Analysis of the implementation of WiMax technology using Motorola Canopy: Case Study in Macedonia

Afrim Mehmedi, Rezarta Zhaku, Bekim Fetaji, and Majlinda Fetaji

***Abstract*—** The focus of this research study is the analysis of WiMax technology, with special emphasis on case study analyses of NEOTEL Company in Macedonia and the implemented WiMax technology using Motorola Canopy. Analyzed and measured is the technology implementation in three city sectors Gostivar, Tetovo and Skopje in Macedonia and measured is the statistics of their use. Analyzed and discussed is the system implementation and how it works and what the main elements are. Analyzed is the software and the management approach of the Neotel users, base stations, as well as the signal quality that is provided to end users. Based on the analysis and measurements of application of Neotel in three cities Gostivar, Tetovo and Skopje, created statistical usage graphs for each antenna and base station and selected data for 3 users each and the graphs are made for each of 3 sectors. Finally insights are stated, results of the analyses are provided and recommendations and discussions of the approach are described.

***Keywords*—** Wifi, wimax, motorola canopy, Neotel, Network Point-multipoint

I. Background Research

WI-FI technology allows the construction of networks without the use of cables connecting customers and thereby reduces the cost of building and expanding them. Places like outdoor spaces and historic buildings, which had not been possible to drop cable, are now covered by wireless networks. Although we live in an age of information, however, in many parts of the world, just the connection slows the growth and progress of the Information Age [2]. These connecting problems can be simple, but also very complicated, depending on the perspective of view - such as providing basic telephone communications to individual users and companies located in sparsely populated areas, providing Internet access or dissemination of broadband services and in urban and rural areas [1]. WiMax technology by using Motorola Canopy solution allows connecting people and places even where wired connections would be impossible [3]. Canopy wireless broadband offers high performance for home and business users. Canopy is commonly used in educational institutions such as schools and universities, government agencies, private corporations, banks, energy producers, farms , health care, private sector - hotels, resorts, etc.

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II. Analyses of Advantages and Disadvantages of WiMax Motorola Canopy

Important features of the WiMax technology system is its resistance to interference, data flow, operating bandwidth, scalability and flexibility, as well as its safety [3]. Motorola Canopy system consists of three basic building blocks: access point, backhaul module and user device. Canopy wireless broadband platform contains access point (AP or module), subscriber module (SM), backhaul (BH) module, a module for managing a cluster of access points (CMM), device for protection against lightning and storms, BAM, and various other devices. For components that support graphical user interface (GUI), access to it is accomplished through a web browser. Since version 8, and picked up by prominent m u, the operator can adjust the graphic interface of its own needs.

Canopy components are available in the frequency range of 2.4-, 5.1-, 5.2-, 5.4-, 5.7-GHz. Additionally, there are available Canopy AP-I and SM-and operating at a frequency range of 900 MHz. Some of them may be subject to national restrictions.

According to [4] to avoid modules to interfere on their own, Canopy network typically uses two or more of these frequency bands. For example, if set correctly, all AP clusters and their corresponding SM-and you can use the range of 2.4-GHz, while bekholite - 5. 2 - GHz, to provide a range up to 3.2 km without reflector bowls. Unlike of them, modules operating at 900-MHz covering a larger area, but at the expense of reduced capacity data transmission. These modules can be used to establish connections to larger distances, add subscribers, you can break the signal through certain obstacles (such as leaves drjva etc.).

2.4-GHz frequency range supports AP-SM links with distances greater than 3.2 km (without lights). 5.7-GHz frequency range supports BH links that reach distances up to

35 miles. Basically, the network point-multipoint consists of at least one AP and one SM. It provides services to more users, usually from 1 to 200 and SM-. Simple Downlink capacity of AP to the SM is about 4Mbps. Typically Uplink capacity of SM to AP is approximately 1.5Mbps.

The basic point-to-point connection consists of a backhaul master master (BHM) and a backhaul slave (BHS). Backhaul connections can be combined in multiple steps to continue along link (link) and provide greater security (confidentiality). Backhaul connections generally used to transfer large amounts of data between the network operations center and AP cluster, or to provide broadband network connection to one or more buildings within a campus or a complex or to continue local network (LAN).

III. Features Of The Access Point

According to [3] Canopy AP module distributes network or Internet services sector from 60 degrees to not more than 200 subscribers, or less than 4096 MAC addresses that can be assigned directly to the PC, various devices, gateway-and, SM-and and the AP. Moreover, there is no limit behind NAT gataway-well. AP-enabled can be configured through the web interface. Canopy AP can only communicate with Canopy SM, not with Advantage SM, or Canopy Lite SM.

Advantage AP module has the same function as the regular AP module, allowing higher capacity and lower latency, and can serve subscriber modules of any type (regular, lite or advantage).

TABLE I
TABLES OF PERFORMANCE: POINT-MULTIPOINT (CANOPY AP AND CANOPY SM)

Frequency	LOS range	LOS range with reflector	Common permanent total capacity
2.4 GHz	8 km	24 km	6.2 Mbps
2.4 GHz (100 mW)	2 km	Reflector focuses the beam and reduces noise	
5.2 GHz	3.2 km	Focus. Beam / reduced noise	6.2 Mbps
5.7 GHz	3.2 km	16 km	6.2 Mbps
5.1 GHz	3.2 km	Focus. Beam / reduced noise	6.2 Mbps
5.4 GHz	3.2 km	/	6.2 Mbps
5.4 GHz (1 W)	3.2 km	Reflector focuses the beam and reduces noise	

TABLE II
ADVANTAGE POINT-MULTIPOINT (AP-SM)

	Advantage AP / Canopy SM 2FSK (≤ 7 Mbps capacity)		Advantage AP / Advantage SM 4FSK (≤ 14 Mbps capacity)	
	Reach	In Spotlight	Reach	In Spotlight
900 MHz	All are 900 Advantage		64 km to 4 Mbps without reflector	
2.4 GHz	8 km	24 km	4 km	12 km
2.4 GHz (Low Power)	2 km	Focal. Beam / us. Noise	1 km	Focal. Beam / us. Noise
5.2 GHz	3.2 km	Focal. Beam / us. Noise	1.6 km	Focal. Beam / us. Noise
5.7 GHz	3.2 km	16 km	1.6 km	8 km
5.1 GHz	3.2 km	Focal. Beam / us. Noise	1.6 km	Focal. Beam / us. Noise
5.4 GHz	3.2 km	Focal. Beam / us. Noise	1.6 km	Focal. Beam / us. Noise
5.4 GHz	3.2 km	Focal. Beam / us. Noise	1.6 km	Focal. Beam / us. Noise

TABLE III
ADVANTAGE AP И CANOPY LITE SM

Frequency	LOS range	LOS range with reflector	Common permanent total capacity
2.4 GHz	8 km	24 km	512 Kbps *
5.2 GHz	3.2 km	/	512 Kbps *
5.4 GHz	3.2 km	/	512 Kbps *
5.7 GHz	3.2 km	16 km	512 Kbps *

* Can be upgraded to higher capacity

TABLE IV
POINT-POINT BH - PTP100

Frequency	LOS range	LOS range with 2 spotlights	Encryption	The usual post. V C. capa city
2.4 GHz (10 Mb / s) 2.4 GHz @ 100mW	8 km 2 km	56 km 16 km	AES or DES	7.5 Mbps
2.4 GHz (20 Mb / s) 2.4 GHz @ 100mW	3.2 km 1 km	56 km 8 km	AES or DES	14 Mbps
5.2 GHz	3.2 km	/	AES or DES	7.5 Mbps
5.2 GHz ER (10 Mb / s) 5.2 GHz ER (20 Mb / s)	3.2 km 1.6 km	16 km 8 km	AES or DES	7.5 Mbps 14 Mbps
5.7 GHz (10 Mb / s) 5.7 GHz (20 Mb / s)	1.6 km 1.6 km	56 km	AES or DES	7.5 Mbps 14 Mbps
5.1 GHz (10 Mb / s) 5.1 GHz (20 Mb / s)	3.2 km 1.6 km	/ 8 km	DES	7.5 Mbps 14 Mbps
5.4 GHz (10 Mb / s) 5.4 GHz (20 Mb / s)	3.2 km 1.6 km	16 km 8 km	AES or DES	7.5 Mbps 14 Mbps

TABLE V
PTP400 и PTP600

Frequency	Reach	Common permanent total capacity
5.4 & 5.7 GHz (30 Mb / s)	200 km	up to 21 Mbps
5.4 & 5.7 GHz (60 Mb / s)	200 km	up to 43 Mbps
5.4 & 5.7 GHz (150 Mb / s)	200 km	up to 150 Mbps
5.4 & 5.7 GHz (300 Mb / s)	200 km	up to 300 Mbps

IV. Designing A Network Point-To-Point

Main definitions are:

Backhaul timing master – is a module used on point-to-point and control air and protocol configurations for the link.

Backhaul timing slave – is a module used on point-to-point and accepts configuration and timing of master master module.

Module to manage the cluster – is a module that provides power, GPS timing and network connections for backhaul timing master-and and clusters of access points if they are located in the same column.

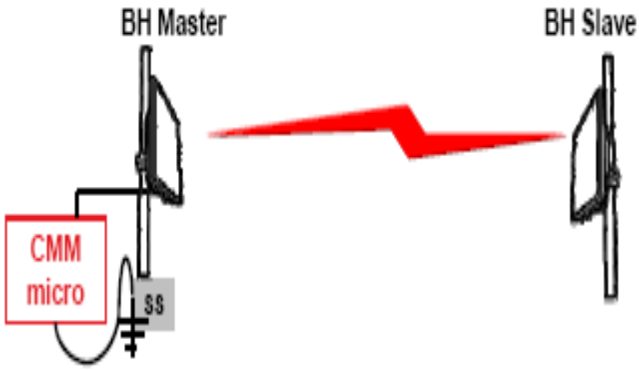

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Fig. 1 Second point-to-point connection

The basic point-to-point connection consists of backhaul timing master and backhaul timing slave. Longer networks point-point can be constructed by mutually connecting multiple backhaul master-and slave-and s. In most cases BHmaser-s must be connected to the module to manage the cluster, so that the GPS timing pulse would allow synchronization of the transmission cycles.

When planning point-to-point networks need to consider the following:

- To consider the option of breaking the long run in several smaller steps.
- To comply with local regulations concerning the use of reflectors.
- The route of transmission for PTP 100 Series modules is in line-of sight.
- Tool to assess the relationship should always be used when planning the implementation of bekholi Series PTP 400 and PTP 600.
- To confirm that the scope and frequency to be used is free from interference from other RF sources.

V. Designing A Network Point-Multipoint

According to [4] access point is Canopy module that distributes network or Internet services to customers in an area of 60 degrees.

Cluster of access points can be two to six access points, which together distributed network or Internet services to a group of subscribers. Given that each access point covers an area of 60 degrees, a cluster could cover up to 360 degrees.

Subscriber Module - Devices that continues network or Internet services through communication with an access point or cluster.

Backhaul Module - device which provides point-to-point link with AP or AP cluster by CMM.

CMMmicro - provides power, GPS timing and network connections AP cluster.

When planning network point to point it is necessary to consider the following:

In densely populated areas, it is desirable to consider the possibility of breaking the system into several smaller clusters.

To follow local regulations for lights and power setting.

For equipment that operates at 2.4 and 5 GHz optical visibility is necessary.

If they can not provide conditions of sight, you should consider the possibility to set up multiple clusters, or to use equipment that operates on 900 MHz.

To confirm that the scope and frequency to be used is free from interference from other RF sources (interference can reduce the range).

To increase the capacity / density clusters of access points can be located at mutual distances less than 3 km.

For smaller distances you can consider to reduce the power of each access point and subscriber module by setting the field output by the transmitter site for configuring the module.

Ingredients:

To assess the need for network throughput that design and, if necessary, to plan placement of Advantage gear to get greater throughput where necessary.

To ascertain whether there are bottlenecks in the system.

To determine the appropriate uplink / downlink relationship.

To establish settings for high priority, if necessary.

To confirm the line-of sight

To confirm the specific levels of RF interference.

Access points should be mounted high enough to allow a clear line-of sight (no first Fresnel zone) to the edge of the area which is planned to cover. Setting AP clustered closer to each other increases the margin of the link capacity and coverage. Konstantoto distance between clusters is best viewed in terms of coverage area.

The centering of the access point involves the use of local or topographic map to determine which direction to focus one or more access points can cover a particular area of 60 degrees.

After centering the access points is complete, access to the subscriber modules centering the relevant access point.

Centering a subscriber to access point modules can be used two ways:

Observing the values of jitter (jitter) and the level of power (dBm).

By using the option for sound positioning. This requires a special cable and headset audio amplifier or speaker.

For 10 Mbps, the value of jitter should be 4 or less (preferably 1 or 2).

For 20 Mbps, the value should jitter is 7 - 9.

Power level represents the Rx sensitivity and jitter is a measure of the signal quality.

Once the subscriber module is registered to a particular access point, slowly changing his position, as long as you get the jitter minimum and maximum value for power level. After centering test link to verify its effectiveness.

The second method, using sound positioning works similarly, except that the height of the tone varies depending on the registered values of parameters and power level.

VI. Planning And Designing Canopy Network

When selecting a location for wireless networks point-to-point and point-multipoint, basically apply the same techniques:

In order for the range of 5 GHz to achieve communication requires line-of sight (LOS). (If you can not see, then you probably will not even be able to communicate with).

In some cases, the signal of 5 GHz can pass through trees and reflected by buildings and enable communication.

The only way to discover whether the radio path / trajectory will work is to try. Usually should be avoided to provide services where the signal reflects off objects or passes through the trees, unless there is control over new construction, growing trees that could hinder the signal and prefarbuvanjeto surfaces that could to reflect RF signal.

High buildings eg. buildings and radio towers and peaks of mountains are ideal locations for setting up equipment.

The location must have a source of power - AC, DC, through light energy, auxiliary power supply (UPS, generator, batteries).

If the location is not used as a repeater, you must be available some type of data source (Ethernet cable, fiber-optic cable modem, multiplexer (Mux), a telecommunications operator, wireless backhaul).

The location must provide protection from lightning and earthing.

If you use peripheral devices such as hubs, switches or routers, it is necessary to ensure their protection from the weather (cabinet resistant to weather conditions, special room where they were placed, etc..).

You must be complied with local regulations regarding the installation and operation of RF devices.

The location must be accessible for maintenance to be provided by vandalism, unauthorized persons and animals.

Buildings that are mounted (columns) must be sturdy and able to withstand the devices are installed and technicians set.

Units with parabolic antennas and reflectors should be mounted on structures that are stable and designed to withstand, at least, the wind load of the antenna.

You need to check the sources of potential interference. They can be sources of different antennas that radiate the same beam frequency and Canopy.

Where there is doubt that there is interference, it is necessary to check the area of the spectrum analyzer.

You can use several methods to determine the line-of sight (LOS) between transmission points and using the following methods:

Maps street: easy to use, but provide limited information about RF planning, determine the location of each area; slash line between two locations is measured by the distance given scale.

Topographic maps: provide data extracted from a different date (NAD 27, WGS 84, NAD 83). Allow the correct offset magnetic North; konturnite lines provide details about the terrain, allowing precise scale.

Aeronautical maps: updated regularly; useful for locating tall buildings and towers; gives podrobnosi airspace around airports, must be taken into account magnetic offset (subtracting the East, adding to the West).

Web based maps: some programs with web-based maps allow input of GPS coordinates for the location under consideration, while some provide the GPS coordinates.

Software for planning the path (EDX, Micropath, Pathloss): often used database of satellite, a number of other programs are available in price ranges from hundreds to thousands of dollars.

VII. Results From Measurements

Results of measurements in Gostivar, Tetovo and Skopje

Fig. 2 Results of measurements in Gostivar

Fig. 3 Results of measurements in Tetovo

Fig. 4 Results of measurements in Skopje

In the above tables is provided the analysed and measured is the technology implementation in three city sectors Gostivar, Tetovo and Skopje in Macedonia and measured is the statistics of their use.

VIII. Conclusion

Motorola Canopy is a complete solution for broadband wireless access for the provision of i or expansion of the existing network to provide broadband services to users. Canopy system allows wireless access point that can be directly connected to the broadband infrastructure, or indirect through wireless backhaul on the radio or optical network.

Canopy products have a number of advantages over wi-fi and other WLAN protocols. The timing of transmissions is explicitly controlled, allowing access points to all poles can be synchronized via GPS, thus avoiding the occurrence of interference. Only the Canopy platform is impossible to lay next to each other access points that operate in the same frequency range, which is not the case, or not recommended by most other protocols. These products are designed for the needs of any WISP and are simple to install and configure, and further management.

Canopy is an excellent alternative to wire networks impractical or inaccessible infrastructures. Thanks to its

features, this platform enables the distribution network and Internet services even in very remote and inaccessible areas. The widespread application of Canopy platform, resistance to interference, the ability to continually upgrading the network, the possibility of using unlicensed frequencies, and safety that are not huge financial investment required to make this one of the most attractive platform for WISP-s. It allows end users to get fast, continuous, reliable and safe service.

Recommendations

When planning network point to point it is necessary to consider the following:

In densely populated areas, it is desirable to consider the possibility of breaking the system into several smaller clusters.

To follow local regulations for lights and power setting.

For equipment that operates at 2.4 and 5 GHz optical visibility is necessary.

If they can not provide conditions of sight, you should consider the possibility to set up multiple clusters, or to use equipment that operates at 900 MHz.

To confirm that the scope and frequency to be used is free from interference from other RF sources (interference can reduce the range).

Recommended approach:

To assess the need for network throughput that design and, if necessary , to plan placement of Advantage gear to get greater throughput where necessary.

To ascertain whether there are bottlenecks in the system .

To determine the appropriate uplink / downlink ratio.

To establish settings for high priority , if necessary .

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Access points should be mounted high enough to allow a clear line -of sight (no first Fresnel zone) to the edge of the area which is planned to cover . Setting AP clustered closer to each other increases the margin of the link capacity and coverage. Constant distance between clusters is best viewed in terms of coverage area .

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