Handover Performance Assessment in Mobility Management Protocols under Video Streaming Network

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Abstract —With the rapid expansion of wireless technologies, the deployment of video streaming services has turned into more popular over the heterogeneous wireless networks in recent years, significantly enhancing the user experience. Generally, the heterogeneous networks are considered vertical handover in which the link capacity is varied significantly because the performance and quality of service of video are affected by the network status. The enriched performance and accessibility of various wireless access technologies are stimulated towards increased utilization mobile users. In such a network it is dominant for transfers to continue seamless connectivity and a satisfactory quality of service for mobile users. Therefore, providing the seamless handover and service quality promises is one of the key matters for video streaming services. The aim of this paper is to present an SINR-based unified procedure of available network and mobility behavior based on the standard of IEEE 802.21 media independent handover, the cooperative Proxy Mobile IPv6 and signal to interference noise ratio to assist lessening of the handover period during the video transmission. This paper also presents both horizontal and vertical handover simulation efforts based on the performance of handover metrics under various existing protocols in terms of packet and frame loss, handover latency, and peak signal noise ratio. Simulation results show that the proposed SINR-based unified procedure performs better quality of service efficiency for both horizontal and vertical handover.

Index Terms—Proxy mobile IPv6, media independent handover, video transmission, handover performance, signal to interference and noise ratio

I. Introduction

With the rapid proliferation of wireless access technologies and advancement in wireless networking presently, it is anticipated that the next-generation wireless networks will be unified as an all-IP based infrastructure with various wireless access technologies which are Wi-Fi, WiMAX, and Universal Mobile Telecommunication Switching (UMTS). The peculiarities of mobile and portable device users today, there is a cumulative demand for accessing Internet-based services from the device anytime, anyplace and continuously be attached to the existing network in order to always be connected to the Internet. However, the provision of services in a continuous manner to the users while they switch between varied Points of Attachment (PoA) to the Internet is a major challenge of the design due to the lack of resources for wireless transmission during handover.

Handover is required when a host switches from one access network to another access network. Handover can be categorized into two different types of the access network which are horizontal handover and vertical handover. As an example in a single-network scenario, when a host shift from one access network to another access network with similar access technology such as WiMAX-to-WiMAX that is referred as horizontal handover. The access network of horizontal handover is also known as a homogeneous network. As an instance in a multi-network scenario, when a host moves away from one access network to another access network with varied access technology which is WiMAX to Wi-Fi that is called vertical handover. The access network of vertical handover is also referred as a heterogeneous network. The host alters the category of connectivity, according to the type of access network. In other words, vertical handover allude automatically drops from one access technology to another access technology so as to maintain communication [1].

The performance of handover affects in two major factors which are the handover latency and packet loss that accordingly suffer the network throughput performance during the period of handover. In order to solve the handover allied matters, numerous researchers have suggested the mobility management protocols. Primarily, the mobility management protocol is functioning at the IP layer. As IP mobility and a handover solution for homogenous in addition to heterogeneous wireless networks, the Proxy Mobile IPv6 (PMIPv6) has been developed and implemented effectively from the concept of network-based mobility management protocol [2], [3]. This network-based mobility management protocol does not require any participation of mobile hosts (MH) in the IP mobility signalling process for setting of mobility. Thus, the load of connecting the mobility stack into MH and signalling overhead on MH has been eradicated [4], [5]. The functionality of PMIPv6 protocol is implemented in the network, therefore, the tracking of MH mobility is the responsibility of this protocol. This protocol has introduced two newly network entities for mobility support of MH which are Local Mobility Anchor (LMA) and Mobility Access Gateway (MAG). In PMIPv6 domain, the LMA includes

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the home agent function and being the topological anchor point for Home Network Prefix (HNP) of the MH used to carry on the MH's reachability state, while the MAG is the component used to execute mobility management for an MH connected to its access link. To identify the movement of MH and to initiate binding registrations to the MH's LMA for updating the route to the home address of MH is the main responsibility of MAG. However, despite the good standing of PMIPv6 to diminish MH's handover and signalling costs, the PMIPv6 still agonizes from some issues in video transmission which are high handover latency and huge packet loss [6].

To overcome the issues of handover in wireless access networks, the Institute of Electrical and Electronic Engineers (IEEE) Standards Association has been publishing the Media Independent Handover (MIH) in the form of IEEE802.21 standardization [7], [8]. This IEEE802.21 standard has been suggested to enable the exchange of components with various access networks and supports handover decision by specifying the set of functional elements to be performed [9]. The MIH is a logical layer placing among layer 2 (L_2) and layer 3 (L_3). However, the MIH defines the simply general framework that the actual implementation of algorithms is left to the researchers to develop their own selection mechanism in order to offer the user the opportunity to conduct an intelligent handover. For this, the pattern has a logical entity called Media Independent Handover Function (MIHF), responsible for managing the mobility and the networking process of change, being positioned between the L_2 and L_3 [10].

This paper proposes a framework of the handover procedure to lessen the handover period based on an SINR-based unified procedure of MIH module and Signal to Interference and Noise Ratio (SINR) [11]. With the assist of MIH to incorporate with wireless access technologies, the proposed framework performs the new network detection, forwards the necessary information to a new network, and the most important handover trigger based on the Quality of Service (QoS) and SINR conversion. The proposed handover procedure is carried out the PMIPv6 protocol to reduce handover performance metrics under video transmission.

The remainder of this paper is organized as follows. The state of the art and existing research efforts on PMIPv6 and IEEE802.21 MIH is presented in Section 2. The proposed SINR-based unified procedure is concisely presented in Section 3. The simulation scenarios and outcomes of the proposed work show in Section 4 and finally concluding of this research follow in Section 5.

II. Related Work

In this section, the existing works are briefly presented in the domain of IEEE802.21 MIH and PMIPv6 protocol. As a study conducted by Ro and Nguyen [12], they have presented inter-domain and intra-domain mobility of the PMIPv6 protocol based on overlapping of MAG. They have showed analytical models and several performance metrics which are handover latency, packet loss, and signaling cost. In paper [13], the researchers have explicated the core desirable features of the PMIPv6 and proposed a method in terms of PMIPv6 drawbacks named Chaining Based PMIPv6 (CBPMIPv6). They have presented three performance metrics in their paper which are handover latency, packet drop and number of extra messages necessary for authentication. However, they have not investigated the video quality performance during the handover process. The researchers of this [14] paper have explored an elucidated review of the handover procedure of PMIPv6 protocols, and suggested mechanisms accompanied by a discussion about their points of weakness. The comparison of efficiency of the existing schemes in terms of handover latency and packet loss is shown in this paper.

The aim of this paper [15] is to enhance the user experience of mobile terminals by allowing handovers between heterogeneous technologies while optimizing session continuity. This paper evaluates the performance using MIH (MIH-WiMAX) by simulating multiple vertical handovers in WiMAX→WiMAX→WiFi under the scope of IEEE 802.21. Based on the QoS parameters, Rahil *et al.* [16] has suggested a network selection scheme to include additional parameters which are MH speed, accessible bandwidth and network type to improve the QoS during selecting a new network for mobile user's application. The results of this paper have shown handover latency, packet loss and throughput in WiMAX→WiFi handover.

Currently, a number of research works are made to assess the performance of IEEE802.21-enabled-PMIPv6 [17], [18]. The researcher in [17] has suggested an alternative IEEE802.21-assisted- PMIPv6 approach for diminishing the signaling cost and latency of handover in heterogeneous wireless networks. The suggested approach can diminish the bandwidth consumption of wireless links and packet loss during the procedure of handover. For the purpose of performance evaluation, researchers have presented IEEE802.21 enabled PMIPv6 protocol and performance evaluation using simulation software in this paper [18]. The simulation results are conducted in handover latency, packet loss, and throughput in different link delays. Gandeva *et al.* [19] have proposed a scheme using MIH for PMIPv6 protocol called MIH with PMIPv6 (PMIPv6-MIH). They have conducted to determine the outcomes of vertical handover on the performance of PMIPv6-MIH and other protocols at Wi-Fi and WiMAX network environment. The parameter metrics are analyzed and showed in packet loss, throughput, and handover latency under FTP, VoIP and Video.

III. Proposed SINR-Based Unified Procedure

The proposed procedure has carried out the MIH module and SINR conversion in PMIPv6 protocol. To minimize the latency, packet and frame loss, and cumulative measured during the handover, the proposed scheme consist of MIH module, neighbor discovery (ND) [20] and SINR procedure for triggering handover, forwarding information before handover, and handover conversion. The Fig. 1 shows the handover flowchart of proposed SINR-based unified procedure in the PMIPv6-MIH-SINR protocol.

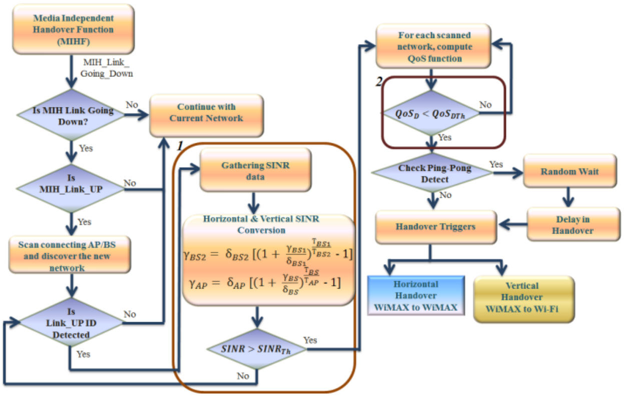


Fig. 1. The handover flowchart of proposed SINR-based unified procedure

The proposed SINR-based unified scheme is performed whenever there is a Link Going Down trigger from MIH. If Link Going Down trigger occurs, it will check handover is required or not. If no handover is required, then continue with the current network. If it is required, MIH Link Up trigger will perform and execute neighbor discovery protocol to discover the n-MAG and forward the essential information for handover. If MIH Link Up trigger will not execute, then stay in current network and waits for the MIH trigger to execute. After performing the MIH trigger, MIH trigger obtains a Link UP ID based on a wireless access network for horizontal or vertical handover.

Let assume that MH is initially attached to the WiMAX Base Station via interface 1 and effort to handover to the Wi-Fi network. Therefore, Uplink id is Wi-Fi and waits for a short period of time to verify that signal strength is increasing or decreasing. Once MH detects new signal from the Wi-Fi network, a Link Detected event is generated by the interface 2 and it is sent to the MIHF. This information is sent by the MIHF to the MIH User.

For the handover selection, the handover metrics are applied to make a handover decision which is Signal to Interference and Noise Ratio (SINR) [21] and Quality of Service (QoS). SINR has defined the power of arriving signal of interest divided by the sum of power of interference the other (interfering) signals in the network and the power of some background noise. It is a measure of signal quality.

To acquire the possible data rate for the given carrier bandwidth and SINR, the Shannon capacity formula is applied. The Shannon capacity equation (1) determines the maximum achievable data rate for a given Signal to Interference and Noise Ratio and carrier bandwidth as:

$$\Delta = T \log_2 (1 + \frac{\gamma}{\delta}) \quad (1)$$

where Δ is the maximum attainable data rate, T denotes the bandwidth of the carrier, γ represents the received SINR at a MH, δ denotes the decibel (db) gap between channel capacity and encoded Quadrature Amplitude Modulation (QAM), minus the gain caused by coding.

The maximum data rate achievable (Δ_{AP} and Δ_{BS}) from WLAN and WiMAX networks respectively for a connected mobile host are easily replicated by the received SINR from the two networks γ_{AP} and γ_{BS} respectively:

$$\Delta_{AP} = T_{AP} \log_2 (1 + \frac{\gamma_{AP}}{\delta_{AP}}) \quad (2)$$

$$\Delta_{BS} = T_{BS} \log_2 (1 + \frac{\gamma_{BS}}{\delta_{BS}}) \quad (3)$$

where δ_{AP} and δ_{BS} are the loss factors of the channel codes for both WLAN and WiMAX networks respectively. By letting $\Delta_{BS1} = \Delta_{BS2}$ and $\Delta_{AP} = \Delta_{BS}$ from equation (2) and (3), has offered users by the two different scenarios (WiMAX → WiMAX and WiMAX → Wi-Fi) networks, then the expected two relationships are established between γ_{AP} and γ_{BS} which is expressed below:

$$\gamma_{BS2} = \delta_{BS2} [(1 + \frac{\gamma_{BS1}}{\delta_{BS1}})^{\frac{T_{BS1}}{T_{BS2}}} - 1] \quad (4)$$

$$\gamma_{AP} = \delta_{AP} [(1 + \frac{\gamma_{BS}}{\delta_{BS}})^{\frac{T_{BS}}{T_{AP}}} - 1] \quad (5)$$

The equations (4) and (5) represent the horizontal and vertical SINR conversion of the handover process. If the SINR of the target network is greater than the predefined threshold value of SINR which is denoted by $SINR_{Th}$ then it compares the available bandwidth of the target network with the threshold bandwidth. This is significant because available bandwidth fluctuates with load on the network. Therefore, it could happen in certain cases on Wi-Fi network due to traffic load that WiMAX may have higher available bandwidth than Wi-Fi. After comparing the value of SINR, the next task will scan the network to compute the QoS values and compare based on the download of QoS (QoS_D) and the threshold value of download of QoS (QoS_{DTh}). The reason for comparison the QoS is that when a MH attaches a jammed access point without considering the exploitation of it, the service degradation may cause owing to delay and possible congestion. If the value of QoS_D is less than of QoS_{DTh} then the ping-pong detection will start and check the ping-pong movement of MH which is the rapid back and forth movement. If no ping-pong movement occurs, handover trigger will initiate and execute the handover to Wi-Fi based on the value of SINR and QoS. If ping-pong movement occurs, MH stays remained randomly until no ping-pong movement happens.

Let's consider that MH switches the network on a new WiMAX station. Therefore, the Uplink id is WiMAX based on the internet access technology and moves to

QoS handover metric for computing and comparing the QoS values. This is essential to compare QoS values in horizontal handover because of quality performance. On the other hand, no need to compare the value of SINR and threshold of bandwidth due to WiMAX provides high signal strength and sufficient bandwidth. After inspecting the QoS, ping-pong detection will occur for checking ping-pong movement of MH. Handover trigger will initiate and execute the horizontal handover if no ping-pong movement occurs.

IV. Simulation Validation

This section conducts the evaluating outcomes of the SINR-based unified procedure with MIH and SINR in PMIPv6 (PMIPv6-MIH-SINR) and other protocols which are PMIPv6-MIH and MIH-WiMAX. The details of the results are obtained during the handover simulation on video transmission in ns-2 [22] and the use of the tool Evalvid [23] to evaluate the video quality. The 802.21 standard called MIH is used to assist in handover decision. The analysis consists of evaluating the efficiency of video quality during horizontal and vertical handover.

The purpose of this study is to evaluate the video performance during horizontal and vertical handover using the evalvid toolkit environment simulated. In order to evaluate the performance of video data on vertical and horizontal handover, simulations are conducted to reach a level of a real network environment and closer to the perception of a real user. The evalvid tool is used for video quality assessment that has its own structure consisting of a set of tools which allows the transmitting, receiving, encoding, decoding and evaluation of quality videos networked simulators.

A. Simulation Setup

The evaluated scenario consists of a WiMAX network and a Wi-Fi network as illustrated in Fig. 2 and Fig. 3. The MH with two interfaces are connected to the WiMAX network and while moves around detects a Wi-Fi network. In scenario 1, the horizontal handover is performed in WiMAX to WiMAX network and scenario 2 shows the vertical handover performed between WiMAX to WiFi network.

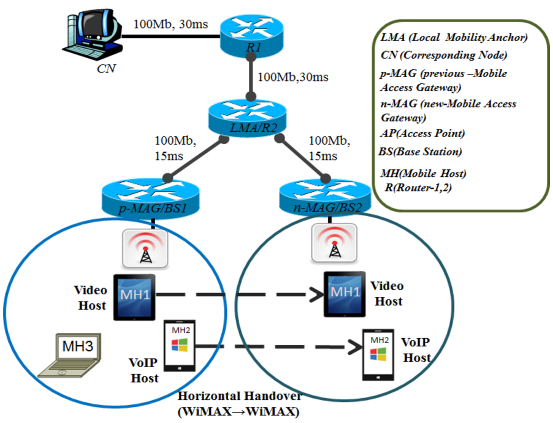


Fig. 2. Simulation scenario setup of horizontal handover

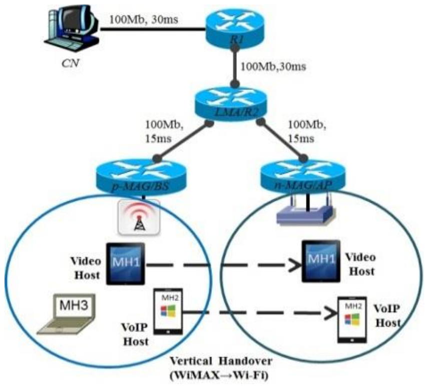


Fig. 3. Simulation scenario setup of vertical handover

The correspondent node (CN) and the router1 are connected by a wired link 100 Mbps. The router1 is connected with LMA/router2 by a wired link 100 Mbps also. LMA/router2 is connected with the p-MAG/BS and n-MAG/BS/AP both with a 100 Mbps link. The Wi-Fi and WiMAX network transmits at 11 Mbps and 75 Mbps. The maximum size of the transmitted video and VoIP packets are 1028 bytes and 32 bytes. The network simulation parameters are defined in Table I for the above simulations.

TABLE I: NETWORK SIMULATION PARAMETER

Networks	Wi-Fi	WiMAX
Transmission Rate	11Mbps	75Mbps
Link delay	15ms	15ms
Distance to cover	100m	1000m
Time for each simulation	130s	130s
Video Traffic Type	MyUDP (CBR)	MyUDP (CBR)
VoIP Traffic Type	UDP	UDP

The MH receiving video traffic competes with other protocol mobile hosts that receive Constant Bit Rate (CBR) traffic. The flow of video traffic is simulated and transmitted from the CN to the MH using MyUDP. The simulation ends 2 minutes 10 seconds and the MH receives video generated by CN for 2 minutes 3 seconds. The video is taken from animated series “Transformers Prime” and converted into yuv format that is used in these simulations. The video has 3726 frames with the Common Intermediate Format (CIF) [24], which has a resolution of 352 x 288 pixels per frame, with 30fps frame rate (frames per second).

B. Simulation Results

The results are obtained from the performance of video transmission during horizontal and vertical handovers under packet and frame metrics in mobility management protocols. The results are represented in graphs, tables and video images of three mobility management protocols during the horizontal and vertical handover. The graphs are denoted into six different colors for two types of handover, which are red, blue, and orange for horizontal handover and gray, purple and green for vertical handover that indicates PMIPv6-MIH-SINR, PMIPv6-MIH and MIH-WiMAX protocols. The handover performances are evaluated in packet and frame metrics which are handover latency, packet loss, frame loss, cumulative measured of video frame, and peak signal noise ratio (PSNR) which is the most common technique is to calculate the PSNR image by image [25].

a) Video packet metrics of horizontal handover

➢ *Handover latency*

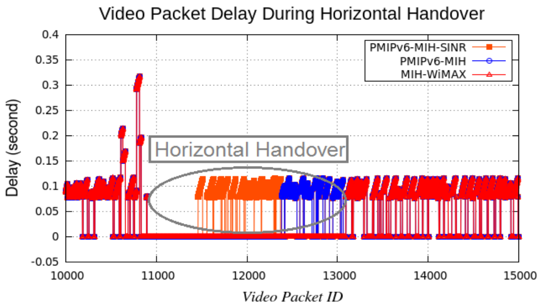


Fig. 4. Packet delay during horizontal handover of mobility management protocols

The above Fig. 4 shows the packet latency during horizontal handover of mobility management protocols. The handover starts in PMIPv6-MIH-SINR, PMIPv6-MIH and MIH-WiMAX on video transmission from video packet ID 10834 and ends handover with the three different video packet IDs which are 11460, 12382, and 13092. The Fig. 4 also depicts the preparation delay of handover going up before MH moves to one BS to another.

➢ *Packet loss*

The below Table II represents the total packet loss during horizontal handover of video transmission over mobility management protocols.

TABLE II: PACKET LOSS DURING HORIZONTAL HANDOVER

Protocols	Total Packet Sent	Total Packet Loss
PMIPv6-MIH-SINR	9819	116
PMIPv6-MIH	9819	171
WiMAX-MIH	9819	294

b) Video frame metrics of horizontal handover

➢ *Handover latency*

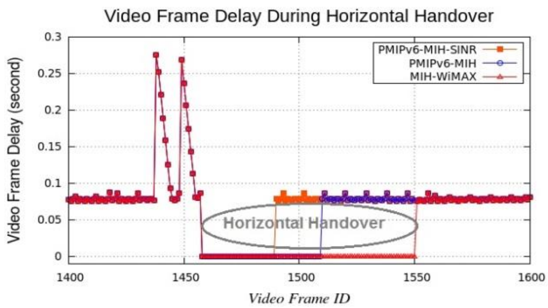


Fig. 5. Frame delay during horizontal handover of mobility management protocols

The Fig. 5 represents the frame latency of mobility management protocols during horizontal handover. The handover initiates on video transmission from video frame ID 1457 and finishes with three different video frame IDs which are 1489, 1509, 1550. The preparation delay of handover increase before the MH handover starts.

➢ *Frame loss*

The below Table III represents the total frame loss during horizontal handover of video transmission over mobility management protocols.

TABLE III: FRAME LOSS DURING HORIZONTAL HANDOVER

Protocols	Total Frame Sent	Total Frame Loss
PMIPv6-MIH-SINR	3727	42
PMIPv6-MIH	3727	61
WiMAX-MIH	3727	103

➢ *Video quality measurement*

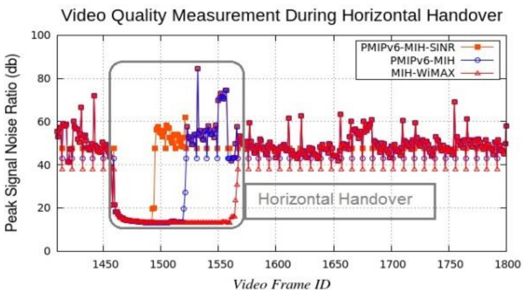


Fig. 6. PSNR during horizontal handover of mobility management protocols

The Fig. 6 limns the video quality measurement which is peak signal noise ratio (PSNR) during horizontal handover of mobility management protocols. The PSNR of a video is calculated by comparing a single frame of sending and receiving video. The value of PSNR is expressed in dB (decibel). The majority values of PSNR are above 40 dB, while during the handover of mobility management protocols suffers from lower PSNR values which mean video images are degraded during the handover period. In Fig. 6, handover begins from video frame ID 1460 and ends from three altered video frame IDs 1494, 1514, 1555.

c) Video packet metrics of vertical handover

➢ *Handover Latency*

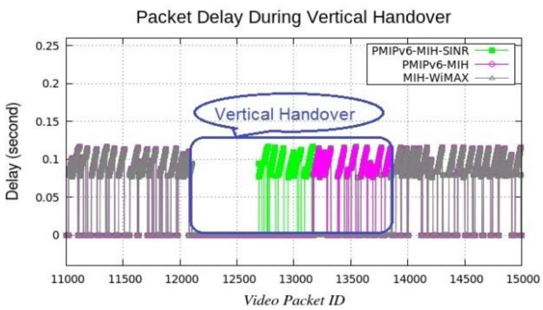


Fig. 7. Packet delay during vertical handover of mobility management protocols

The above Fig. 7 depicts the packet delay during vertical handover of mobility management protocols. The handover initiates on video transmission from video packet ID 12104 and ends with three different video packet IDs which are 12691, 13174 and 13849 for three mobility management protocols.

➢ *Packet loss*

The Table IV represents the total packet loss during vertical handover of video transmission over mobility management protocols. The packet loss is proportionate to the SINR; the higher SINR, the more packet loss can be caused.

TABLE IV: PACKET LOSS DURING VERTICAL HANDOVER

Protocols	Total Packet Sent	Total Packet Loss
PMIPv6-MIH-SINR	9819	266
PMIPv6-MIH	9819	428
WiMAX-MIH	9819	620

d) Video frame metrics of vertical handover

➢ *Handover latency*

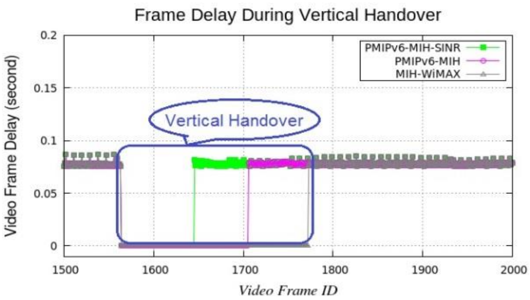


Fig. 8. Frame delay during vertical handover of mobility management protocols

The Fig. 8 depicts the frame delay during vertical handover of mobility management protocols. The handover starts in PMIPv6-MIH-SINR, PMIPv6-MIH and MIH-WiMAX on video transmission from video packet ID 1564. The Fig. 9 also defines the three different video packet IDs for concluding handover which are 1646, 1706, and 1773.

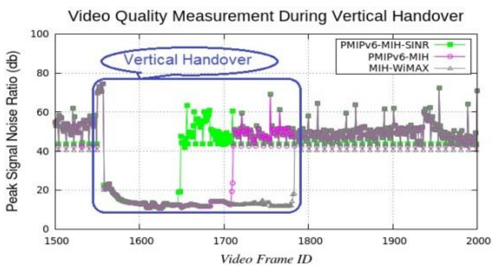


Fig. 9. PSNR during vertical handover of mobility management protocols

➢ *Video cumulative measured*

The Fig. 10 depicts the cumulative measured at the receiver of video quality during vertical handover of mobility management protocols. In this Figure, vertical handover is highlighted when an MH moves from one access technology to another. The degradation video images during vertical handover is indicated on the square shape. The handover starts from video frame ID 1558 and finishes from three altered video frame IDs 1648, 1710, and 1783.

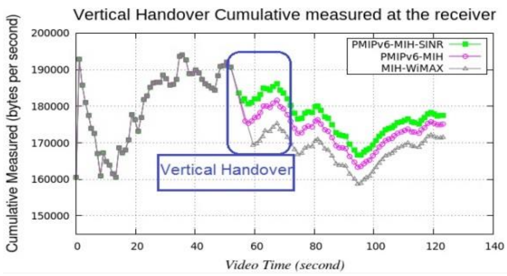


Fig. 10. Cumulative video quality during vertical handover of mobility management protocols

➢ *Video quality measurement*

The Fig. 9 limns the peak signal noise ratio (PSNR) of video quality measurement during vertical handover of mobility management protocols. PSNR is the most popular metrics for video quality measurement which compares the original video with video sequence that is received across the network. The degradation video images during vertical handover are indicated on the rectangular shape. The handover starts from video frame ID 1558 and finishes from three altered video frame IDs 1648, 1710, and 1783.

➢ *Frame loss*

TABLE V: FRAME LOSS DURING VERTICAL HANDOVER

Protocols	Total Frame Sent	Total Frame Loss
PMIPv6-MIH-SINR	3727	81
PMIPv6-MIH	3727	151
WiMAX-MIH	3727	217

The Table V represents the total frame loss during vertical handover of video transmission over mobility management protocols.

The outcomes are shown in horizontal and vertical handover under packet, and frame metrics on video transmission. The handover performances are measured in several factors under both packet and frame performance which are handover latency of packet/frame, packet/frame loss, cumulative measured at the receiver, and PSNR.

As shown in Fig. 4-Fig. 6 and Table II and Table III, it is observed that the horizontal handover on video transmission of PMIPv6-MIH and MIH-WiMAX are lower performance than the proposed SINR-based unified procedure PMIPv6-MIH-SINR based on the handover metrics of both packet and frame due to on the fly packet loss on network, access and verify necessary information from Media Independent Information Service (MIIS) which takes longer time during handover, cannot forward essential information to new MAG (n-MAG) before handover. MIIS contains all the necessary information on the server and provides this information when n-MAG sends a request message to MIIS. Thus, it takes a time to process and verify the information for MH attachment and forwarding the packet from CN. Since the proposed SINR-based unified procedure of PMIPv6-MIH-SINR has all the necessary required information from ND message, it will establish an earlier connection with the n-

MAG before the actual handover takes place. Using ND message, it establishes the earlier connection without having to wait for the address resolution process with the n-MAG. This would save the time pass for the address acquirement and resolution for the connection establishment. The time required to get MH information from MIIS can be omitted since p-MAG sends all information through the ND message to the n-MAG before MH's actual attachment.

During the handover process, high numbers of packets are being transmitted to the previous address because no notification is sent to LMA for forwarding packet to a new address. The packet will forward by LMA to the new address when the handover is accomplished. This cause takes a long time to process and loss many packets. To overcome this problem, the proposed SINR-based unified procedure PMIPv6-MIH-SINR sends a notification message which includes a new network address of the forwarding packet to LMA before the handover and expected to reduce packet and frame handover latency, packet and frame loss and PSNR since the connection to the n-MAG is established before the MH reached. The n-MAG acquires all essential information of MH by receiving an ND message from previous MAG. Therefore, there would be no disruption in n-MAG during the handover condition of MH where LMA can continue to communicate with the MH as usual.

The performance metrics of vertical handover are shown in Fig. 7-Fig. 10. From Fig. 7-Fig. 10 and tables IV and V, the proposed SINR-based unified procedure of PMIPv6-MIH-SINR protocol outperforms the existing PMIPv6-MIH, MIH-WiMAX protocols in terms of handover performance metrics under frame and packet in vertical handover.

TABLE VI: VIDEO TRANSMISSION OVER MOBILITY MANAGEMENT PROTOCOLS DURING HORIZONTAL HANDOVER

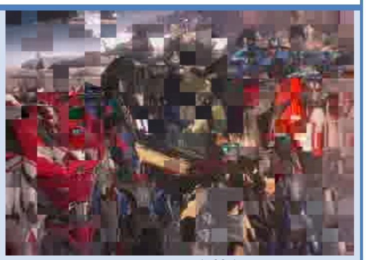
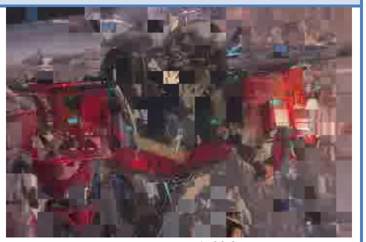
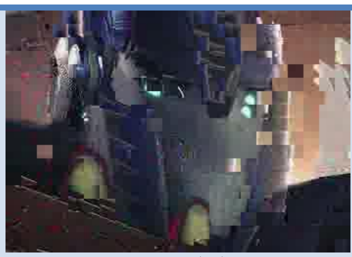
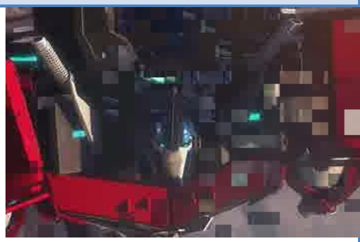
Protocols	PMIPv6-MIH- SINR	PMIPv6-MIH	MIH-WiMAX
Video Images has received at n-MAG during the Horizontal Handover	 Frame→1494	 Frame→1521	 Frame→1691
	 Frame→1495	 Frame→1522	 Frame→1692

TABLE VII: VIDEO TRANSMISSION OVER MOBILITY MANAGEMENT PROTOCOLS DURING VERTICAL HANDOVER

Protocols	PMIPv6-MIH-SINR	PMIPv6-MIH	MIH-WiMAX
Video Images has received at n-MAG during the Vertical Handover	 Frame→1652	 Frame→1715	 Frame→1788
	 Frame→1653	 Frame→1716	 Frame→1789

During the vertical handover on video transmission, the existing protocols have also diminished the video performance on both packet and frame metrics due to facts of same reasons of horizontal handover and also does not make decisions depending on the necessary information and no information about the video traffic during handover. Therefore, when an MH switches in a new network, n-MAG has no knowledge about the traffic and it requires lengthy time to acquire the recognized of data traffic.

In below, Table VI and Table VII present the video quality images during the period of both horizontal and vertical handover. From these two tables, video qualities are measured and evaluated among existing protocols and proposed protocol.

V. Conclusions

This paper has proposed a handover SINR-based unified scheme to diminish the period of handover during video transmission over the homogeneous and heterogeneous wireless networks. The proposed SINR-based unified procedure of PMIPv6-MIH-SINR protocol has lessened the handover latency, packet loss, and PSNR other than the existing protocols of PMIPv6-MIH and MIH-WiMAX. With the assist of SINR conversion and MIH module, the proposed SINR-based unified scheme forwards the essential information to the new network before the handover and performs handover trigger depending on the information. Through the performance evaluation, it is shown that the proposed SINR-based unified procedure protocol has better the experienced quality of video streaming during the handover. In future work, the proposed SINR-based unified procedure protocol will enhance based on the movement speed of MH and high network utilization.

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