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A Survey on Group Mobility Model and Handover in Mobile WiMAX Network

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ABSTACT

Wider Coverage area and high data rates, makes WiMAX (Worldwide interoperability for microwave access) to be one of the most developing technology for offering wireless last-mile connection. Group mobility scenarios are widely seen in military environment, emergency and rescue activities.. Group mobility refers to the scenarios that multiple mobile nodes (MNs) move in a group at the same time, usually in the same direction with a small distance of separation. This paper gives detail description of WiMAX standard and discussed the concept of group mobility in WiMAX. In this paper ,we have described different mobility model & how the mobile station are grouped together. The subgroup of MSs are handed over into different base station is also explained in this paper. Also the different types of handover is discussed.

KEY WORDS: ***Mobility Models, Group Mobility, WiMAX, Handover***

INTRODUCTION

WiMAX is a 4th generation wireless communication technology and it is based on IEEE802.16 specification which is a standard for Wireless Metropolitan Area Network (WMAN). It is a promising technology that offers higher data rate, supports large number of users and covers a larger area (Sundararajan T. V. P.2, 2013, *Volume 2, Issue 3, ISSN 2319 – 4847*). Mobility in a network describes the movement of the nodes in the network. Group mobility is a concept in which a group of MNs moves at a same time particularly in the same direction with small space of the interval between individual nodes in a particular group [2, 3]. Military tactical communication, disaster recovery, emergency and rescue operations are some of the widespread scenarios of group mobility.

In this Paper, it contains introduction of Mobile WiMAX , different mobility model and different types of Handover Process.

MOBILE WIMAX OVERVIEW

Mobile WiMAX stands for IEEE 802.16e specifies handover for Portability, simple Mobility and Full Mobility of the users. The moving speed is in the range of walking speed and low vehicular speed respectively for portability and simple mobility both fall into a hard handover group. We will approach both of these from the point of view of handovers, Group mobility and QoS.

Our aim is to get a good understanding of the framework that Mobile WiMAX offers for all of these. IEEE 802.16e includes Physical layer and flexible orthogonal frequency division multiple access (OFDMA) frame structure that Mobile Wimax uses and move on to see how this enables the MAC scheduler to efficiently and flexibly use the radio resources and provide QoS within one Base Station.

Table.1 Mobile WiMAX system attributes

Bandwidth	2-6 GHz
Duplexing	FDD, TDD
Multiple Access	OFDMA (uplink) SC-OFDMA (downlink)
MIMO	2 × 2, 4 × 2, 4 × 4 (Downlink) 1 × 2, 1 × 4 (Uplink)
Peak data rate in 10MHz	63 Mb/sector(Downlink) 28Mb/sector(Uplink)
Modulation	QPSK, 16-QAM and 64-QAM

HANDOVER TYPES

The basic mean of WiMAX handover is to provide the continuous connection when a Mobile Station (MS) migrates from an air-interface of one BS to another air interface provided by another BS.

In the IEEE 802.16e are defined two types of handover hard handover and soft handover (A. B. Pontes, 2008, *IEEE Wireless Communications*). Soft handover having two types Macro Diversity Handover (MDHO) and Fast Base Station Switching (FBSS). Hard handover is mandatory in WiMAX systems. Soft handover process is optional.

HARD HANDOVER

During hard handover the MS communicates with only just one BS in each time. Connection with the old BS is broken before the new connection is established. Handover is executed after the signal strength from neighbour's cell is exceeding the signal strength from the current cell. This situation is shown in Fig.1.Dark thick line at the boarder of the cells presents the place where the hard handover is realized.

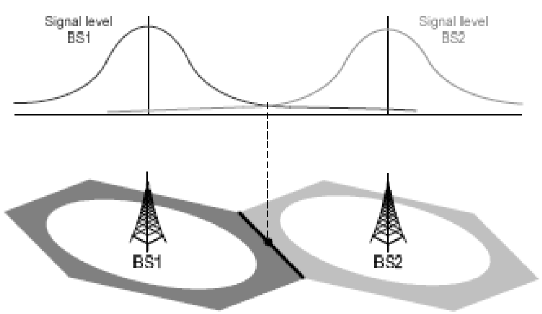

Fig.1 Hard handover realization

MACRO DIVERSITY HANDOVER

When MDHO is supported by MS and by BS, the "Diversity Set" is maintained by MS and BS. Diversity set is a list of the BS's, which are involved in the handover procedure. Diversity set is defined for each of MS's in network. MS communicates with all BS's in the diversity set (see Fig. 2.). For downlink in MDHO, two or more BS's transmit data to MS such that diversity combining can be performed at the MS. For uplink in MDHO, MS transmission is received by multiple BS's where selection diversity of the received information is performed. The BS, which can receive communication among MS's and other BS's, but the level of signal strength is not sufficient is noted as "Neighbor BS".

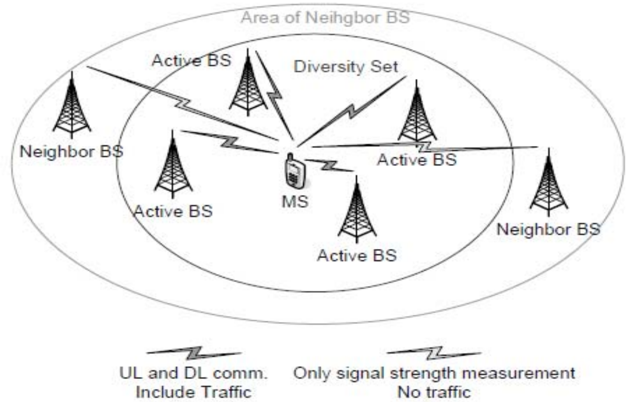

Fig.2 Macro diversity handover

FAST BASE STATION SWITCHING

In FBSS, the MS and BS diversity set is maintained similar as in MDHO. MS continuously monitors the base stations in the diversity set and defines an "Anchor BS". Anchor BS is only one base station of the diversity set that MS communicates with for all uplink and downlink traffic including management messages (see Fig. 3.). This is the BS where MS is registered, synchronized, performs ranging and there is monitored downlink channel for control information. The anchor BS can be changed from frame to frame depending on BS selection scheme. This means every frame can be sent via different BS in diversity set.

GROUP MOBILITY

Main aim of Group mobility which reduces number of messages and consume time for registration of node as compared to Single node in Mobility Scheme. Thus Load is reduced in the Group Mobility Concept.

In Fig.4 Group mobility scenarios show that multiple mobile stations (MSs) move in a group at the same time, generally in the same direction with a short distance of separation(MaodeMan,2011, *Journal of Network and Computer Applications*). When the group of MSs moves out of the coverage of the current serving BS and into that of another BS, multiple handovers processes should be performed at almost the same time.

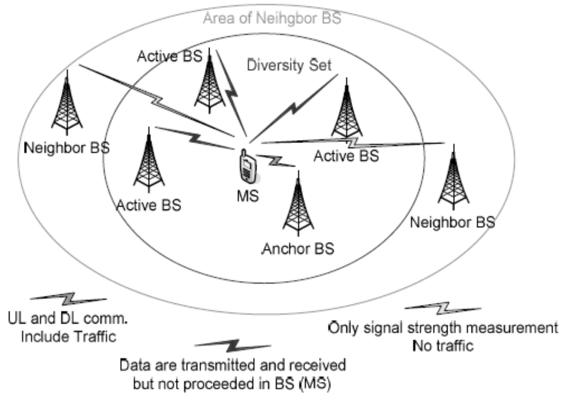

Fig.3 Fast Base station switching

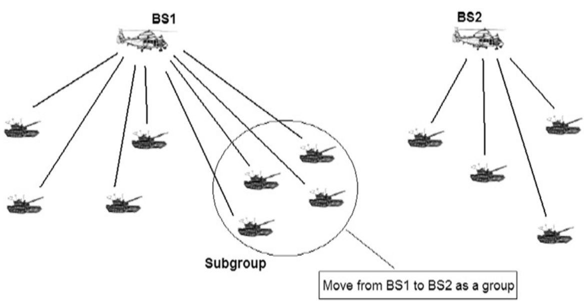

Fig.4 Group mobility scenario

MOBILTY MODEL

Mobility models depict the movement pattern, location, acceleration change over time and the velocity of the mobile nodes. This movement pattern is responsible for determining the performance of the protocol. These mobility models are classified based on the restrictions and dependencies as (Geetha Jayakumar, 2008, *Networks, and Communications Volume,*),

1. Random based: Nodes move randomly and there are neither dependencies nor restrictions modelled
2. Temporal dependencies: The movement of the past decides the movement of the nodes at present
3. Spatial dependencies: The movement of a node is influenced by the nodes present around that node
4. Geographic restrictions: The node movement is restricted to a particular area
5. Hybrid characteristics: It is the combination of temporal dependencies, spatial dependencies and Geographic restrictions

RWP (Random Way Point) MODEL

The random waypoint mobility model contains pause time between changes in direction and/or speed. Once a mobile node (MN) begins to move, it stays in one location for a specified pause time (Bai, Fan, 2004, *Wireless Adhoc Networks*). After the specified pause time is elapsed, the MN randomly selects the next destination in the simulation area and chooses a speed uniformly distributed between the minimum speed and maximum speed and travels with a
Speed *v* whose value is uniformly chosen in the interval (0, *Vmax*). *V*max is some parameter that can be set to reflect the degree of mobility. Then, the MN continues its journey toward the newly selected destination at the chosen speed. As soon as the MN arrives at the destination, it stays again for the indicated pause time before repeating the process.

RPGM (Reference Point Group Mobility) MODEL

Reference Point Group Mobility Model (Bai, Fan, 2004, *Wireless Adhoc Networks*) is used for simulating the group behaviour, where each node belongs to a group with a group leader which determines the movement of the group. All the nodes in a group are distributed randomly around the reference point. The nodes in a group may use different mobility model and added to the reference point for driving the individual nodes in the direction of the group. Each node has a unique speed and direction at every instant, which has been derived by randomly deviating from that of the leader of the group. This makes it useful for creating a variety of models for different mobility applications. Such group mobility models are used for military battlefield applications, where a number of soldiers move together in a group.

THE GROUP LEADER

The movement of group leader at time, *t*, can be represented by motion vector $V_{t\ group}$. Not only it defines the motion of group leader itself, but also it provides the general motion trend of the whole group. Each member of this group deviates from this general motion vector $V_{t\ group}$ by some degree.

The motion vector $V_{t\ group}$ can be randomly chosen or carefully designed based on certain predefined paths.

THE GROUP MEMBER

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The movement of group members is significantly affected by the movement of its group leader. For each node, mobility is assigned with a reference point that follows the group movement.

Motion Vector Of group member described as,

$$V_i^t = V_{group}^t + RM_i^t$$

where the motion vector RM_{ti} is a random vector deviated by group member *i* from its own reference point. The vector RM_{ti} is an independent identically distributed random process whose length is uniformly distributed in the interval [0, r_{max}] (where r_{max} is maximum allowed distance deviation) and whose direction is uniformly distributed in the interval [0, 2π].

$V_{t\ group}$ is the motion vector for the group leader; it is also the motion vector for the whole group. RM_{ti} is the random deviation vector for group member *i*, and the final motion vector of group member *i* is represented by vector $V_{t\ i}$.

In RPGM model, the vector RM_i indirectly determine how much the motion of group members deviate from their leader. The movement can be characterized as follows:

$$|\vec{V}_{member}(t)| = |\vec{V}_{leader}(t)| + random() \times SDR \times V_{\max}$$

$$\theta_{member}(t) = \theta_{leader}(t) + random() \times ADR \times \theta_{\max}$$

Where 0 < SDR, ADR < 1. SDR is the speed deviation ratio and ADR is the angle deviation ratio. SDR and ADR are used to control the deviation of the velocity (Magnitude and direction) of group members from that Of the leader. By simply adjusting these two parameters, different mobility scenarios can be generated.

Because of the inherent characteristic of spatial dependency between nodes, the RPGM model is expected to behave differently from the RWP model. We find that RPGM incurs less link breakage and achieves a better performance for various routing protocols than RWP model.

Each model has its own unique and specific mobility Characteristics. Hence, a method to choose a suitable set of mobility models is needed.

THREE PARAMETERS EVALUATES PERFORMANCE OF RPGM

PDF (Packet Delivery Fraction):
In the PDF, the ratio of total number of packets successfully received by the destination nodes to the number of packets sent by the source nodes throughout The simulation,

$$PDF = \frac{number\ of\ received\ packets}{number\ of\ sent\ packets}$$

This Parameter gives an idea about how successful the protocol is in delivering packets to the application layer. A high value of PDF indicates that most of the packets are being delivered to the higher layers and is a good indicator of the protocol performance.

NRL (Normalized routing load):
In NRL ration between numbers of routing packets transmitted to the numbers of packets actually received,

$$NRL = \frac{number\ of\ routing\ packet\ sent}{number\ of\ data\ packet\ received}$$

NRL gives how different routing protocol is since the number of routing packets sends per data packets gives an idea of how well protocol maintains the routing information updated. The higher NRL, higher the overhead of routing packets and consequently the protocol having lower frequency.

AED (Average end to end delay):
In AED average delay in transmission of a packet between two nodes and is calculated as follows,

$$AED = \sum_{i=0}^{n} \frac{time\ packet\ received - time\ packet\ sent}{total\ number\ of\ packets\ received}$$

A higher value of end-to-end delay means that the network is congested and hence the routing protocol does not perform well. The upper bound on the values of end-to-end delay is determined by the application**.**

ALGORITHM FOR CLASSIFY MSs INTO SUBGROUP

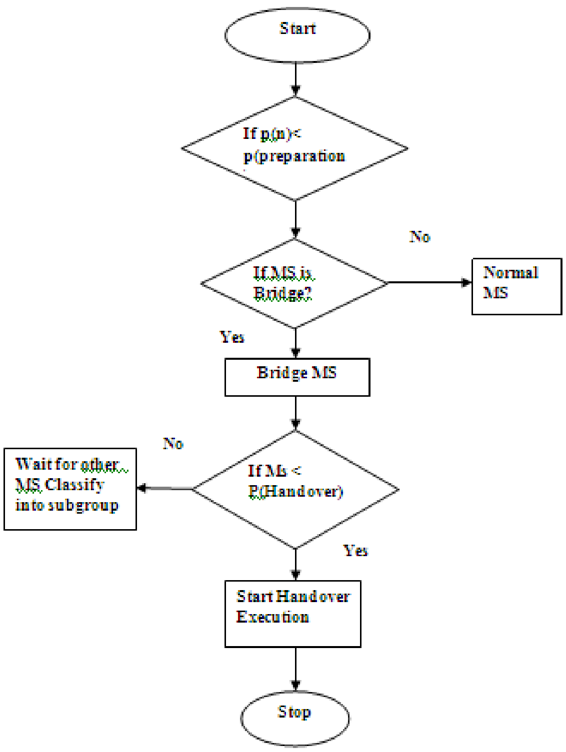

Fig. 5 Algorithm for classify MSs into subgroup (MaodeMan, 2011, *Journal of Network and Computer Applications*)

CONCLUSION

In this document, we discuss about introduction of Mobile WiMAX and group mobility concept. The parameter like Throughput, end to end delay and packet delivery fraction are used for examined the RPGM model. The paper shows the algorithm for classify MSs into subgroup. From survey it is concluded that out of various mobility model, the RPGM gives best performance.

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