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Improved switching technique in soft handovers for wimax network

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Abstract

WiMAX is Wireless Interoperability for Microwave Access. It is a telecommunication technology that provides wireless data over long distances in several ways, from point-to-point links to full mobile cellular type access. The main consideration of Mobile Wimax is to achieve seamless handover such that there is no loss of data. In Wimax both mobile station (MS) and base station (BS) scans the neighbouring base stations for selecting the best base station for a potential handover. Two types of handovers in wimax are: Hard handover (break before make) and Soft handover (make before break). To avoid data loss during handover we have considered soft handovers this research topic. We have proposed a technique to select a base station for potential soft handover in wimax. We have developed a base station selection procedure that will optimize the soft handover such that there is no data loss; handover decision is taken quickly and thus improving overall handover performance. We will compare the quality of service with hard handover and soft handover. We have analysed the proposed technique with an existing scheme for soft handover in wimax with simulation results. Throughput, End to End delay and Packet delivery fraction are main parameters to determine quality of service. These parameters are also analysed and compared with simulation results.

I. INTRODUCTION

IEEE 802.16 standard defines the air interface for fixed Broadband Wireless Access (BWA) systems to be used in WMANs (Wireless Metropolitan Area Networks), commonly referred to as wimax (Worldwide Interoperability for Microwave Access). The original standard IEEE 802.16 does not support mobility and for this purpose IEEE 802.16e-2005 was introduced.[1] It is also known as Mobile Wimax . It is the new mobile version of the older wimax specification known as IEEE 802.16e-2004 which is wireless but fixed, it lacks the ability for user to move during data transmission.

The main purpose of wimax is to provide users in rural areas with high speed communications as an alternative to expensive wired Connections (e.g. cable or DSL). That is wimax is capable to provide high speed internet to last mile connections. But this is not the only purpose of wimax systems. Mobile Wimax allows the user to move freely during data transmission. The main consideration of mobile wimax is that there should be no data loss when the moving user switches from one base station to another i.e. during handover. Handover is procedure when a mobile station changes the serving base station. The reason for handover could be relatively low signal strength or work load of base station.[3]

Wimax is a state-of-the-art wireless technology which utilizes adaptive modulation and coding, supports single carrier (SC) and orthogonal frequency division multiplexing techniques (OFDM) and several frequency bands for different operation environments. WiMAX system is able to constantly monitor the quality of the radio channel and change its operational parameters (e.g. modulation and coding) accordingly.

The wide range of the WiMAX technology depends on the height of the antennas, if they are installed at the suitable position from where there is no barrier between the transmitter and receiver, and then we can get better range and service from it. Even though the frequency for operation of WiMAX is not definite, the most likely band is 3.5GHz .WiMAX can support 30 to 50 kilometres distance with Line-of-Sight (LOS) links. As far as Non-line-of-sight (NLOS) links in concerned WiMAX can support the broad range from 3 to 10 kilometres

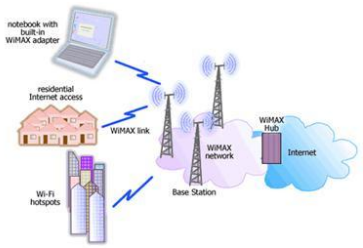

Fig1: Typical Network using Wimax

The above figure shows typical applications supported by WiMAX. The products incorporated in the WiMAX family range from Mobile phones, Laptops, PDAs and many more

II. STAGES OF HANDOVER PROCEDURE

1) Cell reselection: It is a process that finds the potential base station for a handover. Mobile Station has several possibilities to use while evaluating the possible change in serving base station. MS acquires info about the neighbouring BS in the network through MOB_NBR_ADV messages and evaluate the possibility to perform handover. The BS keeps the MAC addresses of neighbouring base stations in mapping tables and

sends this information to MS as MOB_NBR_ADV messages. This process is just a survey for handover alternatives.

2) Handover decision / initiation : The initiation of handover is the decision to migrate MS from serving base station to target base station .This decision can be taken by the MSS, SBS, or some other external entity in the WiMAX network. When the handover decision is taken by the MSS, it sends a MOB_MSHO_REQ to the SBS, indicating 1 or more BSs as handover targets. The SBS then sends a MOB_BSHO_RSP message back to the MSS indicating the target BSs to be used for this handover process. The MSS sends a MOB_MSHO_IND message indicating which of the BSs indicated in MOB_BSHO_RSP will be used for handover. When the handover decision is taken by the BS, it sends a MOB_BSHO_REQ message to the MSS, indicating 1 or more BSs for handover target. The MSS then sends a MOB_MSHO_IND message indicating receipt of the handover decision and its choice of target BS. After the handover process has been initiated, the MSS can cancel it at any time.

3) Synchronization: To communicate with target base station, MS requires to synchronize to its downlink channel. Once the target BS is determined, the MSS synchronizes with its DL transmission, beginning with processing the DL frame preamble of the target BS. The DL frame preamble provides the MSS with time and frequency synchronization with the target BS. The MSS then decodes the DL-MAP, UL-MAP, DCD and UCD messages to get information about the ranging channel.

4) Termination of services : Termination of services at serving base station is the last step of handover process[3]

III. TYPES OF HANDOVERS

1. Hard Handover : break before make
2.Soft handover : make before break
3Hard handovers are compulsory while soft handovers are optional in wimax.
4.Soft handovers are very important to ensure no data loss during handover procedure.

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. thick line at the boarder of the cells presents the place where the hard handover is realized.

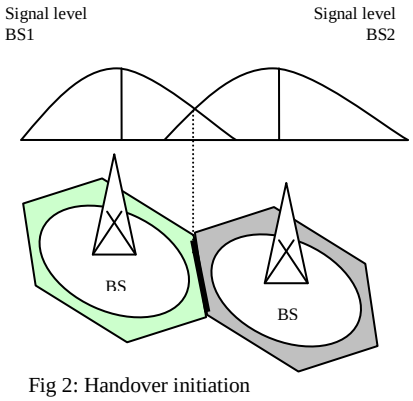

Fig 2: Handover initiation

IV. RELATED WORK FOR SOFT HANDOVERS IN WIMAX ARE:

a) Macro Diversity handover (MDHO)

The MDHO supported by MS and by BS, the "Diversity Set" is maintained by MS and BS. The Diversity Set is a list of the BSs, which are involved in the handover procedure. The Diversity Set is maintained by the MS and BS and it is updated via MAC (Medium Access Control) management messages. A sending of these messages is usually based on the long-term CINR (Carrier to Noise plus Interface Ratio) of BSs and depends on two thresholds: Add Threshold and Delete Threshold. Threshold values are broadcasted in the DCD (Downlink Channel Descriptor) message. The Diversity Set is defined for each MS in the network. The MS continuously monitors the BSs in the Diversity Set and defines an "Anchor BS". The Anchor BS is one of the BSs from Diversity Set in MDHO. The MS is synchronized and registered to the Anchor BS, further performs ranging and monitors the downlink channel for control information. The MS communicates (including user traffic) with Anchor BS and Active BSs in the Diversity Set[1]

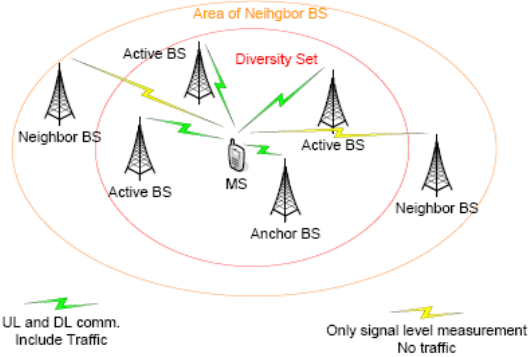

Fig 3: MDHO Handover [1]

b) Fast Base Station Switching(FBSS)

We are considering fast base station switching technique. In this method a diversity set is maintained for each

mobile station. The serving base station and mobile station monitors the neighbouring base stations that can be added in diversity set. Diversity set is maintained by both mobile station and serving base station. Diversity set is collection of base stations that can chosen as target base station for a handover. The mobile station selects one base station from diversity set as anchor base station sends its current location to it which is sent to base station controller for decision of a handover. Whenever there is a need of handover base station controller sends handover initiation message to mobile station. Handover decision can be taken by mobile station, base station or base station controller depending upon the implementation [1].

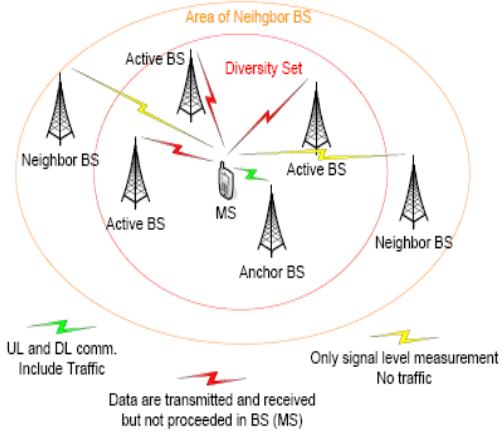

Fig 4: FBSS Handover [1]

VI. ADVANTAGES AND DISADVANTAGES OF SOFT HANDOVER

a) Advantages

- Soft handover reduces or eliminates the “ping-pong" effect common in hard handover. This results in:
  - ✓ Less load on the network from handover signaling and overhead.
  - ✓ Smoother user communications without the “clicks" typical of hard handover when speech transmissions are stopped momentarily during handovers.

- With soft handover, there is no hysteric’s margin, resulting in less delay and equivalent to “instantaneous" macroscopic selection diversity. This is accomplished by \instantaneous" switching to the best base station signal during a soft handover (uplink), and avoids the additional interference associated with handovers with hysteresis. Hence keeping base station separations and (base station and user) transmitter powers fixed, the overall uplink interference is reduced, leading to:
  - ✓ better communication quality for a given number of users.
  - ✓ more users (i.e., greater capacity) for the same required ratio of received energy per chip to total received spectral density.
  - ✓ smaller required uplink transmitter powers, further reducing uplink interference.

Keeping required outage probability and base station separation fixed, the system fade margins are reduced. This leads to smaller required downlink transmitter powers and downlink interference.

Keeping the same required outage probability and fade margins, base station separations increase.Soft handover imposes fewer time constraints on the network. There is a longer mean queuing time to get a new channel from the target base station, so this helps reduce blocking probability or probability of dropped calls.

Against these advantages, soft handover faces the following drawbacks.

b. Disadvantages

- Additional network resources are used during a soft handover. These resources thus become unavailable for use elsewhere.
- Soft handover is more complex.
- Downlink interference (to other users) increases when soft handover is in progress, since several base stations are transmitting what would otherwise be transmitted by one base station. This can add to the uplink interference too, if the same frequency is used for uplink as for downlink. The interference increasing effect should normally be slight, if it is assumed that only a small fraction of the duration of a typical call is spent in soft handover.

V. IMPROVED TECHNIQUE FOR SWITCHING

The proposed scheme is to define a procedure that can select the target base station for soft handover faster and efficiently

Step 1: maintain the diversity set for each mobile station which is updated regularly according to current location of mobile station.

Step 2: Select an anchor base station for mobile station for monitoring the neighbouring base stations.

Step 3: Define a threshold level below which handover will be initiated by the mobile station, this threshold level will depend upon following parameters:

Signal strength of base station

1. Traffic at base station

2. Distance of a base station from mobile station

These are the reasons for a handover to occur and based on these parameters, the mobile station will select target base station for further services.

Step 4. The target base station is selected from diversity set by anchor base station that continuously monitors the neighbouring base stations for a base station.

Step 5: As scanning procedures are already completed the mobile station will do the range selection with the target base

station and when the link is properly established, then it breaks the connection with serving base station.

In the proposed technique, we are trying to modify the FBSS procedure to optimize target base station selection for soft handovers in wimax. We have introduced master base station which is selected from diversity set of mobile station. The function of master base station (MBS) is to communicate with mobile station and maintain the database of potential target base stations for a handover for mobile station. Another advantage of MBS is that whenever ABS fails, mobile station can start data communication with MBS without any loss of data by sending register message.

The mobile station sends its current location to MBS and according to history of mobile station movement and its current location, MBS sorts the TBS's having maximum div parameter.

Div= s/w- d

S= received signal strength

w= work load

d= distance between mobile station and base station

$d=\sqrt{(x_s - x_i)^2 + (y_s - y_i)^2}$

Where (x_s , y_s) are coordinates of mobile station and (x_i , y_i) are coordinates of i'th base station where i=1,2,3…. N

N = total number of base station in diversity set

$s= (k* s^t)/d$

Where s^t= transmitted signal strength

k= other factors affecting signal (interference)

The MBS scans the neighbouring base stations and calculates div parameter for each base station. Then MBS sorts the BS's in diversity set using sorting algorithm in descending order such that the BS having maximum value of div is on the top of diversity set.

VI. HOW MBS IS SELECTED FOR MOBILE STATION?

When a mobile station gets registered to a base station (SBS) , it sends scan_req message to SBS , it responds to this message by sending the data of its neighbouring base stations through scan_rsp message. With this data the mobile station will choose the MBS having maximum value of div parameter. That is mobile station will communicate with best suited target base station so at any point if SBS goes down, the mobile station can easily switch to MBS. As the mobile station is moving continuously the diversity set is required to updated according to current location of mobile station

If the div value of MBS goes below the threshold value. It will send the stored information to SBS and SBS will select new MBS the mobile station.

MOB_NBR_ADV is Mobile Neighbour Advertisement: The Serving Base Station (SBS) broadcast the network topology information or channel information of its neighbouring base stations regularly after a short interval of time to the mobile station (MS).

1) DL-MAP/UL-MAP is Downlink mapping/Uplink mapping: The MS and BS synchronize the downlink/uplink frequencies to start the data communication.

2) DATA_TX is Data Transmission: It denotes data transmission between Mobile Station (MS) and Base Station (BS).

3) SCAN_REQ is Scan Request: Mobile Station sends this message to Base Station as request to scan the neighbouring base stations.

4) SCAN_RSP is Scan Response: The Base Station sends the information of neighbouring base stations to Mobile Station through this message.

5) START_MONITOR: The mobile station sends the message to monitor base station (MBS) that it has selected from active set of base stations.

6) HO_INIT is Handover Initiation: Whenever mobile station needs a handover, it sends this message to Msster Base Station (MBS) to initiate the handover.

7) HO_NOTIFICATION is Handover Notification: The monitor base station selects the target base station (TBS) for handover and sends this message to TBS giving the information about the Mobile Station.

8) HO_REQ is Handover Request: After mapping the downlink/uplink frequencies with TBS, the Mobile Station sends this message to Serving Base Station (SBS) as request for handover and to terminate the data communication.

9) HO_ CONF is Handover Confirm: The SBS sends this message to MS to confirm the handover and terminate the services with the mobile station.

10) HO_CONFIRM is Handover Confirmation: The Serving Base Station sends this message to Target Base Station to inform the confirmation of handover. It also sends the information (e.g. detail of HLR, AAA account detail, data access information) of mobile station to Target Base Station.

The Serving Base Station (SBS) periodically broadcasts Neighbour Advertisement (NBR_ADV) message that contains network topology information or channel information of available neighbouring base stations. Then the mobile station (MS) is able to synchronize with neighbouring base station without listening the DCD/UCD (Downlink/Uplink channel descriptor) broadcast message. The mobile station (MS) continues the data communication with SBS. The mobile station sends (SCN_REQ) message to the serving base station to scan the neighbouring base station according to the current location (div) of mobile station. The serving base station responds to SCN_REQ message by sending the information of neighbouring base station as per the calculation, the base

station with maximum value of div parameter is selected as master base station.

The mobile station sends start_master message to selected master base station (MBS).

The mobile station now communicates with master base station for handover decision.

Whenever mobile station requires a handover, it sends HO_INIT (Handover Initiation) message to master base station that sends the information of target base station to mobile station. The mobile station synchronizes the downlink and uplink frequencies with target base station. The mobile station can now start the data communication with target base station.

Throughput that is the average rate of successful message delivery over a communication channel of hard handover and soft handover in WiMAX is also considered in this work .

End-to-end delay means the time taken for a packet to be transmitted across a network from source to destination is also considered for hard handover and soft handover in WiMAX.

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