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Optimized and Smooth Handover between Wi-Fi and WiMAX using Link Layer Triggers

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ABSTRACT
Mobile devices are beginning to have multiple wireless interfaces. There is a need for these devices to move freely across different networks and achieve seamless handoff across heterogeneous wireless network. In our simulation we performed handover between Wi-Fi (WLAN) and WiMAX network using link trigger [1] mechanism at Layer2. The trigger generated at Layer2 helps in reducing disconnection during handover latency. Trigger mechanism uses certain signal strength level to generate trigger event. Anticipation of the signal strength level improves packet loss performance for various speed of mobile station. The simulation is done for video traffic with NS- 2 [2] simulator.

General Terms
Wireless heterogeneous handover scenario, simulation & graphical results.

Keywords
Multi interfaces**,** Heterogeneous handover, Link layer trigger, Power Level Coefficient, Layer 2 and Layer3 handover latency, Disconnection Time, WiFi (WLAN), WiMAX.

1. INTRODUCTION
With the emergence of third generation cellular networks 3G, the aim is already set towards the next generation. Future generation will be characterized by variable and high data rates and quality of services and seamless mobility both with in network and between networks of different technologies and service providers. IEEE 802.21[3] task group for Media Independent Handover has already done much work in this direction and discussed how to accommodate multiple interface in the mobile set and how hybrid (vertical and horizontal) handover is possible using these interfaces using different protocols. Handovers from one interface to another typically involve the execution of a combination of layer 2 and layer 3 handovers. These handovers may be lengthy and hence disruptive to the Mobile stations (MSs) communications. This is unacceptable for time sensitive and real time applications, such as voice or video. In this paper, the handover performance of switching between interfaces and its impact on real time applications are investigated. We use the link going down trigger to improve the handover performance. We have evaluated this for ideal path loss model using video stream traffic.

The article is structured as follows. Section 2 explains link layer generation and model for propagation.

Section 3 explains simulation scenario and parameters used by us.

Section 4 presents numerical result of the simulation. The section includes packet loss reduced for different power level coefficient at various speed of MS. As WLAN uses beacons for movement detection of mobile station, we calculated effect of number of beacons needed for detecting the link down on handover latency. We also calculated ratio of movement detection time to handover latency time. Besides this the different disconnection time which results when we increase power level threshold coefficient during handover form WLAN to WiMAX for various speed of MS are calculated. All calculations are done for real time video traffic.
Finally, Section 5 contents concluding remarks.

2. MEDIA INDEPENDENT SMOOTH HANDOVER
As two different interfaces of mobile station are using two different protocols the redirection of flow from one interface to other interface requires involvement of Layer 3 network protocols. Also Layer 3 does not know what is happening at Layer 2, hence, we have to transfer the some information form Layer 2 to Layer 3 at the occurrence of some event there, these information called link layer triggers [4].These triggers helps layer 3 to take decision regarding handover.

Power level Threshold Coefficient is the coefficient which decides, how early handover is performed so that handover occurs before link down from current base station to MS and less packet loss occurs due disconnection during handover latency.

Equation for Power level threshold coefficient [5] is following:

$$P_{\lg d} = \alpha P_{xthresh} \text{ where } \alpha \geq 1 \text{ ---------(1)}$$

Where α is the power level threshold coefficient, Plgd is the power level at which Link trigger is generated to inform Layer 3 that link is going to be down in near future and Pxthresh is the actual power level threshold for receiving signal. Plgd is kept at some higher level than Pxthresh. As speed of MS varies the level of Plgd must vary to avoid packet loss during handover and making handover smoother.

A single line of sight path between Base station and mobile station seldom exists. Hence we used Two Ray Ground reflection model which considers both the direct and a ground reflection path.

The model used for simulation is Two Ray Ground Model [6] and signal strength at distance d can be calculated using formula:

$$P_r(d) = \frac{P_t}{d^4 L} G_t G_r h_t^2 h_r^2 \text{------------(2)}$$

Where h_t and h_r are heights of the transmitting and receiving antenna respectively where P_t is the transmitted signal power. G_t and G_r are the antenna gains of the transmitter and the receiver respectively and L is system loss.

3. SIMULATION SCENARIO

In scenario illustrated in Fig 3 was simulated using the ns-2[1] simulator. The scenario consists of an 802.11 cell, overlapped with a WiMAX cell offering a wider coverage area. Initially the MS will start within the WLAN cell 30 meters away from the WLAN Access Point) AP. It then detects the WiMAX base station and performs the association handshake process. Once this is completed, the Corresponding Node (CN) starts sending a video streaming with packet size of 1240 bytes (including UDP, IP, MAC header) per second The MS begins to move towards WLAN at constant speed while receiving packet from the CN. Handover to the WLAN takes place at 20 meter away from WLAN AP; the MS keeps its Journey on across WLAN cell. Eventually, it reaches a point where the signal level is below Pxthresh and it need to perform a handover to the WIMAX cell again. By using the link Going Down event when the signal level reaches Plgd, assuming sufficient anticipation is provided; the number of packet loss during handover is minimized. The packet loss, disconnection time, and handover latency for layer2 & layer3 are calculated for WLAN to WiMAX handover. For the WiMAX to WLAN handover the handover latency is calculated.

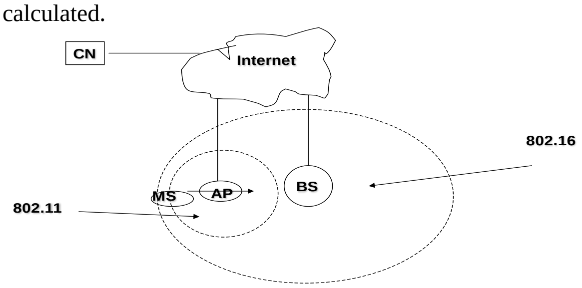

Fig. 1: Simulation Scenario

Table 1: Two ray model specification

Parameter	Value
Transmitter Power (Pt)	0.025W
Wavelength(λ) ,WLAN	0.124m
Receiving Power (Prx) for WLAN AP	6.669 × 10e-9 W
Receiving Power (Prx1) for WiMAX BS	1.26562 ×10e-9W

4. SIMULATION AND RESULTS

4.1 Packet loss

It can be seen by figure 2 that MS with speed of 2m/s or less than 2m/s, can be made to handover without any loss with Plgd less than 2.5 times Prx. For higher speed more significant anticipation is required. As we increase the Power Level Threshold Coefficient, the packet loss deceases for each speed of MS. Higher speed than 2m/s per second have higher packet loss and need more higher value of Plgd to reduce them. More value of Plgd leads to faster handover which reduces the effective area of WLAN.

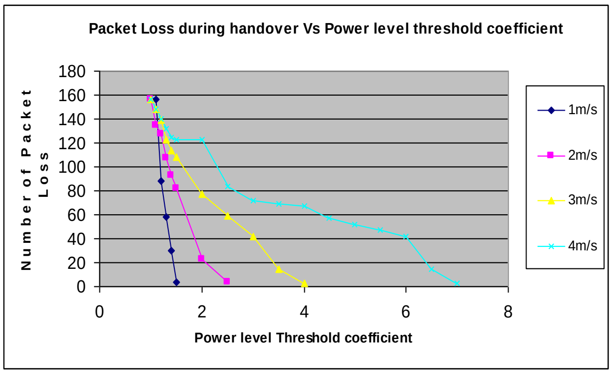

Fig. 2: Packet loss Vs Power level threshold coefficient at various speeds of MS during handover from WLAN to WiMAX.

4.2. Disconnection

The disconnection occurs due to the handover latency when handover from the WLAN to WiMAX. take place. Figure 3 illustrates the disconnections at the various values of Power level threshold at the various speeds of MS. The disconnection is highest for the link down case, Where the Plgd value is equal to the value of Pxthresh or where α equals to 1.Further as the value of α increases disconnection gets decreased. For higher speed of MS, it needs higher values of α to get negligible disconnection.

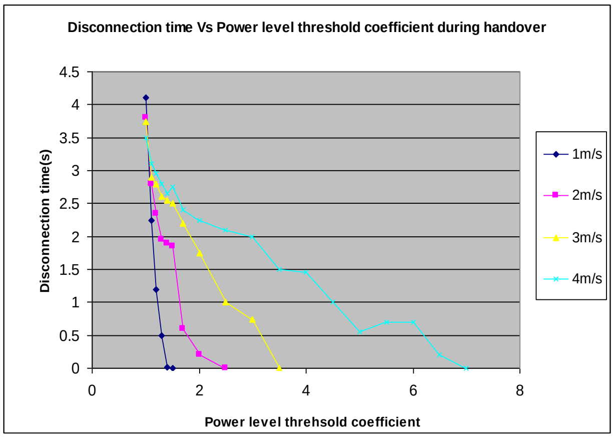

Figure 3: Disconnection Time Vs Power Level Threshold Coefficient during Handover from WLAN to WIMAX.

4.3. Handover latency

4.3.1 *Effect of number consecutive beacons missed by MS before generating link down event on handover latency.*

When MS moves towards leaving the WLAN cell, the MS detects its association with WLAN AP only by receiving the Beacon form the AP. If MS does not receives the beacons in fixed time interval, the MS take takes decision the triggering of Link going down event. Number of beacons the MS missed before generating the Link down event affects the handover latency significantly

Figure 4 illustrates that each additional beacon missed by MS before generating a Link down event increases the handover latency by 100ms.

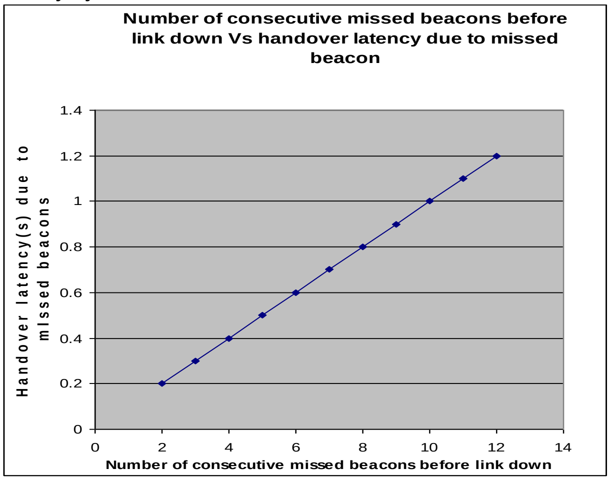

Fig. 4: Impact of the number of consecutive Beacons missed by MS before link going down, on the WLAN to WiMAX handover latency.

4.3.2. *Movement detection efficiency*

Figure 5 shows the movement detection efficiency [7], which varies 5.22% to 25.26% of handover latency as number of beacons missed by MS increases from 5 to 25.

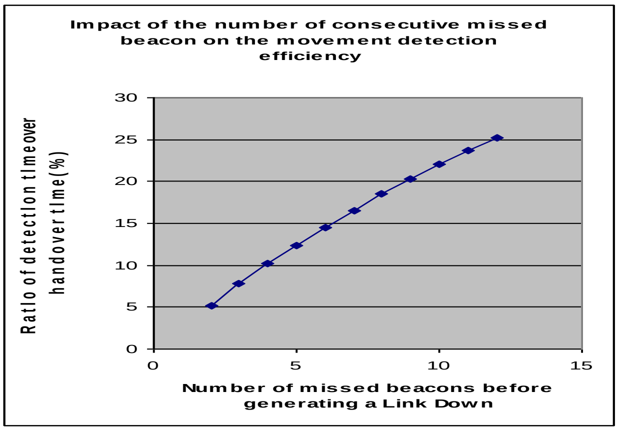

Figure.5: Impact of the consecutive beacon by MS on movement detection efficiency during the WLAN to WiMAX handover latency.

4.3.3. *Layer 2 handover latency*

The factors which affect handover latency during the use of Link Going Down trigger are Layer2 handover latency [8] and Layer 3 handover latency [8]. Layer 2 handover latency includes latency due to channel selection, down link synchronization, Uplink synchronization, initial ranging and registration of MS with base station. Layer3 latency is due request for new prefix, their acknowledgement and redirection of flow from one interface to the interface which is using different protocol.

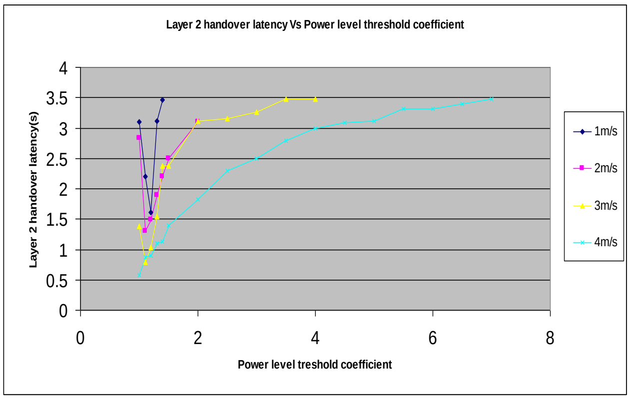

Fig. 6: Handover Latency (s) due to Layer 2 Vs Power Level threshold coefficient (α) during WLAN to WiMAX handover.

Figure 6 shows the Layer 2 handover latency with respect to Power level threshold coefficient (α) Layer 2 handover latency for α=1 is higher than for most of case of α >1 at every speed The reason of this is a number of consecutive missed beacon period and synchronization period .For α greater than 1 the handover latency gradually increases from lowest at α=1.1 value to the highest at value of α for each speed. The reason for this is earlier start of handover due to increase in value of α. As speed of MS increases, the MS comes closer to the WIMAX base station this causes decrease in synchronization period. The decrease in synchronization period leads decrease in Layer 2 handover latency.

4.3.4. *Layer 3 handover latency*

Figure 7 shows Layer3 handover latency Vs power level threshold coefficient (α) at various speed.

The graph shows that Layer 3 latency at value of α=1 quite lower than α =1.1 for every speed, because at α =1, the redirection of flow take little more time compared to Link going down case due to increase in disconnection time.

After α=1.1 the handover latency gradually deceases as α increases, the reason for this decease is that the neighbor discovery modules early starts sending handover sequence by sending and receiving RS and RA respectively, for getting new prefix of new base station. This reduces layer 3 handover latency. At higher speed this decrease is comparatively lesser.

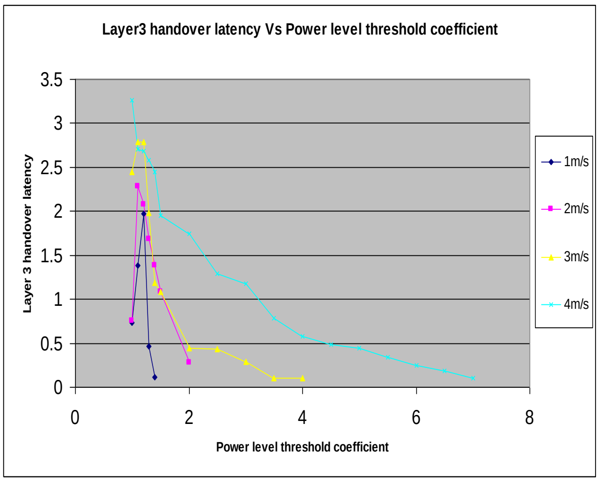

Figure 7: Handover Latency(s) due to Layer 3 Vs Power Level Threshold Coefficient (α) during WLAN to WiMAX handover.

Table 2: Overall Handover Latency

Value of α	Handover Latency (Second)	From-To
α=1, Link Down	3.84	802.11-802.16
α >1, Link Going Down	3.58	802.11-802.16
α =1, Link Down	.39	802.16-802.11

As shown in table2 overall latency is combination of Layer2 and Layer 3 latency. If we improve synchronization period and neighbor discovery time, the overall latency will be lesser.

Table 2 also show latency for 802.16-802.11 handover .As layer 2 latency is only due to beacon detection and association request and association response, it is very lesser than layer2 latency for 802.11- 802.16 handover [9].

5. CONCLUSION

It is concluded from various that as we increases the Power Level Coefficient the packet loss becomes lesser during handover. For higher speed the more value of Power level threshold coefficient is needed to get negligible packet loss and percentage useful area of WLAN reduces. Hence there is a compromise between WLAN coverage area and speed of MS. Besides this it founded that most of time of latency comes from neighbor discovery time and synchronization time. One more point to be noted is that instead of time division of layer 3 and layer2 latency, if overlapping of them is done to some extent by using some technique the handover latency will be reduced significantly.

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7. AUTHORS PROFILE

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