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Research Article

QoS Performance analysis of different hand over mechanisms in WiMAXFemtoCell Network

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Abstract

In this articlean attempt has been made to deploy a WiMAX femtocell network (Han-Jung Chuehet al, 2011) and the network is analyzed from the QoS perspective. The authors have compared the performance of different handover mechanisms like full scanning and neighbor cell scanning and the overall performance is also compared with a WiMAX network having noFemto Cells.

Keywords :*WiMAX, FemtoCell, Handover.*

1. Introduction

WiMAX is defined as Worldwide Interoperability for Microwave Access (WiMAX Forum). This forum was formed in June 2001 to promote the interoperability of the 802.16 standard, officially known as Wireless Man. The WiMAX is described as a standards based technology enabling the delivery of the last-mile wireless broadband access as an alternative to cable and digital subscriber line (DSL) (WiMAX Forum) WiMAX operates over licensed and non-licensed frequencies using non-line-of-sight (NLOS) and line-of-sight (LOS) technologies, extending broadband coverage to cities and towns wirelessly via MAN (Dr.SunilkumarS.Manvi et al 2010)

IEEE 802.16 standards (WiMAX Forum), give the specification for the wireless metropolitan area network (WMAN), also known as WiMAX network. IEEE 802.16a-d standards provide high data rate services for fixed users, and IEEE 802.16e standard supports mobility. To improve indoor (home or small office) signal strength, IEEE 802.16m introduces the FemtoCell (Femto Forum). The FemtoCell Base Station (fBS) is a low power, short-range and easy-to-install BS. It connects to the core network via DSL, optical-cable or similar backhaul technologies, and operates on licensed band, through which indoor users can access the Internet.

Mobile WiMAX based on IEEE 802.16e standard is known as Wireless Broadband (WiBro) in South Korea (Dr.SunilkumarS.Manvi et al 2010). WiBro is more robust in terms of the subscriber's speed compared with the Base station. WiBro uses time division duplex (TDD) only. It uses 8.75MHz maximum channel bandwidth. It uses the 2.3GHz band. It is interoperable with WiMAX equipment. It competes with cable, digital subscriber line (DSL) and wireless local area networks (WLANs) in South Korea.

The WiMAX FemtoCell architecture involves the deployment of FemtoCells in the WiMAX network (Han-Jung Chueh et al, 2011) . The WiMAX FemtoCell architecture gains a lot of attention, because it can provide better indoor services and also WiMAX network traffic can be shared by the FemtoCell. The signal strength of WiMAX network (i.e. the WiMAX base station) is better than FemtoCell (i.e. the Femto Base station),the handover procedure may not be triggeredeven if the neighboring fBS can provide better service, due to rigid handover triggering criteria. In addition, since the coverage of the FemtoCell is small, it is possible that huge number of FemtoCells are located in WiMAX BS coverage.

Figure 1.WiMAX FemtoCell Architecture

There are two conventional WiMAX handover mechanisms: full scanning and neighbor cell Scanning (Han-Jung Chueh et al, 2011) . Full scanning mechanism does not require any information of neighboring cell. However, it needs to scan all WiMAX BSs and fBSs, hence the scanning range is the entire network. Neighbor cell Scanning mechanism scans all geographically neighboring WiMAX BSs and fBSs, depending on the neighbor list which is manually configured by system operators.

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Using traditional full scanning mechanism, MSs should make a great effort to scan all fBSs, which results in significant increase in handover delay and power consumption (Han-Jung Chueh et al, 2011) . In case of Neighbour cell scanning mechanism a WiMAX BS or fBS periodically broadcasts to its set of candidate neighbouring base stations, referred as 'neighbour list'(Han-Jung Chueh et al, 2011) . If the neighbour list is incomplete or incorrect, an MS might handover to an inappropriate BS or even fail to handover. Thus, it is crucial to generate a proper neighbour list for successful and efficient handovers. In the neighbour cell information mechanism of traditional WiMAX network, system operators manually configure and manage the neighbour list based on geographical topology when BSs are initially installed.
The rest of the paper is organized as follows. In section 2, the description of scanning mechanisms is presented. System simulation and performance evaluation are described in section 3. Section 4 is conclusion.

Scanning Mechanisms

Figure 2 shows an example of WiMAXFemtoCell architecture. Six Femto BSs(fBS) are installed within the WiMAX BS coverage and each fBS is connected to the Femto Gateway. Both WiMAX BS and Femto Gateway are connected to the core network using wired link.

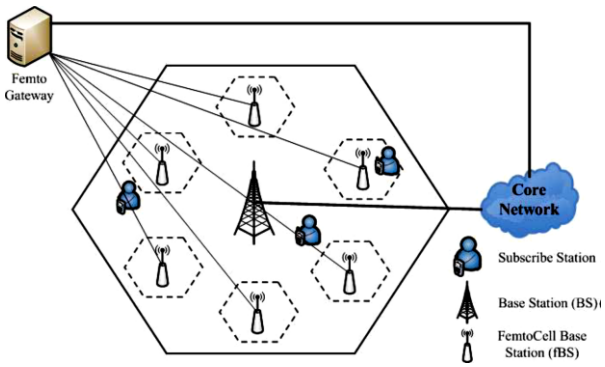


Figure 2.Example of WiMAX FemtoCell Architecture

The FemtoCell is a small base station with a small service area. It's transmitting power and antenna size is small compared to the WiMAX Base Station It is designed to serve fewer than 10 users(Han-Jung Chueh et al, 2011) . The Femto Gateway validates all encrypted IP connections from hundreds of FemtoCells(Han-Jung Chueh et al, 2011) . It not only acts as a security gateway but also acts as a data gateway to forward the traffic. Deployment of FemtoCells is improves the network's throughput. Users can be randomly located in the WiMAX BS coverage, and can communicate with each other through the WiMAX BS or the fBS, depending on the received signal strength.

There are two conventional WiMAX handover mechanisms: full scanning and neighbor cell information (Han-Jung Chueh et al, 2011) (Priya K et al,2012) (MohdSidekPardi et al,2011) . Full scanning mechanism does not require any information of neighboring cell. However, it needs to scan all WiMAX BSs and fBSs, hence the scanning range is the entire network. Neighbor cell information mechanism scans all geographically neighboring WiMAX BSs and fBSs(ZhenxiaZhangi et al,2010). In the Figure 3 the number of items of neighbour list is set to 4.

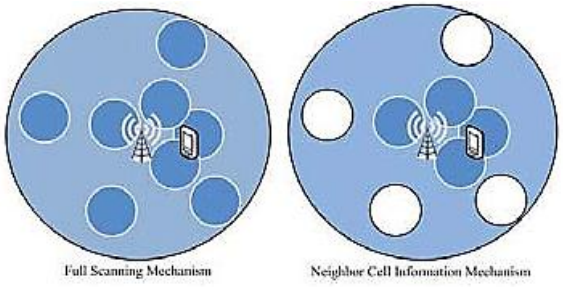


Figure 3.The scanning range under different scanning mechanisms.

System Simulation and Performance Evaluation

To verify the performance of the different handover mechanisms - full scanning, neighbor cell information and the WiMAX network with no Femto Cells, a simulation environment is created using QualNet simulator. The performance parameters used for comparison are Throughput, End- to -end delay, Jitter and Total Power consumption. In the simulation, advanced wireless model library (QualNet documentation) of QualNet 6.0, including both IEEE 802.16 and IEEE 802.16e protocols are used.

Simulation environment and simulation parameters

The simulation scenario is as in Figure 4 and Figure 5. The Table 1 gives the names of the devices used in the scenario.

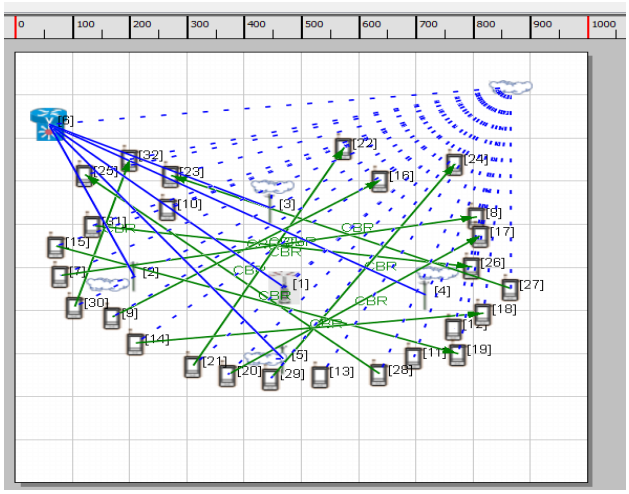


Figure 4. Simulation scenario for both Full scanning and Neighbor Cell scanning mechanisms.

The difference between the two scanning is in the configuration in the Neighboring base station list.

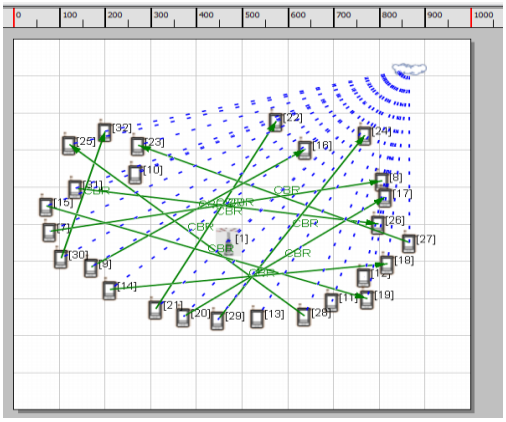


Figure 5. Simulation scenario for WiMAX network Without Femto Cells.

Simulation Results

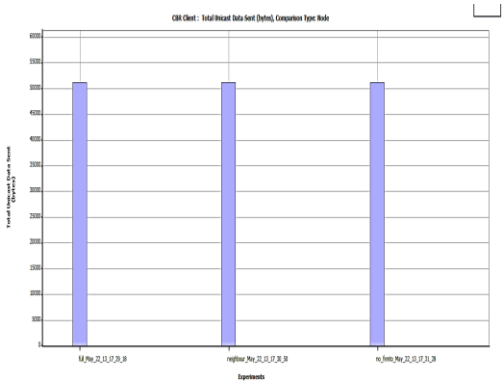
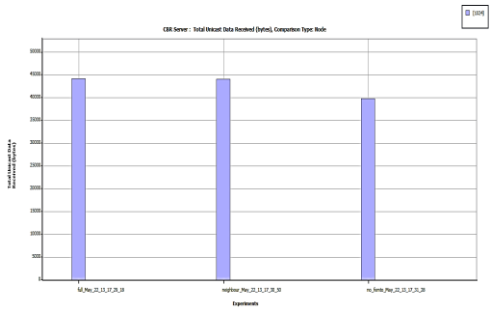


Figure 6 . Total unicast data sent (bytes)

Total bytes sent	Full scanning	Neighbor cell scanning	Without Femto Cells
	51200	51200	51200

Same amount of data is transmitted in all three cases



Figre 7. Total unicast data received (bytes)

Total bytes received	Full scanning	Neighbor cell scanning	Without Femto Cells
	44185.6	44134.4	39889.5

Received data in case of full scanning method is the highest and is least in the network with no Femto cell.In case of network without Femto cell received, data is least due to more traffic load on the WiMAX Base station only which may lead to packet drops.

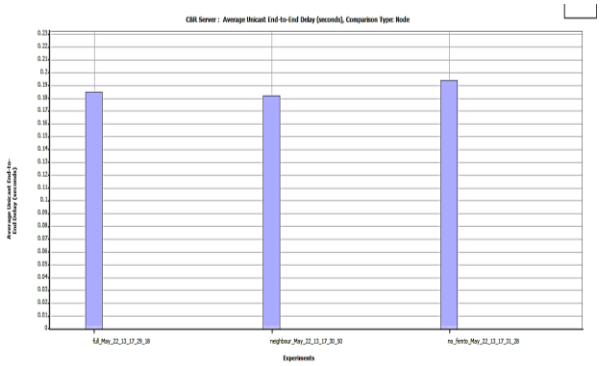


Figure 8 . End-to-End delay

Total delay (seconds)	Full scanning	Neighbor cell scanning	Without Femto Cells
	0.185075	0.182417	0.194069

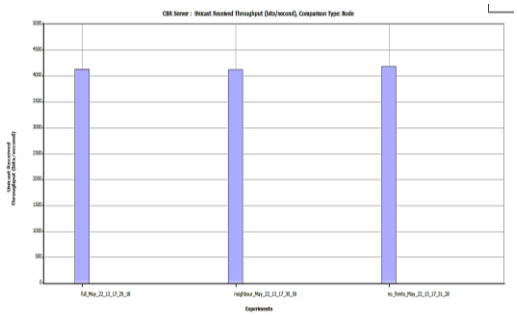


Figure 9. Throughput

Throughput (bits/sec)	Full scanning	Neighbor cell scanning	Without Femto Cells
	4134.47	4127.88	4123.86

Delay in case of full scanning is more compared to Neighbor cell scanning method. Because in case of full scanning method, all the base stations in the WiMAX network need to be scanned for handover whereas, in case of Neighbor cell scanning method only neighboring base stations are scanned. In case of network without Femto cell delay is highest due to more traffic load on the WiMAX Base station only.

In general, Throughput is higher in the case of networks with Femto cells. Because in network with Femto cells the traffic load on the WiMAX base station is shared is shared with Femto base stations.

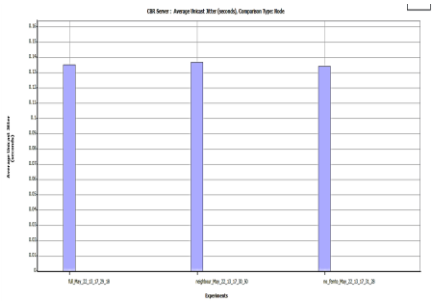


Figure 10. Jitter

Jitter(seconds)	Full scanning	Neighbor cell scanning	Without Femto Cells
	0.13536	0.136813	0.134385

Jitter is highest in case of neighbor cell scanning method and least in case of network without Femto cell. Compared to Full scanning method, Neighbor cell scanning method consumes less power.Because the amount of scanning done in case of neighbor cell scanning method is less compared to full scanning method. But network without Femto cell consumes least power because of the presence of only one base station.

Table1. Names of the devices used in the scenario

Sl. No.	Devices	Name
1	[1]	WiMAX Base Station
2	[2]	Femto Base Station
3	[3]	Mobile Station(Subscriber)
4	[4]	Femto Gateway
5		Subnet(Wireless network)

The difference between this scenario compared to the previous one is that it does not have Femto base station and Femto gateway. The simulation parameters are summarized in Table 2.

Table 2 . The simulation parameters of scenario

S. No.	Parameter	Value
1.	Simulation time(s)	300
2.	Scenario dimensions(meters)	X:1000
		Y: 1000
3.	Number of channels	5
4.	Radio Type	802.16 Radio
5.	Transmission power(BS, dBm)	25
6.	Transmission power(Femto cell, dBm)	20
7.	Antenna Height(BS, meters)	4
8.	Antenna Height(Femto cell , meters)	1.5
9.	Frequency of operation(GHz)	2.4
10.	Bandwidth (MHz)	20
11.	FFT size	2048
12.	Cyclic prefix factor	8
13.	Antenna model	Omnidirectional
14.	Neighbor BS Scanning RSS Trigger(dBm)	-76
15.	Handover RSS Trigger(dBm)	-78
16.	Energy model	Generic
17.	Routing protocol	Bellman Ford
18.	Number of Femto Base stations	4
19.	Number of mobile stations	26
20.	Number of Femto Gateway	1
21.	Number of subnets	5
22.	Mobility model(MS)	Random Waypoint
23.	Pause time(MS, s)	300
24.	Minimum speed (MS, mps)	0
25.	Maximum speed(MS, mps)	10
26.	Number of CBR links	12
27.	Items to send(CBR)	100
28.	Packet size(CBR, bytes)	512
29.	Inter packet interval(CBR, s)	1
30.	Start time(CBR,s)	1
31.	End time(CBR,s)	300

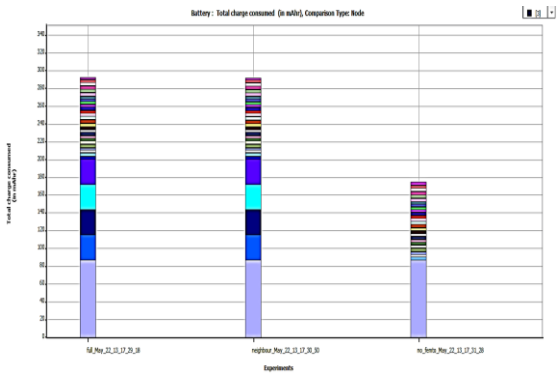


Figure 11. Power consumption

Total charge consumed(mAhr)	Full scanning	Neighbor cell scanning	Without Femto Cells
	293.18	292.98	175..33

Conclusions

WiMAX network without Femto Cell provides lesser Throughput compared to WiMAX FemtoCell Architecture. But, the power consumption in case of WiMAX network without Femto Cell is less compared to WiMAX FemtoCell Architecture. With WiMAX FemtoCell Architecture, Full scanning mechanism consumes more power compared to Neighbor cell scanning mechanism. So, Neighbor cell scanning mechanism is optimum compared to Full scanning mechanism.

Acknowledgement

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