Study of Factors Affecting Handoff Process in Wimax Network

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***Abstract*—WiMAX can make high speed wireless broadband internet services available to many larger areas. In Mobile WiMAX applications with speed up to 72 km/h; the handoff should take less than 50ms. In this study; the handoff latency, throughput and end-to-end delay, is measured and the parameters of the simulator are adjusted in order to achieve the best possible handoff times. The results of this study show that the handoff time could be reduced by adjusting link going down factor, scan iteration, scan duration, interleaving interval and timeout parameter. The handoff time is still below the 50 ms limit up to 28 m/s.**

Keywords— WiMax; IEEE 802.16; handoff; mobility.

I. INTRODUCTION

Mobility for communication devices has become increasingly desired by end users together with emerging services such as audio/video streaming. The methods for supporting various degrees of device mobility, e.g. portability, roaming and full mobility, often vary between technologies and define the mobility characteristics of each.

In [1], authors reveal some challenges that mobile users face when travelling across different base stations in a Mobile WiMAX environment and study the handoff latency and throughput performance with respect to different velocities. Moreover, they have studied the affect of link going down factor but they didn't mentioned or go through any other factors that may affect these. Fast base station scanning (FBSS) was applied to Mobile WiMAX environment. The number of handoffs during data transition were studied but without taking into consideration the handoff time. A comparative study based on comparing the quality of service using hard handover and soft handover was presented in [2]. The standard values for both soft and hard handoff were used, and the results show that the throughput is 70% at velocity 110 km/h.

In this paper; farther improvement to the approach used in [2]-[3] is presented. The hard handoff method is used to improve the throughput. Also here the time duration for handoff is considered rather than number of handoffs. The results show that the handoff time is still below 50 ms when the mobile move at speed reaches up to 100 km/h, by improving the link going down factor, scan iteration, scan duration, interleaving interval and timeout parameter.

II. WIMAX HANDOFF SCENARIO

Serving a large number of Mobile Stations (MS) in practice requires an efficient handoff scheme. Currently, mobile WiMAX has a long handoff delay that contributes to the overall end-to-end communication delay. Recent research is focusing on increasing the efficiency of handoff schemes.

For this purpose of experimenting the properties of Mobile WiMAX in practice; the network simulator version 2.34 with additional modules (WiMAX and Mobility) from NIST project is used.[4]

A three base stations (BS) were aligned on a line such that an overlap of the coverage area for each two neighborhood BS's is achieved. For the entire proposed scenario here; the default values of transmission power and operating frequency were given by NS-2 and WiMAX model are remain constant. The data were sent with a constant bit rate of 1.2 Mbit/s. The packet size was 1500 bytes. The selected bit rate is nearly sufficient to provide MPEG-l video stream [5].The test for performance metrics are also done with speeds 1-40 m/s (3.6-144 km/h) and number of MS with 1-100 MS. The assumed traffic is constant bit rate with data rate of 1.2 Mbit/s.

The simulation is based on the Mobility and WiMAX two packages used in the NIST simulator, especially the Neighbor Discovery (ND) and Media Independent handoff (MIH) modules were the simulator key elements used in the simulation code [4].

Here; the mobile stations (MS) are travelling through the coverage areas of three different base stations as shown in Figure 1. The distance between BS's is 15 Km; which has a 8 km radius and one km overlapping between each two neighbourhood base stations.

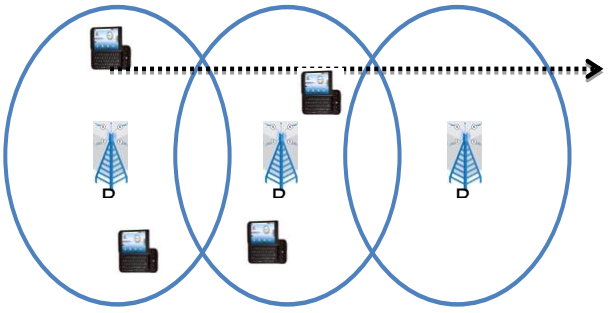

Fig.1. Simulation scenario.

III. PARAMETERS STUDY

In this section the parameters which affect the handoff time are going to be presented.

A. *Link Going Down Factor*

The Link Going Down factor (lgd) determines the sensitivity of detecting a falling link. The factor should be settled such that a link between the mobile and its base station is available. When the received power to the mobile is less than a specified threshold; a trigger is generated to initiate scanning for a new base station [4] [6] - [7].

As stated in the scenario; the mobile moves with the given criteria. For many values of the link going down factor; a minimum handoff time is chosen when lgd_factor is equal to 1.4 as shown in Figure 2.

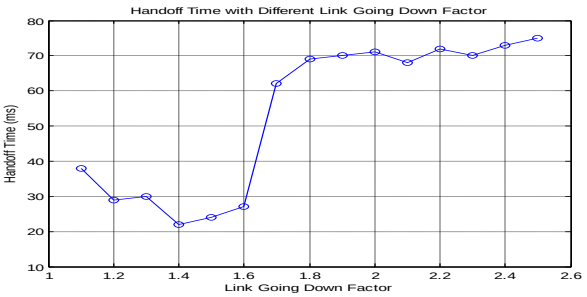

Fig. 2. Handoff time for different link going down factor.

B. *Scan Iteration*

Scan iteration defines the requested number of iterating scanning interval by an MS. This is not the time for MS to complete the scanning process. As shown in Figure 3; as more iteration time provided, the longer handoff duration time is required.

From Figure 3, the minimum handoff time is achieved when two iteration of scanning is choosing. This implies that more iterations give more duration for handoff.

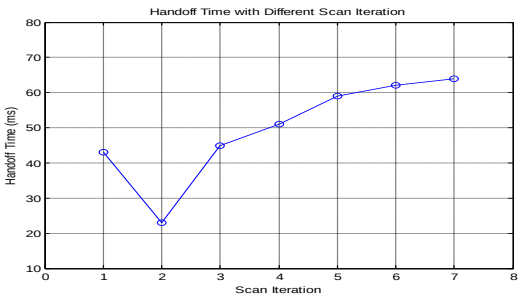

Fig. 3. Handoff time with different scan iteration

C. *Interleaving Interval*

Interleaving interval defines the time duration between the normal operation and scanning periods of the MS in frames.

As shown in Figure 4, if the parameter value is less than or equal to twenty frames it will affect the handoff time with a small variation. However, increasing the value to more than twenty frames causes longer handoff times. The best value we got in simulation is 4 frames.

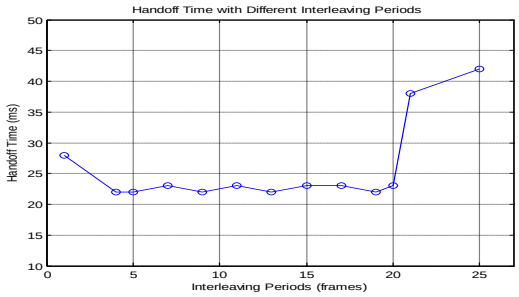

Fig. 4. Handoff time with different interleaving periods

D. *Timeout Parameter*

Defines the time required for MS to find the down link map (DL-MAP) message. The same handoff time is achieved when the parameter value between 5 and 35 ms with optimum value given by 5 ms, as shown in Figure 5.

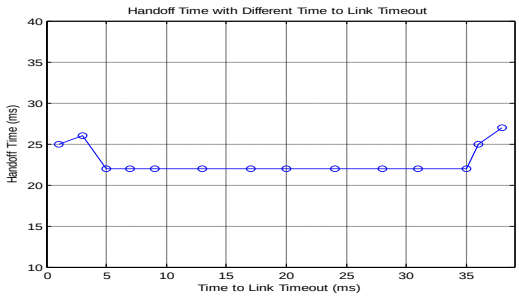

Fig. 5. Handoff time with different time to link timeout

After simulating the parameters in the previous sections and for different velocities in the range of (1-45) m/s, the handoff time is for all the optimum value of parameters is plotted as shown in Figure 6. The optimum values of lgd. Scan iteration, interleaving interval and timeout are 1.4, 2, 4 frames and 5 ms; respectively.

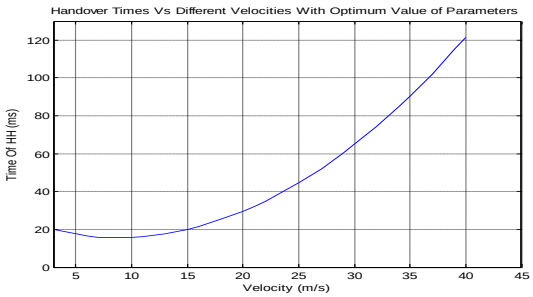

Fig. 6. Handoff time with respect to velocity

IV. PERFORMANCE EVALUATION

In this section; the study of handoff time, throughput and end-to-end delay will be considered for two cases. Firstly; when the velocity is variable and the number of nodes is constant, and secondly when the velocity is constant and the number of nodes is variable.

A. *For Constant Mobile No. and Varied Velocity*

In this section the number of the MS's is set to be 20. For better and optimum result, each experiment is repeated 10

times and the average value adopted. The time of handoff and the velocity relationships is depicted in Figure 7.

The simulation is done with MS speeds between 1 and 40 m/s with 1 m/s step increasing. The handoff time varies in the region around 40 ms and stayed good below the 50 ms limit until the MS reaches the velocity of 28 m/s which is acceptable and complies with WiMAX Forum's specifications.

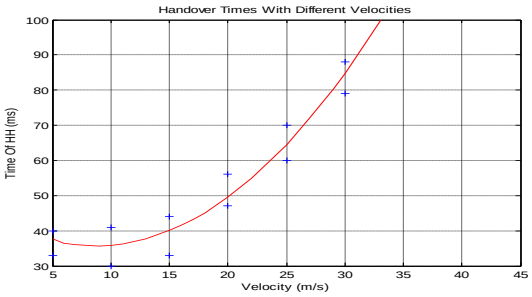

Fig. 7. Time of handoff with different velocities.

The average packet throughput is varying with the velocity of MS's as shown in Figure 8. The average throughput steadily decreases while the velocity is increasing. Throughput remains reliable and good for the velocity up to 30 m/s. When the velocity increases the handoff time increases and the throughput decreases which is compatible with WiMAX Forum's specifications.

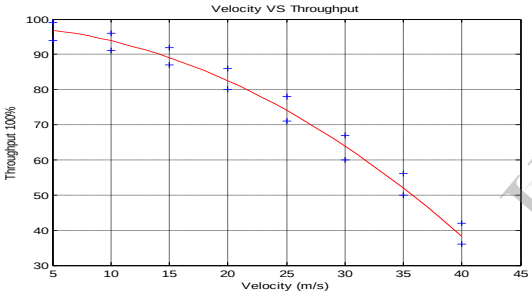

Fig. 8. Throughput with different velocities

Figure 9 shows the average End-to-End delay for variable velocity of MS's. The average End-to-End delay steadily increases while the velocity is increasing. End-to-End delay remains reliable and good when velocity is below 20 m/s (or 72 Km/h). At higher speeds, a steady increase is noticed while the velocity grew up. So we get the best value for mobile speed at the range between 80-110 Km/h. In this range we get the lowest handoff time and the highest throughput and lowest End-to-End delay which is compatible with WiMAX Forum's specifications.

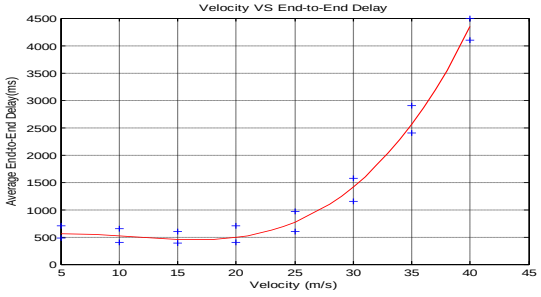

Fig. 9. End-to-end delay with different velocities

B. *For Constant Velocity Varied Mobile No.*

In this section the speed of the MS's is set to constant 10 m/s. The parameters of the simuation is kept constant and the No. of MS's is changed.

The simulation is done with MS density between 1 and 100 mobile with 10 m/s speed. The handoff times varied in the region of 10 ms and stay good below the 50 ms limit until the number of MS's reaches 90 Ms as shown in Figure 10.

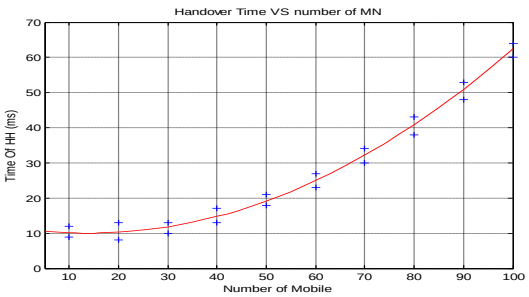

Fig. 10. Handoff times with different number of MS

To justify the result and for the case when the no of MS's is constant (20) and the velocity is varied (10 m/s), the handoff time is 13ms. This result had been compared for the case when the velocity is constant (10 m/s) and the no. of MS's is varied (at 20 MS); the hand off tome is measured to be 11ms. This shows that both scenarios are very close to each other and the obtained results are satisfactory.

Figure 11 shows the average packet throughput is varying with the number of MS's, the average throughput steadily decreases while the MS number is increasing. Throughput remains reliable and good for MS number up to 60 MS. At higher number of MS's, throughput shows also a steady decrease while the number of nodes grows up. The handoff time with 100 MS, is just above 50%. This is acceptable and complies with WiMAX Forum's specifications.

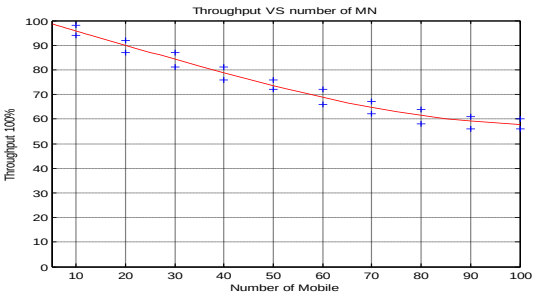

Fig. 11. Throughput with different number of MS

Figure 12 shows the average End-to-End delay varying with the number of MS, simulations show that the average End-to-End delay steadily increases while the MS number increasing. End-to-End delay remains reliable and good for MS number up to 70 MS.

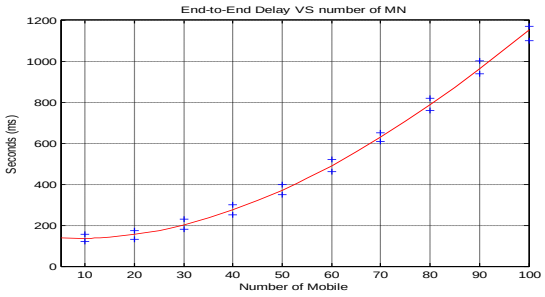

Fig. 12. End-to-end delay with different number of MS's.

V. CONCLUSION

In this paper the factors affecting handoff time in mobile WiMAX networks were studied and given for as specific values. In order to measure the performance of the measured values; a study was done on the handoff latency, throughput, end-to-end delay parameter. The performance was studied in two cases, firstly; when the no. of mobile station is constant and the velocity is variable. Secondly; when the velocity is constant and the no. of MS's is variable. The simulation results shows the lowest handoff time (less than 50 ms) is achieved at velocity of 28 m/s and no of MS's is 90, while the best throughput (over 70%) is achieved at 30 m/s and 60 Ms's. The end-to-end delay time (less than 1 second) is achieved for 20 m/s and 90 MS's.

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