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Mitigating Handover Complexity in Wimax Network by Using Femtocell

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Abstract: WiMAX femtocells are currently under the development and they are expected to play an important role in the development of indoor broadband wireless access. Multiple femtocells are overlapped in WiMAX network for the purpose of improving coverage. The signal strength of WiMAX base station is usually stronger than the femtocell, hence there is no chance of handover. This paper thus proposes the velocity decision handover mechanism is used to reduce neighbor cell list for successful handover. The simulation results show that our scheme improves femtocell usage, offload the traffic of macrocell and decrease the handover delay compared to the conventional mechanism.

Keywords: Femtocell, WIMAX, Handover,Throughput

I. INTRODUCTION

The traditional WiMAX network was not originally designed for femtocell Base Stations (fBSs) usage. However, deploying fBSs in WiMAX networks, also called WiMAX femtocell architecture [1], has gained a lot of attention because fBS can provide better indoor services and offload traffic from the WiMAX network [2]. A sample deployment of fBSs in WiMAX Base Station (WiMAX BS) coverage is depicted in Fig. 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 [3], 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.

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 Fig.2, the WiMAX femtocell network architecture is based on the WiMAX basic network reference model with the additions

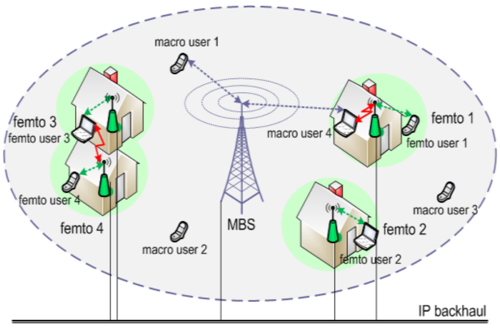

Fig. 1 A sample deployment of fBSs in a WiMAX BS coverage.

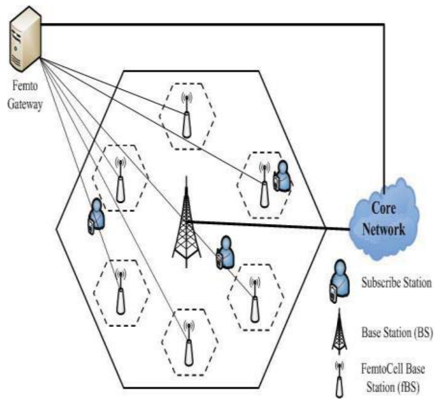

Fig. 2 The WiMAX femtocell network architecture

of WiMAX femto access points (WFAPs) and femto gateways. Due to the fact that more than 70% of the voice calls and data usage are performed in indoor scenarios as stated in [4], WiMAX femtocells have been pointed as good approach for the future deployment of wireless broadband indoor solutions. WiMAX femtocells offer numerous benefits to the operator: zero cell site acquisition cost, increased network coverage, lower cost to maintain transport network, no high energy bills to operate base stations, offloaded macro cell sites, and improved customer satisfaction. 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 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.

II. RELATED WORK

There are some works in the literature about the handover strategies for two-tier networks. In [5], the authors developed an RSSI based strategy to help the macrocell user to handover to femtocells, but they did not consider the MS velocities. The works in force the cell edge users to handover into femtocells by dynamic adjust the RSSI margin in the handover decisions. The MS speed into the consideration of handover decision in the two-tier networks. However, they did not consider about the different between femtocells and macrocells, and thus the increasing of system performance and spectrum efficient are not discussed[6,7]. The handover in the femtocell/macrocell overlay systems, there are many new issues needed to be considered in the handover procedure. The impact of the MS velocity and the scan trigger policies to the handover decision are the focus in this paper.

III. PROPOSED WORK

To increase femtocell utilization, thus, reduce macrocell loading factor and boost system throughput, need a mechanism to force the MS handover into femtocells even when the signal quality for serving macrocell is still good. On the other hand, the handovers resulting in very short femtocell residential time need to be avoided to prevent unnecessary system overhead. For the purpose, we introduce the periodic scan mechanism. To avoid unnecessary handovers into femtocells, include the velocity as a factor into our handover decision. The scan and handover decision procedure for the MS initially served by the macrocell and femtocells respectively.

A. Scan Mechanism Block

The scan mechanism algorithm is shown in the Fig. 3. Before handover decision and execution, the scan processes need to be performed to search for possible target candidate stations and measure the RSSIs from the stations. Both conventional RSSI threshold trigger scan and periodically scan mechanisms are included in our handover procedure[8]. The new periodically scan mechanism is introduced primary to force the MS search for handover possibility even when the current communication quality still acceptable.

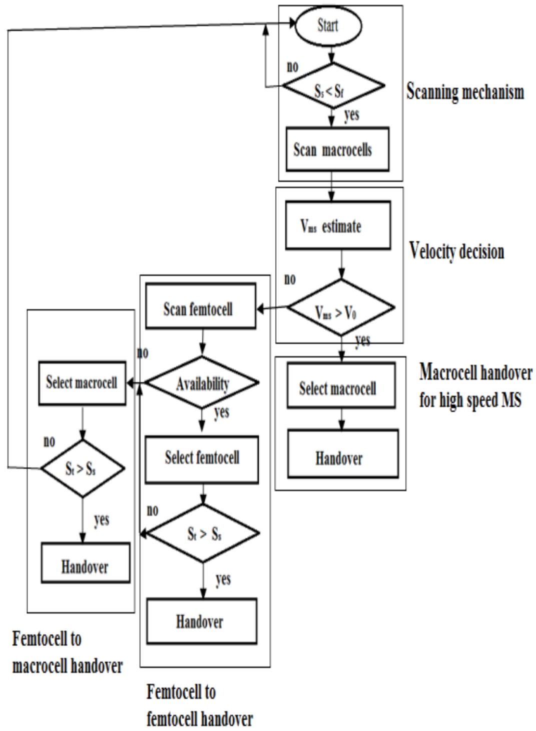

Fig. 3 Scan and speed dependent handover

B. Velocity Decision

If the velocity of the MS, Vms, is higher than predefined threshold, Vo, the mobile station scan macrocells only. That is, if the mobile station is moving in high speed, to avoid unnecessary handoff to the femto station, only handover into macrocell is considered. Here we assume that the MS knows its speed. In practical, there are many methods to estimate the speed of the MS including the use of GPS, Doppler effect, signal strength variation, and etc.

D. Femtocell to Femtocell Handover and Femtocell-to-Macrocell Handover

Now consider the outbound handover mechanism for the MS served by femtocell. As depicted in Fig.3, if the signal strength from the serving femtocell is lower than femtoS, the MS start to look for better base station. Similar to the previous case, the MS create RSSI profile for the server to provide the neighbor femtocell list[9]. The MS first scan the nearby femtocell to select the best target femtocell to hand-in. If the neighbor femtocell list target is empty or no appropriate femtocell to hand-in, the MS then select the macrocell as the target to hand-in.

IV. SIMULATION RESULTS

In order to analyze, compare and validate the performance of the proposed handover scheme in mixed

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Femto/Macrocell environment, an extensive simulation experiments have been conducted using Ns-3. All simulations are based on the IEEE 802.16e PHY model with reference to Table.1. The macrocell layout is Hexagonal grid, 3 cell sites, and 3 sectors per site in this simulation system. The environment includes houses, blocks, and streets. In the suburban area, streets form a grid structure and run in the north-south or east-west direction. Houses are situated in 3 cell Hexagon Architecture. The square blocks separated by streets. There are 100 houses within each block. Users are randomly placed in the area. A user may be inside the house (indoors) or on the street (outdoors).

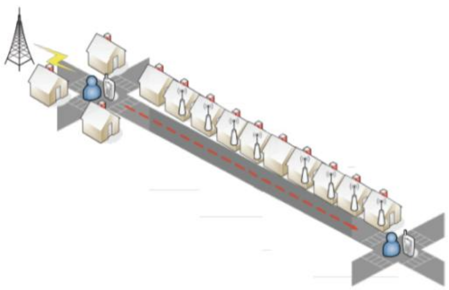

Fig. 4 The moving path of the mobile station

A user may communicate with the macrocell base station or the femtocell base station, depending on the received signal strength. A house occupies a 14x14 meter square area, centering within a 20x20 meter square land. Therefore the distance between two neighbouring houses in the same block is 6 meters. The width of the street is assumed to be 30 meters. Femto base stations (femtocells) are deployed at the midpoint of the houses. Whether or not a femtocell deployed in the house is according to the density parameter. In simulation, when a mobile station (MS) is created, the MS calculates RSSI from the serving base station and also consider the speed of the mobile station . These signal strengths will be used to evaluate link quality and as the signal strength factors in handover algorithm.

TABEL 1
SIMULATION PARAMETER

S.no	**Parameter**	**Value**
1	Simulation time(s)	300
2	Scenario dimensions(meters)	X:2500 Y:2500
3	Radio type	802.16 Radio
4	Transmission power(BS, dbm)	34
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

To simulate the behaviors of the MS using handover algorithm, pick up a street in the above simulation environment and create a MS to move along the street. Assume all of the femtocells are OSG (open subscriber group) and the velocity of the MS varies from 100 meter per hour to 100 km per hour. As illustrated in Fig. 4, the mobile station moves 200 meters with difference speed on the path. On this path, the MS may be served by the macrocell of nearby femtocells depending on the RSSIs, the velocity of MS, and our handover policies.

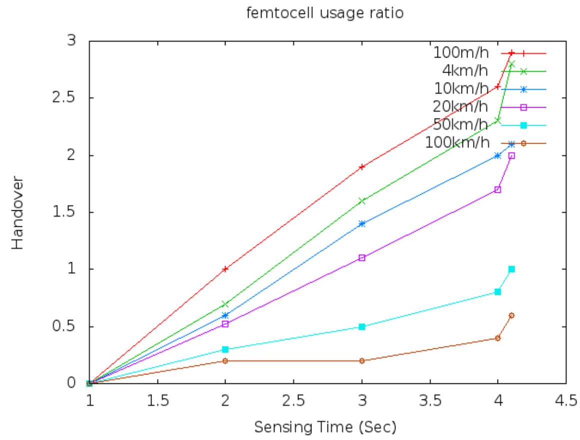

Fig.5 Femtocell usage ratio

The above Fig.5 shows that the femtocell usage ratio of wimax network by using femtocell base station at different speed of mobile station. If MS moves at the speed 100m/hr it use 90% femtocell and reduce the burden to the macrocell.

Two scenarios are analysed:

• **Conventional** :

WiMAX Femtocell Access Points (WFAPs) are introduced in network architecture and Femto/Macro cell handover procedure is similar to standard handover between Target BS and Serving BS.

• **Proposed** :

The proposed handover scheme based on periodic scan and speed decision handover is applied in mixed Femto/Macro cell environment.

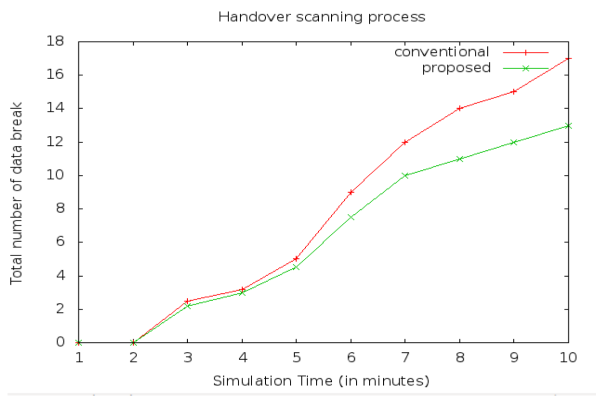

Fig.6 Handover scanning process

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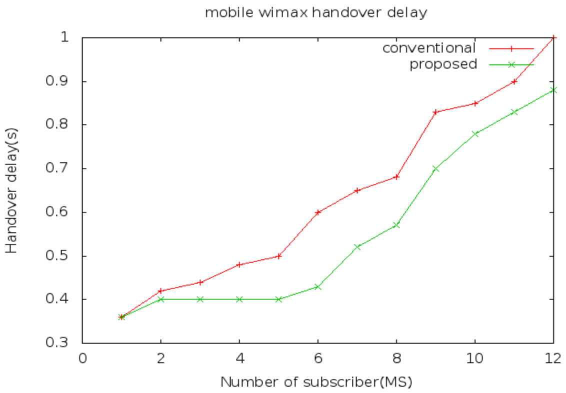

Fig.7 WiMAX handover delay

Fig.6 shows the reduced the number of scanned WFAP and BS. Hence our proposed scheme that implying less MS data breaks submissions compared to that of conventional mechanism. These results influence the delay of handover procedure.

From Fig.7, it is observed that an improvement of about 5% -10% in handover delay between the conventional WFAP method and the proposed one. The proposed enhancement of handover algorithm performance in MS immobility case and in flow management. As a consequence there is a significant improvement in network load balancing.We enhancing the QOS of WiMAX network using the femtocell by using our proposed mechanism compared to that of conventional mechanism.

V. CONCLUSION

The proposed method is used to resolve the new issues of the handover with femtocell deployment in the WiMAX environment. The new introduced scan mechanism can force the macrocell user to handover into appropriate target femtocell to offload the macrocell traffic thus increasing femtocell usage and total system capacity of the network. With the consideration of MS speed in our handover algorithm, the unnecessary handover among femtocells for moving user can be reduced. In the simulation, observe that the proposed system reduces unnecessary handover and improves the femtocell usage ratio compared to that of conventional system.

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