Jurnal Teknologi

Full Paper

IMPACT OF MULTIPLAY TRANSMISSION IN MOBILE WiMAX USING OVERLAY SCANNING

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Article history
Received
5 September 2015
Received in revised form
3 November 2015
Accepted
3 January 2016

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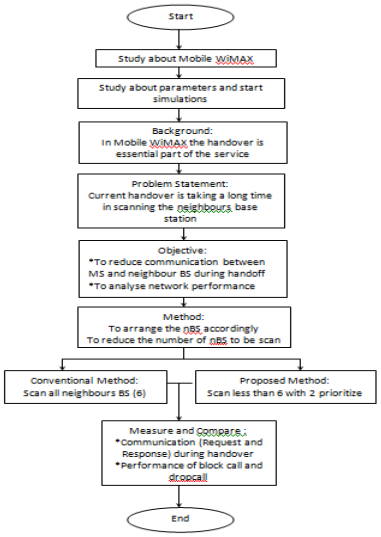
Graphical abstract



Abstract

The growing demand for mobile internet and wireless multimedia applications has motivated the development of broadband wireless-access technologies in recent years. There are several issues that could impact the base station handover as a serious problem in the mobile communication system. In hard handover, a short time break known as handover interruption decreases the quality-of-services (QoS) due to connection between mobile subscriber station (MS) and serving base station (BS) is closed and ranging hand initiation to establish new connection. Prolonged time of request and response due to number of neighbours to scan will cause delay in handover process. This research proposed performance analysis of WiMAX/IEEE 802.16 with mobility supported to scan the channels provided by the mobile station. The proposed strategy required the mobile station for operation with a scan that can be used to reduce the time when trying to establish a network connection or do between neighboring base station handover. A second type is the fast handover that is proposed to reduce the unnecessary surrender to six different access modes. The mobile WiMAX air interface utilizes orthogonal frequency division multiple access (OFDMA) as the preferred multiple-access method in the downlink (DL) and uplink (UL) for improved multipath performance and bandwidth scalability. All simulations are run using MATLAB software to develop a new Overlay Scanning Mechanism (OSMA) algorithm. OSMA mainly focus on when to perform a scan to estimate future needs. Simulation results are expected to show WiMAX coverage by using real world data to detect movement and show that there are strategies that reduce the time required for scanning operations significantly.

Keywords: WiMAX; IEEE; MS; BS

1.0 INTRODUCTION

Tremendous increment of wireless technologies utilization over the last decade resulting from the communication revolution now has been so pervasive, indispensable, spreading and becoming users' necessities across all areas. The emerging of wireless communication technologies in all fields show that there are more spaces to be looked into in order to upgrade and enhance, ensuring customer needs are met. Numerous areas such as healthcare, financial sector, education, transportation, modelling, food sector and many more are looking forward to deploy upgraded and advanced wireless communication technologies.

The current wireless communication standards and broadband access network has emerged and drawing much attention by public as well as support from many organizations and government across all countries. The advances in this field have paved a

route to new collaboration between many areas which are excessively expanding the applications with wireless technologies. Since the fast growing and emerging of the mobile and computing devices and wireless communication with various fields, strong and progressive research cooperation among many diverse areas is becoming vital. As an example, in healthcare areas, it is known that detection of patients' emergency situations at a specific range of time via wireless communications will give high possibility to provide medical help such as first-aid and access to patients in a pervasive manner, thereby improving both system in terms of reliability and efficiency is a requisite. Regardless of the fact that many benefits are extensively recognized, the application of wireless communication are becoming more challenging especially in various issues such as energy-efficiency, quality-of-services (QoS), security, privacy and many other issues. In QoS aspects, the ability to aid different users are based on certain priorities with different types of applications to guarantee a certain level of performance such as maintaining at certain delay and required bit rate aspects, packet drop probability is essential and among important things to be emphasized.

The next generation 4G networks under development in the IEEE 802.16e/WiMAX [4] standards promise to provide a good infrastructure for future high speed mobile internet. A mobile subscriber station (MS) who wanted to join the network must follow the network entry procedure, which involves scanning the frequency of the base station (BS). The MS will be required to perform recurring scans to maintain a connection from one BS to another while moving around the coverage area. This is the part of process to get information from neighbour BS and it is called a handover. Several scenarios can be used to improve the scanning time while searching for the downlink from the BS. Many strategies are focusing to provide network QoS during network entry phase including reducing delay during handover procedure. In this paper, we use overlay scanning mechanism for MS to find out which is the most appropriate BS to be scanned by using certain parameters that can be obtained by the serving BS through the backbone network of the serving BS and the neighbours BS that are encompassing it. This research proposes performance analysis of WiMAX/IEEE 802.16 with mobility supported, to scan the channels provided by the neighbour BS and weighted the priority to the BS based on the certain criteria.

2.0 WIMAX NETWORK ARCHITECUTE AND EVOLUTION

The network architecture of WiMAX is designed to meet the user's requirement which supports for fixed and mobile access deployments as well as unbundling of access, connectivity and application services to allow access to infrastructure sharing and multiple access infrastructures aggregation. Figure 1 illustrates the current WiMAX structure that connects all types of network such as internet hotspot, on demand application users and also applicable to fulfilled business corporation needs and demands.

The potential of IEEE802.16e related applications are enormous as illustrated in Figure 1. It can provide high speed mobile data and telecommunication services comparable to the emerging 4G technologies [9], it offers a wireless alternative to cable and digital subscriber line (DSL) for last mile broadband access, it can also be used to connect Wi-Fi hotspots with each other and to the Internet. However, there are many technical challenges to wide adaptation of WiMAX, in particular its coexistence and interoperability with other wireless technologies [10].

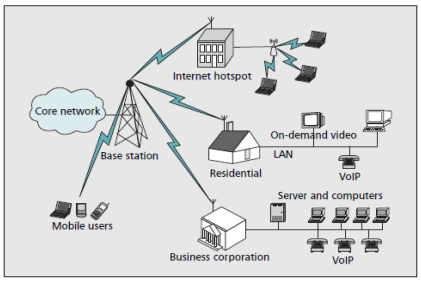


Figure 1 Potential WiMAX scenario

3.0 WIMAX HANDOVER

The mobile user moves from the coverage area of a base station coverage area to another while performing an active call. When a call is transferred from one base station to another or from one channel to another, this is known as the submission or called a handoff (HO) in certain countries such as the United States. These terms are used interchangeably. In 4G systems, submission procedures are classified into the following categories depending on the network structure:

- Hard Handover in WiMAX network

When the handoff is between two base stations operating on different channels, this is called handoff or hard handoff. It is the primary handoff procedure in GSM networks but also occur in the CDMA network.

- Soft Handover in WiMAX network

When the handoff is between two base stations but the channel remains the same, this operation is called soft handoff. In soft handoff, mobile base station handles only calls but channel operation remains the same. This type of handover is found in a CDMA network.

3.1 Handover Scenario

Handover (HO) is the main function which supports mobility of wireless networks and maintains service quality. HO allows the network to maintain connectivity User Equipment (UE) when it moves from the coverage area of one cell or sector to another [15]. HO will continue the process of transferring voice, data or video session from one cell to another cell which is connected to the CN. HO is divided into two broad categories: hard and soft handover. In Hard HO, current source is released before new resources are used. However in Soft HO, the two sources of existing and new are used during HO process. HO initial start-up is the process of deciding upon request HO [14]. In IEEE 802.16e standard, there are three types of handover which are supported [12]:

1. Hard Handover (HHO)
2. Micro Diversity Handover (MDHO) and
3. Fast BS switching (FBSS)

Among these handover types HHO is the simplest one while the other two types are more complicated and optional. The HHO and FBSS are adequately in the standard for practical use. When both types have a physical radio link broken, it is re-established at the target access point that results in handshake latency. The handover process in WiMAX is concluded in the movement of the MS from the BS to another BS with connection. This is illustrated in Figure 2.

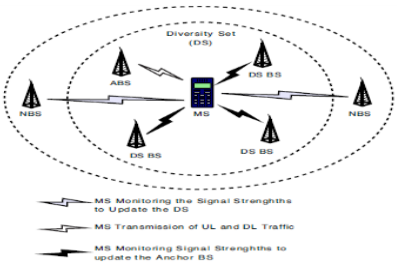


Figure 2 FBSS

3.2 Hard Handover

In hard handover, a MS communicates with just one BS each time. All the connections in serving BS are broken before a new connection to target BS is established. There is a very short time interval when the MS is not connected to any BS. Handover is executed after an observed channel parameter signal strength from the neighbouring BS exceeds the same parameter from the serving BS. This situation is illustrated in Figure 3.

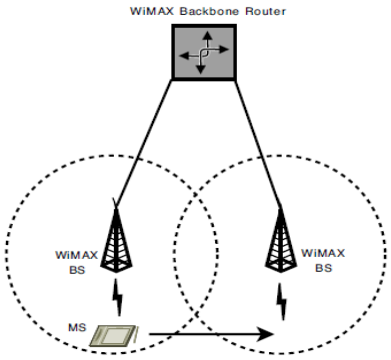


Figure 3 HHO

3.3 Scanning Procedure

In the scan phase of HO, the MS scans and synchronizes with the neighbouring BSs based on channel information from the neighbour advertisement. In order to find an appropriate BS target, the serving BS scans the available channels of the downlink (DL) frequency band.

For scanning with association, the MS requests a scan and performs the association, i.e., initial ranging, procedures during scanning to reduce the service disruption. After the scan is complete, the MS reports the measurement results to the serving BS, so that the serving BS can suggest a list of potential BSs to the MS for handover [2].

The MS is looking for a well-known DL preamble frame [11]. As a result of receiving preamble frame, the channel estimation, initialization and equalization procedures are activated. If the synchronization succeeds, it then starts the ranging procedure. The scanning and ranging processes are shown in Figure 4. The MS selects a candidate target BS based on the signal strength and response time of each BS, acquired from scanning. This response message includes the primary management of the transmission power information and the frequency timing offset adjustments. This procedure ends after the MS has completed ranging with all its neighbours. In the ranging phase, a MS may switch to a new channel, thus temporally loosing connection with the serving BS. As mentioned earlier, if this method is used, at least three base stations are used to estimate the position. [10]

Table 1 Simulation parameters and scenario definition for channel characteristics

Parameter	Value
Number of BS	22
Number of MS	100
BS transmitting Power [db]	46
MS height [m]	1.5
BS height [m]	32
MS speed [m/s]	14, 25, 33
Frequency band [GHz]	2.5
Bandwidth [Mhz]	1Ghz
Cell Radius	1 KM

4.0 RESEARCH METHODOLOGY

This research was conducted to analyse the performance of mobile WiMAX scanning process during handoff to its neighbour BS when the threshold was met. Several parameters were considered to improve scanning time by reducing the number of BSs to be scanned during initial stage of handoff process. The section describes the MS neighbourhood scanning procedure in WiMAX according to the standard IEEE802.16e and then continues with the scanning procedure as proposed in [1] but using different parameters; Receive Signal Strengh Indicator (RSSI) and BS capacity to rearrange the neighbour BSs.

The algorithm developed in Matlab Software is used to simulate the method. The basic parameters of the simulation are set as listed in Table 1. Figure 4 shows the flowchart of handover strategy under the overlay scanning system. The MS scanning selecting a target BS to perform faster network access during the network entry. The mobile station will need to gather all the encompassing neighbour BSs data and estimating the appropriate time and nBS to scan and communicate after that. Communication in this simulation refers to the information exchanging between the MS and the serving BS as well as the selected neighbour BS.

There are several types of applications supported in mobile WiMAX network either in connection oriented or for the mobile users. In this paper, we simulate 4 types of QoS categories which is UGS, rtPS, nrtPS and BE. UGS is Unsolicited Grant Service; rtPS stands for real time Polling Service meanwhile nrtPS and BE both stands for Non Real-Time Polling Service and Best Effort.

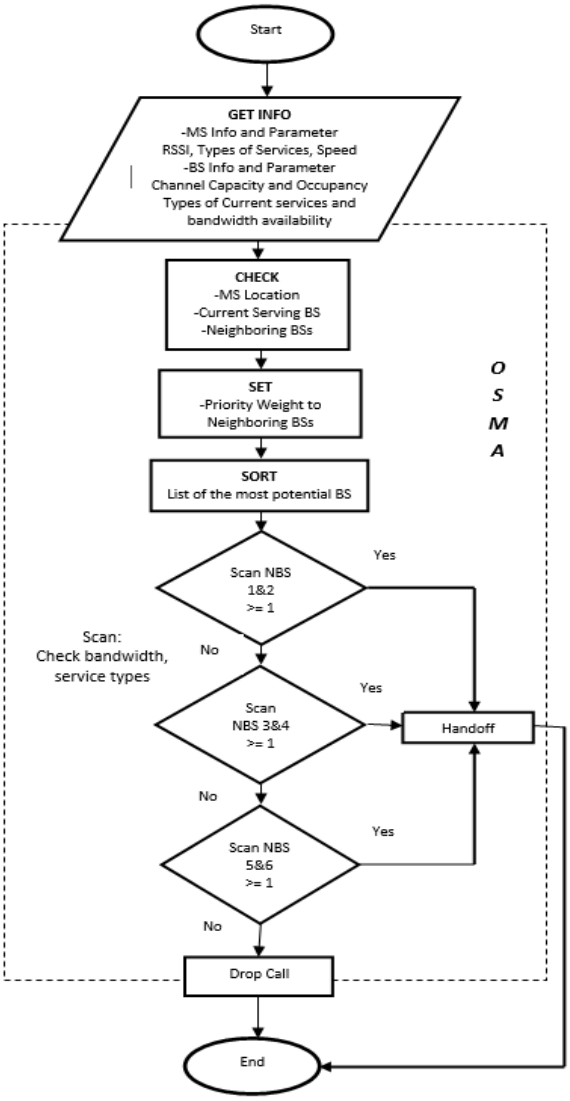


Figure 4 Proposed handover strategy in Scanning Overlay System

The proposed handover method is used to analyse the performance of mobile station that run multi type of services such as video downloading, web browsing, real time gaming, and voice over internet protocol (VoIP) .

5.0 PERFORMANCE ANALYSIS

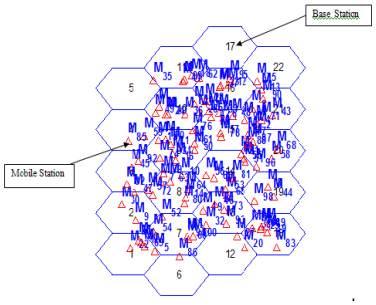


Figure 5: Simulation topology

In simulation performance of the proposed handover strategy that has been carried out, we simulated for 100 MS and 22 BS in proposed topology as shown in Figure 5. The radius of cell area was 1 kilometre. The MS was placed randomly in 22 area of BS and started its movement also using random steps according to the speed that has been set previously at 3 different speeds of 14, 25, and 33 m/s. MS started handover process at threshold time -90db. In our proposed method we arranged the 6 neighbour BSs based on the RSSI and location of the mobile stations. Next, the overlay scanning was conducted by selecting the first 2 BS first to scan and carry out the HO process. It was decided that if the first 2 candidates were not fit to become the new serving BS then the next 2 BSs will be scanned.

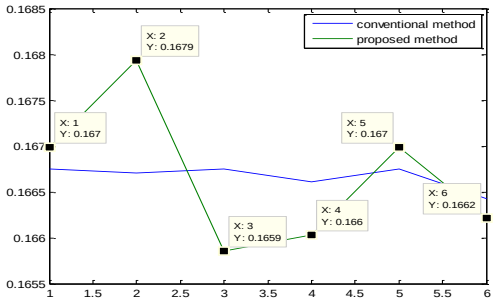


Figure 6(a) Mobile handover probability of 6 neighbour base stations

Figure 6(a) shows the probability percentage of 6 neighbour BSs, with the highest being BS 2 at 0.1679% and 0.167% for both BS 1 and 5. Meanwhile the probability of handover to 6 BSs using the conventional method is almost similar due to the assumption that all BSs have equal probability to be the next serving base station. Therefore, result shows the significance of overlay scanning for the proposed method.

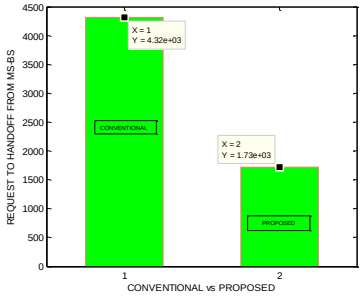


Figure 6 (b) Conventional vs Proposed

In this simulation we assumed the request made by mobile station to base station during appropriate time to handoff was a two-way communication. For successful handoff process, 1 request should equal to 1 response. The duration of interruption caused by handover depends on the duration of network re-entry. Synchronization indicates several processes including communication request to handoff between mobile and BS.

The conventional method shows that successful handover happens after more than 4000 communications between all mobile stations and the neighbouring BS during handoff was initiated and scanning process was being asked and granted by the serving BS , while the proposed method only takes about 1410 communications to facilitate successful handover. There is a significant time consumption difference in favour of the proposed method.

From the Figure 6 (c) below, the performance of both conventional and proposed methods are similar with 3 block-calls at 53% for both methods, while with 9 block-calls it is 85% for conventional method and also 85% but with 10 block-calls for the proposed method (only 1 block-call extra).

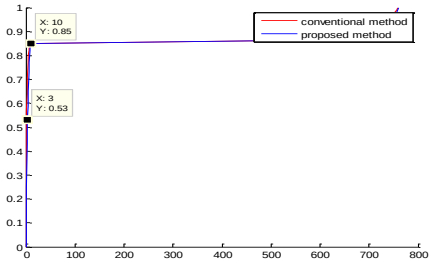


Figure 6(c) CDF plot of block call

Figure 6(d) shows the number of drop calls from 0 to 4000, with the least value at 9% for 9 calls in both methods. This gradually increases until 1115 calls at 64% for the proposed method, a difference of 1114 drop calls at 63% compared to the conventional method. This dropped-call rate in conventional method is extremely low and less than 0.1% drop calls in proposed method. The main reasons for dropped calls in mobile networks are lack of radio coverage

(either in the downlink or the uplink), radio interference between different subscribers, imperfections in the functioning of the network (such as failed handover or cell-reselection attempts), and overload of the different elements of the network (such as cells). In this case, there are possibilities of certain mobiles experiencing difficulties to handoff to new serving base station when the first 2 candidates are unable to facilitate the handoff process. These increases time in order to request permission to handoff from another set of base stations and eventually will cause drop calls.

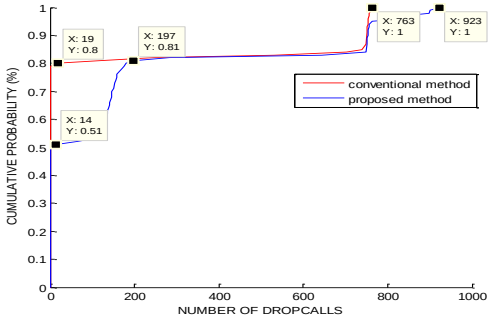


Figure 6(d) CDF plot of drop call

6.0 CONCLUSION

In this paper the impact of quad-play transmission in mobile WiMAX using overlay scanning was proposed and analysed. The handover strategy was done by focusing on the scanning mechanism in handover process by using overlay scanning. Simulation results show that both proposed and conventional mechanism have their own advantages. The proposed method significantly reduced the scanning time thereby reducing the handover time generally. Future work includes the optimization of overlay scanning method by using different speeds of mobile and considering more than 1 threshold value of RSSI to start the handover process.

Acknowledgement

The authors would like to thank Faculty of Electrical Engineering, Universiti Teknologi MARA (UiTM) for their valuable support.

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