EVALUATION OF THE EFFICIENCY TECHNIQUES WIMAX AND WI-FI AND THEIR RELATIONSHIP WITH SOME INTERNET APPLICATIONS

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Abstract: Wireless broadband networks are high performance and give us many capabilities besides coverage to show the works in remote areas that is difficult to accesses and which are lacking for wire networks. Wireless networks provided us an alternative solution to this problem in term of access to information changed the ways people for communicate and exchange information among themselves by overcoming the problems of distance and location. Results of this study showed the analysis and comparison for the implementation of wireless broadband services solving the technical variances and the integration of each other between the networks Wi-Fi and WiMAX.
Keywords: Wi-Fi, WiMAX, QoS , Security and Wireless Network.

I. INTRODUCTION

Wi-Fi Mesh network architecture works with three layers (Data Link Layer, Network Layer and Transport Layer) which are Mesh access handling user access to a Mesh node, Mesh transport interconnecting Mesh nodes, routing traffic to Mesh gateways, backhaul connecting a Mesh gateway to an Internet Point of Presence or other content Gateways. A Mesh network is a kind of wireless networking that employed surplus and distributed nodes to equip greater reliability and range for any given wireless network. A number of smaller nodes, called repeaters, connect to broad nodes or wireless routers to provide coverage over a broad area than would be likely with a wireless router alone [1]. In addition, it can be seen that backhauls for Mesh Wi-Fi networks are also provided using different wired and wireless solutions which are basically fiber optic, leased line, Digital Subscriber Line (DSL), and proprietary point-to-point (PTP) or point-to-multipoint (PMP) radio including some pre-WiMAX equipment [2]. Wireless Mesh networks have been expected to be effective way out for the next decade wireless networking. The attractions of wireless Mesh networks comprise easy plug and play, cost effective and flexible interoperability with other networks [2]. In Wireless Mesh Networks there are two types of nodes included which are Mesh routers and Mesh clients. Mesh routers form the infrastructure backbone for clients. In other words, wireless Mesh networks are multi-hop Ad-Hoc wireless networks. However, compared to conventional Ad-Hoc wireless networks, wireless Mesh networks contain wireless nodes, which can be either mobile or fixed. Communication in wireless Mesh networks between two nodes in wireless Mesh networks mostly relies on infrastructure. The majority of the traffic is user- to-gateway oriented, whereas in conventional Ad-Hoc networks, traffic is mostly user-to-user oriented.

In this paper, investigate the current technical trends of (Wi-Fi and WiMAX) Mesh network and possible methods for different configurations. The rest of the paper is organized as follows. Section II material and methods. Section III contents the results and discussion and in section IIII conclusions.

II. MATERIALS AND METHODS

A. Wi-FI and WiMAX Comparison

In[3]. Wi-Fi connection can transmit up to 54Mbps under optimal condition, so reach up to (46m) indoor and (92m) outdoor. It is found that alternative broadband service model would be with both Wi-Fi and WiMAX where Wi-Fi can be used to reach the end user and at the same time can take advantage of WiMAX to minimize backhaul cost, reduce the time for service provisioning and reduce customer acquisition cost. Hierarchical model for bandwidth management and admission control in integrated IEEE 802.16/802.11 wireless networks is presented. In order to satisfy the Quality of Service (QoS) requirements integration method proposed [4]. It also presented a novel architecture for integrating IEEE 802.16-Mesh with IEEE 802.11. Indeed this architecture adds the Mesh capability to the already existing integrated wireless local area network (WLAN) – wireless metropolitan area network (WMAN). It can be showed that the Mesh architecture has indeed superior performance due to the inherent properties of Mesh networking paradigm. The proposed model for the integration of Wi-Fi and WiMAX Mesh network architecture with the existing model can be shown in Figure 1.

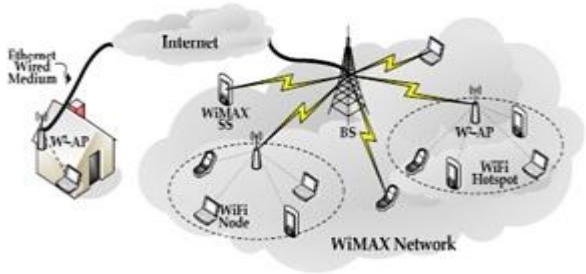

Figure (1): General Architecture for Integration of Wi-Fi and WiMAX Mesh Network

In addition, there are some differences in these techniques. Wi-Fi is a WLAN, based on the IEEE 802.11 standard, published in 1997, and the 802.11b is a variant, published in 1999. WiMAX is a broadband wireless access (BWA), including mobility, based on the IEEE 802.16 standard, published in 2004, and the 802.16e variant, published in February 2006. Furthermore, there is a variance of about some years between the two [3]. Table 1 shows, some comparison elements like (data rate, QoS, range frequency, multiple access and typical usage) between Wi-Fi & WiMAX. One of the key factors appear in Table (1) below is the Physical data rate. The highest data rate method is displayed in the table. For all these packet-type transmissions, there is no fixed value for a data layer data rate value due to retransmission, link adaptation, and variable header sizes. WiMAX has a much better performance than Wi-Fi but this comes at the price of a higher cost in frequencies and in devices complexity. Then, it is insures that WiMAX could one day soon replace Wi-Fi for some applications [5].

Table (1) Comparison between IEEE (802.11 and 802.16)

items	Wi-Fi (802.11)	WiMAX (802.16)
Primary Application	Wireless LAN	Wireless MAN designed for broadband wireless
Scalability	MAC designed to support tens of user	MAC designed to support thousands of users
Range and Coverage	Mainly designed for indoor Optimized for 100 meters No mesh topology is supported	Designed for outdoor NLOS performance Optimized for 50 km Mesh topology is supported
Half / Full Duplex	Half	Full
Security	Security is optional here. Better encryption technique like WPA and WEP available now	3 DES (128 bit)
Frequency Band	Unlicensed Band (2.4 – 5) GHz	Licensed and Unlicensed Band 2 GHz to 11 GHz
Mesh	Vendor Proprietary	Yes
QoS	No QoS support	Grant Request MAC Mainly designed to support voice and video
Mobility	In Development phase now	Mobile WiMAX build in to 802.16e
Channel Bandwidth	On the range from (20-25) MHz	Adjustable range from 1.25 to 20 MHz
Bandwidth Efficiency	(0.44 - 2.7) bps/Hz	<=5 bps/Hz

B. Connection Configuration:

There are three different connection configuration as follows

* Connection between Wi-Fi mobile stations in the same domain. This type of connection, the Wi-Fi mobile user's stations are able to simply connect to each other through the access point component of WiMAX-Wi-Fi Routers(WWR).

* Connection between Wi-Fi mobile stations of two different domains. That means the source station should send its request packet to the WWR and it will forward the packet to the WiMAX base station.

* Connection between the WiMAX subscriber stations and Wi-Fi stations, which WiMAX subscriber station (SS) sends its request packet to the base station (BS), which forwards it to the destination station through the WiMAX, Wi-Fi Routers [6].

C. WiMAX Mesh and Wi-Fi Network Architecture

The Mesh transport layer improves the correlations between Mesh nodes. Mesh nodes using standard equipment based on the IEEE 802.16-2004 or 802.16e which includes support for optional Mesh topology. In addition to, WiMAX has built-in QoS support and is optimized for longer distance (WiMAX is a wireless MAN while Wi-Fi is a wireless LAN). Substantially, at the moment, Wi-Fi solution uses proprietary technology developed which cause interoperability issues. Meanwhile, WiMAX can substitute of Wi-Fi in this layer. The Mesh Wi-Fi and WiMAX network works with three layers for the operation which are described as follows:

* Mesh Access Layer

For Mesh access layer, at the moment users connect using their Wi-Fi-enabled laptops, IPad, or smart phones. WiMAX integration into such portable/mobile devices is still in its early stage of development. However, in several months/years to come one may expect the emergence of dual-mode Wi- Fi/WiMAX devices and network adapters (network interface controller (NIC), personal computer memory card (PC), peripheral component interconnect express (PCI Express)) which can connect automatically to any available network with the best signal quality [7].

* Mesh Transport Layer:

The Mesh transport layer provides the interconnection between Mesh nodes. WiMAX can naturally replace Wi-Fi in this layer, interconnecting Mesh nodes using standard equipment based on the IEEE 802.16-2004 or 802.16e which includes support for optional Mesh topology. Functions between systems the WiMAX cellular systems come closer to WiFi through architecture, that is includes

* Operating Frequency.
* Services.
*Data Rates and.
* Range.

In table 2: represents the specifications between them [8].

Table (2) Represent the Specifications between WiFi and WIMAX

Item	Specifications
Data rates	(7.2 – 14.4)Mbps

Operation Frequency	(1.9 – 2.6)GHz
Power	(10, 100)mW
Range	(20-30)m
Services	Voice, video, and data

D. Network Security

It is well known that the problem of the networks security is related to the most dangerous threats on the Wi-Fi and WiMAX networks.

Major and essential to begin security network by securing the passage of devices that is allowed client access security, and this needs a means of minimize weaknesses in the network.

Most of the security problems in wireless networks can be identified in three steps as follows.

* Rogue Access Point (AP).
* Rogue Client.
* Denial service Dos.

E. Advantages and Disadvantages of theTwo Standards

* The WiMAX specification provides bandwidth over many kilometers and stronger encryption (TDES or AES) with less interference. Wi-Fi is short range (approximately 10's of meters) has WEP or WPA encryption and suffers from interference as in metropolitan areas where there are many users.
* Wi-Fi Hotspots are typically backhauled over Asymmetric Digital Subscriber Line (ADSL) in most coffee shops therefore Wi-Fi access is typically highly contended and has poor upload speeds between the router and the internet.
* It provides connectivity between network endpoints without the need for direct line of sight. The non-line-of-sight propagation (NLOS) performance requires the .16d or .16e revisions, since the lower frequencies are needed. It relies upon multi-path signals, somewhat in the manner of 802.11n.
* One disadvantage of WiMAX is the limitation of wireless bandwidth. For use in high density areas, it is possible that the bandwidth may not be sufficient to cater to the needs of a large clientele, driving the costs high.
* A disadvantage of WiMax over Wi-Fi is that, with Wi-Fi anyone can set up a wireless network for free, not everyone can set up a WiMax wireless network; and one must pay incredibly huge amounts of money to be given the right to set up a WiMax wireless network in a region.

III. RESULTS AND DISCUSSION

A. Wi-Fi and WiMAX Applications:

Technology which is used the Wi-Fi and WiMAX can be integrated with each other. This means their ability to support each other and integrate in order to achieve the greatest number of subscribers. Wi-Fi and WiMAX be economical for mobile operators specially from the cost issue, for example, as cost and provide alternative ways to backhaul BS traffic from the cell to controller. The infrastructure of the current Wi-Fi standards extends widely in the world wide; either WiMAX standards can provide Non-Line-of-Sight (NLOS) backhaul for network.

In terms of the differences there are two reasons: First, the router devices that operate on unlicensed frequencies do not allow being fully data traffic and strong as licensed. Second reason, Wi-Fi access point does not work in the long distances, such as WiMAX[1]. In Wi-Fi network preferably with small areas, such as (rural areas, schools, and universities). While WiMAX networks with large areas and many population, such as (urban areas and huge areas). In addition, WiMAX security is much stronger than Wi-Fi because that WiMAX cover large area.

* Backhaul

This type of application is shown in Figure 4. Through combining technologies. Backhaul is getting data from one point and spreading it over a network with high data rates and low price. In simple words backhaul acts as a backbone for the distribution of data between subscriber stations (sender) to the base station (receiver). While Wi-Fi connected directly to the subscriber.

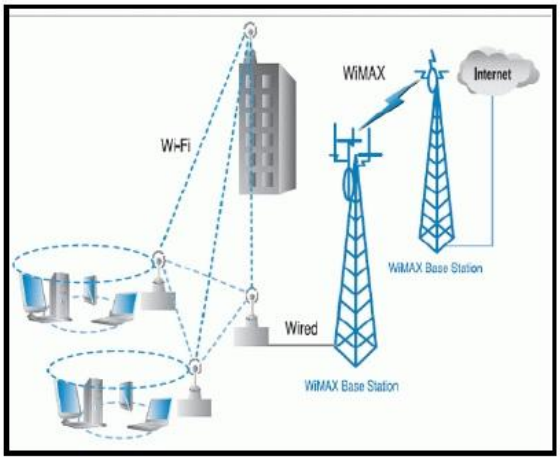

Figure (2) Backhaul Design

* Backhaul inter Mesh network

Figure 5 shows. WiMAX was used a part of Wi-Fi Mesh. Subscriber terminals of WiMAX put on access point. The Wi-Fi Mesh technology, which produces more reliability in large coverage areas and reduces the cost of the connection.

Furthermore Backhaul acts as a cart for transportation of data between different areas within. Another very unique feature of WiMAX backhaul is that it gives protection against theft of services.

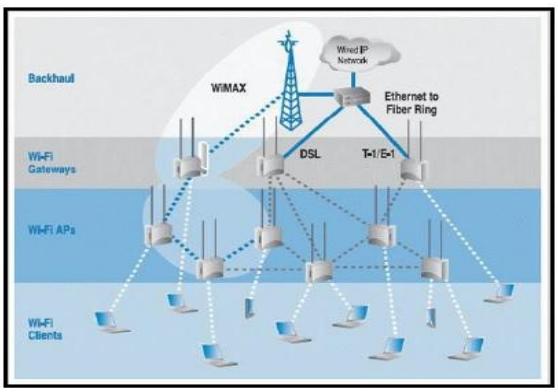

Figure (3): Backhaul with Wi-Fi Mesh Network.

* Wi-Fi & WiMAX Full Integrated

Figure 6 shows another application of WiMAX with Wi-Fi. In this application, it can be demonstrate a client through the overlapping coverage between WiMAX with Wi-Fi. Thereby obtaining better data transmission reliable reliability. In addition, with the implementation of the dual access point (AP) which will be WiMAX and Wi-Fi easier in the application and development.

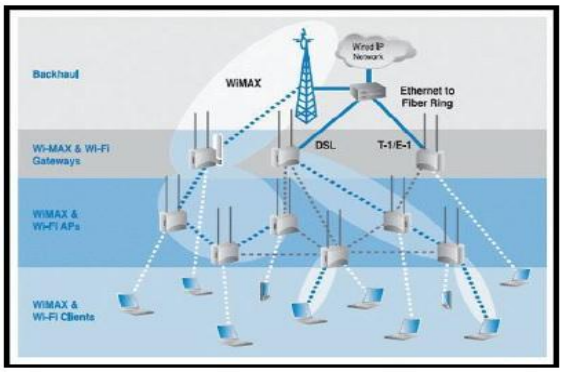

Figure (4) Wi-Fi and WiMAX Fully Integrated

B. Wi-Fi/ WiMAX System Performance:

Figure 5 shows mean throughput in integrated Wi-Fi and WiMAX-Mesh and non-Mesh Architectures. The mean delay in integrated Wi-Fi and WiMAX-Mesh and non-Mesh architectures are shown in Figure 6.

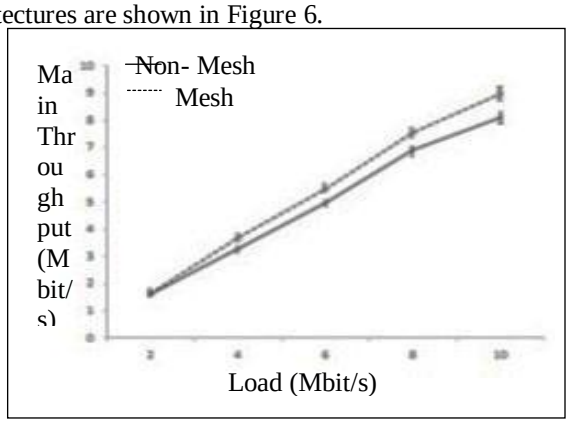

Figure (5) Mean Throughput in Integrated Wi-Fi and WiMAX-Mesh and Non-mesh Architectures

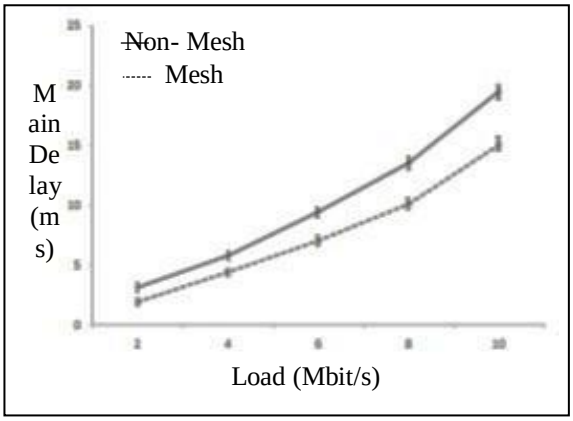

Figure (6) Mean Delay in Integrated Wi-Fi and WiMAX-Mesh and Non-mesh Architectures.

C. Gains of Wi-Fi Mesh

Wi-Fi is a local area network technology designed to provide in-building broadband coverage. It offers shorter-range local connectivity, often with significantly higher throughput. A Wi-Fi Mesh networking topology provides a more solution than a solely directional antenna application. These Wi-Fi access points (AP) are deployed in dense clusters to get around wire dependency and to increase client coverage [9].

In Wi-Fi Mesh network the smaller nodes act as routers and each node transmits a low power signal which is capable of reaching neighboring nodes, each of which in turn transmits the signal to the next node, with the process being repeated until the data arrives at its destination. Since each node has many routes to a mesh gateway it is very reliable. In deploying this technology, large obstacles, such as a mountain which can block a subscriber from reaching a base station can be avoided by navigating around. Using Wi-Fi as last mile solutions, Wi-Fi with directional Antennas (Fixed access) and Wi-Fi Mesh topology network (Portable access) can be adopted. Besides, that items such as laptops that use Wi-Fi are able to be used in many countries [1].

* The Benefits of Operating Wi-Fi for last-mile Solutions Now are [10]:
* Off-the-shelf 802.11 standards
*. cost effective for small deployments
*. Flexibility
* Challenges of Wi-Fi Mesh [4].

The encumbrances to Mesh networks are:

*. In a large base station (BTS) is required to cover larger areas.
*. Shared bandwidth.
*. High latency.
*. Possessory implementation.
*. Without the implementing 802.11s standard Wi-Fi Mesh-network topology is not working.
*. Without the implementing 802.11s standard Wi-Fi QoS is not sufficient.

Mesh infrastructure is a new way of delivering broadband access for residential and office buildings. It is identified that there are different types of architectures by which Mesh systems can be formed. Weight the advantages and disadvantages of each different systems and more careful analysis is required before WiMAX deployment [8].

The major obstacles of large Wi-Fi Mesh network include low capacity, limited system performance, the uncertainty of Mesh topologies and wireless link quality. Possible reasons for those problems inside large Mesh networks may be listed as follows:-

* Multi-hop transmission is one of the major reasons that limit the system performance.
* Due to network topology and link or node failures, some Mesh nodes (Known as Island Nodes) may fail to find available paths to the portals. Depending on specific topologies and failure probabilities, the proportion of island nodes may not be negligible.
*In large Mesh networks, centralized MAC-layer schemes, global link transmission scheduling, or synchronization are not practical. Therefore, hidden terminals could cause

collisions and further reduce the capacity.
*Because of the traffic dynamics, Wi-Fi Mesh network is prone to network congestions and congested links negatively influence the performance of Mesh networks (Ping, et al., (2006)). All of the above drawbacks come from the network architecture itself instead of specific protocols or algorithms. This motivates us to improve the network structure to alleviate the inherent limits of Wi-Fi Mesh networks. In summary a Wi-Fi or WiMAX Mesh can offer a much more cost-effective backhaul capability for BSs in metropolitan environments. Therefore, the comparison shows that WiMAX has better where it shares performance enhancing features with evolution-data optimized (EVDO) and high-speed downlink packet access (HSDPA)[4]. Furthermore, the technologies WiMAX is based results in lower equipment complexity and simpler mobility management due to the all-IP core network. In addition, it also provide mobile WiMAX systems with many other advantages over code division multiple access (CDMA) based systems in terms of Self-interference, tolerance to multipath, Scalable channel bandwidth, Quality of Service (QoS), Frequency reuse and Frequency-selective scheduling [3].

D. Gains of WiMAX Mesh

Wireless Mesh Network (WMN) is consist of nodes connecting to neighboring nodes show in figure7, forming a web of nodes, this creating arrange patterns the Internet [11].

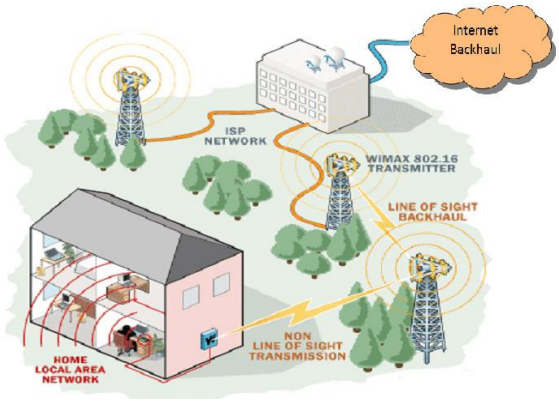

Figure (7) WiMAX Network Infrastructure

WiMAX wireless Mesh network allows traffic to be routed during and between entrants stations (ES) or called Mesh ES, exceed base station (BS). The node that connects the network to the back haul is specific Mesh BS. Within a WMN network, the Mesh entrant's stations that the nodes have direct links with are called neighbors, also called "one-hop" and all of them make up the neighborhood. An extended neighborhood (also called "two-hop") includes all the neighbors of the neighborhoods [1].

*Advantages of WiMAX Mesh

WiMAX Mesh system has the capability to self-heal by self-reconfiguration. If one source collapses, the network automatically re-configures and connects to a work new links This gives balanced traffic to avoid any malfunction when a link is overloaded. As path loss is driven by obstacles, a Mesh network is flexible enough to exceed the obstacles by automatically selecting the best link. As well as, if all the links have the problem, WiMAX has the capability to exceed the obstacles. This method proves and ensures that all the nodes are connected. As a result of these abilities, WiMAX Mesh offers end user throughput and high QoS for multimedia traffic [8] .WMN shows a low cost advantage by minimizing infrastructural cost that comes from using low cost entrant equipment's, unlicensed band, and low installation costs. This system is also able to naturally measuring itself to accommodate more members. Additionally, WMNs are strong because they are not dependent on a single source.

IV. CONCLUSIONS

Through this paper, it can conclude as follows:

* Wi-Fi Mesh networks are driving the demand for WiMAX by increasing the abundance of wireless access, increasing the need for cost-effective backhaul solutions and quick performance.
* Also heightens that the strength of WiMAX be utilized to enable community Mesh to be practical in developing countries, with the wider coverage that WiMAX Mesh offers, WiMAX Mesh will remarkably help to bring information equality.
* WiMAX can be employed to combined Wi-Fi networks such as Mesh-network topologies and Wi-Fi users to the backend. Recently, a Wi-Fi Mesh-network offers mobility, while WiMAX offers a long distance backhaul solution.
* Wi-Fi Mesh and WiMAX exploitation recommends a more cost-effective way out than a sole Wi-Fi directional-antenna deployment or a Wi-Fi Mesh network with wired backhaul to extend the LAN or cover the last mile.
* Due to the varieties of communication technologies, handover is needed for many reasons including mobility, network availability, and service availability.

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