Providing QoS in WiMAX Network by using FemtoCell

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ABSTRACT
WiMAX is described as standards based technology enabling the delivery of the last-mile wireless broadband access as an alternative to cable and digital subscriber line. Deploying femtoCells in WiMAX network gains a lot of attention due to better sharing of WiMAX network traffic by the FemtoCell. However, since the signal of WiMAX base station (BS) is stronger than FemtoCell Base Station (fBS), the handover procedure may not be triggered even though fBS is within the BS coverage. Besides, since the coverage of FemtoCell is small, it is possible that a huge number of fBSs are deployed in WiMAX BS coverage. The proposed work uses a beacon-based handover scanning mechanism to prevent the loss of signal strength during the handover process in femtocell. The proposed mechanism supports the QOS and also improves the throughput performance of network. A simulation is conducted using QualNet simulator. From the Simulation results it is observed end to end delay of the proposed work is small as compared with conventional handover mechanisms.

Keywords
Femtocell, WIMAX, Handover, Quality of Service (QoS**)**

1. INTRODUCTION
The traditional WiMAX network was not originally designed for fBSs usage. However, deploying fBSs in WiMAX networks, also called WiMAX femtocell architecture [3], has gained a lot of attention because fBS can provide better indoor services and offload traffic from the WiMAX network [4]. A sample deployment of fBSs in WiMAX Base Station (WiMAX BS) coverage is depicted in Figure 1. To make the architecture efficient, several subtle problems require being resolved. For example, since the signal strength of WiMAX BS is usually stronger than fBS, a handover may not be triggered to a femtocell even though it can provide better indoor service, and WiMAX network traffic cannot be offloaded by femtocell deployment. In addition, due to the smaller coverage of the femtocell, a huge number of fBSs could be located within a WiMAX BS boundary. Using the traditional full scanning mechanism [6], mobile stations (MSs) should make a great effort to scan all fBSs, which may cause significant handover delay and extra power consumption.

Another scanning problem occurs when a WiMAX BS or fBS periodically broadcasts a set of a candidate station's neighboring base stations, referred as a neighbor cell list (NCL). If the NCL is incomplete or inaccurate, an MS may hand over to an inappropriate base station or even fail to hand over. Thus, it is crucial to generate a proper NCL for successful handover triggering. the basics of WiMAX femtocell networks and femtocell deployment are briefly described. The issues of WiMAX femtocell networks such as NCL generation, femtocell discovery, and scanning schemes are also discussed.

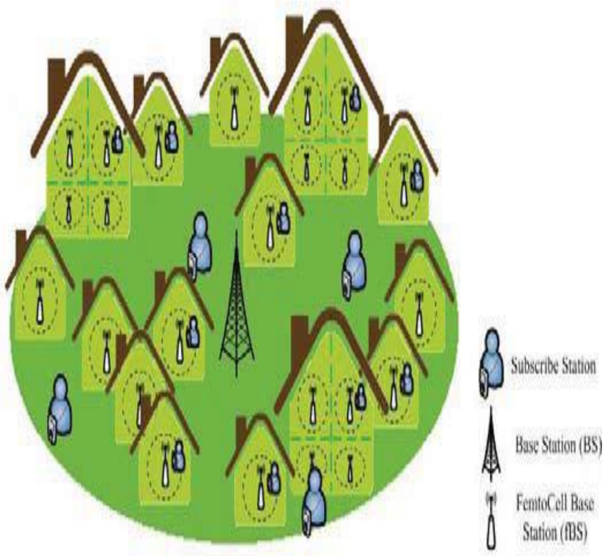

Figure 1. A sample deployment of fBSs in a WiMAX BS coverage

WiMAX femtocell networks offer several benefits such as providing better indoor signal coverage, reducing macro network deployment costs, and increasing capacity in home or small office environments. As shown in Figure 2, the WiMAX femtocell network architecture is based on the WiMAX basic network reference model with the additions of WiMAX femto access points (WFAPs) and femto gateways. Femto gateway is an entity that controls and manages WFAPs and is owned by a service provider. It also performs bearer plane routing to the core network. In addition, a femto gateway also supports femto-specific functionalities such as closed subscriber grouping (CSG), subscriber admission control, handover control, and interference management. Since fBSs are installed by users as demanded, both self-organization and self-management functions are very important for the operation of WiMAX femtocell networks. Although the self-organizing network (SON) algorithm (Han et al. 2009) is adopted to configure femtocell deployment automatically to maximize system capacity and reduce the burden on the operator, dynamically installed fBSs may result in interference.

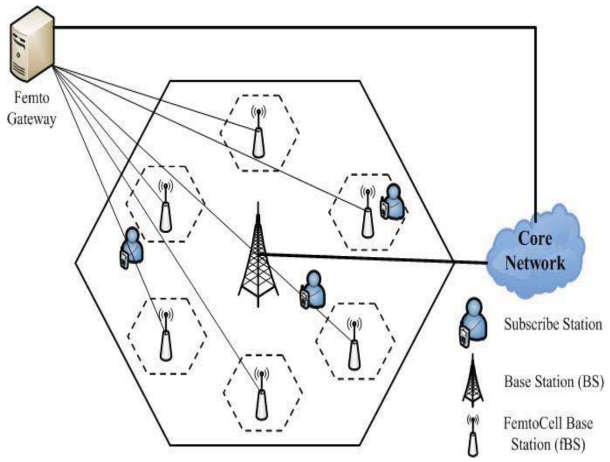

Figure 2. The WiMAX femtocell network architecture

2. RELATED WORK

Shang-Juh Kao proposed a beacon-based handover scanning mechanism with Quality of Service (QoS) support. Through the modified beacons and MOB_NBR-ADV messages, a neighbor cell list with QoS parameters is generated automatically at each mobile station. Han et al. [8] have proposed an automatic neighboring base station list generation scheme for femtocell networks, which is utilized by MSs to determine a target cell for handover. This scheme repeats periodically and is triggered by the management server when network topology is changed. Kim and Cho [5] proposed another scanning scheme to determine the scanning set, which has the minimum number of scanning items and includes the appropriate target cell. The minimal scanning set can reduce the scanning information message size received from the serving macrocell.

3. PROPOSED WORK

The proposed mechanism can be divided into three phases. Initially, the proposed mechanism uses beacon messages and the modified MOB_NBR-ADV messages to generate Neighbor Cell List. In the second phase, if the RSS (Received Single Strength) or QoS is below the threshold value, or a nearby fBS is discovered, the scanning procedure will be triggered. Finally, the Neighbor Cell List is sorted according to QoS parameters, and an appropriate target cell is selected to handover depending upon the priority and RSS.

3.1 Automatic Generation of NCL

In the proposed approach, serving WiMAX BS or fBS broadcasts the MOB_NBR-ADV message periodically. In order to perform efficient scanning, this message contains the information and additional QoS parameters about neighboring WiMAX BSs, such as Service Level, bandwidth, FemtoCell or not, and the number of associated users. The proposed method inserts the additional QoS parameters in the reserved area, in order to efficient and successful handover. The Femto Gateway collects information via backhaul network, and notified each FemtoCell the information of its' neighboring WiMAX BS. Similarly, FemtoCell also broadcasts beacon messages periodically, using the radio channel known on all FemtoCell and MSs.

As MOB_NBR-ADV and beacon messages received by MS, it is able to generate the NCL automatically. The proposed mechanism only needs to scan geographically neighbouring BSs and fBSs based on received beacon message. This decreases the number of items of neighbour list to 3. In neighbouring cell information mechanism, neighbour list is manually configured and managed by system operators; it only contained the MAC address and the frequency channel of BS. The value of RSS and CINR (Carrier to Interference Noise Ratio) will be updated at the next scan. Both WiMAX BS and fBS are responsible to calculate Service Level, as it is required in the extended NCL. To include QoS consideration, we associate the five service flows [11], UGS, ertPS, rtPS, nrtPS, BE, with the value of 5, 4, 3, 2, and 1 respectively. For instance, if a base station contains one UGS service flow, one rtPS service flow, and two BE service flows, its service value is 5+3+(2*1)=10.

3.2 Discovery of Neighboring Cells

In this phase, MS may not be able to find the neighbouring FemtoCell with different frequency channels. If the threshold for MS to initiate scans for handover is set too low, it will scan frequently and waste time and power. On the other hand, if the threshold is set too high, it will not be easy to switch to FemtoCell, even though the FemtoCell provides better services and QoS support. FemtoCell broadcast beacon messages periodically, and use the radio channel known for other FemtoCell and MSs. Hence, MS can easily discover the target fBS of different frequency channel upon it roams.

If the RSS or QoS is below than the predetermined threshold, or the proposed mechanism discovers a nearby FemtoCell via beacon messages, MS will trigger the scan procedure. In order to get the channel information, MS sends a scan request (MOB_SCN-REQ) to the serving cell. The MOB_SCN-REQ message contains NCL which is generated from the previous phase. The serving cell returns a scan response (MOB_SCN-RSP), which includes the scanning time, a cell list to scan, and channel information. MS will synchronize with neighboring cells the information of MOB_SCN-RSP. Finally, MS reports the scan status to its serving cell via the MOB_SCN-REP message for the purpose of triggering a handover.

3.3 Determination of an Appropriate Target Cell

In this phase, an appropriate target cell from the Neighbour Cell List will be determined by priority order. The beacon based handover scanning mechanism calculates the priority Pi for ith cell using the formula (1), and sorts Neighbour Cell List by priority.

$$Pi = (Wi * Ui)(Si + Fi) \qquad (1)$$

In the above equation, Wi indicates cell has sufficient bandwidth or not, with 1 for having enough bandwidth and 0 otherwise. Ui indicates whether the upper bound of users has been reached or not. Si is the service level and Fi indicates whether it is FemtoCell or not, with 1 for fBS, and 0 for traditional WiMAX BS. Pi reflects the QoS feature, the bigger value of Pi means the better service can be provided.

Once, we discover an appropriate target cell with enough signal strength and less interference noise by priority order, the handover procedure will be triggered. On the other hand, if there is no target cell discovered, the next information collection for NCL will continue until the scanning procedure is triggered.

4. SIMULATION RESULTS

The simulation, use advanced wireless model library [20] of qulanet 5.0, including both IEEE 802.16 and IEEE 802.16e protocols. The simulation parameters are summarized in Table I.

Table 1. Simulation parameters

S.no	Parameter	Value
1	Simulation time(s)	300
2	Scenario dimensions(meters)	X:1000 Y:1000
3	Radio type	802.16 Radio
4	Transmission power(BS, dbm)	25
5	Transmission power (femtocell, dbm)	20
6	Antenna height(BS, meters)	4
7	Antenna height(femtocell, meters)	1.5
8	Number of femto base station	6
9	Number of mobile station	30
10	Mobility model(MS)	Random waypoint

The simulation time is set to be 300 seconds and the traffic flow is set be constant bit rate (CBR) with packet size 512 Kbytes. One MS from each fBS transmits constant bit rate (CBR) packets to another MS in different fBS within the same Femto gateway

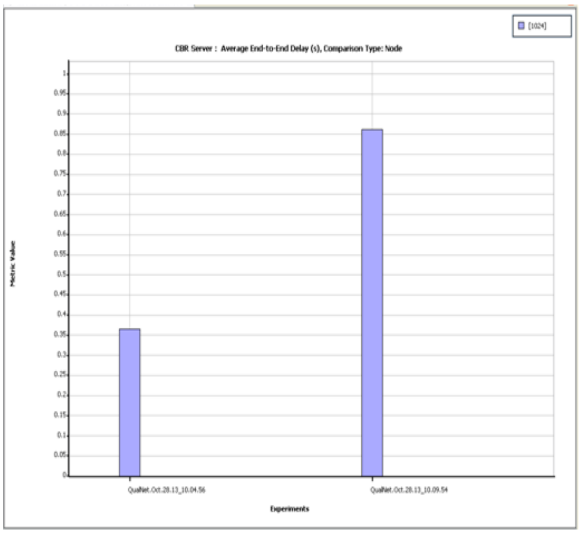

Figure 3 Average end to end delay

The average end to end delay is very low in with femtocell compared to the without femtocell.

Table 2 Average end to end delay

Average end to end delay	
With femtocell	Without femtocell
0.365676	0.861206

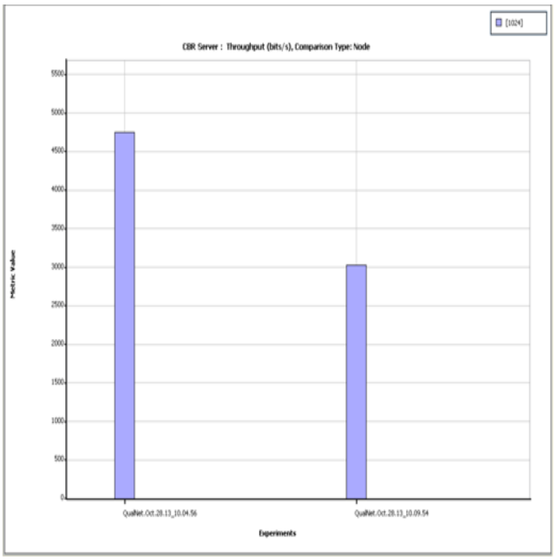

Figure 4 Throughput

The throughput is very high in with femtocell compared to that of without femtocell in wimax network.

Table 3 Throughput

Throughput	
With femtocell	Without femtocell
4746.2	3024.67

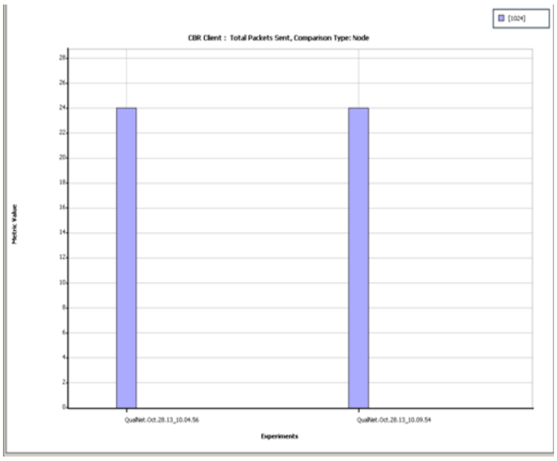

Figure 5 Total packet sent

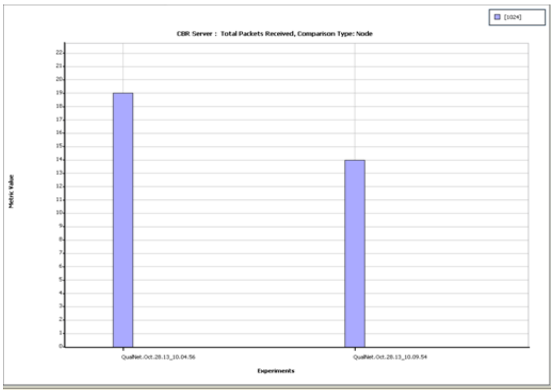

Figure 6 Total packet received

Table 4 Total packet send and received

Total packet sent		Total packet received	
With femtocell	Without femtocell	With femtocell	Without femtocell
24	24	19	14

The above table describe that, the number of total packet received in with femtocell is very high compared to the without femtocell.

5. CONCLUSION

In WiMAX FemtoCell architecture, using either full scanning mechanism or neighbour cell information mechanism, MS may not trigger the handover procedure even if the neighbouring fBS can provide better service, due to the rigid handover triggering criteria. This could result in inefficiency of resource usage. A Beacon-Based Handover Scanning mechanism with Quality of Service (QoS) support is proposed. Through the broadcast beacon messages and modified MOB_NBR-ADV messages, a neighbour cell list with QoS parameters is generated automatically at MS side. Through the adoption of the proposed mechanism, the overall system throughput can be improved and the traffic load through the WiMAX BS can be reduced effectively. The simulation results reveal that the beacon-based handover scanning mechanism outperforms the full scanning mechanism and neighbor cell information mechanism from the aspects of the system throughput and the utilization of FemtoCell in WiMAX FemtoCell architecture.

6. REFERENCES

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