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Performance Analysis Of Wi-Fi And Wi-Max Networks During Vertical Handover

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Abstract

The seamless Vertical handovers depends on the various factors such as hand-off delay, number of handovers and packet drops during handovers. So, for the seamless handover the timing of handover and the interface selection between two networks is the challenging issue in next generation wireless network. Here the interface selection and the timing of the handover depends on various factors like the price of the link, signal strength, the user mobility, available bandwidth and power of the battery etc. IEEE 802.21 provides a seamless handover in heterogeneous wireless networks. But there are some limitations for the IEEE 802.21 , it uses only signal strength and interface type for seamless handover and handover methods based on only Received Signal Strength (RSS) are no longer applicable for heterogeneous handovers because different network standards use different RSS and cannot be compared directly to each other. Here an algorithm module has been proposed which is based on not only the signal strength but also the available bandwidth coverage radius , user mobility and power of the battery for performance improvement of Wi-Fi and Wi-max during vertical handover.

Index Terms—*Vertical Handover, IEEE 802.21, Interface Selection , RSS*

1. Introduction

According to ABC (Always Best Connected) and Any where Any time internet connectivity the user should be able to take advantage of the best available access network at any point in time .The 802.21 standard or Media Independent Handover (MIH) is a first step which allow mobile devices to successfully make a Hand-Over (HO) between networks of different technologies, such as Wi-MAX , Wi-Fi, UMTS, Bluetooth, or Ethernet . A **handover** is the process where the MN changes radio transmitter or access media used to provide the bearer services, while maintaining a defined bearer QoS [3GPP-Release 5].When there is a handover between same technologies (Homogeneous Networks) it is called as **Horizontal Handover**, whereas when there is a handover between different technologies (Heterogeneous Networks) it is called as **Vertical Handover**.

1.1 Handovers in heterogeneous networking

When a new network is established before the old connection is lost then it is called as **soft** handover. When the MN switches from smaller coverage, high bandwidth network to larger coverage low bandwidth network e.g. WLAN to Wi-MAX, is known as **upward** vertical handover. In difference in **downward** vertical handover the MN switches from larger coverage low-bandwidth network to a smaller coverage high-bandwidth network e.g. UMTS to WLAN.

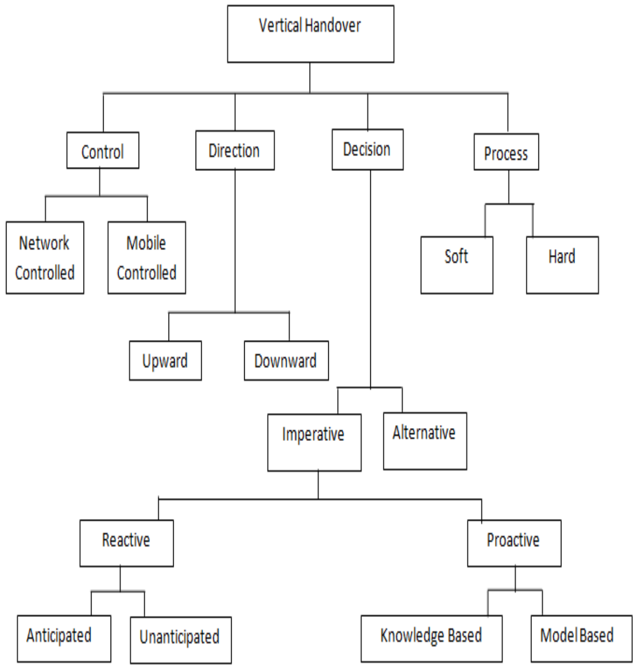

Fig.1 Classifications of Vertical Handover

If network maintains an up to date knowledge of MN and decides when and how it should perform a vertical handover then it is known as **network controlled** approach. While In the **client-controlled** approach, all MN will keep information about network. An **imperative handover** takes places because a MN has determined through technical analysis that it is good to do so. when the preference has given to a network based on other non-technical reasons such as price or incentives called as **Alternative handovers. Imperative handovers** can be **reactive or proactive** in nature. Reactive handovers cannot take decision based on future conditions; they can only take decision based on available network information. Proactive mechanisms possess the ability to reserve resources in advance based on the knowledge of network parameters such as topology, coverage and positioning information. The **knowledge-based** approach makes use of pre-recorded network coverage information together with a MN‟s location to predict the availability of different networks at a particular location. The **modeling-based** approach predicts future conditions with the help of mathematical models.

The IEEE 802.21 Framework

The IEEE 802.21 has proposed a client-based framework that aims to offer different services for the optimization of vertical handovers between different networks such as WLAN, Wi-MAX, UMTS and GPRS while interfacing with policy and higher layer mobility protocols. The various factors affecting handovers decisions are service continuity, application class, quality of service, network discovery and selection, security, power management and handover policy. The 802.21 framework employs information gathered from both the MN and network to choose the most appropriate network.

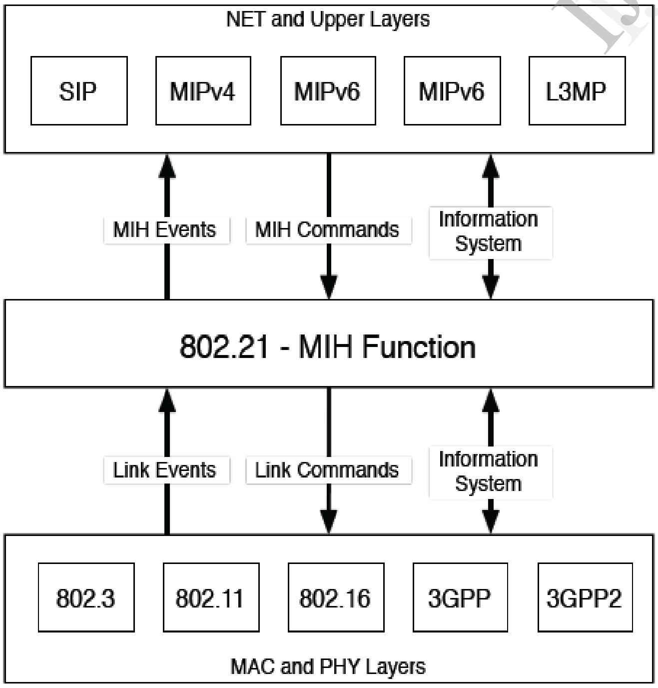

Fig.2 Information flow between MIH components

The main component of the 802.21 framework is the Media Independent Handover Function (MIHF) shown in figure 2 which acts as a unified interface that exposes network independent service primitives to higher layers. It communicates with higher and lower layers through Service Access Points (SAPs) and offers three different services:

- **Media Independent Event Service (MIES):** The MIES provides classification, filtering and reporting of events pertaining to dynamic information concerning link status. Events are generated within link layers and sent towards the MIHF. The MIHF propagates these events towards interested MIH users who previously registered to receive them. Events can be generally related to media access control (MAC) and physical layer (PHY) state changes which motivate link event triggers, such as link handover or link transmission events. These events can be used to inform MIH-users about radio conditions, which can trigger a quick handover to preserve connectivity, or switch to a technology which better suites running applications under dynamic conditions.
- **Media Independent Command Service (MICS):** The MICS commands are employed by the higher layers to find out the status of connected links and for the execution of higher layer mobility and connectivity decisions to lower layers. Some examples of commands are MIH Poll, MIH Scan, MIH Configure, and MIH Switch.

Media Independent Information Service (MIIS): This service provides a set of mechanisms that enable the MIHF to obtain both static and dynamic network information within a geographical area. Static information can be the names and providers of neighboring networks, and dynamic information can be parameters such as MAC addresses , security information ,channel information, and other higher layer service information.

2. Related work

In 2004 Areej Saleh proposed a location-aided handover decision algorithm for the prediction of unnecessary vertical handovers. This thesis is limited to only predicting handovers it is not telling about the drastic changes in the direction of the MN. After that in 2007 Wang and colleagues proposed an algorithm based on Decision Theory which aimed to predict the duration of disruption in LOS communication which in turn helped to decide whether or not the device should switch to WLAN. This concept was limited to resolving uncertainty in LOS communication in indoor environments and it did not consider the issues which are based on WLAN vertical handovers due to topological effects.

X. Yan in 2008 proposed a mathematically derived model based on the prediction of travelling distance which aimed to avoid unnecessary vertical handovers from cellular networks to WLANs. While this approach was good for predicting unnecessary vertical handovers to WLAN, it had some drawbacks also. First problem is that the MN could do unnecessary vertical handover only when it will actually cut the WLAN cell coverage boundary and could not capture the random movement of the MN within the WLAN cell. For example suppose the MN is entered the WLAN cell and moving inside it. Second, the accuracy of the proposed solution in predicting unnecessary vertical handover will increase only when the speed of MN will be above then 15m/s.

3. Problem Statement

The IEEE 802.21 standard uses only signal strength and the interface type for the interface selection. There are a lot of parameters which can be consider for the interface selection, such as available bandwidth, the user mobility, the price of the link and power of the battery etc.

The user mobility, power of the battery and RSS has been taken as a parameter for batter interface selection.

4. Proposed solution

The three important parameters have been taken for batter interface selection, in which the user mobility is taken as a key parameter. The MN can move upward or downward direction so in general two cases have been formed.

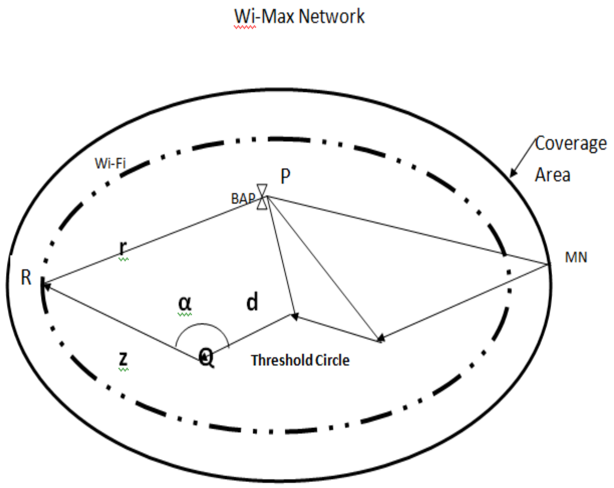

Fig.3 MN movement towards the coverage boundary

First, when the MN is moving from outside to inside the network and second, when MN is moving from inside to outside network. Here the second case has been discussed. According to that MN is moving towards coverage boundary of Wi-Fi.

In the Fig. 3 the MN is moving towards the Wi-Fi coverage boundary. The outer circle indicates the coverage area and the inner circle indicates the threshold area of the Wi-Fi network.

The MN is moving to upward direction and it is attached with Boundary Access Point (BAP) because it is moving towards boundary.

After reaching the threshold point MN will predict about vertical handover. That prediction time is very important for batter handover.

4.1 Proposed Algorithm for Batter Handover Time Prediction (BHTP)

INPUTS - RSS, z, r, d, α, v, T
OUTPUT - BHTP

z : the difference between previous position of MN say Q and current position of MN say R.
r :the distance between BAP to current position of MN
d : the distance between BAP to previous position of MN
α : the angle between BAP and previous position of MN.
v : velocity of MN
T : the threshold time

Step 1-Mobile node is using Wi-Fi network.
Step 2-It is moving towards the coverage boundary
Now
CAP = BAP
& NXAP = 0
Step 3-Calculate the Received Signal Strength (RSS)
for t =0,1,2……n $RSS_{CAP}(t_n) < RSS_{CAP}(t_{n-1})$

Step 4-Switch on the normal mode of MN

Step 5-Calculate the BHTP

$$BHTP = \frac{distance\ (z)}{v} \quad \text{------------------ (1)}$$

Calculate the distance z

$$r^2 = d^2 + z^2 - 2dzcos\alpha \ldots\ldots (2)$$

Solve the quadratic equation (2)

$$z = d\cos\alpha \pm (r^2 - d^2 \sin^2 \alpha)^{1/2} \quad \text{-------- (3)}$$

By solving (1) and (3)

$$BHTP = \frac{d\cos\alpha \pm (r^2 - d^2 \sin^2 \alpha)^{1/2}}{v} \quad \ldots\ldots\ (4)$$

Step 6-Compare BHTP with T

If BHTP >T do the handover
or else remain in same network.
Step 7- END IT

When the mobile node receives the beacon message it calculates the "BHTP". If "BHTP" is less than threshold time T, MN will avoid the handover.

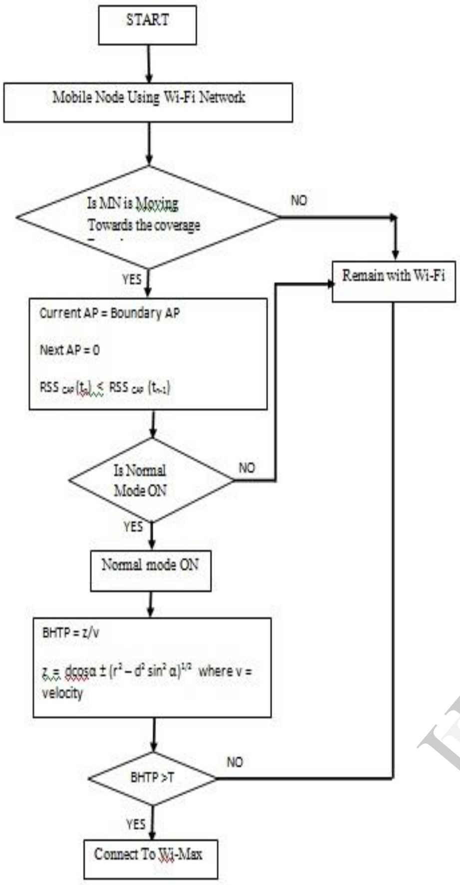

Fig .4 Interface Selection Flowchart For Wi-Fi to Wi-Max

Where T = C1.HD + C2.TR + C3

and "HD" is the handover delay, "TR" is the traffic rate and C1, C2 and C3 are the positive constant whose value are dependent on the type of the application, traffic rate of mobile node. Consider the battery life, the speed of MN and the coverage area of access point. Wi-Fi to Wi-Max handover Trigger when the MN is moving away from the BAP towards the coverage boundary of Wi-Fi.

The interface selection flowchart between Wi-Fi and Wi-Max in Fig . 4, consider the battery life, the speed of MN and the coverage area of access point. Wi-Fi to Wi-Max handover Trigger when the MN is moving away from the BAP towards the coverage boundary of Wi-Fi. Now if the normal mode of battery is ON the MN will calculate the BHTP and if the BHTP is greater than T, the MN will remain with Wi-Fi or else it will connect with Wi-Max.

5. Conclusion

Here the mobile node can also access the multiple interfaces but the problem with multiple interfaces is that MN must be selecting the best interface. In this paper it has been proposed an interface selection based on user mobility, power consumption and coverage area of the mobile node. The proposed architecture for interface selection can provide a good handover decision for overlaying network.

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