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RESEARCH ARTICLE

A LINEAR REGRESSION BASED CELL RESELECTION APPROACH FOR SELECTING DESTINATION BASE STATION DURING HANDOVER IN WIMAX

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ABSTRACT

Worldwide Interoperability for Microwave Access (WiMAX) specified by IEEE 802.12 supports Wireless Metropolitan Area Network (WMAN). It is one of the most prominent technology for the next generation networks and it provides high data rates and long range with full support of mobility. It is based on IEEE 802.16 standards and the modifications specifying the MAC and physical layers for fixed, portable, nomadic and mobile access. The aim of the WiMAX Forum Network Working Group is to provide controlled transition of the Mobile Station (MS) between Base Stations (BSs) without the loss of data. In this paper, an enrichment of a Cell Reselection approach is introduced for selecting the Destination Base Station (DBS). Here, the Selection of Destination Base Station Algorithm (SDBS) is proposed to select the targeted (destination) BS. The proposed method uses the Linear Regression Model (LRM) to formulate a hard handover algorithm to predict the Received Signal Strength Indicator (RSSI) value. The value is broadcasted in order to trigger the scanning process. The performance of the proposed SDBS algorithm is compared with the existing technique without using the Linear Regression Model. The proposed SDBS algorithm provideslesser handover time, handover latency with better network throughput and bandwidth consumption ratio than the existing approach.

INTRODUCTION

The steady global boom in the number of users of the Internet has led to the growth of various fixed and mobile broadcast technologies, which supports for high speed streaming, ubiquitous coverage, unhampered QoS and personalized services. The traditional Wireless Local Area Network (WLAN) and third generation (3G) technologies had been successfully providing internet access for the past several years **(Ahmed, 2014)**. It has the following drawbacks such as prohibiting their full-fledged growth. WLANs suffer from the restricted scalability and short coverage. Moreover, the 3G systems have such restrictions as high infrastructural expenses and low bandwidth. The result of the recent IEEE 802.16-based WiMAX family of standards (IEEE 802.16a, 16d and 16e) for Wireless Metropolitan Area Networks has filled this gap between the LAN and WAN technologies. The WiMAX technology provides more promising features in terms of low cost, high bandwidth and extended coverage area. This has led to its fast rise as one of the most popular last mile broadband access technologies and as a likely component in the 4G networks.

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While the OFDM-based IEEE 802.16d technology **(Huang and Wu, 2013)** (usually called as fixed WiMAX) delivers fixed broadband access from anywhere within a metropolitan area network. The novel mobile air interfaces specified in the IEEE 802.16e (**So-In *et al.,* 2010; Winston and Shaji 2012**) (usually called as mobile WiMAX) has successfully addressed the requirements for higher data rates and efficient spectral efficiencies in tackling full-fledged mobile broadband access. An IEEE 802.16e-based Base Station (BS) can support both fixed and mobile broadband wireless access (**Tsai *et al.,* 2011**). Related to the different cellular and broadband technologies, the global mobility related area in WiMAX is typically concentrated on two main areas of concern: handover management and location management. Handovers can be largely classified into two types that depends on the primary technology: horizontal handovers and vertical handovers. Horizontal handovers are homogeneous intra-network inter-cellular, while the vertical ones are heterogeneous inter-network inter-cellular. For example, handovers among multiple WiMAX networks are horizontal, whereas those between WiMAX and 3G or WLAN networks are vertical.

The underlying network technology tracks and preserves the exact devices of wireless terminals in cases when they are powered-off, powered-on or even on the move. The existing techniques deals with the active transfer of wireless terminals from the control of a BS in one cell to the control of alternative BS in a diverse cell. The existing WiMAX handover techniques are suffer from the certain drawbacks, related to the handover latencies, wastage of channel resources and loss of data. In this proposed paper, a novel approach is proposed for cell selection and planning in WiMAX. Based on demand, profit and capacity the coverage based cell selection is introduced to handover the mobile device from one base station to another. The DBS is selected based on the received RSSI of the neighbor BS, where the RSSI value is greater. It will be the idle DBS for handover. But it is not mandatory to select the DBS which is idle for MS in real time services. It may not have enough capacity to tackle the data of MS. Hence, the proposed system provides a solution by identifying the scalable idle capacity of neighbor BS with RSSI for selecting the DBS. Based on this scheme, it scan less neighbor BS and hence the handover latency can be minimized. Here, the better network throughput and bandwidth consumption ratio are provided by the Cell Re-Selection Based on SDBS algorithm.

The rest of the paper describes as follows: Section II presents the works related to the handover in WiMAX. Section III describes the detailed description of the proposed method. Section IV presents the performance analysis and Section V describes the conclusion.

Related Work

In the customary networks, the handovers are mostly occur due to the mobility reasons. When the devices move out of coverage of the currently connected network, it needs to forward its connection to a new or base station or access point in order to preserve its connectivity to the network. The handovers can occur for other reasons, such as quality of service (QoS) or performance reasons. It inferences that the device will execute handovers to the networks that are enhanced from the point of view of the user. Some users might prefer networks with greater data rates, others can cope with low data rate networks as long as the service is delivered with low costs. Heterogeneous networks consist of multiple radio access networks of diverse technologies. These technologies are different on the layer 1 and the layer 2 (physical layer and data link layer) of the Open Systems Interconnection (OSI) model.

Xiao *et al.* ()proposed a handover algorithm in WiMAX system. The algorithm selects the best base stations with strongest signal strength as the diversity sets (**Xiao *et al.,* 2011**). **Abdullah *et al.*** introduced an efficient wireless network discovery method for vertical handover among WiMAN and WLAN. An enhance access router discovery was used to solve the discovery time and power consumption problem for mobile networks **(Abdullah *et al.,* 2013**). **Kaur *et al.*** designed an improved switching technique in soft handovers for WiMAX. The BS selection process optimizes the soft handover such that there is no data loss (**Kaur and Malhotra, 2012**). Gonchigsumlaa *et al.* formulated an enhanced multicast and broadcast services handover process. The handover procedures were described in the mobile WiMAX standards. But, an IEEE 802.16 was still developing and the performance was based on the current running standard IEEE 802.16e **(Gonchigsumlaa *et al.,* 2012**). Li proposed a fast handover scheme for WiMAX system. Before the MS executes the handover process, the MS get a handover code and a ranging opportunity was allocated by the target. During the handover process, the technique reduces the handover delay and the MS can design the network reentry (**Xujie, 2010**).

Moon and Cho presented an efficient cell selection algorithm for hierarchical cellular networks. An uplink transmit power used as a key parameter and cells are selected based on the coordination of multiple users to improve performance of multiple supportable users and the SINR **(Moon and Cho, 2010**). **Myoung *et al*.** introduced an improved mobility management scheme for fast handover. It simplifies the re-authentication and IP configuration processes. It supports low handover latency based on the AAA key and Mobility agent identifier. The mobile network request an access to new network using the mobile agent ID and all the mobile networks accessed without the additional key allocation **(Myoung *et al.,* 2011**). **Tamijetchelvy *et al.*** (2012) formulated an optimized fast vertical handover strategy for heterogeneous wireless access networks based on the IEEE 802.16 media independent handover. This handover scenario is used to evaluate the vertical handover performance involving multimode terminal with WLAN/WiMAX interfaces and IEEE 802.21 entities (**Tamijetchelvy and Sivaradje, 2012**). ***Ben-Mubarak et al*.** (2013) proposed a fuzzy logic based self-adaptive handover algorithm. The proposed algorithm was derived from the self-adaptive handover parameters to overcome the mobile WiMAX ping-pong handover and handover delay issues. The handover parameters was based on a set of multiple criteria, which includes the RSSI and MS velocity (**Ben-Mubarak 2013**). Also, Ben-Mubarak *et al.* introduced a mobile station movement direction prediction based handover scanning for mobile WiMAX. Here, only two BSs can become candidates; the two that the MS moves toward them chosen as the candidate for the handover scanning purpose. Hence, the handover scanning process repetition was reduced with these two shortlisted BS candidates instead of scanning all BSs (**Ben-Mubarak *et al.,* 2013**).

A Linear Regression based Cell Reselection Approach

In order to support and manage the MS mobility, the IEEE 802.16e standard facilitates a handover. Due to the interference or fading in mobility, the signal quality of the serving BS gets worsen. Then, the MS handover to the other BS that permits a high quality signal and Quality of Service (QoS). The handover procedure in WiMAX is divided into two processes:

1. Network Topology Acquirement Phase and
2. Actual Handover Phase.

Network Topology Acquirement Phase

The Base station collects information about physical quality about their neighbor base station. The Network Topology Advertisement and Scanning process are performed for gathering network topology information. The message is broadcast by aiding base station in every 30 seconds, containing the information such as number of neighboring base station, their physical frequency, downlink and uplink channel descriptor (DCD/UCD) messages according to each neighboring BS's identity. The Mobile Station (MS) scans the broadcasted BSs in a given time given by Aiding Base Station (ABS) based on NGBR-BRDCST message to find a destination BS for handover.

The MS scan neighboring BSs by exchanging the following messages with the serving BS:

SCN-RQT: Sent by the MS to request scanning and transfer a number of scanning factors namely interleaving interval, scan duration and the number of scan iteration.

SCN-RPS: Sent by the BS as a response to the MOB_SCN-RQT message in order to inform the MS whether it approves or rejects the scanning request.

SCN-RPL: Transmitted by the MS to report the scanning results, which can be received signal strength indication (RSSI), carrier to interference noise ratio (CINR), and round trip delay (RTD). The MS can transmit this message to its ABS at any time or at the time indicated in the SCN-RPS message after each scanning period.

Steps for Scanning the BSs

1 : Begin
2 : MS receives the NGBR-BRDCST
3 : If the trigger condition is satisfied
4 : MS sends SCN-RQT to ABS to activate the Scanning step
5 : Activate step includes size of scanning interval and number of scan iterations
6 : If BS receives the SCN-RQT
7 : BS responds with the SCN-RPS
8 : MS request or reject the SCN-RQT by setting the scan duration to zero
9 : After receiving the SCN-RPS message, the SCN-RQT is approved
10 : MS starts to scan for NGBR BS
11 : This process gets continued throughout the scanning interval
12 : When a NGBR BS is identified
13 : MS attempts to synchronize with its downlink transmissions
14 : Calculate the Quality of physical channel
15 : After the end of each scanning interval
16 : MS sends SCN-RPL to report the scanning results
17 : Scanning intervals are repeated for the specified number of scan iterations
18 : End

Actual Handover Phase

The actual handover begins with a decision for MS to switch from Aiding BS (ABS) to Destination BS (DBS)

When a handover occurs it observes the following procedures

Cell Reselection and Capacity Estimation

Based on NGBR-BRDCST message the MS chooses the final DBS from the multiple DBSs. The resource available on a WiMAX BS for data transmission to MS is explained in terms of effective capacity. The capacity of the interfaces involved can be used to estimates data rates in communication systems. The OFDMA signal structure and the duplexing scheme are the root cause for capacity of the mobile WiMAX. With the help of physical layer implementation, the possible data rate across the air interface can be determined. The effective capacity of the OFDMA are functions of several parameters such as channel bandwidths, FFT size, sampling factor, cyclic prefix time, modulation scheme, encoding scheme and encoding rate.

Handover decision and initiation

The MS sends MSHO-REQ message to Aiding Base Station (ABS) which is acknowledged by BSHO-RSP message. Upon receiving MSHO-REQ message, the ABS sends Handover (HO) notification message to one or more destination base station containing MS information. The ABS sends Handover (HO) notification message containing the MS information upon receiving MSHO-REQ to one or more destination BSs through backbone network. If the ABS receives a handover notification response from the destination BSs, it selects a destination BS suitable for the MS. The MS sends HO-IND message to current ABS informing about HO activity. The MS terminates its connection with the current ABS at this point.

Algorithm for DBS selection

Input: List of BS,

Output: Selection of DBS

1 : Begin
2 : for each base station in the network
3 : maintain the modified BS list with entries namely signal strength & effective idlecapacity.
4 : ABS provides the modified BS list to the MS
5 : if (entry=true)
6 : if{BS0(signal strength & effective idlecapacity)> B SN(signal strength &effective idle capacity)}
7 : MS chooses the BS0as the DBS
8 : DBS=BS0
9 : MS performs scanning for the DBS0
10 : else
11 : entry=0
12 : end if

The MS selects DBS based RSSI value and idle capacity. Sorting RSSI and idle capacity of all the DBSs and select that BS whose value is large.

Linear Regression Model (LRM)

The proposed system uses the LRM to optimize the hard handover algorithm. LRM can reduce the handover latency and the packet loss rate. It can be formulated based on the RSSI value to broadcast the MS to initiate the scanning process. When the ABS gets worsen and it becomes lesser than the scanning threshold value, then MS initiates the scanning procedure. Based on the calculated regression, the MS can predict the future RSSI value and it can be defined as follows:

$$T = C_t + \Delta T$$

Here C_t is the current time and ΔT denotes the prediction interval. The RSSI is calculated based on the following equation:

$$(RSSI)_i = \alpha + \beta T_i + \varepsilon_i$$

LRM selects the estimator value of α and β which minimizes the value of RSSI based on:

$$\begin{cases} \alpha = \overline{RSSI} - \beta \bar{T} \\ \beta = \dfrac{\sum_{i=1}^{T}((T_i - \bar{T}) \times ((RSSI)_i - \overline{(RSSI)}))}{\sum_{i=1}^{T}(T_i - \bar{T})^2} \end{cases}$$

The decision is made based on (RSSI) Destination > Handover threshold – (RSSI) Aiding.

Performance Analysis

In this section, the performance of the proposed model is computed and compared with the existing approach without Linear Regression Model (LRM). The total handover time, handover latency, network throughput and the bandwidth consumption ratio are examined and measured for the existing approach and the proposed Selection of Destination Base Station (SDBS).

Handover Time vs Frame Duration

The total handover time is defined as the time elapsed between a mobile node sending the MSHO-RQT to the current BS and the time the MS can receive the first packet through the destination BS.

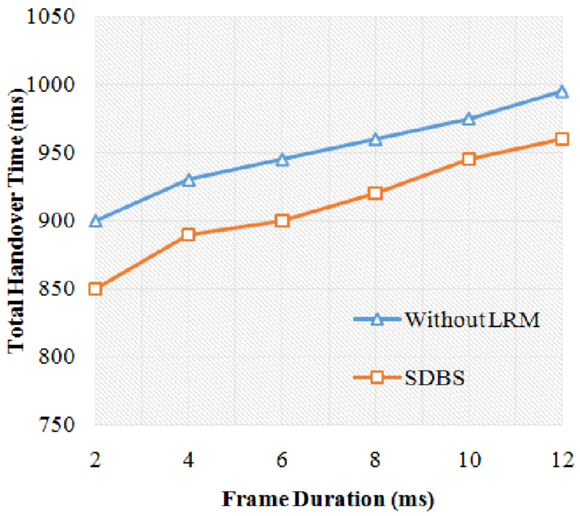

Fig.1. Total handover time vs frame duration

Fig.1 shows the total handover time between the proposed SDBS with the existing technique without the linear regression model.

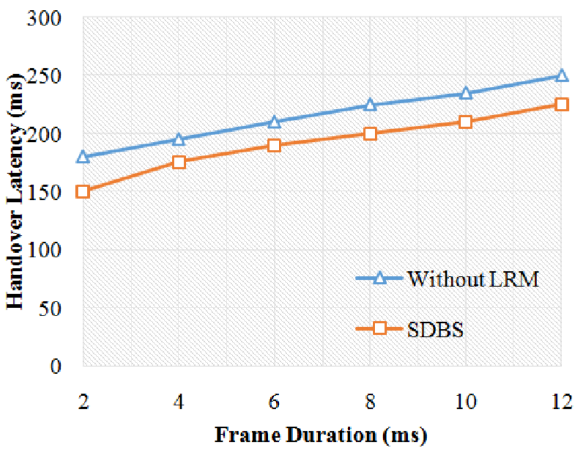

Fig.2. Handover latency vs frame duration

Handover Latency vs Frame Duration

Handover latency is defined as the elapsed time between a mobile node receiving the last packet through its current access router and the first packet through the destination BS. Fig.2 shows the handover latency for the proposed SDBS and the existing technique. It shows that the proposed method results lesser handover latency than the existing method.

Network Throughput Analysis

The network throughput is determined as the delivery rate of successful message through a communication channel. This data is transferred via a logical or physical link. Fig.3 shows that the proposed model provide better network throughput than the existing approach by varying the number of mobile stations.

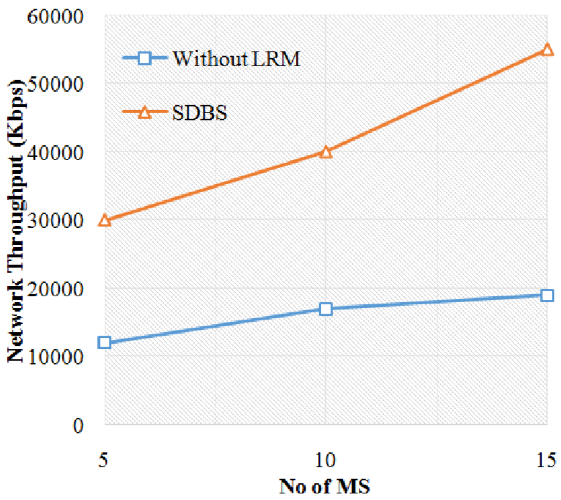

Fig.3. Network throughput vs No of mobile stations

Bandwidth Consumption Ratio

Network bandwidth is an amount of the bit rate of available or consumed data communication resources stated in terms of Kb/s, Mb/s etc.

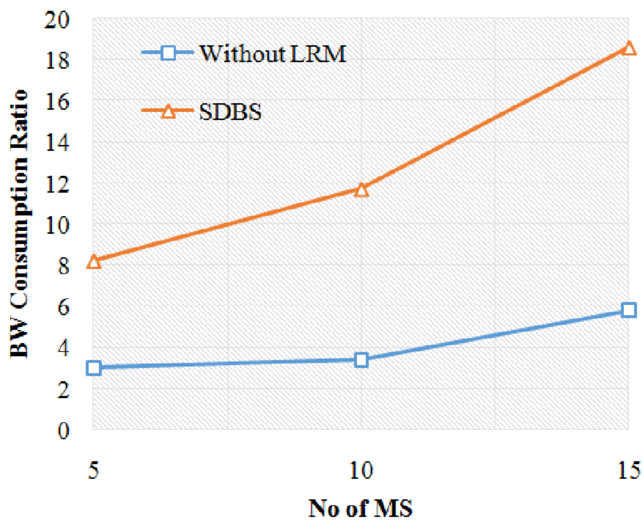

Fig.4. Bandwidth consumption ratio vs No of mobile stations

Fig.4 describes the relationship between the number of mobile stations and bandwidth consumption ratio. The number of mobile station is varied and the bandwidth consumption ratio is computed. The proposed SDBS algorithm provide better bandwidth consumption ratio than the existing approach.

Conclusion

In this paper, a linear regression based cell reselection approach is proposed during the handover. The best coverage base station is chosen by using the proposed SDBS algorithm. The proposed method uses the linear regression model to build a hard handover algorithm to calculate the Received Signal Strength Indicator (RSSI) value. The RSSI value is broadcasted to the neighbor MS in order to trigger the scanning process. The performance of the proposed SDBS algorithm is compared with the existing method without the usage of LRM. It apparently confirms that the proposed system can produce lesser handover time, handover latency with the better network throughput and bandwidth consumption ratio than the existing approach.

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