Analysis of Handover in Wimax for Ubiquitous connectivity

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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.

Keywords: Wimax, Topology, handover, QOS, ubiquitous connectivity.

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. 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.

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.

II. Materials and methods

1.1 Handovers in Wimax
A special requirement of a mobile device is the ability to change its serving base station if there exists another base station with better signal strength in the reach of mobile station (MS). Handover is a procedure that provides continuous connection when a MS migrates from the air-interface of one BS to another air-interface provided by another BS without disturbing the existing connections. Handovers are needed to support mobility.
For a handover to occur, one needs to have at least two base stations : serving base station(SBS) and target base station(TBS). The handover is generally considered as change in serving base station but it does not necessarily mean that the base station must be changed. In some cases there may be different reasons why a handover might be conducted:

- When the MS is moving away from the area covered by one cell and enters the area covered by another cell the connection is transferred to the second cell in order to avoid data loss when the MS gets outside the range of the first cell;
- When the capacity for connections of a given cell is used up, the new connection which is located in an area overlapped by another cell, is transferred to that cell in order to free-up some capacity in the first cell for other users, who can only be connected to that cell;
- When the channel used by the MS becomes interfered with by another MS using the same channel in a different cell, the call is transferred to a different channel in the same cell or to a different channel in another cell in order to avoid the interference;
- Signal strength is not enough for maintaining proper connection.

Behaviour of MS changes, for example in case of fast moving MS suddenly stopping; the large cell size can be adjusted by a small size cell with better capacity.
In CDMA networks a soft handover may be induced in order to reduce the interference to a smaller neighbouring cell due to the "near-far" effect even when the phone still has an excellent connection to its current cell;

1.1.1 Stages of Handover procedure:

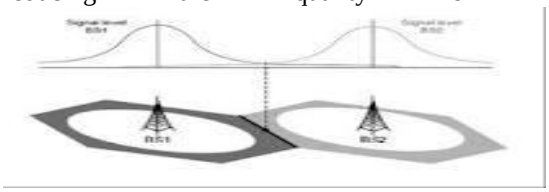
- Call restriction
- Handover decision/initiation
- Synchronization
- Termination of service

Types of handovers

There are two types of handovers used in cellular network systems: hard handover and soft handover

Hard handover

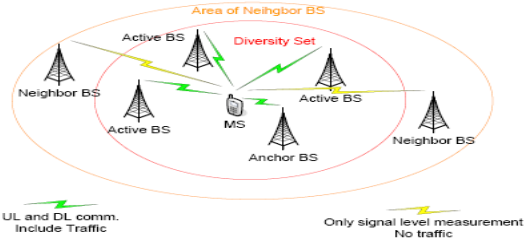
The hard handover is used when the communication channel is released first and the new channel is acquired later from the neighbouring cell. For real-time users it means a short disconnection of communication. Thus, there is a service interruption when the handover occurs reducing the quality of service.



1.2.1 Methods of Soft Handovers in Wimax

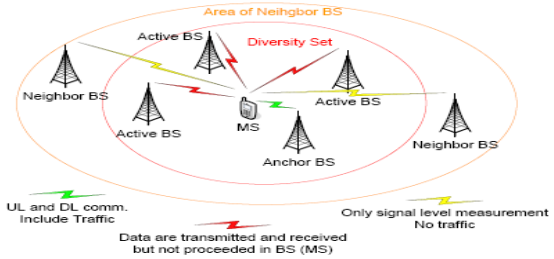
I. Macro Diversity Handover (MDHO)

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]



II. 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. Handover decision can be taken by mobile station, base station or base station controller depending upon the implementation.



Modification in Efficient FBSS technique

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 monitor base station which is selected from diversity set of mobile station. The function of monitor 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 (xs , ys) are coordinates of mobile station and (xi , yi) are coordinates of i'th base station where i=1,2,3…. N
N = total number of base station in diversity set
s= (k* st)/d
Where st= 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.

Selection of MBS

When a mobile station gets registered to a Serving Base Station (SBS), it sends scan_req message to SBS, it responds to this message by sending the data of its neighboring 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. The Serving Base Station (SBS) periodically broadcasts Neighbor Advertisement (NBR_ADV) message that contains network topology information or channel information of available neighbouring base stations. 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 neighboring base station as per the calculation, the base station with maximum value of div parameter is selected as monitor base station.

Whenever mobile station requires a handover, it sends HO_INIT

(Handover Initiation) message to monitor 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

III. Simulation and Result

The proposed technique is implemented in NS-2.34 Simulator in Linux environment. We have modified ns-2.34 by adding mac802.16-e layer to it for supporting Wimax. The wimax.tcl file is coded on c++, when executed it generates a .nam file which can be viewed in Network Animator tool of ns2 simulator.

Parameters Used

Packet size : 1500 bytes

Time interval of data sent : 6 ms

Total Number of nodes : 3

Number of Base Station : 2

Physical layer : 802.11

Data link layer : 802.16-e

Step 1

Fig. shows 3 nodes used in simulation of base station selection procedure for soft handover. Here node 1 is mobile station and all the other nodes are base stations. The simulation shows the handover procedure as mobile station changes its position

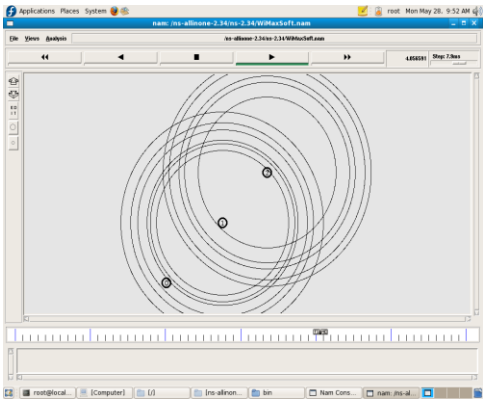


Fig Nam file for soft handover

Step 2

Above figure shows the ranging between node 0 and node 1. The node 0 acts as serving base station for mobile station (node 1). The node 1 starts data communication with node 0. As the mobile station moves, its distance from serving base station increases and the mobile station looks for another base station for soft handover ie. Target Base Station. The below figure shows handover when the mobile station connects with target base station. Node 2 is target base station.

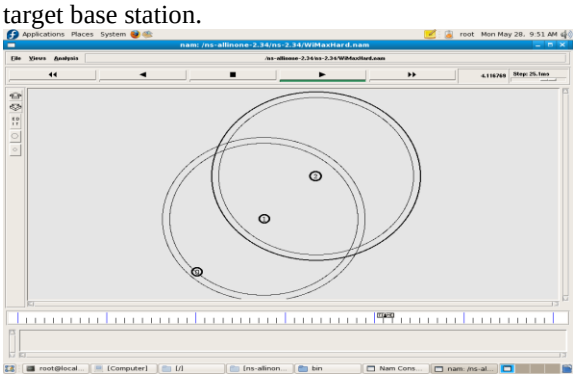


Fig Signaling with serving base station

Step 3

First result is comparison between the fast base station switching handover and our proposed technique. It shows that using the proposed technique the performance of soft handover is improved.

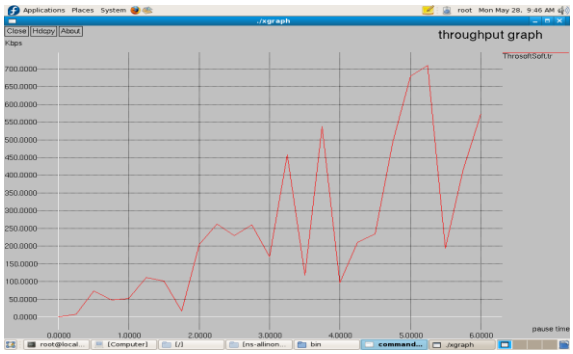


Fig Graph of soft handover with modified FBBS technique

Step 4

The x axis denotes the time and y-axis denotes the packet received

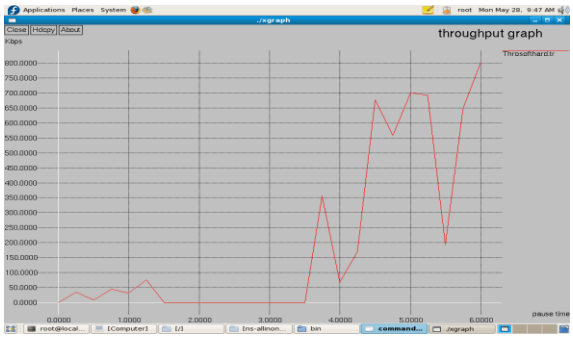


Fig Graph for hard hand over

IV. Conclusion:

We simulated the more realistic handover in the mobile WiMAX using NS-2 with WiMAX and mobility modules. The goal of this simulation is to find out the relationship between the handover latency and the velocity of mobile station. It can be seen that the current handover mechanics used in the NS-2 module meets the requirement of seamless handover in mobile WiMAX when the mobile station travel at the speed of 20 m/s. Although, using link-going down mechanism will dramatically reduce the handover latency, it is still a challenge to achieve the full mobility: up to 120 km/h, handover latency of less than 50 ms with an associated packet loss that is less than 1 percent.

V. Future scope:

As extension to this research work, two topics for future research investigations are suggested. Since there is a trade off between handover threshold and margin, an adaptive threshold window could be used to balance the load of base station and the QoS of the mobile.Also, the current work is restricted to hard handover only. Possibilities of extending this work to macro diversity and fast base station switching can be worthy of an investigation. Although these are soft handover techniques and currently optional in the WiMAX standard, the BS selection procedure based on location predication algorithms and current load factors of the target BSs give an alternative way of deciding the target BS. Further, reducing the number of handovers is highly desirable from a system perspective.

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