REVIEW OF COMPUTER ENGINEERING STUDIES

ISSN: 2369-0755 (Print), 2369-0763 (Online)
Vol. 4, No. 3, September 2017, pp. 87-92
DOI: 10.18280/rces.040301

A publication of IIETA

IIETA International Information and Engineering Technology Association
Advancing the World of Information and Engineering
http://www.iieta.org/Journals/RCES

Impact of femtocell on the performance of WiMAX

Asim Ismail, Muhammad N. Brohi

Shaheed Zulfikar Ali Bhutto Institute of Science & Technology Dubai

Email: asimismail7@gmail.com

ABSTRACT

Femtocells are low power base stations operating in licensed spectrum with the intent to improve coverage and performance of multimedia and broadband services. The femtocells provide a solution to improve indoor coverage of cellular mobile devices in the areas where the coverage is weak and intermittent while using macrocells. The use of data hungry devices such as, tablets, smartphones and other wireless devices are increasing rapidly with time and is a driving force for innovative ways in wireless communication to provide fast access to the internet, more capacity and higher quality of service. Femtocells can provide a useful way for mobile operators to offer a better user experience and deliver indoors broadband services consistently and reliably for a comparable context of application, distances, and obstacles. The proposed work will analyze the efficiency of femtocells in terms of its convergence along with WiMAX wireless technologies. The study will show how the coverage is improved by femtocells and how the total network capacity gains can be up to many times as compared to the current macro layer networks. This analysis will be based on more detailed performance parameters such as throughput, packet loss, packet end to end delay, download and upload response times for multimedia traffic. The femto access points (FAPs) will enhance data rates via improving link quality, shorter communication distance and less penetration loss resulting into increased capacity of the entire system.

Keywords: WiMAX, Macrocell, Femtocell, Microcell, Femto Access Points (FAPs), 3G, LTE/ 4G.

1. INTRODUCTION

Femtocells are low power base stations installed in office or residential area in order to improve the cellular coverage within a building. Commercially, it is sold with different brand names like Airave (Sprint), Microcells (AT&T) and Network Extender (Verizon) in the market [1]. The connectivity of smart phones, cellular phones and portable devices is increased using femtocells through cellular network especially in those areas where coverage of large cell is weak. The femtocell architecture may look different to an ordinary user from macro base station architecture, actually femto access point (FAP) is connected to the backhaul network by simple DSL or any other internet link. The difference is that a standard mobile device is connected to an outdoor high power base station but in femtocell it is connected through its own low power base station located at home. This localized base station provides efficient and stable connection for indoor users. There are many benefits of femtocells both for users and network operators. It provides better coverage and many additional services to the user by combining internet technologies and better mobile phone signals within the home. For network operator prospective, they can collect more revenue by providing many additional services and better coverage to users [2] [3].

There are many motivations for users to deploy femtocell at home or in office. Femtocell fulfills the consumer's demands for better coverage and improved quality of service at home. Therefore the demand of femtocell has been increased from last decade and many commercial mobile operators have shown their keen interest to expand this technology through 3G and LTE/4G. The purpose of our research is to measure the performance of femtocell in WiMAX.

2. PROBLEM STATEMENT

The network operators are using smaller cell sizes to offer better services to higher number of users due to increasing capacity and coverage demands. People make a large portion of phone calls and use higher data rate services mostly at that time when they are at home or office. There are 81% of total data traffic originates from offices and homes according to Infroma Telecom & media statistics report [4]. This percentage is also increased due to the penetration of data hungry devices such as tablets, dongles, smartphones that generate large amount of data traffic on macro cellular networks. The user applications consist of voice, video calls, web surfing, receiving and sending emails, social networking and music downloads etc. In a related study it was found that one indoor user uses the same capacity equal to ten outdoor users. But these macro cellular networks are not able to deal with high data rate traffic demands effectively [5].

Furthermore, many dead zones could be found under the macro cells coverage areas such as at the edge of the cell, thick walls indoor environment and basements etc. For the network operators, it is a big challenge to find an efficient solution to deal with this increasing data traffic demand and to satisfy their customers by providing high quality services. Femtocells dramatically improve indoor coverage and data performance for subscribers. Femtocells are also useful in offloading data traffic from the macro cells [6].

According to Pakistan Telecommunication Authority (PTA) report, telecom traffic in Pakistan is being operated through macrocell technology but it is not friendly to provide an access for high speed data and good quality indoor reception. There is an above 60 percent of the population has access to voice and data service through cellular network or DSL. Most of the end users are not satisfied from the cellular network services due to poor indoor signal reception and additional cost. Therefore, PTA suggested the operators to use small cells or femtocells which are the best solution to provide better wireless data services for indoor consumers where macro cells may not provide the same speed [7]. The book size will be in A4 (8.27 inches x 11.69 inches). Just as it is now, it uses custom margins: left margin 0.51 in, right margin 0.51 in, top margin 0.55 in and bottom margin 0.79 in. As the body text is divided into two columns in equal width (3.44 in), the spacing between them is 0.35 in. Please make sure that you do not exceed the indicated type area.

3. OBJECTIVES

The objective of this research is to analyze the performance of femtocell with WiMAX technology. In order to accomplish this task, this will use different performance parameters in the area of accessing internet. This will try to increase data rate of voice traffic and will consequently get improved quality. Then heavy data files through File Transfer Protocol (FTP) will be transferred in WiMAX systems in various environments. It will evaluate its performance in various conditions and analyze the upload and download times. Then finally, this will cater the area of accessing the internet using Hyper Text Transfer Protocol (HTTP). It is a protocol that defines the way for message formatting and transmitting. It is used in every action of the process of accessing the web. This will try to measure the page response time and the amount of traffic received in the case where femtocell is being used and the other way round without femtocell. All simulation will be based on ideal and non-ideal environments. In non-ideal conditions, all nodes will access the above mentioned services at the edge of the cell in indoor environment. But as far as ideal condition is concerned, a femtocell will be deployed for these nodes in the same indoor environment. After that we will be able to measure the efficiency of femtocell in the technologies such as WiMAX.

4. RESEARCH ELABORATION

4.1 Methodology

To evaluate the efficiency of femtocell, experimental work is performed on WiMAX. All experimental work is performed on OPNET 14.5 simulation implement to get the results which provides a utilizer cordial environment to deploy this technology. This is quantitative research that will provide the results of efficiency of femtocell with WiMAX performance.

4.2 WiMAX and Femtocell

To commence evaluation process, it will first deploy conventional WiMAX technology and run variants of traffic on it to analyze the results. Then it will deploy femtocell in the conventional WiMAX technology and run the same traffic over it. After that, we will give a comparison predicated analysis utilizing variants of performance metrics and show the femtocell efficiency in WiMAX predicated technology.

4.2.1 Conventional WiMAX without femtocell

In the first scenario, a WiMAX cell is implemented using OPNET 14.5 Simulator with coverage radius of 30 KM. There is a base station in the cell that is connected to the backbone and four variants WiMAX servers are fixed to the spine. There are 5 nodes subscribers under this base station. These five nodes subscribers taking advantage accommodation WiMAX over the cell boundary in an indoor environment as shown in Figure 1. These nodes are receiving poor signal force quality at this location due to the very long distance base station and some other environmental conditions. This simulation is executed according to the default parameters for as indicated in Table 1 for 500 sec.

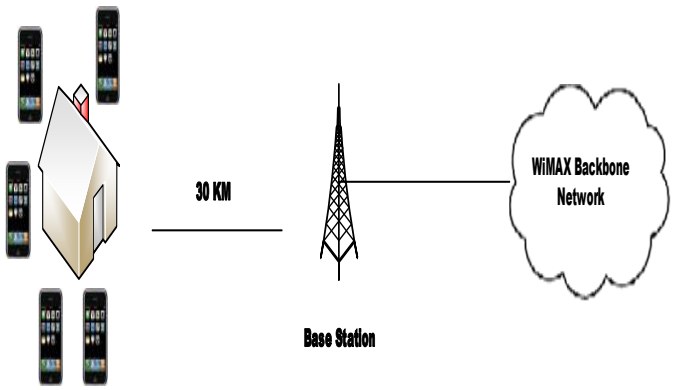

Figure 1. WiMAX without femtocell

Table 1. Parameters for conventional WiMAX

Wireless Technology	WiMAX
Cell Radius	30 KM
Antenna Height	40 Meters
Propagation Model	Indoor
Antenna Model	Omni directional
Scenario	Conventional WiMAX
Maximum Power of Macrocell BS	15 W
Antenna gain of UE	2 dBi
Maximum Power of UE	0.5 W
Number of Mobile Nodes	5
Simulation Time	500 Sec

4.2.2 WiMAX with femtocell

In this case, a base station is implemented Femto tiny the above dilemma scenario order to provide good quality accommodation for those subscribers who suffer from performance degradation in the indoor environment. Femto access point is connected to the cyber world via a broadband router installations using Utilizadores a single Ethernet cable. Then it is connected via WiMAX Femto Gateway backbone [8]. Again same 5 nodes are emptied to quantify the

efficiency of femtocell using the same external environmental conditions. But here in this case is based covering low power radio station just 10 meters femtocell. These 5 nodes subsist in the total coverage of femtocells as shown in the following figure 2. This simulation is executed according to the following parameters listed in Table 2 for 500 sec.

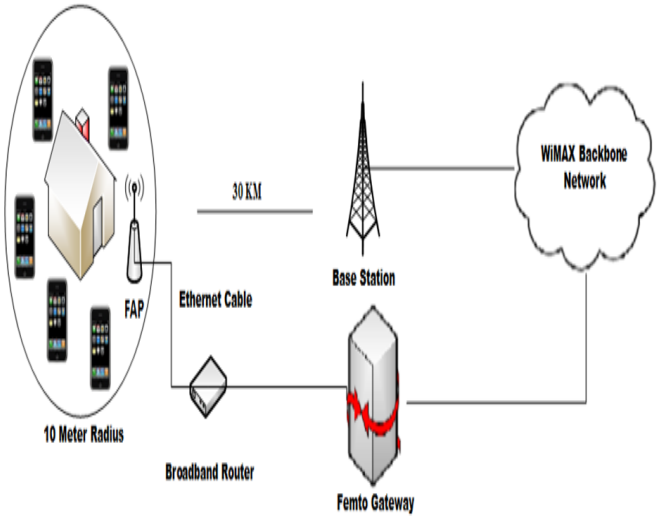

Figure 2. Proposed WiMAX using femtocell

Table 2. Parameters for WiMAX using femtocell

Wireless Technology	WiMAX
Cell Radius	10 Meter
Antenna height	1 Meter
Propagation model	Indoor
Antenna model	Omni directional
Scenario	WiMAX using Femtocell
Maximum Power of Femtocell BS	0.1 W
Antenna gain of UE	-1 dBi
Maximum Power of UE	0.2 W
Number of Mobile nodes	5
Simulation Time	500 C

5. RESULT AND FINDINGS

In both above cases different applications are configured to evaluate the efficiency and performance of femtocell. These applications are GSM Quality, File Sharing (FTP Cumbersomely hefty), Web Browsing (HTTP Heftily Ponderous) [9].

5.1 Throughput

Throughput is one of the most essential to quantify the system performance parameters, as it is an average rate distribution prosperous message on a communication link. The overall performance represents a clear image among WiMAX systems conventions and use of Femtocell in the system subsists. In the dilemma scenario that gives an average yield of 50 Kbps for the five nodes that are in the region of accommodation degradation WiMAX macrocell. On the other hand, when a femtocell is deployed for these nodes then 170 Kbps data rate is average achieved due to better network coverage and enhanced QOS. It is easy to decide that femtocell is a better solution for indoor users to achieve high data rate WiMAX conventional connection as shown in Figure 3.

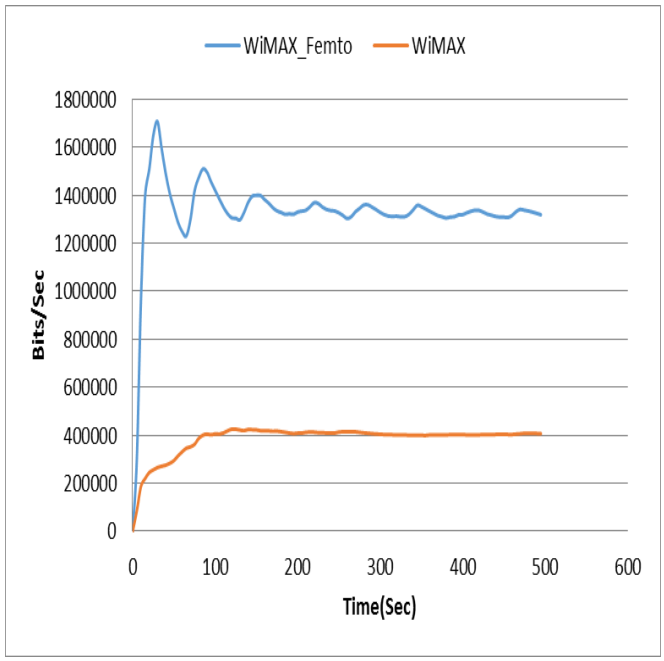

Figure 3. Throughput comparison for WiMAX

5.2 Packet end to end delay

The cessation of completing delay is another parameter that favors the use of femtocells indoor environment while awkwardly heavy applications are used. As we can discern pellucidly optically using the femto base station it is very efficient incurring minimal delay. Initially at the start of the simulation it was not much lower due to the difference heftily heavy load of applications running at the same time showing the end to complete delay of 0.16 seconds. But after a few seconds femtocell performed well and its value was reduced to 0.14 seconds which is quite plausible that offers good performance overall. While in the reverse, WiMAX femto access point without showed high delay 0.16 sec entire time simulation housing causing degradation as shown in Figure 4.

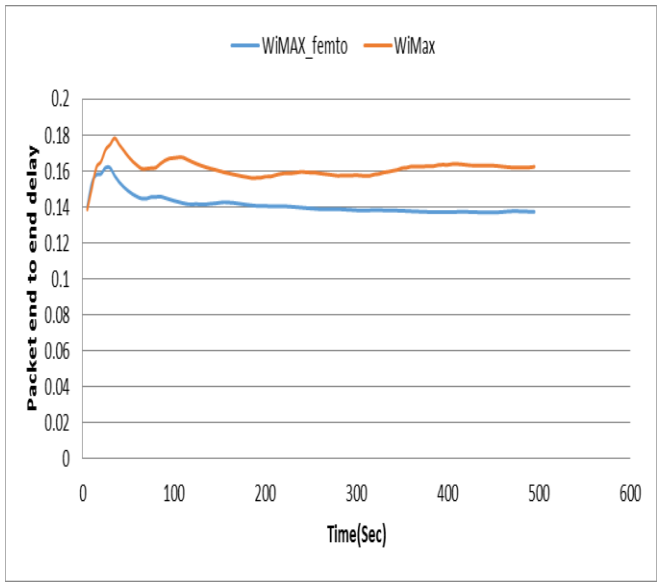

Figure 4. Packet end to end delay comparison for WiMAX

5.3 HTTP page replication time

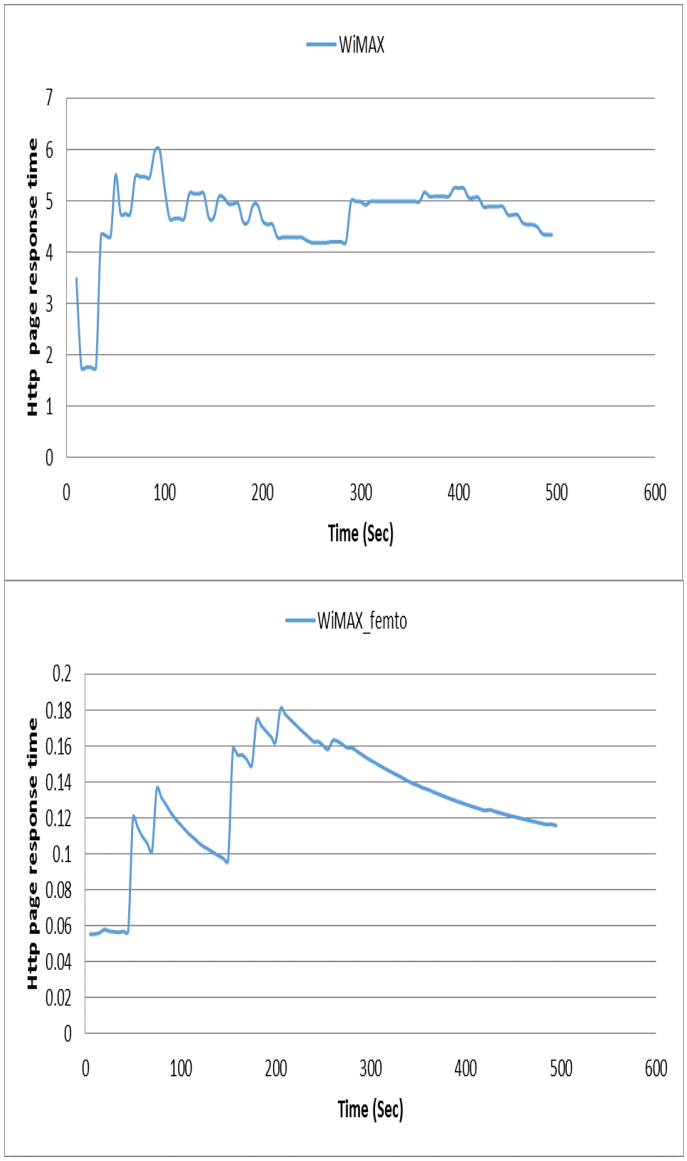

Figure 5. HTTP page response time comparison for WiMAX

Hypertext Transfer Protocol (HTTP) is a stateless application level protocol that is utilized in every action involved in Internet "web surfing." It sends a request to a server for concrete web site and server responds back to that request. The value of this time depends upon the size of return data and bandwidth of the network. As we mentioned earlier that we are utilizing cumbersomely hefty web browsing application to test the performance of conventional WiMAX and femto predicated WiMAX connection. These cumbersomely hefty websites consist of cumbersomely hefty images, videos and audio data. There is sizably voluminous difference in page replication time is observed when same type of websites will be accessed in both scenarios. In Femto WiMAX cell this time was 0.06 sec and commenced inclined to 0.14 sec after 100 sec of simulation run time. After 230 sec it incremented to 0.18 sec and exhibiting fluctuating state due to cumbersomely hefty load of web applications. Then this load is managed by the femtocell predicated WiMAX system and page replication time fall down to 0.1 sec again. But in case of second scenario utilizing WiMAX conventional connection it commenced from 2 secs and perpetually booming up to 6 secs after one fourth part of the total simulation run time due to impotent signal vigor and poor quality of services at the boundary of the cell. It is managed to scarcely and falling down to approximately 4 secs at the terminus of simulation but still exhibiting a tremendous distinction between both systems as shown in figure 5.

5.4 FTP bytes received /sec

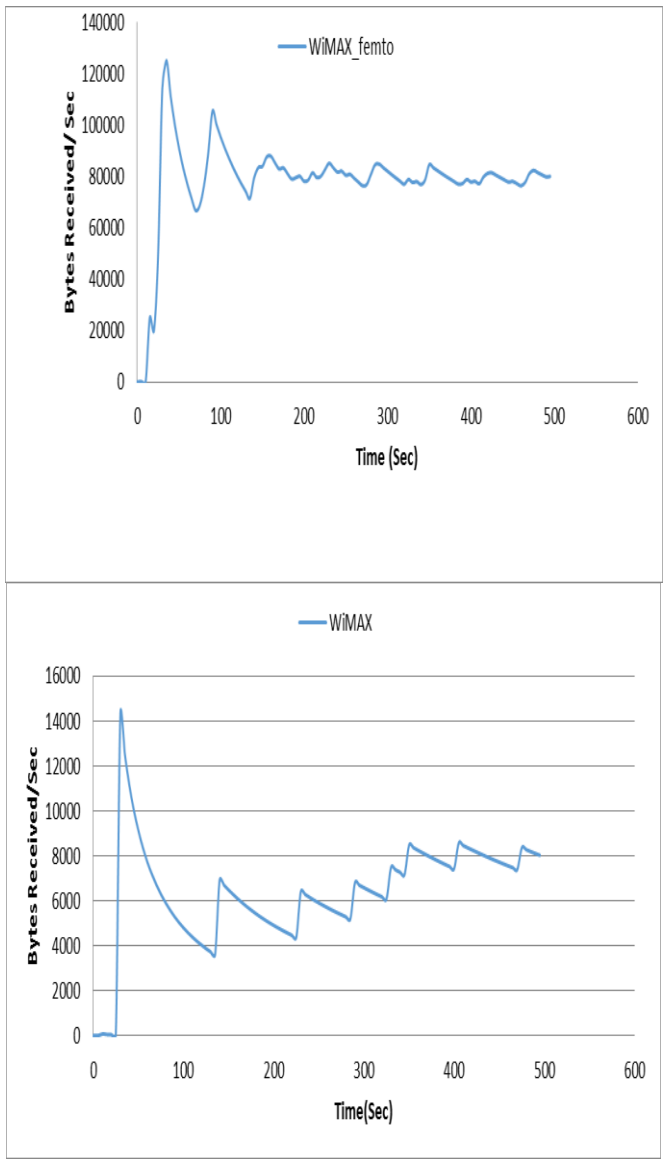

Figure 6. FTP bytes received comparison for WiMAX

FTP "File Transfer Protocol" is a TCP/IP predicated protocol used to exchange data files over the network. As we discussed afore that femtocell provides high data rate for indoor users so received data rate of heftily ponderous files is a considerable way to test the efficiency of femtocell. In our research same types of cumbersomely hefty files are transferred in both scenarios concurrently. A paramount difference is observed in both cases, a substantial amount of bytes are received at femtocell users. These are receiving about 120000 bytes per second at the commencement of simulation but after some time this amount is decremented to 70000 due to heftily ponderous load of applications and network congestion. After a very little time, femto predicated WiMAX system stabled itself and again data rate increase to 80000 bytes per second. It remained virtually same for all the time of simulation run time. On the other hand, this rate is

much lower due to sundry environmental factors in case of conventional WiMAX system. In this case only 6000 to 8000 bytes per second are receiving while utilizing the WiMAX macrocell most part of the simulation time as shown in the figure 6.

5.5 FTP upload replication time

As we discussed afore there are cumbersomely hefty file transfers in both the scenarios and it will take some time for uploading. Ergo upload time is a paramount parameter to distinguish between both systems. In femto predicated WiMAX cell, it remained between 20 to 24 seconds during the whole simulation time. But in case of conventional WiMAX system it was 45 second at the commencement due to impotent signal vigor and long distance between the macro base station and UEs. After 150 seconds it was down to 36 secs and remained virtually same for 400 simulation seconds. It then decremented to 35 secs further for the last 100 seconds of simulation and remained constant at the cessation of simulation. So it can be verbalized that average uploading replication time was 36 sec in conventional WiMAX cell and 22 sec in femto predicated cell. Hence, it was conspicuous that femto base station offered least upload replication time as compared to macro base station as shown in the figure 7.

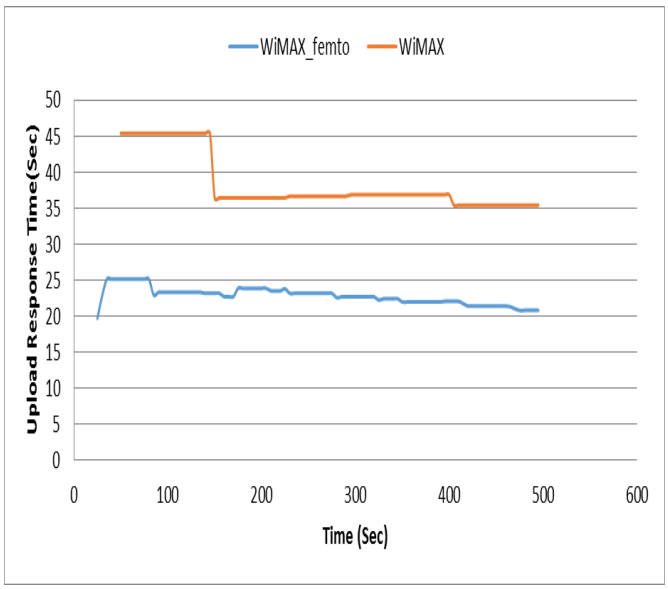

Figure 7. FTP upload response time comparison for WiMAX

5.6 Uplink SNR WiMAX

Signal to noise ratio (SNR) is another dominating parameter to evaluate the efficiency of femtocell deployment in WiMAX network that measures the acceptable BER of a network. We have evaluated SNR for uplink connections for both cases. It is pellucidly observed that average SNR is very much high in femto case due to its high efficiency. In Macrocell case received signal power falls down due to sizably voluminous distance and path loss results into low SNR. Ergo it value falls down from 4.5 to 2.5 dB and remained virtually same throughout the simulation run time. While on the other case femtocell provides high SNR which about 25 dB and commenced to fall down to 21.5 dB after few seconds and again incremented to 23 dB as shown in figure. This value remained constant for till last second of the simulation as shown in figure 8.

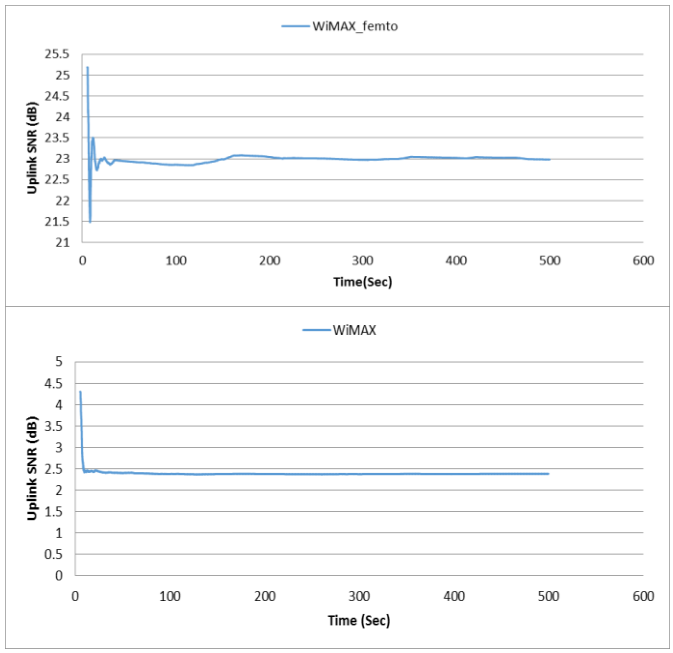

Figure 8. SNR comparison for WiMAX

6. CONCLUSIONS

The main objective of this work was to evaluate the performance and analyze the efficiency of femtocell in the areas where macrocell coverage was so impotent. To accomplish this task, the comparison of femtocell enabled networks with the traditional wireless networks is conducted utilizing different utilizer authoritatively mandating applications. The results showed multiple benefits of adopting femtocell by utilizing different performance metrics. The femto predicated network showed amended throughput and less delay for both data and voice traffic. For web, the HTTP page replication time is lower utilizing femtocell as compared to macrocell with WiMAX. Furthermore, there is more preponderant FTP traffic received in femto predicated cell along with lower upload times. The Packet dropped ratio is additionally diminutive offering high SNR in femtocell enabled networks. Here the quantifications of these performance metrics argue that femtocells provide better coverage and high data rates than traditional macro-networks for indoor communications. A co-operation between mobile operator and fine-tuned line internet accommodation provider is indispensable element for the deployment of femtocell with wireless accommodations which may appears to be a potential impotency. The utilization of tablets, smartphones and other future wireless contrivances will be more ascendant which demands high speed internet connection and ameliorated quality of accommodation. Hence, mobile network operators may offer high quality of broadband accommodations to indoor users with more reliability utilizing proposed femtocell architecture despite of more astronomically immense distances and obstacles.

In future, billions of mobile devices will be connected to internet through 3G and 4G wireless networks. The users will use multimode devices which support 3G and 4G or LTE. This work can extend for LTE that is evolution of GSM and UMTS technologies. LTE offers high speed data rates. The deployment of femtocell with LTE can better serve the growing demands of future.

REFERENCES

[1] Bao L., Liao S. (2010). Scheduling heterogeneous wireless systems for efficient spectrum access, *EURASIP Journal on Wireless Communications and Networking*, Vol. 11. DOI: 10.1155/2010/736365

[2] Andrews J.G., Claussen H., Dohler M., Rangan S., Reed M.C. (2012). Femtocells: Past, present, and future, *Selected Areas in Communications, IEEE Journal on*, Vol. 30, No. 3, pp. 497-508.

[3] Mohjazi L., Al-Qutayri M., Barada H., Poon K., Shubair R. (2011). Deployment challenges of femtocells in future indoor wireless networks, *In GCC Conference and Exhibition (GCC), 2011 IEEE*, pp. 405-408.

[4] Huang L., Zhu G., Du X. (2013). Cognitive femtocell networks: An opportunistic spectrum access for future indoor wireless coverage, *Wireless Communications, IEEE*, Vol. 20, No. 2, pp. 44-51.

[5] Akyildiz I.F., Chavarria-Reyes E., Gutierrez-Estevez D.M., Balakrishnan R., Krier J.R. (2013). Enabling next generation small cells through femtorelays. *Physical Communication*, Vol. 9, No. 4, pp. 1-15.

[6] Stocker A.C. (1984). Small-cell mobile phone systems, *Vehicular Technology, IEEE Transactions on*, Vol. 33, No. 4, pp. 269-275.

[7] Andrews J.G., Claussen H., Dohler M., Rangan S., Reed M.C. (2012). Femtocells: Past, present, and future, *Selected Areas in Communications, IEEE Journal on*, Vol. 30, No. 3, pp. 497-508.

[8] Ahson A., Ilyas M. (2007). *WiMAX: Standards and Security*, CRC Press, Inc., Boca Raton, FL, USA.

[9] Li N. (2011). Overview of WiMax technical and application analysis, M.S. thesis, Dept. Information. Technology, Turku University of applied sciences. Turku, Finland.