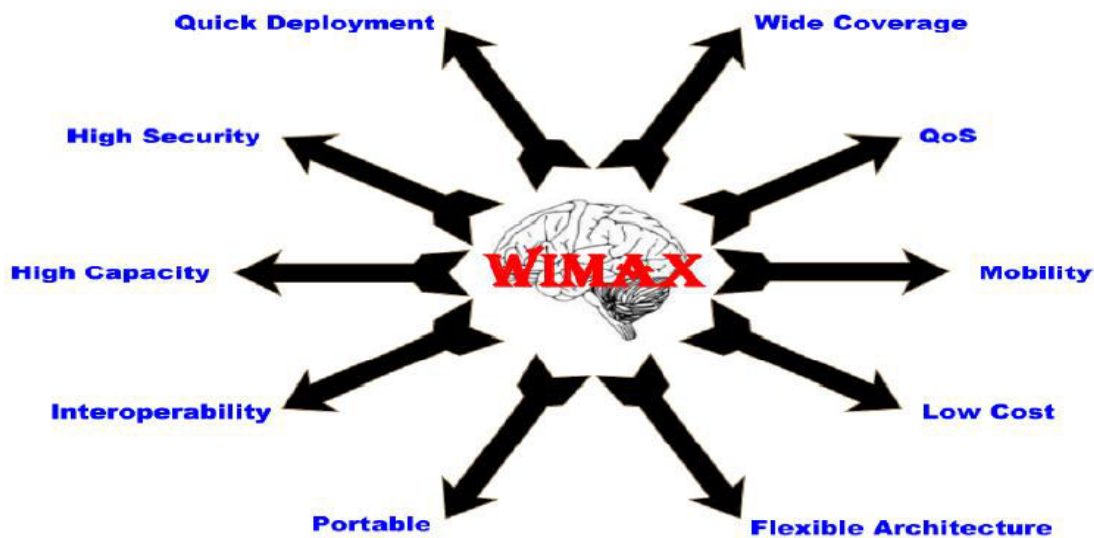


Figure 04: WiMAX advantages.

Interoperability:

Interoperability is the main objective of WiMAX. International standards acknowledge that interoperability makes it easier for users to move and use their subscriber module with different operators. All operators are able to choose equipment from different vendors because of the standardized adoption.

Wide Coverage:

WiMAX can adopt techniques that support several modulation levels, i.e., QPSK, 16 –QAM and 64 – QAM and thus WiMAX systems can cover large area.

High Capacity:

WiMAX provides higher bandwidths as compared to Universal Mobile Telecommunication System (UMTS) and Global System for Mobile communication. (GSM). It uses 64-QAM modulation technique which offers channel bandwidth up to 10 MHz.

High Security:

WiMAX can easily fit latest encryption standards like Triple-DES and AES. It encrypts the connections between the base station and the subscriber module, ensuring users authentication, integrity and confidentiality.

Flexible Architecture:

WiMAX supports several system architectures including:

- Point-to-Point
- Point-to-Multipoint
- Ubiquitous coverage

Quality of Service (QoS):

For ensuring QoS, WiMAX can be optimized for different types of traffic:

- VoIP
- Multimedia applications
- Data

Mobility:

The main key feature of WiMAX version based on IEEE 802.16e standard is mobility that is accomplished by introducing S-OFDMA and Multiple Input and Multiple Output (MIMO) techniques at physical layer, rendering it highly convenient for the mobile environment.

6.4 Disadvantages/ Disruptive of WiMAX Technology

6.4.1 Disruption for Telephone Companies

The broadband Internet connection made possible by WiMAX is IP and, using Voice over Internet Protocol (VoIP), the PSTN is bypassed. With the possible exception of terminating a voice call to a PSTN number, calls need not touch the PSTN. This is potentially very disruptive to incumbent telephone companies.

6.4.2 Disruption for Cable TV and Satellite TV Companies

A technology called TV over Internet Protocol (TVoIP) does for cable TV what VoIP does for telephone companies. It is now possible to simply convert cable TV programming and deliver it over a broadband Internet connection such as WiMAX. The programming is available in real time identical to the cable TV broadcast, and channels can be changed using a set top box while programming is displayed on a conventional TV set. No PC skills are required [9].

6.4.3 Disruption for Cell Phone Companies

VoIP technologies can be used for mobile telephony to replace incumbent cell phone technologies. It will soon be possible to replace an incumbent cell phone infrastructure for a small fraction of the cost of building the incumbent cell phone network. All that is really necessary is a WiMAX mobile phone and access to a WiMAX base station (the same base stations that deliver broadband Internet access, VoIP and TVoIP to residences and businesses).

6.4.4 Disruption for the Backhaul Industry

The building of multibillion dollar fiber optic networks marked the telecommunications boom of the 1990s. Very simply put, if WiMAX can beam 7.2 Mbps over 30 miles and the infrastructure costs only a few thousand dollars (radios, antennas), then services that backhaul (or transport) data via fiber optic cables and charge their customers thousands of dollars per month to do so are in jeopardy. This model can be extended to long distance backhaul as well. Microwave towers have long been the means of long distance backhaul for telephone companies. WiMAX is a means of simply expanding or augmenting these networks.

6.5 Orthogonal Frequency Division Multiplexing (OFDM)

6.5.1 OFDM Technique

OFDM modulation technique allows the combination of the concepts of modulation and multiplexing. It is available in research laboratories and text books for a quite long time but OFDM use in digital radio and wireless data networking has only been set in the last decade due to the rapid changes in modern communication system. Now-a-days, OFDM is practically used in many new wireless communication technologies. OFDM technique became so popular and is basically a special case or derived from the Frequency Division Multiplexing (FDM) [16]. Compared to traditional single carrier modulation scheme, the OFDM technique (multicarrier modulation) has several advantages:

- Very high frequency spectrum efficiency. Since in the OFDM system, sub-carriers are orthogonal to each other, channel spectrum overlapping is permitted, which can utilize limited spectrum resources maximally [7].
- OFDM system realization is relatively simple. Modulation and demodulation can be accomplished by FFT and IFFT.
- OFDM has the ability to fight multi-path interference. High-speed serial data streams are conveyed to parallel transmission which augments the duration of data symbols carried by corresponding sub-carriers. This effectively decrease the channel time dispersion caused by ISI.
- OFDM can use a different number of sub-channels to deliver different transmission rates between uplink and downlink. Actually, wireless data services are often nonsymmetrical, that is, downlink channels carry more traffic than uplink channels. This necessitates a physical layer that supports non-symmetric high-speed data transmission.

OFDM Shortcomings are:

- Is vulnerability to the effects of frequency offset. OFDM sub-carrier spectrums overlap each other, which necessitate strict orthogonality among them. Frequency offset impairs orthogonality and is able also degrade demodulation performance. Time offset can lead to OFDM symbol interference and amplitude attenuation.
- High peak-average power ratio is introduced by the use of OFDM. It is known that in OFDM, the output is a superposition of sub-carriers. When the phases of carriers are the same, this could lead to some instantaneous power

outputs which are higher than the mean power of the system. This leads to a larger Peak-to-Average Power Ratio (PAPR). The peak power can be out of range of linear power amplifiers if it is too high. This gives rise to non-linear distortion and changes the superposition of the signal spectrum. It also destroys sub-carrier orthogonality and degrades the performance of OFDM.

6.5.2 Basics of OFDM

OFDM is a combination of multiplexing (sharing of bandwidth between different channels) and modulation (scheme for transfer of information over carrier). OFDM divides the bandwidth of the transmission medium into multiple narrowband subchannels. Then on these parallel subchannels data is transmitted to defeat frequency selective fading [15, 17, 18].

6.5.3 Orthogonal Frequency Division Multiple Access

The major challenge of WiMAX is to deliver the high information rate efficiently in limited bandwidth to multiple users in the same locality. To perform this task, WiMAX employs Orthogonal Frequency Division Multiple Access technique in version 802.16e via which users share time slots and sub-carriers [20, 21]. OFDMA system has many advantages including:

- OFDMA provides a single user OFDM with respect to frequency diversity and robust multipath suppression.
- OFDMA systems can lodge many users through flexible multiple access techniques.
- It provides a variety of applications, data rates and QoS features.
- Allocation is dynamically and efficiently possible in OFDMA bandwidth
- In order to serve user population in an efficient way, OFDMA combines algorithms in the time and the frequency domain.
- OFDMA system relates to OFDM. It can minimize the transmitter power and PAR problem.
- OFDMA systems use hybrid multiple access techniques, FDMA and TDMA.

6.6 WiMAX's Path to Overcome

Several challenges are facing WiMAX. Following are classified some issues which require solution in order to fulfill the dream of last mile solution [10, 11].

6.6.1 Attenuation

Attenuation is the loss of power as the signal propagates in distance and time. Signals must be properly strong in order for the receiver to identify and interpret the signals. The receiver might not be able to identify the signal at all if the attenuation is high. Attenuation and delay should be constant for reliable communication [12].

6.6.2 Noise

Noise refers to the unwanted energy from sources other than the transmitter. It includes [3, 19]:

- Inter Symbol Interference (ISI)
- Intermodulation
- Thermal Noise
- Cross Talk
- Additive White Gaussian Noise (AWGN)
- Impulse Noise

6.6.3 Fading

Fading is the distortion experienced by a carrier signal during transmission. It is due to multipath propagation [13, 14]. Fading can be characterized as follows:

Flat Fading: takes place when bandwidth of a signal and delay spread is smaller than the symbol period and the channel bandwidth.

Fast Fading: takes place when there is a high Doppler spread spectrum in the channel and the coherence time is less than the symbol period.

Slow Fading: takes place when there is a low Doppler spread spectrum in the channel and the coherence time is greater than the symbol period.

Rayleigh Fading NLOS: (indoor, city) Rayleigh fading takes place when no multipath LOS does exist between transmitter and receiver and there is only indirect path to receive the resultant waves which is called NLOS.

Rician Fading: Rician fading best characterizes a situation where there is a direct LOS path in addition to a number of indirect multipath signals between the transmitter and receiver [4].

6.6.4 Delay Distortion

Delay distortion occurs as a result of different frequency components happening at different times, which corrupt the amplitude of signals and also delay the signals by different amounts at the receiver. Following are factors that introduce delay distortion in a communication channel:

Reflection: when radio waves collide with a smooth surface having a length larger than the wavelength of radio waves, then the waves make the same angle at which they collided to the surface and reflect back.

Diffraction: when a signal is obstructed by the edge of a dense body which has larger length as compared to the wavelength of the signal, then this phenomenon takes place.

Scattering: signal scatters into different direction when it hits a large rough surface with length similar or less to the wavelength of the signal.

VII. RESEARCH METHODOLOGY

The research methodology that would be used here tries to ensure that a consistent approach is applied to all phases of a project [5]. Methodology facilitates the achievement of the project with the necessary structure of the related process in the light of the phase defined. Additionally, research methodology is not just collections of method to execute a research; it is a systematic means to solve the research problem. This section concerns typically the research methodology which will be adapted from general methodology [6], but with slight modifications phases aimed to constitute on the development methodology phase and evaluation.

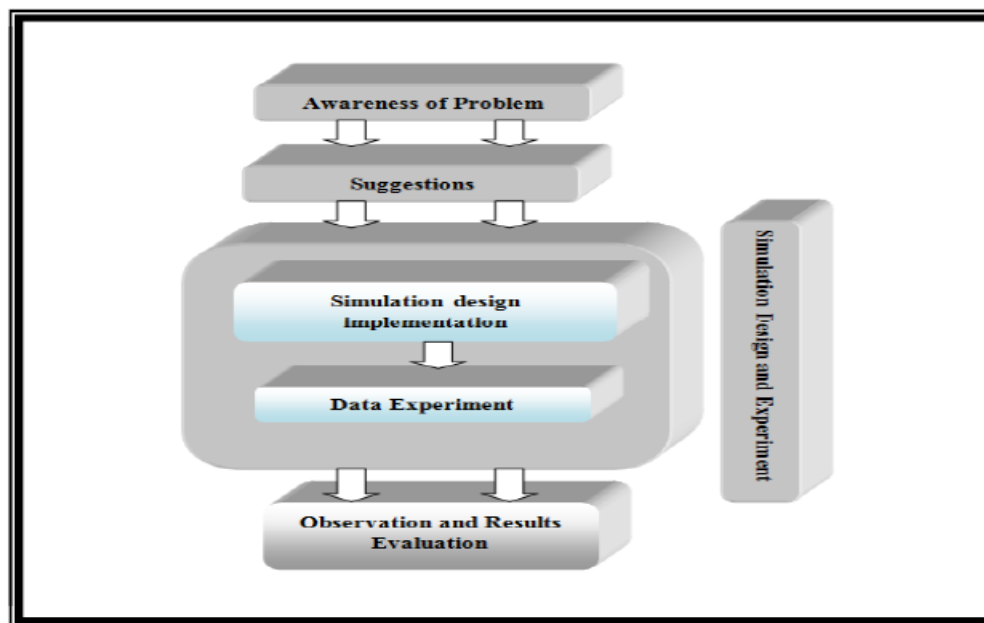


Figure 04: Research steps.

7.1 Awareness of problem

Through stage the candidate starts exploring various potential research topics in his domain of interest, and reviewing the problems that need solutions. The selection of these topics can be done during this phase through discussion and review of the similar proposed research. Data collection; firstly, understanding the research domain is critical step that allows the student to come up with the objective of his study are all involved in the awareness of the problem involves also the. More specifically in this study, as long as it will be about a WIMAX technology, information gathered in the

literature review covered all aspects of the WIMAX technology with OFDMA techniques, and all related sources of information about the study, while data concerning the practical will be drawn from LIBYANA and AL MADAR operators.

7.2 Suggestion

The implementation of simulation model design and the comparison between the two companies in terms of OFDMA parameters used represent the suggestion of this study. As tools will suggested to Handel that job is like MATLAB software application.

7.3 Simulation design and data experiment

7.3.1 Simulation design implementation

All the components of the OFDMA model will be implemented during this phase through the use of MATLAB simulink, The new simulation model design of modulation technique will be the outcomes of this phase.

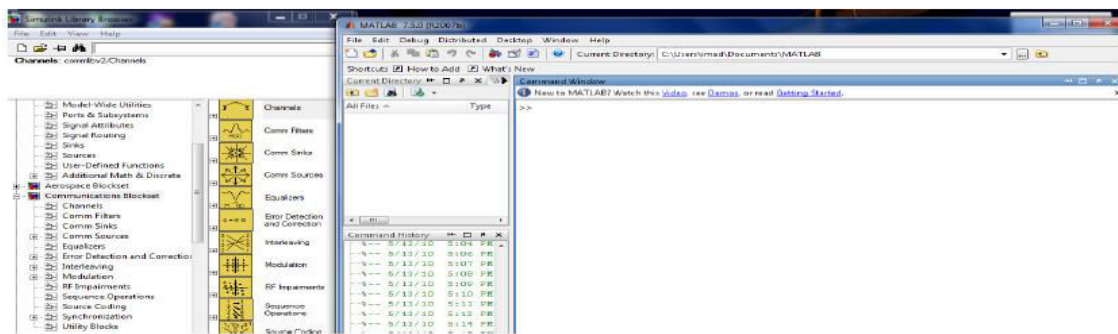


Figure 07: Matlab software application

7.3.2 Data experiment

The data collected from the companies during phase will be examined by using the simulink model which would has been implemented on the previous phase.

7.4 Observation and Results evaluations

This section will involve two parts observation and result evaluation. The observation concerns the implementation of simulink model. Then it will be followed by the treatment of the outcomes from the data experiment in order to evaluate results.

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