VOL. 10, NO. 9, MAY 2015 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

A NOVEL COHESIVE AND SERVICE DRIVEN METHODOLOGY FOR AUGMENTING THE VERTICAL HANDOVER PERFORMANCE IN HETEROGENEOUS WIRELESS NETWORKS

A. Prithiviraj[1], K. Krishnamoorthy[2] and M.Usha[1]
[1]Sona College of Technology, Salem, India
[2]Sudharsan College of Engineering, Pudhukottai, India
E-Mail: prithivipranav@gmail.com

ABSTRACT

Due to the mounting requirement for anytime, anywhere network services, we need to integrate diverse kinds of wireless networks. For assisting this integration, the mobile users should be allowed to freely move across networks (Atiq, *et al.,* 2010). The chances of delay in packet transmission, jitter and out of order arrival of packets are predominant when the mobile node gets detached with its home network. This could possibly become a problem when vertical handover needs to be addressed. Proxy Mobile IPv6 (PMIPv6) is a network based mobility management protocol which facilitates the removal of overhead on the mobile node (Hyon-Young*, et al.,* 2011). In order to achieve seamless handover we have proposed a new algorithm which helps to overcome the challenges and issues that can occur during vertical handover. In this paper we have introduced multiple attribute decision making approach for selecting the next access network when the mobile node moves away from its home network (Mohamed Lahby, *et al*., 2011, Thanachai, *et al*., 2010). Media independent localized routing is the strategy for accomplishing vertical handover. The proposed algorithm greatly reduces the packet loss and other mobility oriented issues when compared with the prevailing algorithms.

Keywords: wireless networks, proxy mobile IPv6, mobility management, vertical handover, media independent localized routing.

INTRODUCTION

The evolution of wireless technologies has led to different groups of wireless cellular systems which can be referred as NGN (Next Generation Networks), e.g., 2G, 2.5G, 3G, etc. (Atiq, *et al.,* 2010). The fourth generation wireless network will be of heterogeneous environment consisting of different access networks that may overlap each other. Media Independent Handover (MIH) remains as a promising solution for the continued service when the mobile node switches between networks (Igor Kim, *et al.,* 2011, IEEE Standard 802.21, 2009). Currently, a mobile user is able to communicate through various wireless networking architectures and to ramble within these architectures. For continuous mobility in a heterogeneous wireless network environment, the handover decision process plays a vital role. The amount of complexity of a decision process is dependent on the number of parameters that need to be examined before a decision is completed. Thus, it is very important to develop intelligent and efficient techniques in order to provide the service continuity and seamless mobility to bring this vision of the future. Handover between different technologies (vertical handover) should be performed with the minimum possible packet loss and latency. It is further apposite that the vertical handover decision is made on the multi-parameter basis (Thanachai, *et al*., 2010). The handover decision is based on three stages, namely network discovery, handover initiation, network selection. Network based mobility management still suffers from several aspects, such as high handover latency, data traffic loss, signalling overhead, power consumption. The buffering of data and the delay in delivery of data packets may slow down the performance of seamless handover.

The idea is to provide seamless mobility to the IP devices such as mobile node without their involvement. Although several fast handover schemes based on PMIPv6 have already been introduced to reduce the handover latency and packet loss, these schemes still experience some packet loss and packet ordering problem during a handover (Igor Kim, *et al.,* 2011). Several problems that can happen in a heterogeneous environment are a single point of failure, triangular routing problem and a false handover initiation that becomes an overhead for the decision making. For achieving better performance, we have proposed an algorithm that will take many parameters for calculating the next optimal network to which the mobile node can switch over. The suggested techniques are using different metrics and heuristics for solving the above mentioned problems. We have a centralized router called Service providing Access Point (SPAP) which provides media independent event, command and information services. It is also responsible for smart buffering and the calculation of reward function.
Section 2 deals with the explanation of vertical handover in heterogeneous networks, whereas Section 3 explains the background and related work. Section 4 describes the proposed architecture followed by the technical specifications of our proposed algorithm. Section 5 shows the simulation results and the performance analysis of the proposed algorithm with the existing algorithm. The conclusion of the proposed work is described in Section 6.

Vertical handover in heterogeneous networks

The practice that signposts that a connection between a terminal and a network moves from one source to another are called as handover (Alessandro, *et al.,* 2010). In an environment where a vertical handover is employed, the mobile users are free to travel between different access networks. Depending upon the factors such as bandwidth, received signal strength, cost, network coverage the preferred network is picked (Atiq, *et al.,* 2010). When it comes to vertical handover, the handover decision is the decisive mechanism that benefits us to choose a better network for warranting the continued service. The issues of assisting inter-technology (vertical) handover in PMIPv6 mean that the MN should not be involved in performing the handover. Our work is motivated from various approaches that are intended to progress the network selection process in the occasion of vertical handover verdict.

BACKGROUND AND RELATED WORK

IEEE 802.21 assisted PMIPv6

IEEE 802.21 assisted PMIPv6 mechanism by Pyung Soo Kim (Pyung Soo Kim, *et al.,* 2013) reduces the handover delay and signalling cost in heterogeneous wireless networks, the essential objective of PMIPv6 is involved, which does not require the involvement of Mobile Node (MN) in Media Independent Handover (MIH) functionality. This objective further supports fast vertical handover for the mobile node. The handover is performed by the base station with MIH functionality rather than the Mobile Node (MN). The Mobile nodes (MN) power consumption is reduced due to limited resource and battery power. A unified interface which provides services to the upper layers and augmenting user's experience of mobile devices by enhancing handover is the purpose of MIH function. Thus the services offered by MIH function provides upper layers in maintaining service continuity, service adaptation to varying quality of service, link selection, battery life conservation and network discovery. This mechanism requires a new entity named MIH, which is capable of wireless base station (MIH-BS), which maintains MIH related signalling on behalf of the MN that is attached to its L2.

There are five operation procedures during the MN handover and they are explained below:

Acquirement of information on adjacent networks

1) The MN decides the L2 handover, when the signal strength of the serving MIH-BS becomes weak that is sensed by the MN in the serving network. The handover trigger which is produced by the MN'S L2 is sent to the serving MIH-BS.
2) The serving access router consists of a serving Point of Service (PoS), which receives a MIH_Link_Going_Down indication sent by the serving MIH-BS.
3) The MIIS (Media Independent Information Service) Server retrieves the information about available adjacent networks to which the MN committed may handover when queried by the serving PoS.
4) The exchanging of MIH_Get_Information_Request and MIH_Get_Information_Response messages further allows the retrieval of information.

Determination of handover target

1) A network-initiated handover message is triggered by the serving MIH-BS which also sends MIH_Net_HO_Candidate_Query_Request message to the serving PoS.
2) In candidate networks the Resource availability query is done to provide QoS by sending MIH_N2N_HO_Query_Resource_Request message from the serving PoS to different candidate PoS.
3) As a response, the serving PoS receives a MIH_N2N_HO_Query_Resource_Response message from the candidate PoS.
4) By receiving the MIH_N2N_HO_Query_Resource_Response message, the serving PoS can able to know the resource availability information about candidate networks. Then it identifies the target network and the new MAG (NMAG) for the handover.
5) To announce the determination of the target network, the serving PoS sends the MIH_Net_HO_Candidate_Query_Response message to the serving MIH-BS.

Handover preparation

1) The requests to handover commitment is done by the serving MIH-BS which sends a MIH_Net_HO_Commit_Request message to the serving PoS which resides in the serving network.
2) The serving PoS informs the target PoS regarding the MN's movement to other network and its connection to NMAG through the MIH_N2N_HO_Commit_Request message.
3) The serving PoS receives a MIH_N2N_HO_Commit_Response as a reply from the target PoS as a result of the handover commitment.
4) To notify the result of the handover commitment, the serving MIH-BS receives a MIH_Net_HO_Commit_Response message from the serving PoS.
5) When NMAG in the target network receives the MIH_N2N_HO_Commit_Request message, the MN's profile information is routed to a policy store named AAA server.
6) The profile information for PMIPv6 processes is obtained by NMAG corresponding to the MN.

Handover execution

1) The MN's attachment to target network i.e. target MIH-BS is noticed by nMAG through L2 connection with them, after which an Router Advertisement (RA) message sent to MN by nMAG

ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

2) The RA message is tagged with MN's profile information. Every message is solicited by the Router Solicitation (RS) message from the MN.
3) On retrieval of RA message, IP addresses are configured on their interfaces that are currently used to connect to NMAG.
4) The Proxy Binding Update (PBU) message is sent from NMAG in target network to LMA when it registers the current MN's location.
5) In response to the Proxy Binding Update (PBU) message, LMA sends a Proxy Binding Acknowledgement (PBA) message to update the lifetime of MN's entry in the binding cache table and by the creation of a tunnel between the LMA and NMAG the buffered data are transmitted.
6) The retrieval of packets are from both NMAG and LMA further leading to the completion of PMIPv6 procedures.

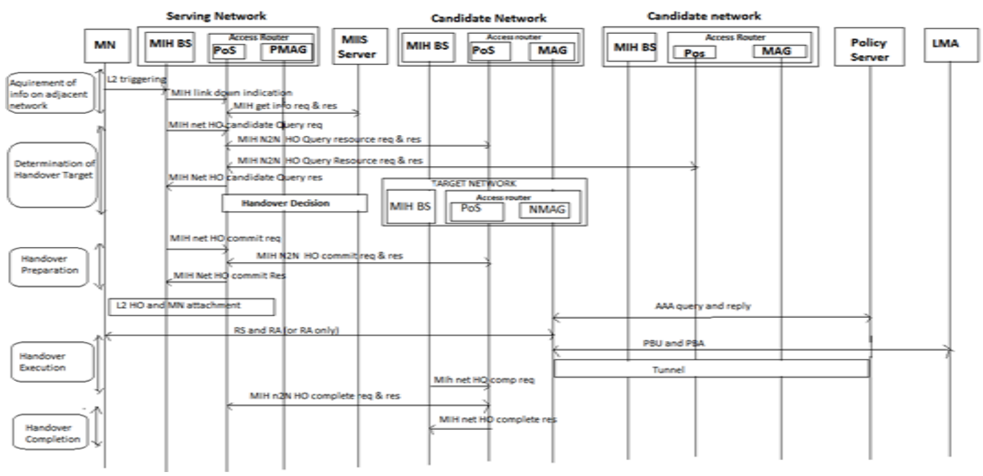

Figure-1. Message signaling flow of IEEE 802.21-assisted proxy mobile ipv6 (Pyung Soo Kim, *et al.,* 2013).

Handover completion

1) Once the PMIPv6 procedure has been completed, its announcement is sent by target MIH-BS to the target PoS as a MIH Net HO complete Request message.
2) The request and response messages such as MIH N2N HO complete request, MIH N2N HO complete response are being exchanged with the target PoS and the serving PoS.
3) The MIH Net HO complete Response message is sent to the target MIH-BS by target PoS in order to indicate that the handover procedure has been completed.

Multi criteria vertical handoff

In Service-Adaptive Multi-Criteria Vertical Handoff Algorithm (Jin Chen *et al.,* 2012), the service continuity and quality of service (QoS) are influenced by vertical handoff. Selection of target is an important problem when vertical handoff algorithm is designed. Here, a new entity known as the Service-Adaptive multi-criteria vertical handoff (SMVHO) is introduced which takes care of QoS requirements and user preferences. The SVMHO, which is used to select target network and multiple attribute decision making algorithm (MADM) frames network selection.

System model

- Assuming there are M different types of network in heterogeneous wireless network. The network N1 and N2 has several homogeneous macro cells, which are having lower bandwidth that covers the entire area.
- Higher bandwidth with narrow coverage is delivered to network Ni (2<i<M) at the center of the service area.
- Let us consider N1 and N2 denotes the wireless cellular networks WLAN. When mobile nodes are distributed consistently, more connection is available in overlapped area.

Vertical handoff decision

The vertical handoff happens in three phases as explained further:

Network discovery

As soon as the handoff request is received, the network discovery phase makes a decision of choosing the network for mobile stations.

- Discovering all networks available with RSS measurement which is done by vertical handoff. The mobile node takes care of measuring RSS from corresponding network, and enable mobile node's activation in every wireless interfaces in a time interval.
- A hysteresis is added to the necessary threshold which nullifies the Ping-Pong effect and hystereses have to be laid down depending on the mobile nodes velocity.
- The mobile station makes an immediate response to RSS change, when very limited hysteresis is set to the high speed mobile nodes.

- Ideal mobile nodes of low speed and enormous hysteresis are only chosen. Once all candidate networks are scrutinized most suitable networks are selected among all available networks having mobile node.

Handoff decision

In this phase a new process is coined to select the networks based on the weighted average concept, known as multiple attribute decision making algorithms (MADM).

- Calculation of the total score for each alternative, to select the network is done by considering set of decision attributes and weight of attribute.
- Network having highest total score is selected as the target. The set of decision attributes is made by the handoff decision function (HDF) in MADM.
- The QoS requirement and network condition finds weight of all attribute depending on the SVMHO algorithm decision rule.
- Handoff priority score evaluates all other networks to the calculation that are acquired by the product of weight ascribed to each attribute to the scaled value of other network attributes.

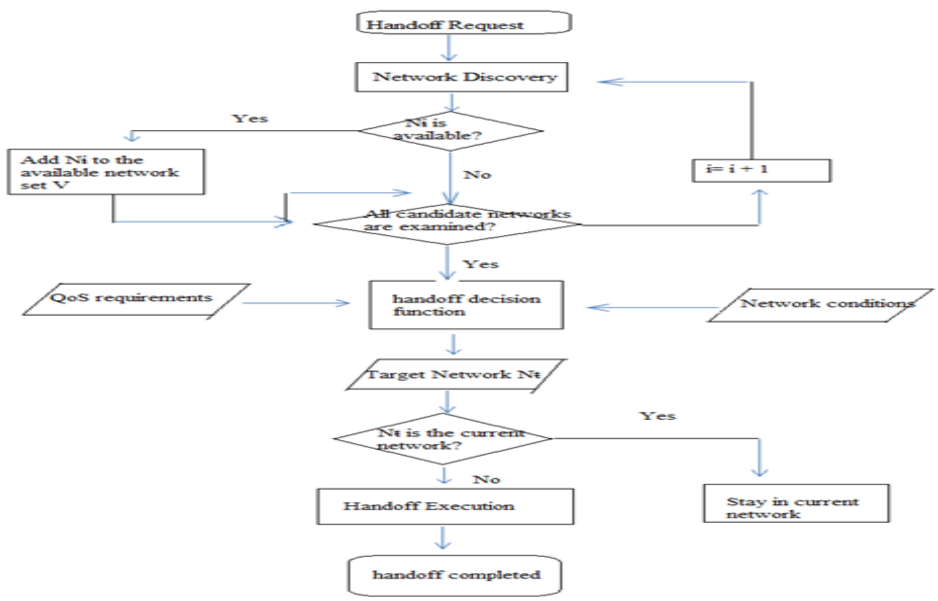

Figure-2. Vertical handoff decision data flow (Jin Chen *et al.*, 2012).

Handoff execution

- Connection from current network to the target network is substituted for vertical handoff chosen in handoff decision step.
- When the mobile node is about to establish the connection and there is no other network available the target becomes current network.
- In such an occurrence the mobile node should not descend from the network and halts in current network itself.

THE PROPOSED METHODOLOGY

This section explicates the proposed architecture of instigating the vertical handover mechanism in the heterogeneous environment. We have hosted a special constituent called as Service Providing Access Point (SPAP) that is capable of being the core element of the entire environment. The functional architecture is encompassed of the network elements, namely SPAP, previous MAG, next MAG, the mobile node (MN) and the corresponding node (CN) which propels the data packets to the mobile node.

The SPAP is capable of carrying out both Local Mobility Anchor (LMA) and Mobile Access gateway (MAG) roles. LMA is the home agent for a mobile node and it possibly will manage the binding state information of the mobile node. MAG is the access router for MN and the first hop router in the infrastructure that provisions localized mobility management. Media independence is the standard that can expedite handover between heterogeneous networks (www.cisco.com), thereby improving the user experience. The SPAP is capable of doing media independent services such as event services, information services, and command services. Media independent event service handles both local and remote events like link going up (IEEE Standard 802.21, 2009); link getting down and detection of the link. The Media independent command service assists the mobile users to control and succeed the behavior of the handover and mobility. The commands transmit the upper layer verdicts such as polling, scanning and configuring the handover to the lower layer. Media independent information service entails static and dynamic information and is proficient in providing active system access grounded in the

VOL. 10, NO. 9, MAY 2015 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

congregated information about all the networks in the geographic infrastructure.

The Figure-3 exemplifies the home network entailing of the PMAG and a foreign network where the NMAG resides.

The MN which is in motion passages from the home network to the foreign network during which the handover happens. The centralized router SPAP is present in the mid of the inter domain network. SPAP is liable for tracking the mobile node, authenticating it, and reckons the reward function to select the next ideal network to which the mobile node gets attached after the handover condition occurs.

System discovery and mobile node attachment

The discovery of system implicates congregation of the information of mobile node, authenticating it and register it with the home network. The SPAP implements the authentication by means of a dedicated protocol known as Extensible Authentication Protocol (EAP) (www.tools.ietf.org). It is a highly flexible protocol, which makes use of authentication methods such as Generic Token Card (GTC), One Time Password (OTP), message Digest 5 (MD5), Transport Layer Security (TLS). The SPAP takes the considerations of mobile node such as the mobile node identifier (MN ID), the prefix of the mobile node and ensues with the authentication before it gets attached to the network for the very first time. After successful authentication, the MN is free to get attached to the home network.

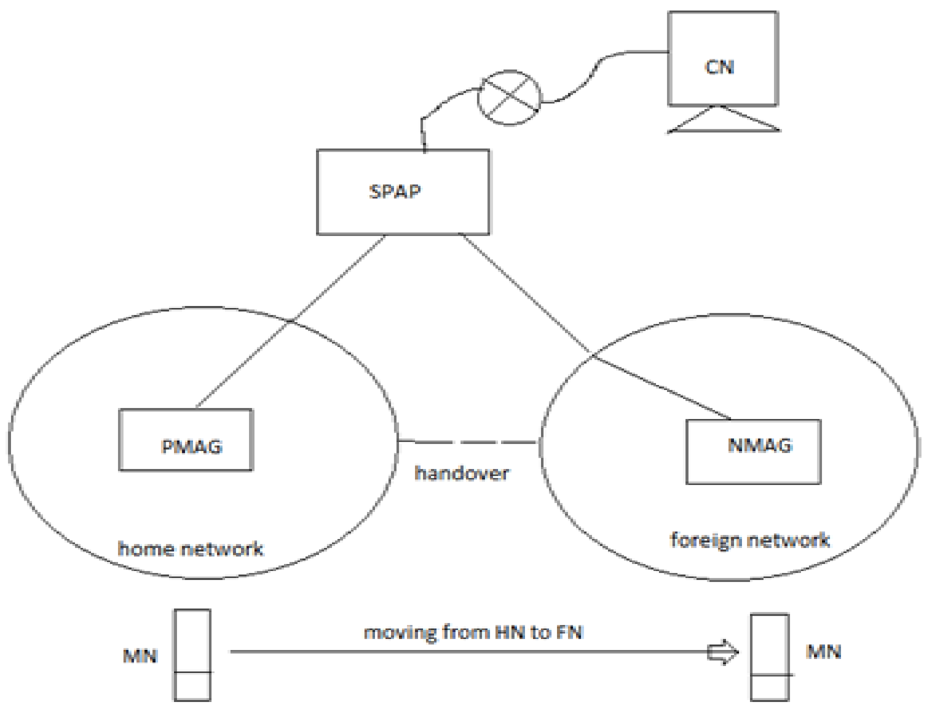

Figure-3. The Proposed mechanism.

Pre-handover phase

The centralized router SPAP passes the credentials (MN ID, MN prefix) of MN to the corresponding node so that it can send data packets to the mobile node through PMAG. SPAP buffers the data packets by a technique called smart buffering (Hyon-Young Choi, *et al.,* 2008) in order to elude the out of order sequencing and loss of data packets which are being in motion from CN to MN. During smart buffering, SPAP server starts buffering the packet which was sent by the CN. SPAP server is capable of tracking the MN. When the received signal strength of MN reaches a particular threshold value, SPAP server decides the movement of MN is looming, it starts buffering the packet and forward to NMAG. In order to avoid excess buffering of the packet in SPAP server, all the packets are time- stamped. If the lifetime of buffered packet is perishing, the packet is discarded. The life time of buffered packets depends on the maximum expected handover time in the current domain. To fetch the buffered packets from SPAP server, NMAG sends the request message to SPAP server and SPAP replies with a corresponding acknowledgement message.

Handover scenario

When the Received Signal Strength (RSS) exceeds the threshold value of the home network (RSS < Ø HN). This measure is continuously updated by the mobile terminal to certify the contemporary network is still available. Received signal strength is an imperative factor for the Quality of Service (QOS). As the RSS of foreign networks outstrips the RSS of home network, the MN starts moving away from the home network. Since SPAP is capable of trailing the MN, it detects the

ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

Link_Going_Down and signposts it to PMAG. After the entreaty for next optimal network from PMAG, the SPAP computes the reward function (Shusmita A. Sharna, *et al.*, 2011) and sends the NMAG credentials to PMAG.

The formula for receiving signal strength for the heterogeneous environment is given as follows:

RSS = 69.55 + 26.16 log f - 13.82 log h (t) - a (h (r)) + 44.9 - 6.55 log h (t) log (d)

Where,
f is the frequency of operation,
h(t) is the height of the transmitter,
a(h(r)) is the HATA correction factor,
d is the coverage distance.

HATA model is the most widely used models for predicting the behaviour of mobile transmission.

Calculation of reward function

The reward function takes into considerations delay, bandwidth, jitter and distance. Assume 'c' epitomizes the current network, f_{bw} signifies the available bandwidth, f_{ji} represents the average jitter and f_{de} represents the average delay. Now the bandwidth, delay and jitter reward can be calculated respectively:

$$f_{bw}(s,a) = \sum_c^{N=1} b_c X (b_a/b_{max})$$
$$f_{de}(s,a) = \sum_c^{N=1} d_c X (d_{min}/d_a)$$
$$f_{ji}(s,a) = \sum_c^{N=1} j_c X \ (j^{min} / j_a)$$

Where's' is the current state and 'a' is the action to be performed.

The overall expected reward function can be estimated using the formula:

$$R\,F = f_{bw}(s,a) + f_{de}(s,a) + f_{ji}(s,a) + D$$

Here 'D' signifies the shortest distance among all the available networks.

Proposed message flow

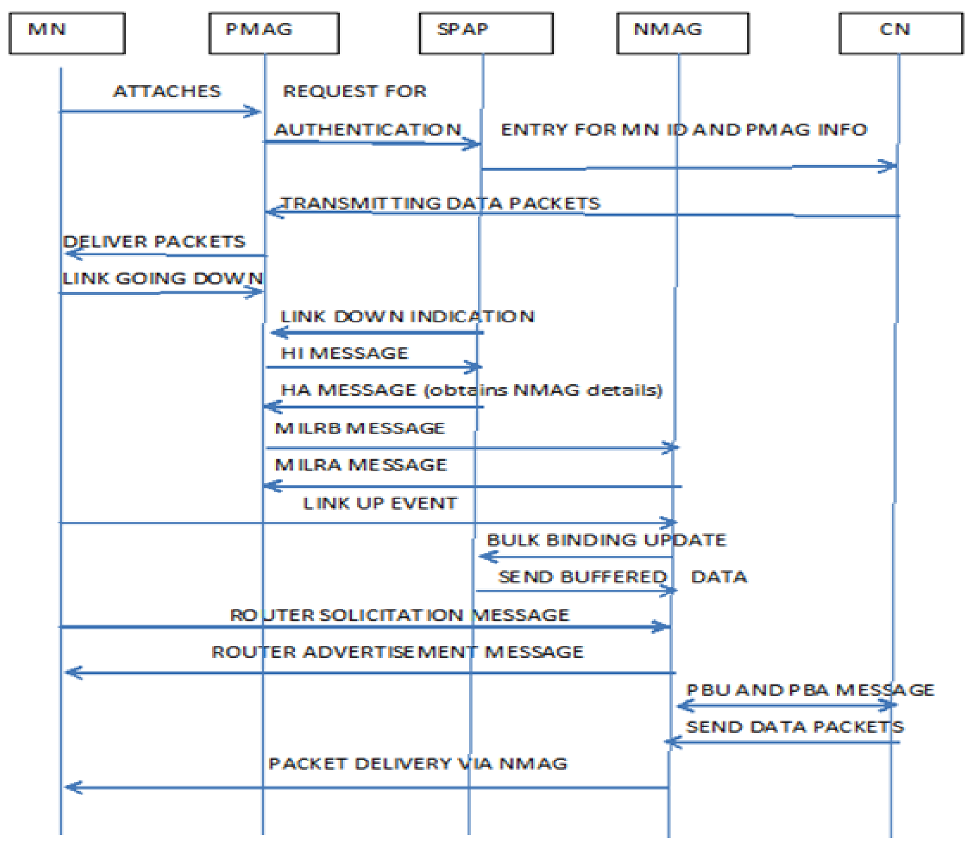

Figure-4. Message signalling flow of the proposed architecture.

1) The mobile node comes in the service of the home network. The PMAG obtains the mobile node details such as MN ID, prefix and send it to SPAP.
2) The SPAP authenticates it by using Extensible Authentication Protocol (EAP). It then sends the MN ID, PMAG ID to (CN). The CN sends the data packets to MN through PMAG.
3) The SPAP buffers the packets which are being sent by CN before the handover condition occurs. When the mobile node moves away from the home network, the SPAP tracks it and sends a handover indication message to PMAG.
4) The PMAG sends a handover initiation message to SPAP. SPAP calculates the reward function to select the next foreign network. It sends a HA message containing the NMAG ID to PMAG.

VOL. 10, NO. 9, MAY 2015 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

5) The PMAG sends the MILRI message to NMAG for authenticating the mobile node. NMAG sends the corresponding MILRA acknowledge message.
6) Link_Up event occurs when MN gets attached to NMAG, which in turn sends a bulk binding update to SPAP. The SPAP sends the buffered packets to NMAG. Now the buffer in SPAP is cleared and it further stores the packets which are going to be sent.
7) MN sends the Router Solicitation message to NMAG. The corresponding advertisement message is sent to the MN. PB Update and Acknowledgement message is sent to and from NMAG and CN. Now the CN send packets to NMAG. From which MN gets the data.

EXPERIMENTAL RESULTS AND PERFORMANCE ANALYSIS

This section describes the comparison of performance oriented metrics of the proposed algorithm with the existing related algorithms, namely Assisted PMIPv6 and Service adaptive multi criteria vertical handoff for heterogeneous networks. Using the network simulator, the performance of various access technologies is compared and results are generated. The parameters considered for our assessment are Packet Loss, Handover Delay, and Latency. The problem of packet loss could be momentously abridged because of the introduction of the centralized router SPAP which buffers the data packets during handover and also delivers it to the foreign network as soon as the mobile node gets attached with it. Also, we can assure that the out of order sequencing of the packets could be flabbergasted by the scheme of smart buffering. The delay that occurs during handover could be reduced since the binding update and acknowledge messages sent in parallel.

Packet loss

Packet loss can be demarcated as the some of the packets has been mislaid which was sent to the mobile node in the course of the handover process. In our proposed scheme, we curtail the packet loss by buffering the packet in SPAP centralized access router using the practice called smart buffering. The buffered packets are cleared and sent to the MN through NMAG to avoid the packet loss.

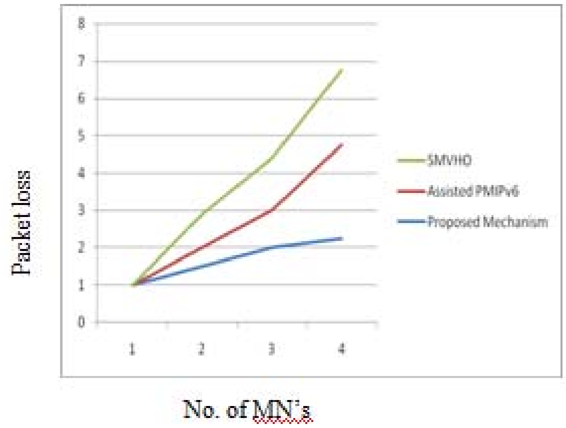

Figure-5. Performance comparison of packet loss.

Latency

Latency can be defined as the time interval for guiding the packets from source to destination. Handover latency can be defined as the deferment that befalls during the diffusion of packets. Since the simultaneous update and acknowledgements are empowered, our proposed mechanism aids in tumbling latency moderately.

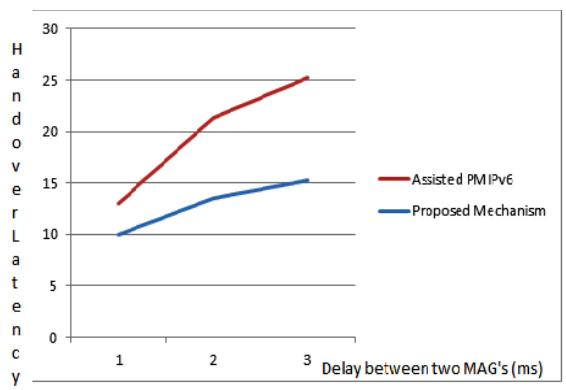

Figure-6. Performance analysis of handover latency.

Handover delay

Packet delay can be defined as the delay in the delivery of packets which has been sent by the CN to the MN. The packet delay problem occurs payable to delay in the revealing of MN, delay of router discovery on the new link, binding update registration delay and IP address validation delay. The Extensible Authentication Protocol authenticates the mobile node faster, which in turn facilitates faster and proficient attachment of MN and overall performance during handover.

ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

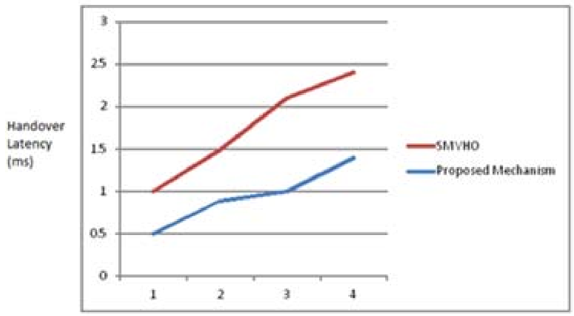

Figure-7. Performance analysis of packet delay during handover.

CONCLUSIONS

We have proposed an algorithm that provisions seamless global handover in heterogeneous networks. The annexation of the centralized router SPAP with effectual functionalities such as smart buffering, reward function calculation prominently condenses the amount of packet loss compared to the existing handover decision schemes. The delay in delivery of data packets could be overcome, which ensures a much better performance. Through the performance evaluation it is understood that the proposed method outperforms the fast handover in PMIPv6. Our future direction focuses on plans to secure the handover process by authenticating the mobile node.

REFERENCES

Atiq Ahmed, Leila Merghem-Boulahia and Dominique Gaiti, “Cooperative Agent Based Vertical Handover Scheme for Heterogeneous Networks”, Sixth Advanced International Conference on Telecommunications, Vol. 10, 2010, pp. 410-415.

Hyon-Young Choi, Sung-Gi Min and Youn-Hee Han, “PMIPv6-based Flow Mobility Simulation in NS-3”,Fifth International Conference on Innovative Mobile and Internet Services in Ubiquitous Computing, Vol. 11, 2011, pp. 475-480.

Mohamed Lahby,Charkaoui Leghris and Abdellah Adib, ”A Hybrid Approach for Network Selection in Heterogeneous Multi-Access Environments”, Fourth IFIP International Conference - IEEE, Vol. 11, 2011.

Thanachai Thumtha Watworn and Anjum Pervez, “Multi-level Rule-based Handover Framework for Heterogeneous Wireless Networks”, Wireless Advanced (WiAD) - Sixth Conference, Vol. 10, 2010, pp. 1-6.

Igor Kim and Young-Tak Kim, “Performance Evaluation and Improvement of TCP Throughput over PFMIPv6 with MIH”, Sixth IFIP/IEEE International Workshop on Broadband Convergence Networks, Vol. 11, 2011, pp. 997-1004.

Alessandro Bazzi, ”A Softer Vertical Handover Algorithm for Heterogeneous Wireless Access Networks”, 21st Annual IEEE International Symposium on Personal, Indoor and Mobile Radio Communications, Vol. 10, 2010, pp. 2156-2161.

IEEE Std. 802.21, "IEEE Standard for Local and metropolitan area network: Media Independent Handover Services", IEEE, January 2009.

http://www.cisco.com/web/about/ac123/ac147/archived_issues/ipj_12-2/122_ieee.html.

Hyon-Young Choi, Kwang-Ryoul Kim, Hyo- Beom Lee and Sung-Gi Min, ”Reactive Smart Buffering Scheme for Seamless Handover in PMIPv6”, Proc. 12th International Conference - OPODIS 2008, Luxor, Egypt, Vol. 5401, 2008, pp. 568-571.

Shusmita A. Sharna, Mohammad R. Amin and Manzur Murshed, “An Enhanced- MDP Based Vertical Handoff Algorithm for QoS Support over Heterogeneous Wireless Networks”, IEEE International Symposium on Network Computing and Applications, Vol. 11, 2011, pp: 289-293.

Pyung Soo Kim, “An Alternative IEEE 802.21-Assisted PMIPv6 to Reduce Handover Latency and Signaling Cost”, Engineering Letters 21: 2, EL_21_2_03, Korea Polytechnic University, Shiheung-City, Vol. 21, 2013, p. 68.

Jin Chen, Zaixue Wei, Yu Wang, Lin Sang, Dacheng Yang, “A Service-Adaptive Multi-Criteria Vertical Handoff Algorithm in Heterogeneous Wireless Networks”, IEEE 23rd International Symposium on Personal Indoor and Mobile Radio Communications (PIMRC), Wireless Theories and Technologies (WT and T) Lab, Beijing University of Posts and Telecommunications, pp: 899-903, 2012. http://tools.ietf.org/html/rfc3748.