International Journal of Networks and Communications 2017, 7(3): 55-62
DOI: 10.5923/j.ijnc.20170703.02

WiMAX for Online Service Transmission

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Abstract One of the most challenging in today's technology based world is working on real time for almost everything, an interrupted and high data speed is required. This paper attempt to proffer WiMAX as the best option amidst all other technology for wireless network deployment. A scenario was created, and after a comparative analysis, mobile WiMAX leveraging on the WiMAX Broadband Service (WBS) is preferred and used to proffer a solution.

Keywords Base Station, WiMAX Broadband Station

1. Introduction

With the rapid increase in computer devices such as laptops, personal computers, mobile devices and other intelligent devices, our lives had been totally networked and it is almost impossible to exist without it. Information is required at every point in time – personal details for bank transaction, business information for effective distribution of products and services, travel guide details for security, bus pass readers etc.

Computer networking is concerned with communication between and amongst all intelligence devices [1] which may be widely apart (www, internet) or within same vicinity (LAN, Bluetooth). The main purpose is for information and resource sharing which has become essential in our world today to save cost – money, time and energy.

This report will essentially provide a general over of networking technologies available, the types of device used, mode of transmission and the different areas of implementation. It will present analysis of online systems, its operations – referring to how online systems are implemented and managed in today's world with examples. It will also outline a detailed explanation of WiMAX which is the focal point and how it can / could be used in transmitting online services that are essential in our daily lives of fast track.

2. Networking Technologies

Networking technology in general term is the application of networking architecture within an organizational system, applying the principles of networking-interconnecting systems within the establishment. The e-learning system in colleges and universities today is based on it. Network monitoring devices are used to collect data for authentication and structured in a centralized manner for effective management, online resource availability and to facilitate the front end of learning [2].

The network technology an organization implement depends on the network policy in place [3]. The policy defines the priorities – measuring performance against speed, data security, availability, reliability, quality of service and above all cost.

In a broad approach, network technology has 2 distinct categories – the traditional and the active network [4]. The traditional network transmits data passively with no direct input from the user in the course of transmission while the active network provides room for user program injection. Thus users and vendors are at liberty to introduce programs runable in the network.

As much as the active network speeds up the transmission of data, it also have a security breach, any person with access (legally or hacked) can inject a program.

The knowledge of this has rapidly aided the development of networking technologies from the wired (the use of cables) to wireless (radio frequencies) and standardization of technologies. The focus of this report is on wireless.

Wired network involves the use of traditional cables, digital subscriber line, Ethernet and optic fiber. It is efficient, reliable and has high bandwidth. However, it is expensive to deploy and maintain for carriers. Also, in remote and rural areas, carriers are not willing to build the necessary infrastructures; this explains the slow pace of internet deployment in these areas.

The wireless networking technology is based on radio frequency (RF) which dates back to the 1970s [5] and has developed over the years with different technological reforms ranging from the architecture, the devices and how frequencies are distributed during data transmission. Frequencies used in transmission are usually regulated by the

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Published online at http://journal.sapub.org/ijnc

IEEE which also establishes standardization for wireless devices enabling coexistence and interoperability amongst such devices. Unlike its cable counterpart that has low interference, wireless transmission has high rate of interference which constantly distorts signals during transmission. The level of interference tolerance is greatly determined by the technology used, such as the way in which frequencies are distributed, channelization, the range, the line of sight and the general mechanisms of the technology.

Just as in the case of wired network, the wireless network has the logical and the physical architecture.

i. The physical comprises of the various topologies such as point to point, mesh, star, point to multiple etc [5].
ii. The logical architecture is made up of the different layers such as network, data link which actually coordinates the signal / data transmission.

3. Examples of Wireless Technologies

i. 3G Technology – this uses satellite radio channel, antenna and the cellular system for communication – transmission of signals. Within the ambits of this is modulation technique, multiplexing technique, signal propagation and spread spectrum.
ii. Bluetooth – is an IEEE 802.15 that operates in a short range, uses low power and cost less compare to other forms of technologies [6].
iii. Infrared – this uses line of sight and diffuse light reflected in objects (walls, furniture etc), and exist between sender and receiver [7].
iv. WiFi – is wireless fidelity, 802.11. It is designed to operate within indoors and easily incorporated into wired LANS. It is a technology that easily serves the front end of a network.
v. Others are WiMAX (which will be discussed later), HIPPERMAN, WiBro etc.

4. Wireless Concept Definition

Signals – the physical representation of data or information. Communication is done through the sending and receiving of signals.

Signal propagation – has 3 elements: range of transmission, range of detection and interference range [7].

Multiplexing – this is the description of how several users can share a medium to send and receive data with minimal or no interference.

Modulation – this is the wave that shows how signal looks like during transmission. Different things can the discovered by observing the sine wave curve such as the strength of the signal.

Frequency – this is the repetition of wave.

Channel – splitted or slice bandwidth into small sections.

Features of Wireless Network

- Wireless network is not synonymous with mobility although it has element of mobility.
- Has high rate of interference. However, the level of interference varies from technology to technology
- Can easily be implemented in rural and war turned zones where infrastructures had been destroyed.
- Have varieties of technologies to choose from with standardizations.
- High level of security as authentication is required at every instance of communication.
- Convergence and extensible
- Cost saving

5. The WiMAX Technology

Broadband wireless access technologies have been available for a while and the primary aim of all the technologies was to provide a high data rate transmission but wirelessly connected to fixed and stationary sites [8]. Examples of such applications are the building to building bridging, access / connection to remote sites etc.

Just like every proprietary technical solution, there were lots of problems such as poor interoperability and compatibility amongst product, high scale economy, readily unavailability, deployment issues etc.

WiMAX belongs to the IEEE 802.16 WMAN technology family and is referred to as Worldwide Interoperability for Microwave Access. It is intended at the following:

- To provide a standard broadband access
- Make it affordable
- Revolutionized broadband communication in developed countries and at same time bridge digital divide in third world countries [8]
- Improve quality of life which will eventually lead to large economic of scale.

The summary is to make wireless broadband access available anywhere, anytime and run on any device that has some form of intelligence. These intentions characterized the basic features of WiMAX, which;

- Flexibility, extensible and robustness
- Improved performance
- End to end IP based support
- Secure mobility
- Broadband speeds for voice, data and video
- Adaptive Modulation
- Use of OFDMA
- Supports FDD and TDD
- Shares data up to 70mbps and 3-5 mile coverage
- Expanded capability on the IEEE specifications.

6. The Architecture

i. The Physical Architecture
ii. Logical Architecture

***6.1. The Physical Architecture*:** This comprises the physical connection between the base stations (BS), the subscriber station (SS) and the World Wide Web / internet. See the figure below

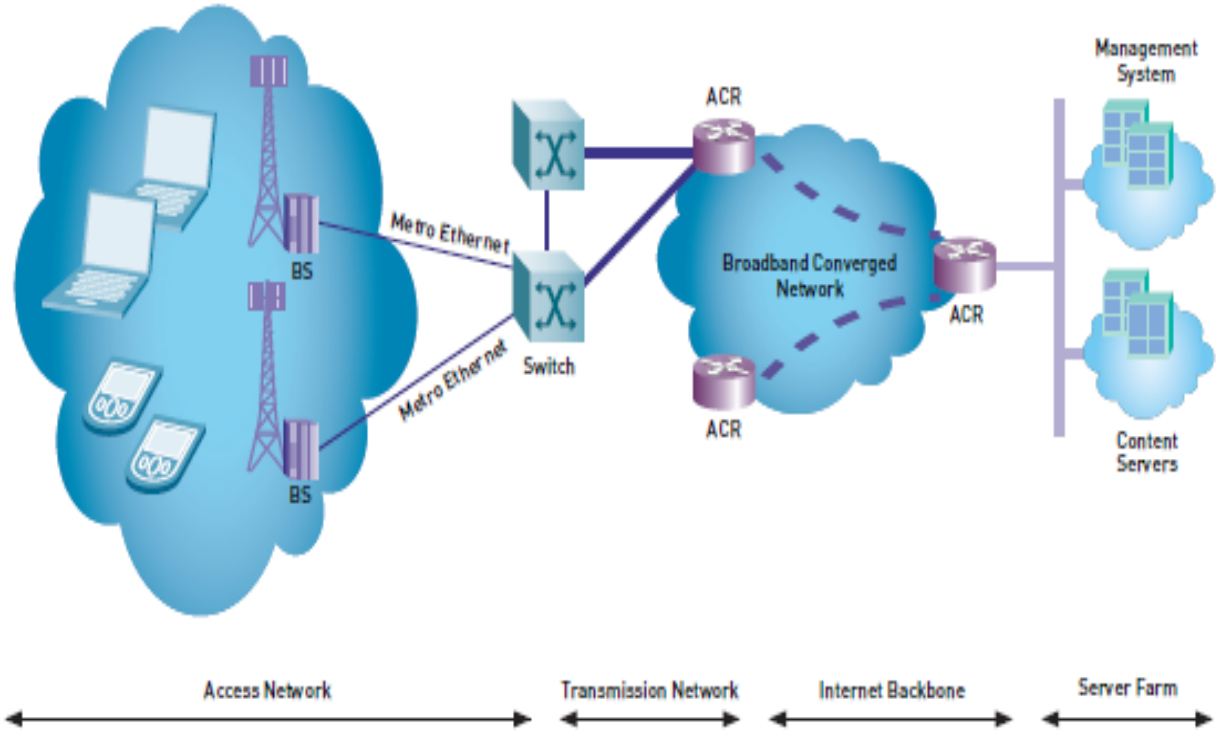

Figure 1 [9]

A subscriber station connects to the base station which makes up the access network, the in turn connect to the switches, linking it to the access control router (internet) and the content servers making the page content available.

6.2. The Logical Architecture: this is made up of 2 layers.

- Media Access Control (MAC) Layer
- Physical Layer

6.2.1. The Media Access Control (MAC) Layer:

This supports both point to point and point to multipoint architecture.

There are 3 sublayers:

- Convergence sublayer: this has 2 specifications; ATM and packet. Features / function of this sublayer are
  i. It is programmable. That is it is distinct from other parts of MAC as such vendors to reprogram it to support other protocols
  ii. It is also the platform that connect MAC to the upper layer with the OSI layer structure
  iii. It receives data from the higher (upper) layer and makes classification of the frame and sends it to CPS. Based on the classification made, further processing could be carried out.
  iv. It also accepts data from CPS
- Common Part Sublayer (CPS): this is the central aspect of MAC. It performs the following functions:
  i. Defines the medium access
  ii. Responsible for duplexing, network entry and initialization
  iii. Quality of service, framing and channel access
  iv. Can send data to CS
- Security Sublayer: this is a privacy layer. It responsible for privacy across wireless network and also provision of strong protection to operators. It encapsulates protocols and manages the privacy key protocol.

6.2.2 Physical Layer: PHY layer converts the data frame into signal for transmission across air interface. It is designed for 2-11GHZ range. It is also responsible for time slot allocation to subscribers, thus guaranteeing bandwidth availability. It uses time division duplex, frequency division duplex or OFDMA.

WiMAX Transmission

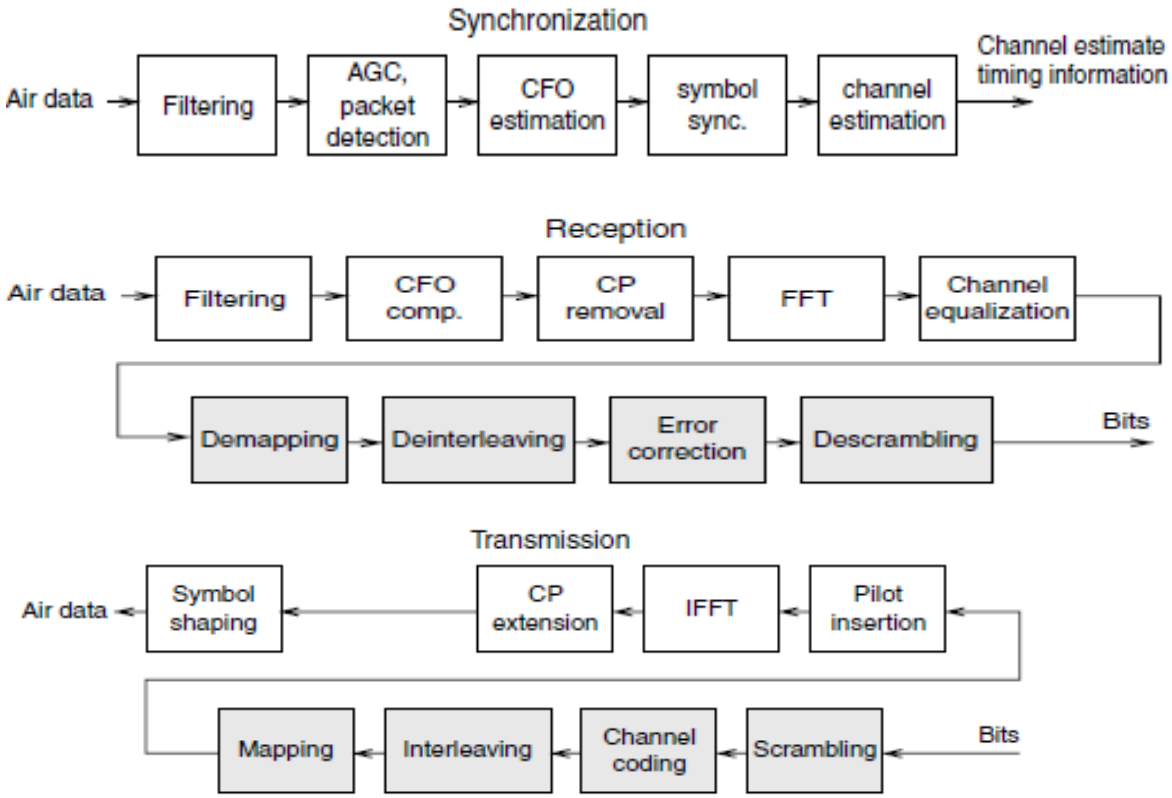

Figure 2 [10]

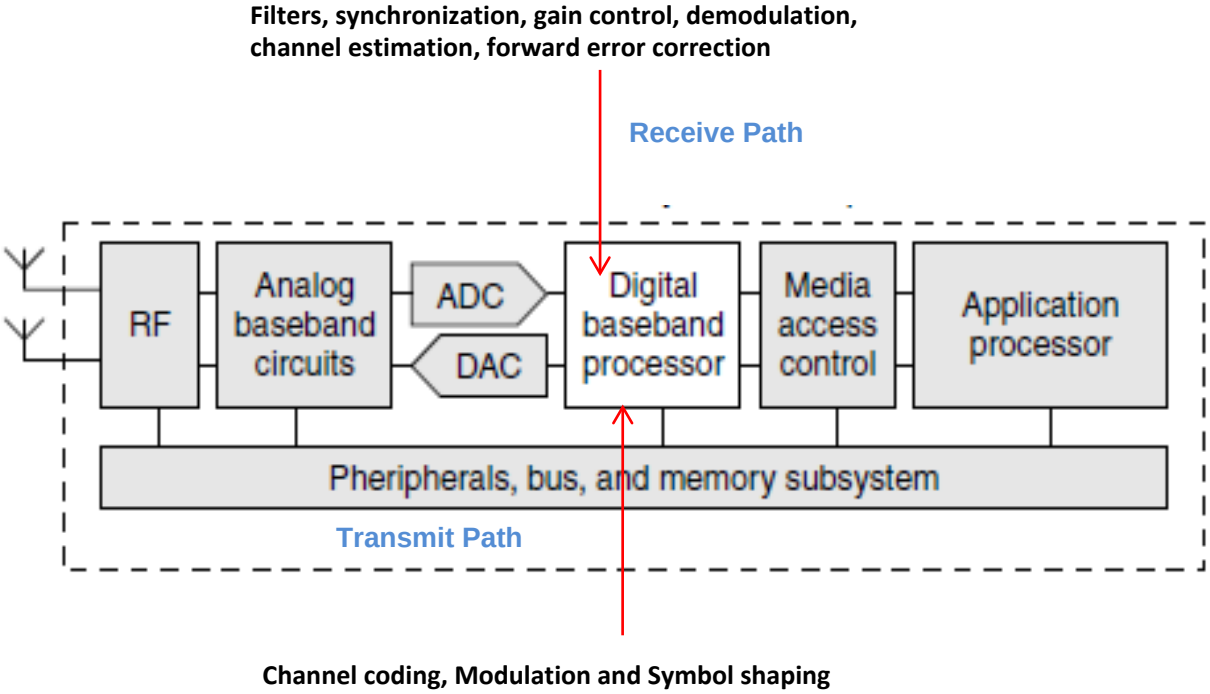

Figure 3

In the transmit path, the radio frequency is converted into analogue using the digital analogue converter before been sent to baseband processor where channel coding, modulation and symbol shaping is carried out then to the application processor. On the receive path, the opposite is carried with the analogue digital converter converting the signal into digital, demodulation, filtering, synchronization and forward error correction. WiMAX attempts to synchronize the frequency used and the time slot in other to maximize the overall throughput.

7. Current Issues on WiMAX and Applications

This section deals with brief summaries of researches going in WiMAX technology and the various areas where it is been applied.

WiMAX backhaul for environmental monitoring is a research work that summarizes the possibilities of using WiMAX as a backbone for monitoring the environment [11], using sensor to collect data. In this case, WiMAX is deployed as a backbone.

Dynamic System-Level Simulation of Dynamic Frequency Planing for Real Time Services in WiMAX Networks introduces and reviews the use of WiMAX analyzing the performance several other networks [12]. In other to achieve the desired result, WiMAX simulation was used in real time services such as voice over IP and video.

WiMAX is been considered as a suitable wireless network technology for dynamic spectrum access in heterogeneous networking environment [13]. It is proposed that a cross layer PHY-MAC using certain algorithm will allow WiMAX to access spectrum, maximizing the bandwidth.

With live streaming of videos been a common place on the internet, buffering is becoming an issue. Several solutions are recommended and some are been implemented, yet researchers are currently looking at how to reduce buffering and waiting time on WiMAX systems [14]. The whole idea is to provide video on demand and improve draw back mechanisms by using the reminder arrangement broadcasting to reduce the required buffer and hybrid RAB to shorten the waiting time.

The utilization of sleep-mode to save processing power and redirect it to where is required is been propounded by using certain algorithm (periodic on-off scheme and aperiodic on-off) in WiMAX [15]. It was observed that using PS and AS effectively and efficiently scheduled packets in real time communication in WiMAX, thereby saving processing power but then it was been utilized by another within same system.

8. Online Service Transmission

An Online System is a standby system which is connected and managed at all times by an intelligent device (pc, mobile phone etc) that receives and disseminates data [16]. It is not same as website even though websites are usually online. Such a system could be hardware or software that runs in the system. Whatever the case, it has to be readily available for retrieving data as at when needed.

8.1. Problem Assumption

A medical doctor (GP) wants x-ray result of his patients sent to him as soon as it has been taken for prompt medication, easy transfer of reports to a specialist and control purposes. He lives about 100miles away from the city, the conventional method is postage which sometimes comes late and is just a summary of the result, he wants details and in its original content.

8.2. Proposed Solution

Factors to consider

- Reliability
- Security – data protection policy
- Cost
- Speed – time frame
- Coverage
- Architecture
- Existing system incorporation

This requires interconnection between the GP's office (hospital) to the radiologist office (hospital). The use of wired network is not feasible due to the cost, architecture and already existing LAN in both hospitals. The use of wireless on the other hand is visible but which of the wireless technology can be deployed?

9. Comparative Analysis of Wireless Technologies

WiFi – Wireless Fidelity (IEEE 802.11) is basically for indoors and limited in it coverage (about 10-30m). It is suitable for short distance connection (Local Area Network).

Cellular – This includes GSM and CDMA with complex architecture because several antennas and cell base station had to be erected for effective transmission. It is also relatively expensive but very high bandwidth.

WiMAX – IEEE 802.16, belong to WMAN family. It is not an extremist technology. It can be deployed in different situation and also extensible to accommodate expansion and at same time serve as the backhaul for WiFi. Relative cost effective compared to Cellular technology.

See detailed comparison in the table below.

Table 1

Features	WiFi	WiMAX	Cellular (3G)
Cost	Relative	Cheaper than 3G	Expensive (frequency and infrastructure)
Range (Coverage)	10 – 30m (indoors)	50m – 20km (outdoor)	5 – 30km
Security	802.11i – standardize version	Supports different security mechanism and is open for vendors to include their security support.	Cryptographic authentication, IMEI integrity, radio interface encryption, user allocation and temporal identity.
Interoperability	Can be incorporated into wired network, wimax.	Compatibility with most wireless network. Can serve as a backbone	Backward compatibility
QoS	No load balancing and no known QoS enforcement	Data oriented MAC, has 4 standard ways of ensuring QoS, load balancing enforced at the BS	Circuit-Switched MAC, provides end to end service, has 4 classes of QoS.
Scalability	Possible when deployed with other technology	Programmable MAC, extensible, radio technology, different channelization and network architecture	Can easily be expanded as the technology is based on cellular cites, working on including OFDMA
Technology maturity	Several standardizations including security (802.11i)	Available standards, OFDMA already in use, yet to develop and implement HSDPA	HSDPA is already been used but is yet to incorporate OFDMA
Deployment	Easy deployment.	Requires the setting up of base stations.	Requires erecting antennas and setting up cell sites
Speed	54mbps (depending on the standard been used)	30 – 50mbps	15 – 20 MHz

Each technology has its merits over the other, however considering the required features, WiMAX is a better option. The cellular (3G) has a strong base in mobile communication with well-established modulated frequency. It is complex and the cost is too for the purpose. But in situation where inter connectivity within the entire region (UK and Europe) instance, 3G offers better solution in terms of technology and cost (reuse of cell cites).

10. Implementation

In implementing WiMAX to solve the assumed problem, there are basically 2 levels in which patient's health record details are required – the local detailed clinic (use by the healthcare communities (GP)) and the national summary clinical record(to support for emergency, those that falls ill while away). See diagram below.

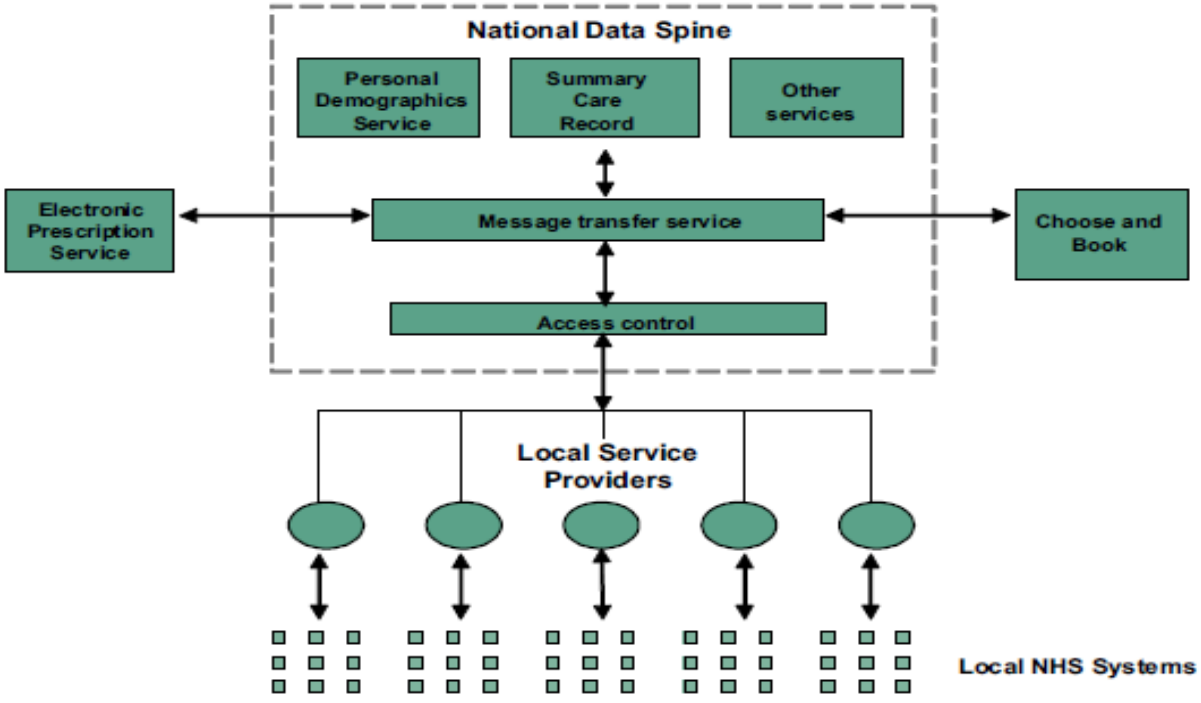

Figure 4 [17]

At each level there has to be a computer accessible x- rays (picture archiving communication system) of patients by authorize persons. At the local service provider (Local clinics of the GP and the Radiologist), WiMAX technology is deployed which makes it easy for the radiologist to send the result via internet to the GP. On the other hand, all local clinics within a county (Nottingham) could have a centrally administered system and access / authorization is granted to registered NHS doctors. This means that the radiologist simply saves the result in the central system which is access by the GP. This in turn can be periodically uploaded to the national central system for archiving purposes. In each case WiMAX is deployed. See figure below.

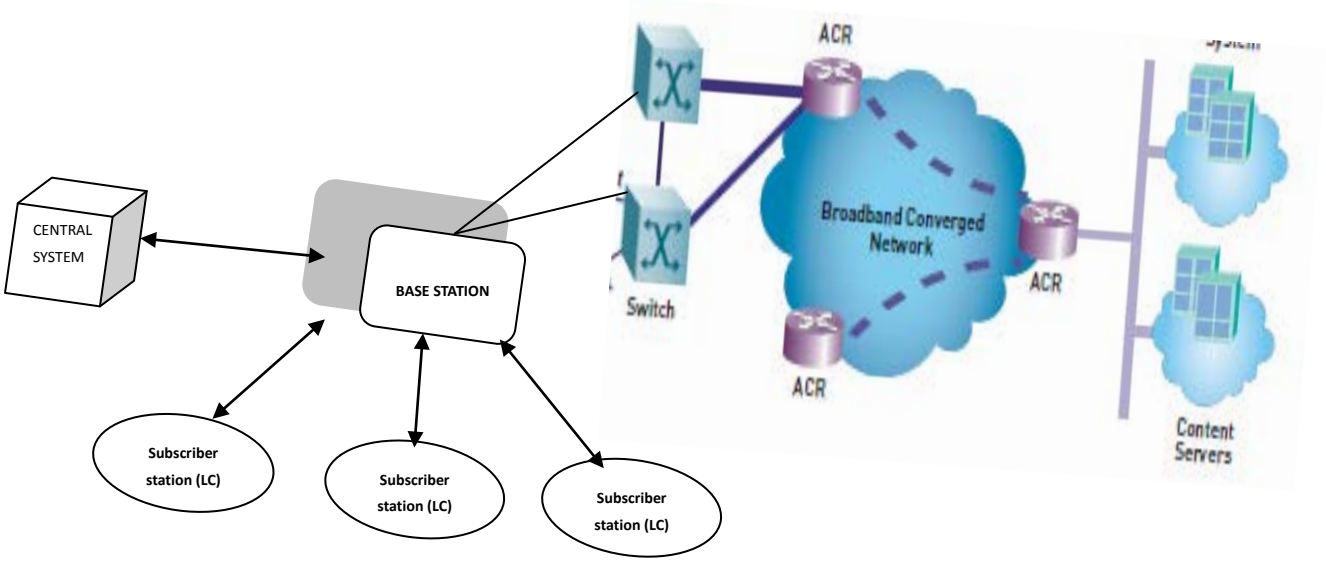

Figure 5

11. WiMAX Performance Analyses

Quality of Service: WiMAX maintains QoS by defining certain requirements such as admission control and proper scheduling. It determines when a call is put through or accepted depending if the call QoS is supported or not. The IEEE 802.16 also predefined 4 basic standards: unsolicited grant service, best effort, real-time polling service and nonreal-time polling service [10], and bandwidth is given based on request and granted per connection or per SS (GPSS). There will be bandwidth availability for both transmission and reception on each subscriber.

Security: Since WiMAX is open and support different mechanisms, only devices from reliable vendors with additional security features will be purchase. Also, the system administrator can implement other levels of securities aside the ones already provided by the technology and the vendor.

Interoperability: Already existing LAN can be easily incorporated into the new network enabling server – client environment with the WiMAX serving as the backhaul. This minimizing fresh or total overhauling of the entire system.

Speed: The available bandwidth is sufficient for data transmission and the fact the technology could be extended to meet increased demand makes it suitable and reliable.

WiMAX supports high data rate, high sector throughput, multiple handover mechanism and power saving mechanism for mobile advances [18]. The low latency supports real time application such as live video streaming.

The distance coverage ranges from 7-10km and can be extended 50km when omni directional antenna is used [19].

12. Conclusions

WiMAX based on the IEEE 802.16e standard is fast becoming the alternative solution to DSL for the Broadband Wireless Access (BWA) [20], with its improved handover hopping system – determining the best handover with base station (BS) while in mobility (MS). [21]. WiMAX despite its challenges, is most preferred in an online even real time service transmission. It has been able to handle mobility and availability with speed.

Off cause, we have the politics of technology deployment, and will always be there just like the right and the left wing. However, cost is a major determinant as well as the question ‘can the technology do the job?’

The researcher’s duty is to objectively look at each and propose a solution which is what this report is all about.

In essence, requirements set the basis for technology deployment and in areas of conflict trade-offs are made to accommodate or improve performance, and in this case, WiMAX mobile does the job well.

REFERENCES

[1] http://compnetworking.about.com/od/basicnetworkingconcepts/Networking_Basics_Key_Concepts_in_Computer_Networking.htm

[2] Li Bian, Research on E-learning Based on Network Technology, Networking and Digital Society, 2009. ICNDS '09. International Conference on 30-31 May 2009 Vol.1, page 289 – 292.

[3] Ceruti, M.G. Duffy, L. Arias-Thode, Y.M., Analysis of Policy and Standards for Joint C4ISR Network Technologies, Policies for Distributed Systems and Networks, 2007. POLICY '07. Eighth IEEE International Workshop on, 13-15 June 2007, pages 273 – 273.

[4] Su Sen Yang Fangchun Chen Junliang, An intelligent network architecture based on active network technology, Communication Technology Proceedings, 2000. WCC - ICCT 2000. International Conference on, 21-25 Aug. 2000, pages1081 - 1086 vol.2.

[5] Steve Racley, Wireless Networking Technology from Principles to Successful Implementation, 2007, Newnes Oxford.

[6] James F Kurose and Keith W Rose, Computer Networking – A Top Down Approach, 5th ed., 2008, Perason, USA.

[7] Jochen Schiller, Mobile Communication, 2nd ed., 2003, Wesley, England. A Wireless Networking Technologies Overview over Ubiquitous Service Applications.

[8] Syed Ahson and M Ilyas, WIMAX – Applications, 2008, CRC Press, America.

[9] Symmetricom, Timing and Synchronization in WiMAX Networks, NGN Series.

[10] Syed Ahson and M Ilyas, WIMAX – Technology, Performance Analysis and Quality of Service, 2008, CRC Press, America.

[11] Tuomas Nissilä Kostas Pentikousis Ilkka Harjula Jyrki Huusko Mika Rautio, WiMAX Backhaul for Environmental Monitoring.

[12] David López-Pérez, Alpár Jüttner, Jie Zhang, Dynamic System-Level Simulation of Dynamic Frequency Planing for Real Time Services in WiMAX Networks.

[13] Soumaya Hamouda, Bechir Hamdaoui, Dynamic Spectrum Access in Heterogeneous Networks: HSDPA and WiMAX.

[14] Jenhui Chen, Jui Hsiang Sun, Low Buffering and Waiting Time Videoon Demand Broadcasting Scheme for WiMAX Systems.

[15] Shiao-Li Tsao, You-Lin Chen, Energy-efficient packet scheduling algorithms for real-time communications in a mobile WiMAX system, Computer Communications 31 (2008) 2350–2359, March 2008.

[16] http://www.britannica.com/EBchecked/topic/429262/online-system

[17] House of Commons Committee of Public Accounts Department of Health: The National Programme for IT in the NHS Twentieth Report of Session 2006–07 *Report, together with formal minutes, oral and written evidence Ordered by The House of Commons to be printed 26 March 2007*. http://www.itr-rescue.org/bin/pubdocs/mtg-weekly/9-1605%20Intel_WiMAX_White_Paper%20%28Hassib%29.pdf.

[18] Merchant, Ali Asghar and Sohi Ravneet, Performance Evaluation of WiMAX Networks with Mobility in Metropolitan Area Network, 2014.

[19] Deepika Rathore, Rajeev Paulus, AK Jaiswal, Magur Kuman, Performance Evaluation of A WiMAX Mobile Networks Using Omnidirectional Antennas, International Journal of Current Engineering and Technology, Vol.4, No2, April 2014.

[20] Samtosh Kumar Yadav, Rajeev Paulus, AK Jaiswal and Ashish Xavier Das, Performance Analysis of Mobile WiMAX Handovers with Various Speed Using CBR Application, International Journal of Current Engineering and Technology, Vol.4, No3, June 2014.

[21] M Dhmvakumar, MC Chandrashekar, MZ Kurian, Design and FPGA Implementation of Address Generator Using Different Modulation Schemes For WiMAX Deinleaver, International Journal of Current Engineering and Technology, Vol.4, No2, April 2014.