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MODIFICATION OF LOAD BALANCING METHOD IN NETWORKS WITH WIMAX TECHNOLOGY

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ABSTRACT

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 a base station (BS) scans the neighboring base stations for selecting the best base station for a potential handover. This paper presents an analysis of the particularities of handover process in modern wireless and mobile networks, as well as the factors that impact such process.

Several factors affect the quality of mobile networks functioning, one of them is the process of handover. Moreover, a method that allows mobile hosts with equal or close signal-noise ratio to switch to the less loaded base station is proposed; which allows such base station to initiate handover process to distribute all the loadings from mobile hosts more uniformly between the nearest base stations. The method gives accurate and timely decisions and considerably decreases of data transfer time using all

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available bandwidth.

I. INTRODUCTION

The modern development of telecommunications means is characterized, above all, the rapid evolution of wireless and mobile communication networks. The development of such networks requires the integration of mobile and traditional terrestrial telecommunications network of various architecture. Using a wireless medium for the transmission of data imposes additional conditions on the technology used since they are much more vulnerable to noise and attacks. Furthermore, the mobility of the user complicates the process of data transmission as during the delivery of the data packet (it has passed through several transit nodes), the location of the subscriber may change, and there are various problems associated with routing. One of the main tasks of management is to create an efficient mechanism for the delivery of data, which is of particular relevance in the mobile networks, due to the constant movement of the subscriber systems [1].

Thus, the presence of effective data delivery mechanism, the possibility of free movement of nodes and their connections for continuity in this movement. When the nodes move from one zone to another, the access servers will implement the corresponding adjustment of table’s placement nodes.

Many factors affect the quality of mobile networks functioning, one of them is the process of handover. The success and effectiveness of this process are reflected not only in the formation of assessing the quality of customer service but also on the performance of the whole network. Currently, proposed a number of methods that support the mobility of the user, such as H-MPLS [2], MM-MPLS [3, 4] and described in reference [4- 9]. These methods allow one to determine quickly the address of the zone to switch, but they are unable to support the required level of quality of service. For mobile networks, the topology which is constantly changing as move nodes, it should be provided by a minimum data transfer time on the network.

The purpose of this work is to analyze the process of the handover in wireless and mobile networks based on WIMAX technology. The work presents the method of improving load balancing between adjacent zones for the mobile nodes with equal or close signal to noise ratio.

II. CHARACTERISTIC OF HANDOVER IN WIRELESS AND MOBILE NETWORKS

Currently, there is a rapid increase in a multiple access wireless environments, allowing the mobile node to send and receive data, regardless of its location. Any of WAN’s device is identified by its IP address, which is also used for routing; Thus, IP address associated with a particular location on the network, which leads to change the IP address whenever the mobile node moves between zones, to ensure continuity of the connection. Because of higher levels of the TCP / IP stack protocol is used to identify the IP address of the session. Therefore, the adjustment of the address must be transparent to such levels.

The mobility of a node in a wireless network may be a cause of the handover. Since the location of the node is directly related to its IP address, therefore the fact of changing the IP addresses by changing access to the network requires notification. A handover is an event which may occur due to mobile node's displacement. Correct handling of such events allows the mobile node to maintain the continuity of the connection during its movement and change network access points.

In general, there are two types of handover; each one is defined by the ability to connect a node to a particular access point: soft handover and hard handover [10, 11]. Possible scenarios that illustrate the situation of occurrence of such events are shown in Figure. 1.

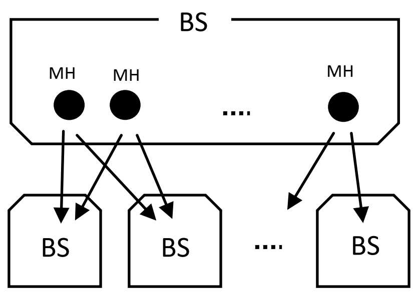

Figure 1. Possible scenarios for the process of Handover

In the case of hard handover, the connection of mobile node with the previous access point is broken before the connection time to a new access point, resulting in loss of packets. However, In the case of a soft handover connection with a previous access point is broken only after a connection with the next available. Therefore, during soft handover, the mobile unit can simultaneously communicate with both access points.

In the case when a node moves to another access point belonging to the same subnet it can take place a link-layer handover "L2". Such handover includes detecting new access point and the subsequent authentication at the data link level. If the mobile node moves between subnets, layer network layer handover "L3" may take place, which complements the link layer handover and includes the new IP address for the mobile node in the new subnet.

Different types of handover greatly affect both the speed and quality of information transmission. This is particularly important when combined traffic of various kinds (e.g., multimedia data) with different QoS requirements.

Handover process includes three stages: detection, correction, and registration [12, 13].

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Detection phase commences when the mobile node entering a new area. Then it gets a notification (message) from the nearest access point of the zone. Phase correction begins when a mobile node receiving notification from the new access point and continues until the end of setting the network interface by the new IP address obtained. Registration phase is to confirm the mobile node obtained IP addresses.

One can use T_d as duration of detection step, T_c - correction phase and T_r - registration stage, thus total duration of the handover process (T_h) can be calculated in accordance with the following expression:

$$T_h = T_d + T_c + T_r \quad (1)$$

III. HANDOVER FEATURES IN WIMAX NETWORKS.

WIMAX Technology (IEEE 802.16) is a wireless broadband technology that supports both fixed and mobile access methods [14-16]. To meet the requirements of wireless technology support different access methods and defined two versions of WIMAX. The first one is (Rev.D) based on the IEEE 802.16-2004 standard and is intended for using in both fixed and mobile networks. The second version (Rev.E) based on the IEEE 802.16e standard and is different from the first processing means implementing the handover. The IEEE 802.16e standard (Rev.E) defines three methods of implementing the process of handover: hard handover, soft handover, and handover to the macro-diversity [17].

In the WIMAX network maximum and minimum handover is calculated as follows [15]:

$$t_{max} = t_n + t_s + t_i\,, \quad t_{min} = t_i \quad (2)$$

Where t_{max} - the maximum time of the handover, t_{min} - the minimum time of the handover, t_n - the exchange of messages between the two neighboring areas, t_s - duration of the interval scan for new access point by mobile node, t_i - time of message delivery handover to the access point.

To optimize network performance in the event of a handover at the moment there are several methods. The method proposed in reference [11]. for its implementation requires the introduction of a new control message, which in turn requires a modification of the standard IEEE 802.16. Moreover, in this method, upon occurrence of a handover, a mobile node for selecting a new base station takes an unacceptably long period of time. The method which is proposed in [12] makes it possible to reduce the duration of handover due to a rapid selection by the mobile node the new base station and synchronizing with it, provided that the neighbor base stations operate at the same frequency (which is practically unattainable in the real world).

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IV. IMPROVE LOAD REALLOCATION METHOD

The process of handover can be initiated as a mobile node or base station. This process is a result of measuring the signal quality of nearby base stations and comparing it with a predetermined threshold value. Mobile nodes for which the signal quality of neighboring base stations close to the threshold value, that base station considered as potential candidates for starting handover (Figure 2).

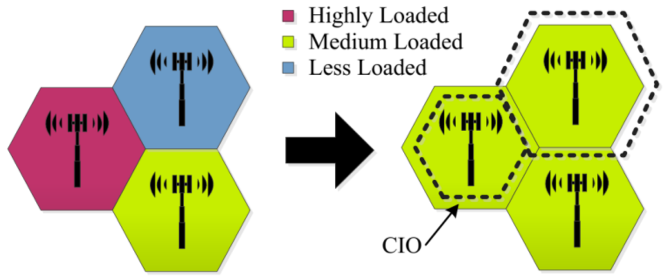

Figure 2. Adjusting balance the load in the network

The proposed modification of the method function is added in the base station to estimate the bandwidth of uplink and also added threshold to use its capacity, equal to 75% of maximum capacity. Thus, when the value of the current capacity reaches a threshold, the base station starts to send a message to all the mobile nodes and checks a free neighboring zone for switching mobile nodes to that zone. In the presence of the neighboring zones with a less load, the base station notifies all potential candidates about the need to switch them. In evaluating of possibility to start a handover to a particular host, using the following conditions:

- The difference between the signal-to-noise ratio (ΔS) in the area of the base station must be no more than 5 dB ($\Delta S \le 5$):

$$\Delta S = S_n - S_{n-1}, S_n = \frac{P_{s_n}}{P_{n_n}},\ S_{n-1} = \frac{P_{s_{n-1}}}{P_{n_{n-1}}} \quad (3)$$

Where S_n - signal to noise ratio for the zone into which the mobile node switched, S_{n-1} - signal-to-noise ratio in the current zone, P_s - the average power of the signal, P_n - average noise power;

- The zone in which the mobile node moved (switched) must have at least 25% of the free bandwidth uplink.

After evaluation of the signal quality for all mobile nodes, and selecting appropriate nodes to switch, initiation of the handover is made. Figure. 3 shows a diagram of a handover processing according to the proposed modification of the method, which demonstrates the process of transmitting messages *(DSA-REQ, MOB_BSHO-RSP, MOB_BSHO-RSP, MOB_HO-IND)* between mobile units and base stations in accordance with the technology of WIMAX.

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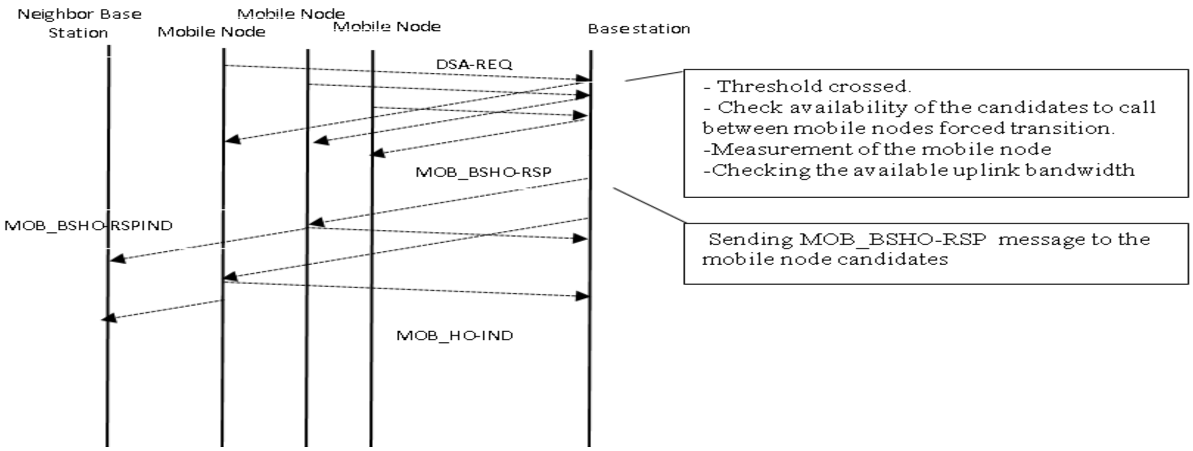

Figure 3. Diagram of a handover processing according to the proposed modification

V. SIMULATION

The following example illustrates one embodiment of location of mobile nodes and base stations (see. Figure. 4), and results of comparative analysis of the handover process in networks based on technologies WiMAX, which are derived by modeling environment OpNet [18].

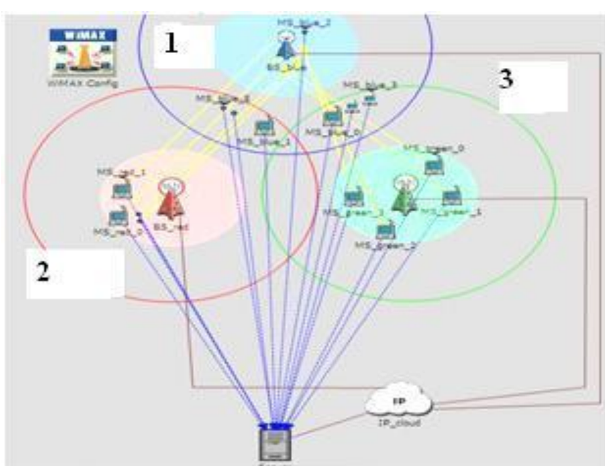

Figure 4. The topology of the simulated network

The model includes three network service area WiMAX (three zones). In the first zone there are seven mobile nodes, and the second and third there are four. All mobile nodes simultaneously send voice traffic server. The nodes of the first zone are stationary and the other two zones - moving towards

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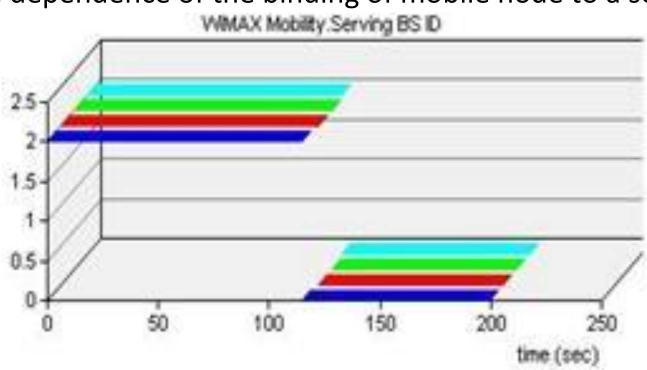
the first zone. The process of handover occurs when the mobile node is moving from the second and third zones to first. When you run the simulation, the movement begins at 110 seconds of simulated time.

Entrance to the first zone of all mobile nodes occurs from 115 to 120 seconds (Figure. 5 and Figure. 6).

Figure 5. The time dependence of the binding of the mobile node to a service area when moving from the third zone to the first.

Figure 6. The time dependence of the binding of mobile node to a service area as they move from the



second zone to the first

When mobile nodes switched to the first zone part of the uplink capacity of the zone allocated newly-found mobile nodes. As a result, the first zone begins to experience a decrease in capacity and an increase in uplink load. The other two zones (second and third), after leaving the mobile nodes, channel capacity increases, as shown in Figure. 7.

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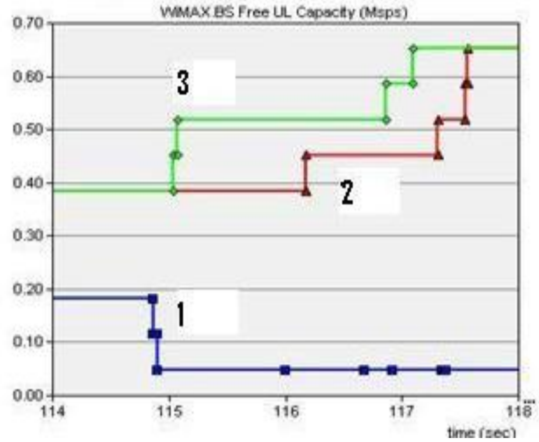

Figure 7. Changing the bandwidth of uplink channel of each zone during handover

The analysis conducted for the uplink channel showed that for the second and third zones, the throughput capacity increases with a decrease in the number of mobile nodes served by them. According to Figure. 8, in the first zone has a negative impact on the handover on channel bandwidth, which is periodically reduced. This is due to the interference caused by the mobile nodes of the second and third zones when they close to the boundary of the first zone and then move to it.

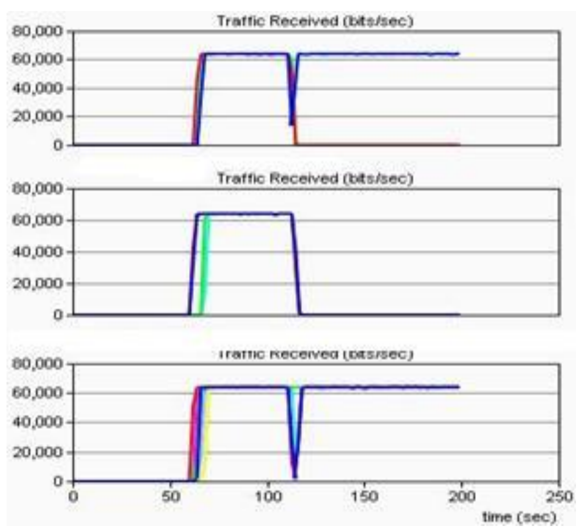

Figure 8. The dependence of the channel bandwidth on handover time

After such a transition, the load on the first zone increases, and if it exceeds the threshold value, the base station starts the first zone selection and switching of mobile nodes that satisfy the criteria in other areas (Figure. 9).

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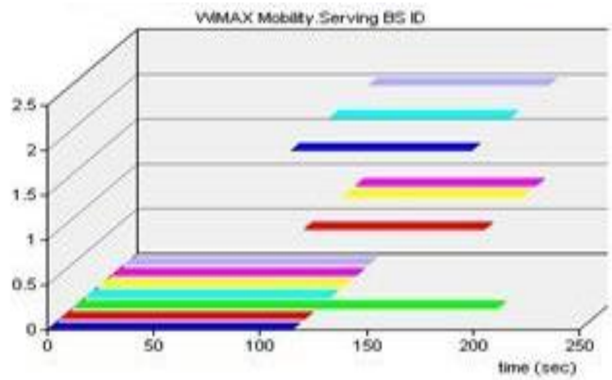


Figure 9. The time dependence of the binding of mobile nodes to a service area

Below one can consider the change of uplink channel bandwidth in these three zones. Figure. 10 shows that at time 115, a uplink channel bandwidth of the first zone is reduced to 140 Kb/s, whereas in the third zone corresponding value increases. This is due to switching two mobile nodes in the third zone to the first while the bandwidth of the first uplink zone is reduced below a predetermined threshold. In this case, according to the proposed method, the base station in the first zone evaluates the status of all mobile nodes in the zone (at time 115.75 seconds), and then launches a handover for the relevant mobile node.

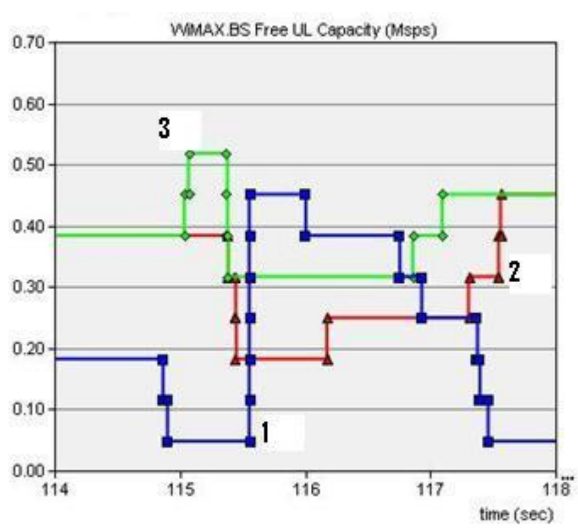
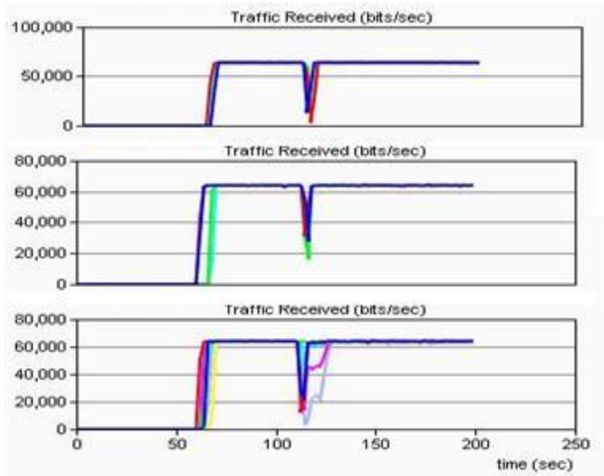


Figure 10. The dependence of the uplink bandwidth on handover time for the proposed method

According to the proposed method, nine mobile units will be in the first zone and the three switches in the second and third zones. As a result, the throughput of channel increases, as shown in Figure. 11. In the above examples, the fixed values of the signal-to-noise ratio are used, and restrictions imposed by the distribution of univariate case.

In general, possible to optimize the process of redistribution of mobile nodes between adjacent base stations, taking into account some additional factors that will be discussed in subsequent publications.

Figure 11. The dependence of the channel bandwidth on handover time publications.



CONCLUSION

This paper proposed a method that allows the mobile nodes with equal or close signal-to-noise ratio switch to a less loaded base station. This approach enables the base station initiates a handover process, which allows a more evenly distribute the load from mobile nodes between neighboring base stations in wireless and mobile networks. Handover process initiated at lower values of the available bandwidth of the base station is less than a certain threshold. Therefore, it is possible to optimize WiMAX network performance by the criterion of the total capacity of base stations.

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ملخص

الشيء الرئيسي في mobile WiMAX الذي يجب الاخذ بنظر الاعتبار هو التنقل السلس لتفادي فقدان البيانات . في WiMAX كلا من المحطة الرئيسية ("Main Station "MS) والمحطة القاعدة ("Base Station "BS) تقوم بالبحث عن اقرب وافضل (BS) لنقل البيانات وللمرور . في هذا البحث تم تحليل خصائص عملية التسليم في الشبكات اللاسلكية والمتنقلة الحديثة، فضلا عن العوامل المؤثرة في هذه العملية.

هناك العديد من العوامل التي تؤثر على نوعية شبكات الاتصالات المتنقلة، واحدة منها هي عملية التسليم . وبالإضافة إلى ذلك، تم اقتراح طريقة تسمح بتشويش المضيفات المتنقلة لتكون قريبة من ضوضاء الاشارة للتحويل الى lower base station، مما يسمح لـ (base station) للشروع في عملية تسليم لتوزيع جميع الحمولات للمضيفات المتنقلة على نحو اكثر اتساقا بين اقرب (base stations). هذه الطريقة تعطي قرار دقيق وفي الوقت المناسب وتقلل وقت ارسال البيانات بشكل كبير باستخدام كل عروض النطاق المتاحة.