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Performance Analysis of Vertical Handover between WiMAX and Wi-Fi Networks

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*Abstract— **The efficiency and reliability are the major requirement of any network. In case of high speed network like WiMAX, or the Wi-Fi Networks, the network gives more data loss as some problem occur over the network. One of the major problems of such high speed network is handover. This problem becomes more critical when it is between two different networks. Such handover is called vertical Handover. In this work we are dealing with problem of data loss during the vertical handover between Wi-Fi and WiMAX network.***

Keywords— WiMAX, Wi-Fi , BS;HO, OFDM.

I. Introduction

WiMAX and Wi-fi are the high speed telecommunication technologies that offer transmission of wireless data via a number of transmission methods; such as portable or fully mobile internet access via point to multipoint links. As the size of a Wireless Network is much vast because of this the complete network is divided in terms of clusters. Each cluster having a cluster head or the base station the controls all nodes of the network. As of wireless network these network support the concept of mobility. When the mobility is during data transmission it is more critical. The main problem arise when a node move outside its coverage area, In such case some other base station get the control of the node. This situation is called handover. When the handover is between two different network architecture the selection of the particular base station for the node is more critical [1].

II. Vertical handover

Efficiency and the Integrity are always the major requirement for any network and when we talk about some wireless network the problem is more critical. We are proposing one of such a target cell selection scheme in case of handover in wimax network. The proposed handover scheme will evaluate the maximum effective capacity and the idle capacity of the base station for any point of time in the network. Then the triggering will be performed based on some decision factor. Base station having the more effective capacity will be elected for the next base station after handover[3]. The proposed system will provide a reliable and energy efficient hand over. The steps involved in the algorithm are given here

- Let the communication is being performed between 2 nodes present in coverage area of two different base stations or they can be in same base station called Node i and Node j
- During the data transmission Node i start moving to some indefinite direction.
- As it moving there can be the requirement of hand over. Now the following steps are performed.

Find the capacity of each base station. For this we need to calculate the number of OFDM(Orthogonal Frequency Division Multiplexing) symbols and the overhead symbols in WiMAX and Wifi Networks MAC frame. For this calculation the Time Division Duplexing is being used in this work. According to TDD every frame is further divided in two sub frames called DL

In the original HO triggering is based only on RSSI or CINR .This scheme is still valid here but works in parallel with additional trigger based on BS idle capacity. The trigger policy is expressed using a probabilistic variable $P_{trigger}$. In this proposed work we defined the triffering on the basis of effective Capacity of the base Stations in case of hybrid networks. Let we have N of base Stations that are the eligible to perform the handover and to take charge of the mobile node. In this case we will find the effective capacity of each node called C1,C2,C3….Cn l base stations BS1, BS2…BSn[3].

Now we have to elect the base station such that

$$\mathrm{Min}(C(i)) \text{ where } i>=1 \text{ and } i<=n$$

Here also exist variable p probabilistic variables globally controlling the HO frequency to avoid ping-pong effect. This means that the trigger will take place with the probability p when the condition is reached. When the condition is not reached nothing happens. A greater p implies more frequent cell switch. A cell with heavy traffic load will be relieved quickly but congestion in the target cell might be produced due to massive cell switch; whereas a smaller p implies less frequent cell switch therefore less HO cost, but the traffic load will be balanced more slowly. And μ is the assurance factor in order to avoid useless scanning. By choosing a greater μ, MS will be assured to switch only to another WiMAX cell with sustainable idle resources.

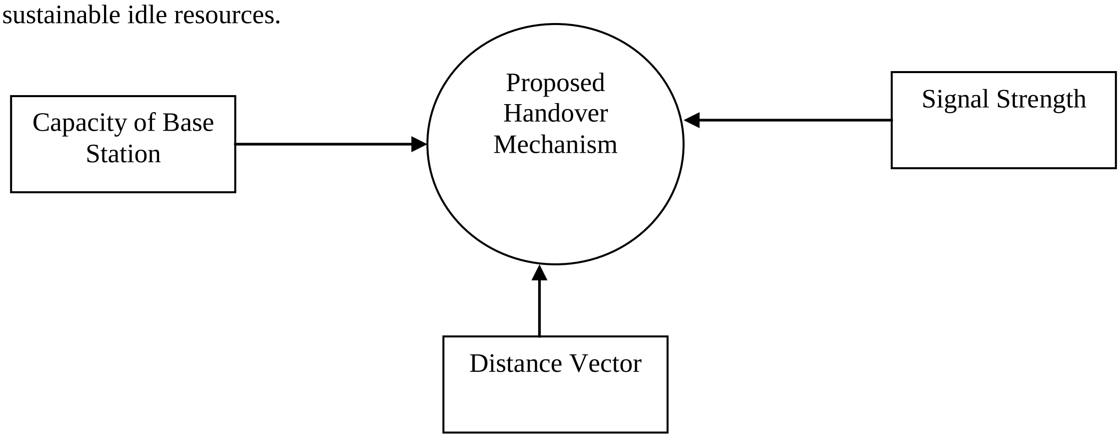

Figure 2.1 : Factors to perform Handover

In our decision algorithm the decision factor for each candidate BS depends on both factors: idle capacity and signal strength. We have combined the two factors into a weighted target cell decision function as shown in figure 2.1.

The vectors that will give the effective handover are shown as [4].

A. BS Maximum Capacity Evaluation

To evaluate the BS capacity we will calculate total number of OFDM (Orthogonal Frequency Division Multiplexing) symbols and number of overhead symbols in WiMAX or Wiifi Network MAC (Medium Access Control) frame. Here we consider Time Division Duplexing (TDD) where every frame is divided into sub frames.

To calculate total number of OFDM symbols transmitted per frame, first we have to calculate OFDM symbol duration which is given as:

TD_{OFDM} = useful symbol time + guard time

TD_{OFDM} = useful symbol time + G * useful symbol time

$$\mathbf{TD_{OFDM} = [1 / (f_s / N_{FTT})] * (1 + G)} \qquad - (1)$$

B. Idle Capacity Advertisement

The BSs periodically broadcast Mobile Neighbor Advertisement control messages. These messages contain both physical layer and MAC address information. By means of such broadcasts, the MS becomes aware of the neighboring BSs. Each BS can also broadcast the idle capacity information of itself and of the neighbor BSs to the connected MSs.

Through statistics a BS is also aware of the current data traffic throughput. Therefore, each BS could obtain the effective idle capacity as:

$$\mathbf{C_i = C_{effective} - C_{throughput}} \qquad -- (2)$$

C. Handover Trigger

In the original HO triggering is based only on Distance Vector. .This scheme is still valid here but works in parallel with additional trigger based on BS idle capacity. This means that the trigger will take place with the probability p when the condition is reached. When the condition is not reached nothing happens. A greater p implies more frequent cell switch. A cell with heavy traffic load will be relieved quickly but congestion in the target cell might be produced due to massive cell switch; whereas a smaller p implies less frequent cell switch therefore less HO cost, but the traffic load will be balanced more slowly.

D. Target Cell Decision

In our decision algorithm the decision factor for each candidate BS depends on both factors: idle capacity and signal strength. We have combined the two factors into a weighted target cell decision function.

III. RESULTS

A. Simulation Environment

- MATLAB Editor is used for writing the code to implement our algorithm.
- The result will be shown in the command window of MATLAB.

You can use MATLAB in a wide range of applications, including signal and image processing, communications, control design, test and measurement, financial modeling and analysis, and computational biology. Add-on toolboxes (collections of special-purpose MATLAB functions, available separately) extend the MATLAB environment to solve particular classes of problems in these application areas.

MATLAB provides a number of features for documenting and sharing your work. You can integrate your MATLAB code with other languages and applications, and distribute your MATLAB algorithms and applications[5].

B. Study of OFDM Networks

Frequency division multiplexing (FDM) is a technology that transmits multiple signals simultaneously over a single transmission path, such as a cable or wireless system. Each signal travels within its own unique frequency range (carrier), which is modulated by the data (text, voice, video, etc.).

Orthogonal FDM's (OFDM) spread spectrum technique distributes the data over a large number of carriers that are spaced apart at precise frequencies. This spacing provides the "orthogonality" in this technique which prevents the demodulators from seeing frequencies other than their own. The benefits of OFDM are high spectral efficiency, resiliency to RF interference, and lower multi-path distortion. This is useful because in a typical terrestrial broadcasting scenario there are multipath-channels (i.e. the transmitted signal arrives at the receiver using various paths of different length). Since multiple versions of the signal interfere with each other (inter symbol interference (ISI)) it becomes very hard to extract the original information.

OFDM is sometimes called multi-carrier or discrete multi-tone modulation. It is the modulation technique used for digital TV in Europe, Japan and Australia[7].

C. Wimax Network Setup

The simulation scenario consists of a test area covered by WiMAX BS, and MSs which are randomly dispersed in the test area with overlapped contiguous areas. The position of each MS is random but there are ten MS served by each BS. The traffic model that each MS requests is a non real time Polling Service (nrtPS) at 50 kbps. Table 1 lists the main parameters of the simulation scenario.

Table 1 : Wimax Scenario

PARAMETER	VALUE
Frequency Band	5 MHz OFDM
Modulation Scheme	1/2 BPSK
No of BS	2
No of MS	10
Simulation duration	20 s
Requested data rate	50 kbps
BS coverage	1000 m
Frame duration	20 ms
MS Speed	20 m/s

The figure is showing the Wimax and WiFi networks with N number of nodes and two base station. To show the concept of heavy load we have taken a multicast communication. The node will move from one network to other and the handoff will be performed.

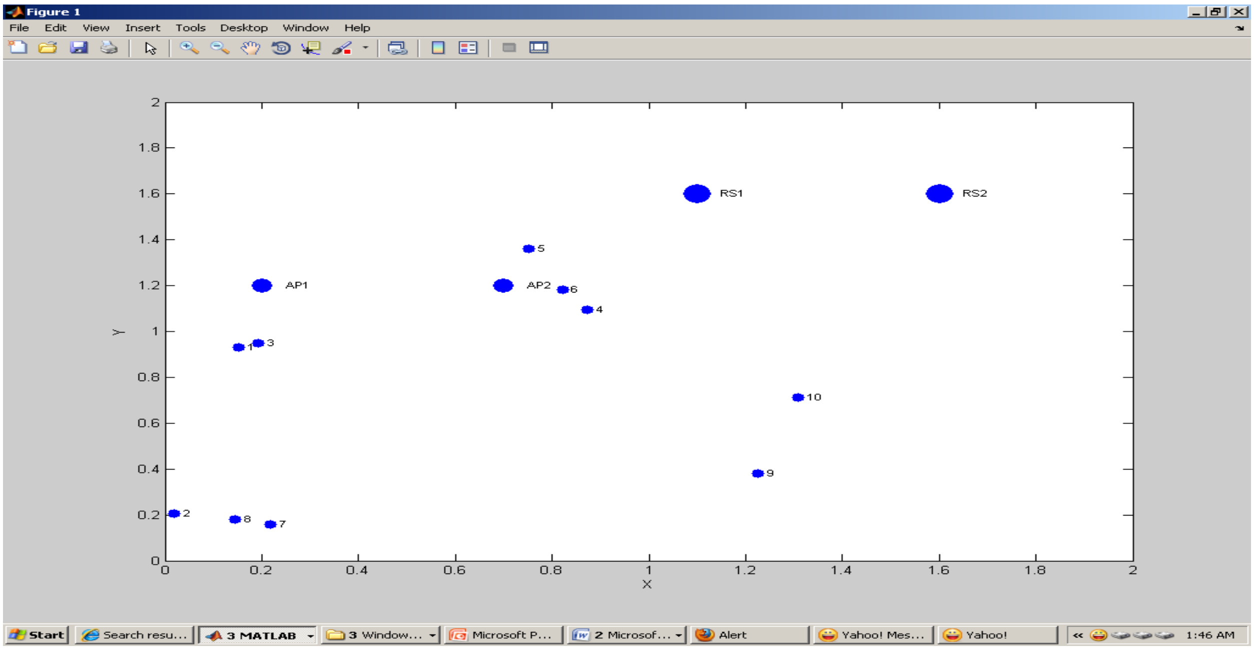

Figure 3.1 : Network Setup

As we can see the hybrid network with n mobile station and 2 base station one for the wifi network and wimax network. The basic parameters considered here for the handoff analysis are Mobile Node Speed and the Distance vector. The results are driven in the form of error and the BER detection for the network

1) Case 1 :

In this particular network the node is moving outside the network at speed 10m/s and the probabilistic vector for the distance is .1. The obtaintained results are given in the form of error value 19 and the BER is 0.0586. The effect of the signals for the wifi and the wimax network is shown in figure 3.2

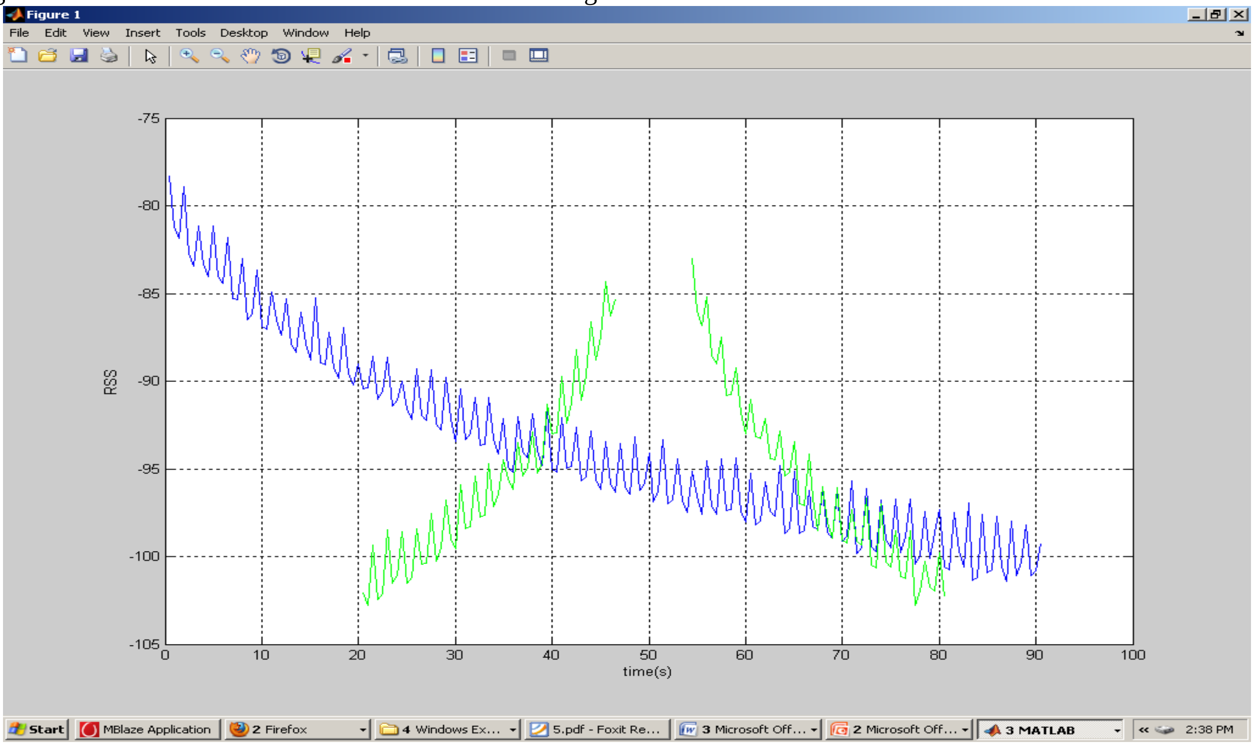

Figure 3.2 : Signal Strength for WiMax and Wifi Network

As we can see in figure 3.2 the signal strength is shown of both the wifi and the wimax networks. Here the green line shows the wifi network that represents the signal strength of local wifi network and blue line shows the WiMax Network.

2) Case 2 :

In this particular network the node is moving outside the network at speed 15m/s and the probabilistic vector for the distance is .2. The obtaintained results are given in the form of error value 25 and the BER is 0.0772. The effect of the signals for the wifi and the wimax network is shown in figure 3.3

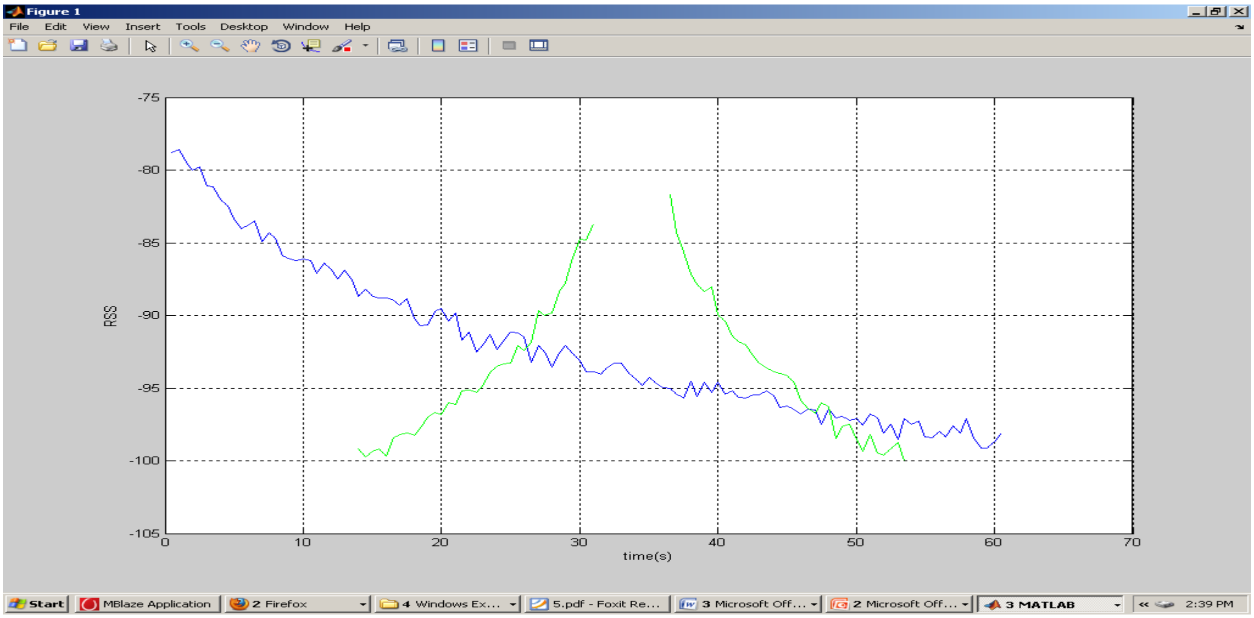

Figure 3.3 : Signal Strength for WiMax and Wifi Network

As we can see in figure 3.3 the signal strength is shown of both the wifi and the wimax networks. Here the green line shows the wifi network that represents the signal strength of local wifi network and blue line shows the WiMax Network. As we can see as the speed increases the signal strength goes low.

3) Case 3 :

In this particular network the node is moving outside the network at speed 20m/s and the probabilistic vector for the distance is .3. The obtaintained results are given in the form of error value 28 and the BER is 0.0864. The effect of the signals for the wifi and the wimax network is shown in figure 3.3. As we can see as the mobile speed increases there are more chances of error occurance

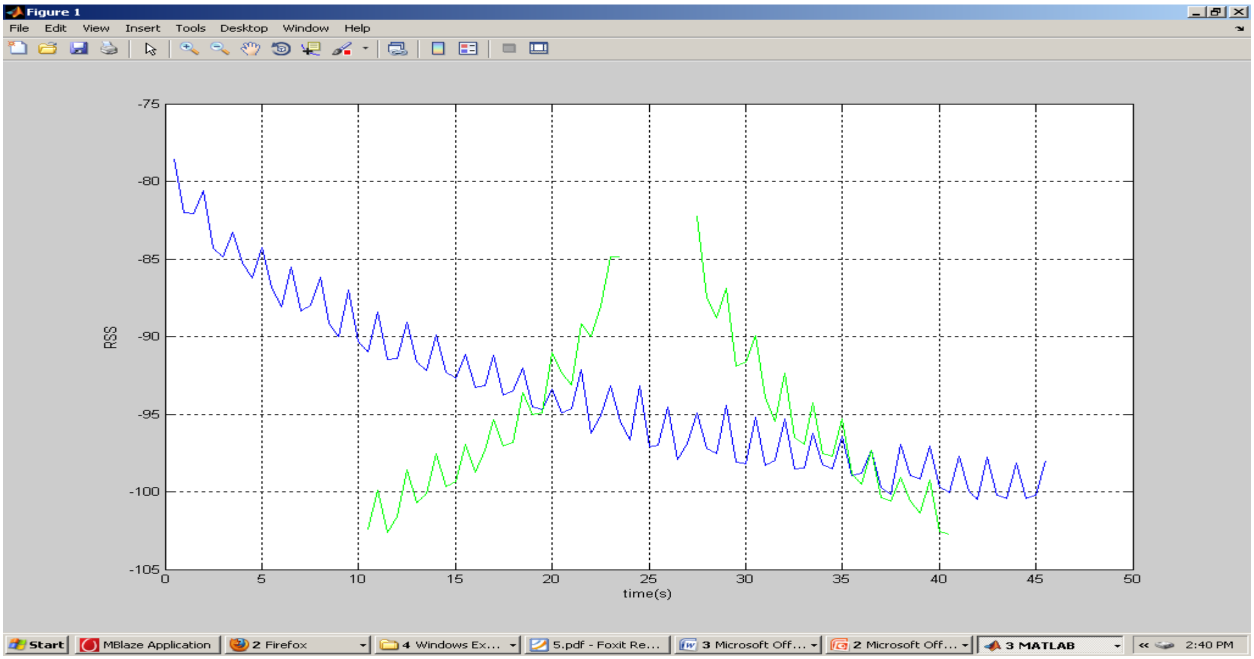

Figure 3.4 : Signal Strength for WiMax and Wifi Network

As we can see in figure 3.4 the signal strength is shown of both the wifi and the wimax networks. Here the green line shows the wifi network that represents the signal strength of local wifi network and blue line shows the WiMax Network. As we can see as the speed increases the signal strength goes low.

4) Case 4 :

In this particular network the node is moving outside the network at speed 25/s and the probabilistic vector for the distance is .4. The obtained results are given in the form of error value 20 and the BER is 0.0617. The effect of the signals for the wifi and the wimax network is shown in figure 3.4. As we can see as the mobile speed increases there are more chances of error occurrence

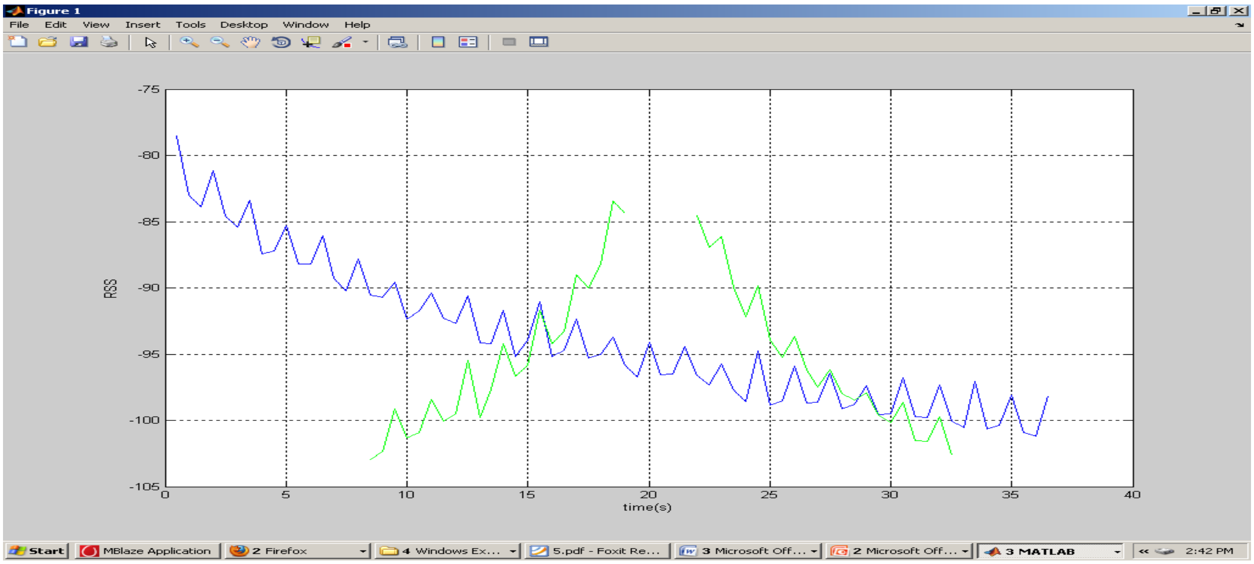

Figure 3.5 : Signal Strength for WiMax and Wifi Network

As we can see in figure 3.5 the signal strength is shown of both the wifi and the wimax networks. Here the green line shows the wifi network that represents the signal strength of local wifi network and blue line shows the WiMax Network. As we can see as the speed increases the signal strength goes low.

5) Case 5 :

In this particular network the node is moving outside the network at speed 30m/s and the probabilistic vector for the distance is .5. The obtained results are given in the form of error value 28 and the BER is 0.0741. The effect of the signals for the wifi and the wimax network is shown in figure 3.6. As we can see as the mobile speed increases there are more chances of error occurrence

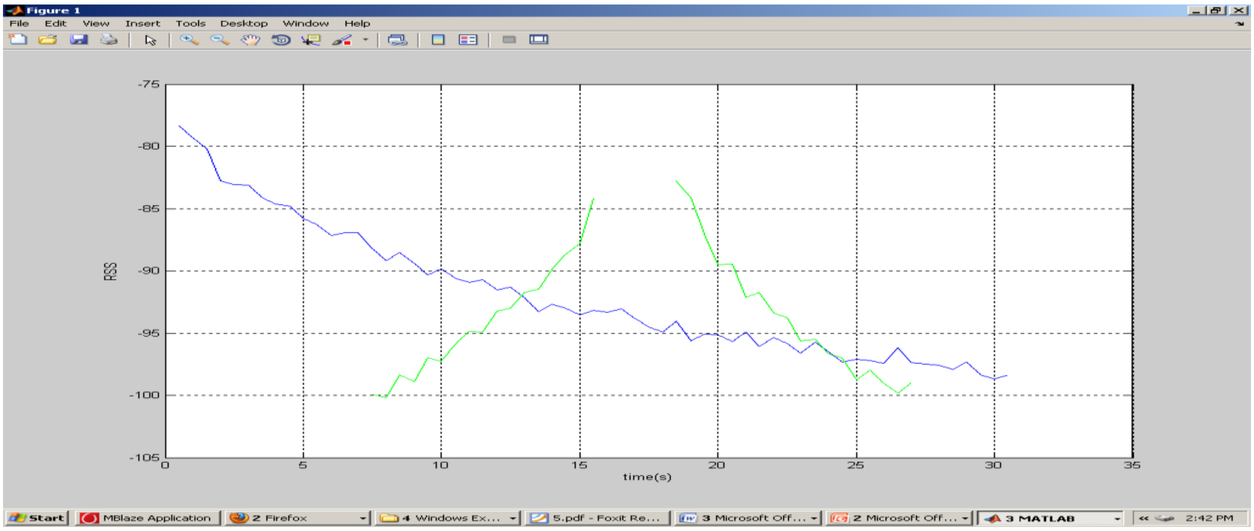

Figure 3.6 : Signal Strength for WiMax and Wifi Network

As we can see in figure 3.6 the signal strength is shown of both the wifi and the wimax networks. Here the green line shows the wifi network that represents the signal strength of local wifi network and blue line shows the WiMax Network. As we can see as the speed increases the signal strength goes low.

6) Case 6 :

In this particular network the node is moving outside the network at speed 35m/s and the probabilistic vector for the distance is .6. The obtained results are given in the form of error value 25 and the BER is 0.0772. The effect of the signals for the wifi and the wimax network is shown in figure 3.7. As we can see as the mobile speed increases there are more chances of error occurrence

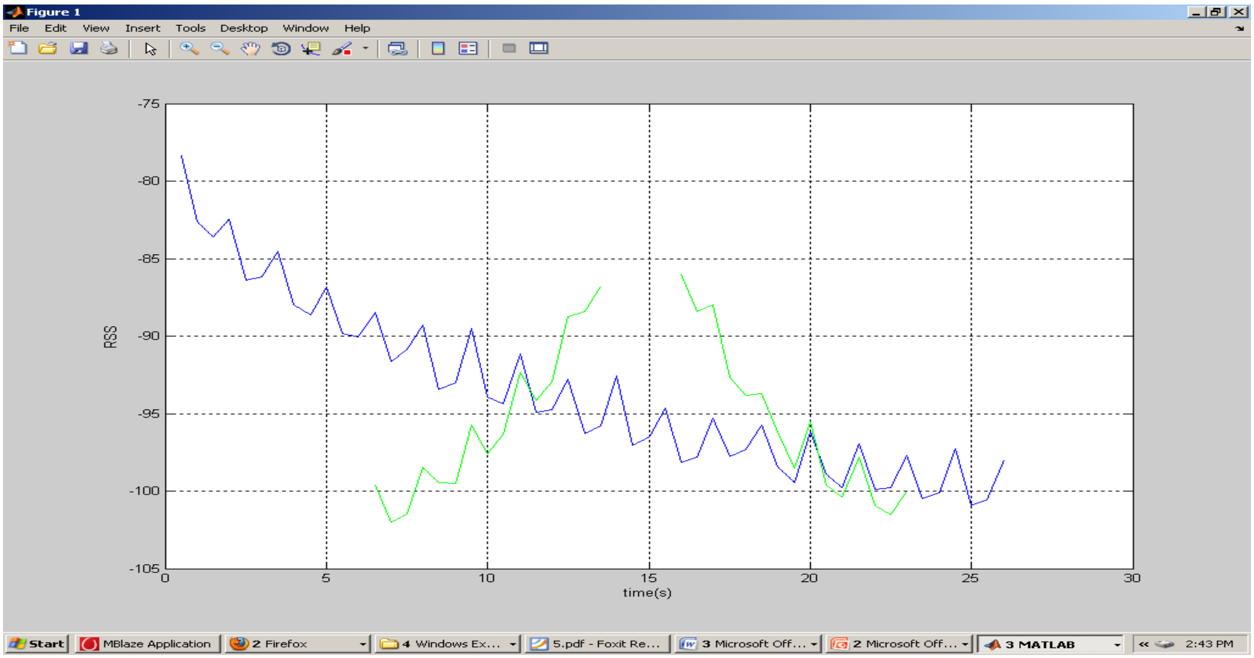

Figure 3.7 : Signal Strength for WiMax and Wifi Network

As we can see in figure 3.7 the signal strength is shown of both the wifi and the wimax networks. Here the green line shows the wifi network that represents the signal strength of local wifi network and blue line shows the WiMax Network. As we can see as the speed increases the signal strength goes low.

D. Result Analysis

We have perform the vertical handoff at different speed of mobile nodes and different distance vectors and derive the results in the form of error and the BER ratio. The analysis is here presented in the form of bar graph.

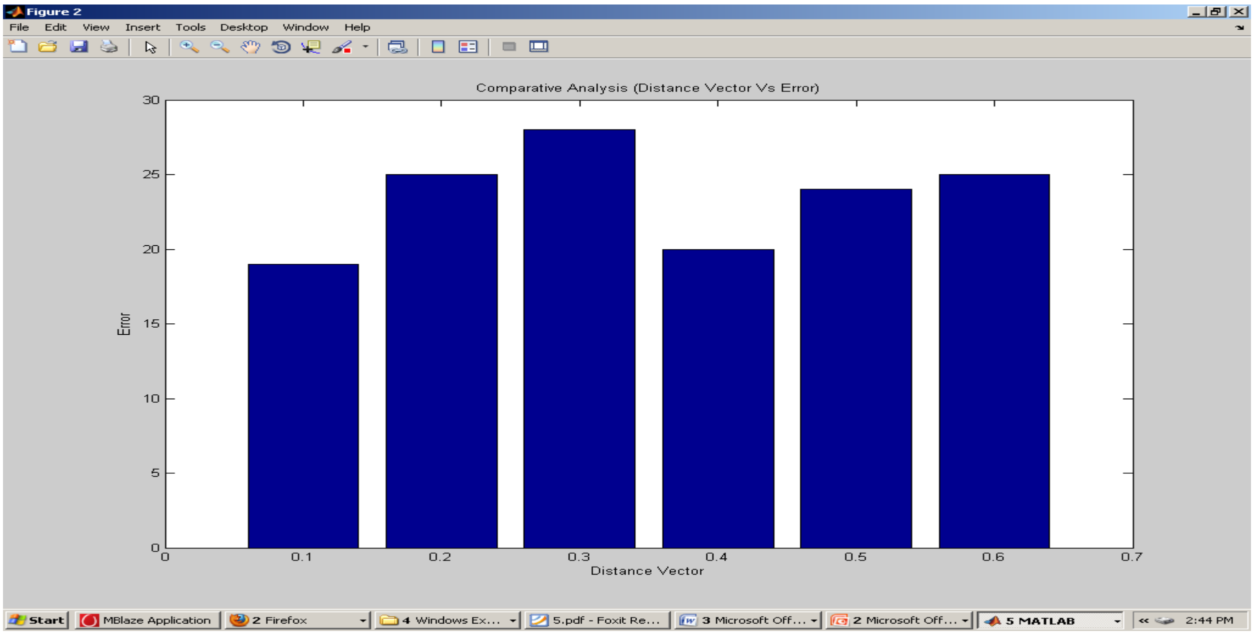

Figure 3.8 : Error Analysis

As we can see in figure 3.8 the result is analyzed at different mobile speed and the distance vectors. Here we can see at the initial stage as the distance vector increases there are more chances of error occurrence. But it is influenced by other factors also such as mobile node speed load etc. Because of this the error rate can be reduced if the slots are free and communication is possible.

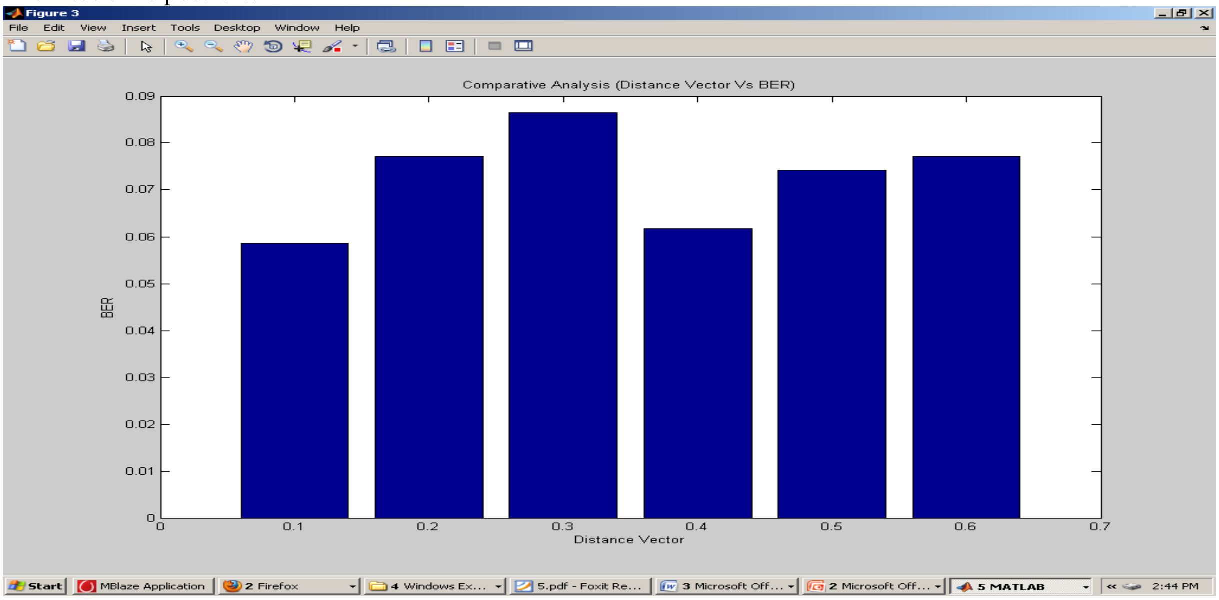

Figure 3.9 : BER Analysis

As we can see in figure 3.9 the result is analyzed at different mobile speed and the distance vectors. Here we can see at the initial stage as the distance vector increases there are more chances of error occurrence. But it is influenced by other factors also such as mobile node speed load etc. Because of this the error rate can be reduced if the slots are free and communication is possible.

IV. CONCLUSIONS

A Hybrid network architecture supports all usage models (fixed, mobile & nomadic). It is also support high capacity real time and non real time voice, data and multimedia services while maintaining the appropriate QoS. Moreover it supports idle mode operation and paging for the mobile station. Its network reference model support interoperability.

By comparing the Proposed Handover Approach and Existing and, we observed that Proposed Handover Approach offers better services than the Existing Approach. Its network can be a good choice to fill up the gap between the Existing.

Here we combine 3 parameters while performing the handover Load on Base Station, Distance and the Transmission Time.

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