Wireless Networks Interoperability

Wifi / Wimax Handover

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Abstract - The mobility with quality of service in wireless networks is a reality ever closer. The need for mobility while communicating becomes more and more necessary. Technologies for wireless networks with interoperability develops the concept of "communications anytime anywhere". Interoperability uses the handover to ensure the mobility of a mobile terminal through various communication infrastructures, supported by different technologies of wireless networks. Maintain the connection between base stations and mobile terminal is the key of the customer's satisfaction, with the guarantee of continuity of services and applications running, moving between different cells, using the technology of wireless communications to provide better coverage in the position where is.

The aim of this study is to examine how the mobility between different access technologies in wireless networks can be optimized and what their behavior in scenarios of interoperability.

To examine the quality of the service of mobility, we analyze the time required for the handover and the existing loss of packages, the latter being a very important factor to satisfy the user.

Keywords: MIH, seamless mobility, handover, interoperability.

I. Introduction

Currently, the mobility of a terminal is a requirement of great importance, supported by a procedure known as handover. In wireless technology networks, handover is the terminology used to describe the transition of a mobile terminal between cells in a transparent manner to the user, and the cell coverage area of access to a wireless network, which may combine different communication technologies, such as Wifi, Wimax and Universal Mobile Telecommunications System (UMTS).

Ensuring that a mobile terminal can move while maintaining connectivity to the running services, it is also increasingly important. In IPv6 networks[1], mobility can be implemented on any mobile device, via the MIPv6 protocol [2]. The MIPv6 is the Internet Engineering Task Force (IETF) standard that deals with this form of transparent mobility to the user. This protocol allows the service continuity and IP maintenance by the mobile terminal, regardless of where it is and what technology is connecting it. The act of moving to other networks is called handover. The handover may occur in two situations: when the mobile terminal crosses a zone boundary with coverage in the intersection of two technologies, in a situation of a position shift, or when the signal is degraded by equipment problems and try to find a better signal. The negotiation process with the newer network during the transition phase, leads to the inevitable loss of packets. This loss of packets can be minimized through mechanisms such as packet resend.

The Network Simulator [3] is an application able to simulate communication networks environments, used in the planning of networks. It has several modules and versions depending on the type of simulation to do. This work aims to simulate a typical scenario of handover between WiFi and Wimax and to draw conclusions about the feasibility and reliability of this process in wireless networks. The utilized NS (Network Simulator) module is the one of the NIST [4], named "Seamless Vertical handover 802.21 MIH (Media Independent Handover) Protocol" that added considerable changes to ns2.29. With this module is possible to simulate the vertical handover between wireless networks of different technologies, using the draft 3 of 802.21 protocol. We intend to examine the reliability of this module, and study the anomalies during transitions.

In this study, we use the specifications of wireless technologies for the Handover. Initially, we address the interoperability between wireless networks of different technologies such as Wifi and Wimax, describing the process of handover. Later on we specify the components of the scenario, set the parameters for simulation and perform the analysis of results.

II. Wifi / Wimax Handover

In data communications using wireless technologies, the quality of service is conditioned by the characteristics of communication networks. In a operator communication

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network (e.g. ISP (Internet Service Provider)), the quality of service is established by him, according to the established service agreement. The operator can guarantee a level of mobility, but always limited to the communication technology in use (e.g. 3G, Wimax and others) and coverage provided by this technology. In several scenarios involving mobility, it is very easy to reach areas where no coverage of service exists and situations where the moving speed of mobile agents does not allow the continuity of communication. The challenge is to make use of several technologies for wireless communications and do the reuse of the best areas of coverage of these networks (technologies) to enable continuity of communication, using the best technology available.

A. Parameters that Influence the Time of Handover

The process of handover is directly related to the time of sending a Router Advertisement (RA), they are messages that, when a given frequency, creates congestion or are insufficient for proper management of the network, able to enforce time transition and maintain acceptable quality in service. This latency is considered minimum and maximum values. When messages are configured in the RA minimum value, the time of handover decreases because there are more sent messages from RA once the mobile terminal detects easily that there is a movement and performs the handover. The minimum and maximum values considered following a suggestion of RFC3775 [2] to MinRtrAdvInterval of 0.03s and to MaxRtrAdvInterval of 0.07s. It is the source of RA that allows the configuration of the new Care-of-Address (CoA). In the simulations performed is not possible to draw conclusions concerning the time of handover at speeds above 150Km \ h.

B. Handover Decision

When Handover is necessary, the mobile unit continues to receive traffic for the existing connection and start the registry process of a near Base Station (BS). One way to trigger the process of handover algorithms is the introduction of the agents of the client or the BS (operator) which make the management of the mobile unit state by sending messages across the network. [5] Another way to do this is to implement a solution that provides the mobile unit of capacity to decide the best time to perform the handover. This way of implementing the handover is based on a module with the name of Handover MOH that manages the transitions between networks. [5] The management by the MOH (Module Of Handover) module is based on identification of the BS using three layers of the network. Use the link layer to identify the connection status, the IP layer to obtain / exchange information from the communications routers (BS) and Router Advertisements (RA) through the module of the Neighbor Discovery[4], and the transport layer (TCP) where messages are exchanged for monitoring the status of the connection.

The mobile station starts the process of handover when it receives an RA. To avoid the unwanted Handovers MOH filter the RA to deny the connection with BS with a weaker signal. The determination of a best point of connection is to implement a RA cache in the mobile, to allow a better choosing of BS. There are two groups of selection criteria for RA, one highest and other lesser important. The quality of the signal and the time since the last update in RA cache are criteria that belong to the group of greatest importance, whereas criteria such as number of hops to the BS or the BS is available in the local connection, are criteria of lesser importance.

The MOH uses the state of the link layer to monitor the connectivity of the link. This component helps increase the speed of detection / connection and disconnection of a link.

C. Handover Suitable For Multimedia Applications

IPv6 was specified for support of multimedia applications and real-time using the Flow Label and Priority header fields.[1] The Flow Label is a field which can be specified to manage "special" quality of service support or real-time applications. Priority Label allows the source of the communication to specify the priority of traffic according to it type. These fields are essential to implement Quality of Service, however, the current development in mobile communications networks do not support the desired quality of service, already offered on the fixed communications network. There are different performances even considering implementing similar scenarios in terms of traffic and data transport.

IPv6 facilitates this process because it allows the mobile terminal maintains an address while negotiating other, acquiring a Care-of-Address (CoA) as an interface configured to receive data, the current, and another to connect to the next BS.

The RSVP (Resource Reservation Protocol) [6] is a transport layer protocol, designed to reserve resources through a network of integrated services for the internet. It should not be understood as a data transport protocol but as a signaling protocol to transport management and control packets. The RSVP is then used in real-time applications to reserve resources in the path between two terminals (e.g., BS and mobile terminal). The path is reconfigured if a terminal is mobile, as it is the case. This reconfiguration can be achieved only after the mobile terminal determines the new Care-of-Address (CoA) and sends an update to the terminal that is communicating.

The use of an adaptation of RSVP [5] allows optimizing the process of the handover. It established a tunnel between the old BS, where the terminal mobile is and the new BS, where to move. This tunnel will allow the flow of traffic follow the "normal" communication between BS and mobile terminals, until they change their BS.

When the mobile terminal acquires a new CoA, it sends an update to the destination while using the old path and starts to send RSVP to the new BS setting the parameters of quality of service in connection to the new BS.

All tests were performed using the MIPv6 protocol to perform the Handover. Using this protocol the Handover is one of the components in test module to be developed in the NS used (2.29 NIST) [4]. Have been studied protocols as FMIPv6 (Fast MIPv6) that promise an optimization a real time level for realization of Handover. However, the performance test will be the subject of future work.

III. Testing Scenario

The tests performed in this work provide a theoretical overview of the operation of the protocols for the management of handover between different technologies, in this particular case, the MIH [4], between different technologies

Through the use of the Network Simulator [3] were simulated scenarios of implementation of the protocol MIH (802.21) [7] for the Handover. A first approach simulates the time of Handover from an area with coverage using the technology of wireless WiFi (802.11) [8] to an area with coverage using the technology of wireless Wimax (802.16) [9]. Tests were conducted varying the parameters that directly influence the time of handover, as the speed of travel of the mobile node with the aim of studying the behavior of communication in the transition stage of the network. The test scenario presented in Figure 1 consists of: Server, Router, BS Wifi, Wimax BS and mobile terminal. The server is responsible for generating traffic that will be received by the mobile terminal. The Router is responsible for interconnecting the server with the BSs and a possible management-level quality of service or access control. BS is the equipment that provides access to network of the client and the future wireless communication between this and the server, either by Wifi or Wimax. The mobile terminal is a node that has two network interfaces (one Wifi and other Wimax) to connect to the BS. Figure 1 illustrates the interconnections between the equipment and the test scenario.

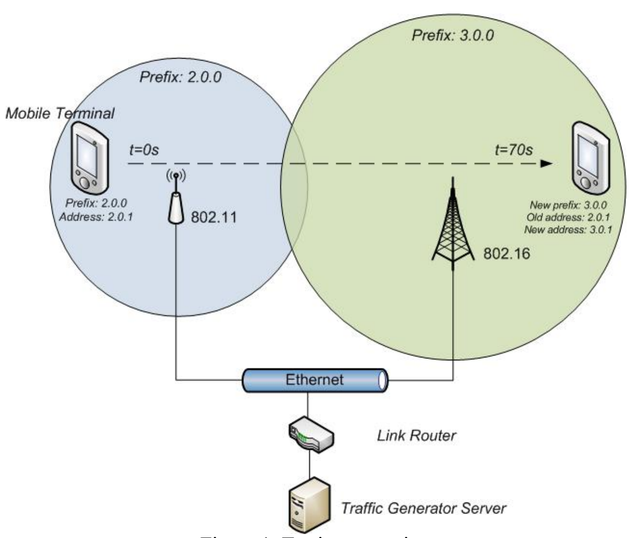

Figure 1. Testing scenario

Traffic is always the same type (traffic CBR - Constant Bit Rate) with parameters identical to the typical video transmission, with a Data Rate of 1.2 Mbps between server and client.

The bandwidth of the link cable, Ethernet, and server, router management and BSs is 100Mbps, considerably higher than necessary (1.2 Mbps) to avoid possible node bottlenecks and therefore influence the time of handover, as would trigger mechanisms for the management of the transport protocols for treating congestion of the channels.

The bandwidth of the links between BSs and mobile client may vary within the limits considered to be a valid wireless communication. The used values are 11Mbps for Wifi and 32Mbps to Wimax. In all tests we used the TCP protocol to transport data, to provide mechanisms for referral of lost packets in case of failures, and thus provide a better reliability of service. The speed of the mobile terminal in the tests where this is not fixed, varies in the range of 2m/s to 45m/s. For values greater than 45m / s reaches values theoretically impossible due to restrictions in the simulation module of the simulation.

The coverage of Wifi BS is 20 m, while the Wimax BS is 1000 meters. It used a very different value for Wimax BS because this technology has much greater coverage and reach 3 to 4 Kilometers without line of sight.

IV. Implementation

The development of the script was based on the events supported by NS version 2.29 with the NIST MIH module [4]. The communication technologies used are 802.11, 802.16 and 802.3. Among the events supported by the module, are used: Link Up, Link Down, Link Going Down, Link Detected, Link Handover Imminent e Link Handover Complete, for 802.11 and 802.16 technologies. The 802.3 technology allows Link Up and Link Down. Figure 2 shows how these events are used over time and in particular the moment of handover. The grid area of Figure 2 is a trigger that is activated in the exact moment of transition, extending for a few moments to prevent the breaking of the link during the network transition.

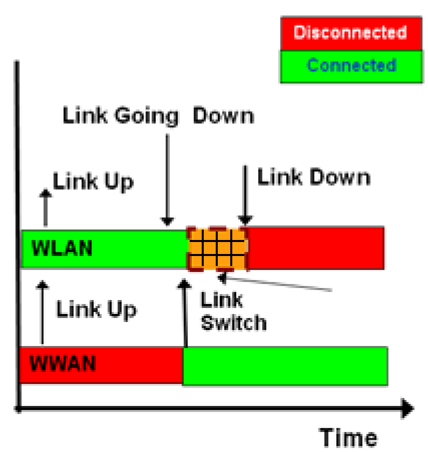

Figure 2. Demonstration of L2 events over time [4]

The discovery made by the mobile node of the neighbor network is based on Neighbor Discovery model of NIST Add-on for the IEEE 802.21.

This module offers the detection of motion in the layer 3 of OSI model. Periodically are sent by the BSs the RA to inform the mobile nodes (MN) about the prefixes of the network where they are connected. This prefix is identified as the address of the Base Stations. The RA are sent through broadcast messages, in the case of Wifi and Wimax technology, or unicast, in the case of Ethernet technology. The mobile nodes are associated with an agent Neighbor Discovery (ND) that receives the RA and determines if the message contains a new prefix informing the Interface Manager. It is also associated with a timer and a lifetime for this prefix. When the mobile node loses connectivity with the BS, the prefix time ends and the Interface Manager (IFM) is notified. The IFM is an agent in the mobile terminal which does the control of interfaces, according to the network to connect. Figure 1 illustrates the procedure for allocation of network prefixes.

V. Results

In order to perform the following tests, we used a constant speed for the mobile node of 1 m / s. Looking at the figure 3,was found that the size of packets and bandwidth of links, does not influence the time of handover, i.e., varying these parameters does not cause any significant change in the transition process. This is because the Data Rate is always lower than the bandwidth of the channel. Suppose we wanted to get a higher Data Rate, logically would have to configure a bandwidth greater for the track, not making sense making use of this parameters since we are using these values as not recommended for this.

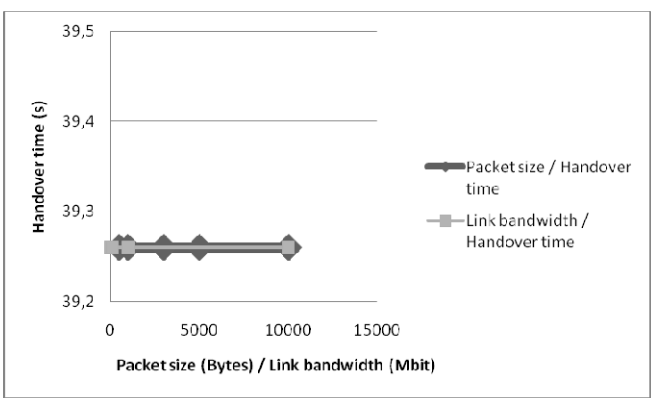

Figure 3. Handover time according to packet size and link Bandwidth

The same situation happens in the particular case where there is packet fragmentation. Testing also performed by setting a value for the packet size exceeds the size of the Ethernet window, forcing the fragmentation, but which are also irrelevant for the reasons explained above in the analysis of the graph in figure above.

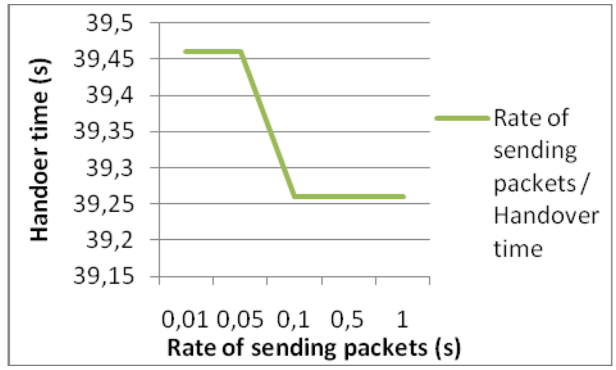

Figure 4. Handover time according to packet send interval

Further notes that the interval of sending packet undergoes a minor change, it is sent with frequency below 0.05 seconds, the process becomes slower because there are more packets in the network and sending / receiving of those related to affect the Handover time.

For the next tests, the speed of mobile node varies from 2 m/s to 45 m/s.

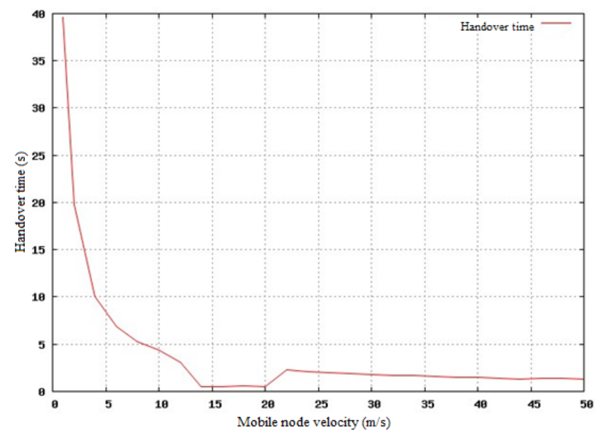

Figure 5. Handover according to mobile node velocity

An analysis of Figure 5 shows that, with increasing speed, the time of handover tends to decrease. This is because the mobile node reaches the threshold more quickly in transition to the destination station, receiving less RAs and thus speeding up the registration process in the destination station. There is also that, when the mobile node is carried over to another station, he continues to receive packets, but they arrive with errors, so it discards them. But due to TCP be able to control the traffic on the network, adjusting the rate if packet loss, and also have a resend timeout, there is an interruption in the transmission of packets. From the moment the first packet is delivered by the second station, the frequency returns to baseline values (0.1 seconds).

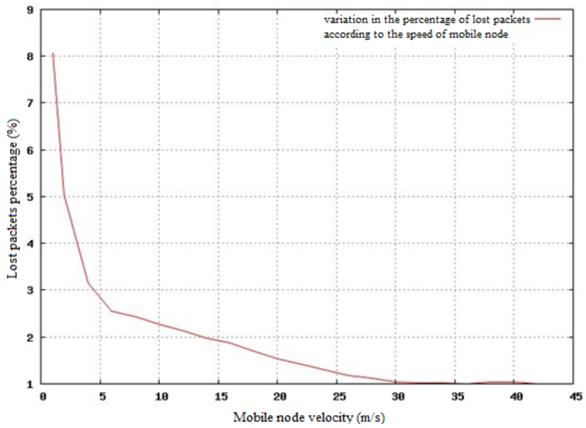

Figure 6. Discard percentage of packets according to the speed of mobile node

Analyzing the graph of Figure 6 shows that the percentage of discard packages is higher at reduced speed. This is partly explained by the analysis for Figure 5. Due to the node is moving at a slower speed, the time of transition between two BSS is greater, then there is a greater loss packages. There is always a packet loss, even if very small, as from 30 m / s speed, because this may be a limitation of the module or the NS2.29, not be possible to make the desired Seamless handover. This situation is still in study.

VI. Conclusion and Future Work

With the intensification and massive use of mobile devices with Internet connection it is required to implement a protocol for mobility, achieved through protocol 802.21 (MIH) that allows mobility across different wireless technologies. This protocol deals with the transitions between wireless networks of different technologies (handover). Using the NS2.29 we made the analysis of transition from a Wifi network to a Wimax network. It was found that parameters such as packet transmission rate, packet size and speed of links, can be considered irrelevant because it does not has much interference in the time of handover using the most common settings for these parameters. Packet loss always occurred but increasing the speed of the mobile node, will decrease it until 1%. Regarding the time of handover, it has the same behavior, i.e., decreases until approximately 1 second. From the analysis in the previous paragraph, we can conclude that this protocol still does not allow full mobility without packet loss, i.e. without loss of data.

This work pretends to create a basis for future scenario simulations using the same simulation but using the FMIPv6 protocol [11] instead of MIPv6 and comparing the results, since it promises a significant improvement in the time of handover. Also pretends to helps the development of the module to perform the simulation of handover between UMTS and Wimax or Wifi, because the module does not allow mobility in UMTS interface. The UMTS component implemented in the NS is an extension of the EURANE's module [12] that does not have an implementation of mobility. Mobility's functionality implementation in the interface module used in UMTS is also helped by this study as well as errors of implementation of the NS2 and should be considered in the development of this module.

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