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STUDY OF VARIOUS PROTOCOLS OF IPv6

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ABSTRACT

Currently, there are various Internet routing Protocols available over the Internet network. However, the data of these different types of mobile routing protocols are not sufficient. Moreover, the design of network topology for these mobile routing protocols are least developed. Having known these issues, this research aims to investigate the performance of different types of mobile routing protocol namely, mobile Internet Protocol version 6 (MIPv6), Fast Handover Mobile Internet Protocol version 6 (FMIPv6), Hierarchical Mobile Internet Protocol version 6 (HMIPv6) and Fast Handover with Hierarchical Mobile Internet Protocol version 6 (FHMIPv6) in Distributive Mobility Management(DMM) environment. A topology for all the mobile routing protocols is proposed to be designed and developed. At the end of this survey, it is believed that the design and development of all protocols performs better as compare to the others routing protocols over the Internet.

INDEX TERMS—. *IPv4, IPv6, MIPv4, MIPv6, FMIPv6, HMIPv6, PMIPv6, DHMIPv6, FHMIPv6 and DMM.*

1. INTRODUCTION

The technology of wireless communication is increasingly utilized by the Internet users. Gradually, more and more users connect wireless devices to the Internet. These cause lots of and disconnection because of the huge number of users. Therefore, lots of researches have been conducted to solve the congestion and disconnection issues over the wireless communication.

In all-IP mobile networks, IP mobility is a crucial concept to meet the demand of ubiquitous Internet connectivity as well as new service requirements such as seamless handover across heterogeneous networks, consistent quality of experience and stringent delay constraints. Considering conventional IP mobility management (e.g., Mobile IPv6, Proxy Mobile IPv6(PMIPv6) [1]), which leverages on the centralize mobility management approach in a flat architecture, it raises several issues for the network operator like inefficient use of network resources, poor performance, and scalability issues [2].

A novel concept, the so-called distributed or dynamic mobility management (DMM) [3] has been introduced to overcome the limitations of the centralized mobility management. The key concepts of DMM are: **i)** the mobility anchors are placed as close as possible to the mobile nodes(MNs); **ii)** the control and data plane are distributed among the network entities located at the edge of the access network; and **iii)** the mobility support is provided dynamically to the services/MNs which really need it. While DMM is expected to be an effective solution in terms of IP mobility management. To deal with a huge number of devices and traffic, IP multicast can be considered as a valuable solution from service point of view. In some cases, IP multicast can provide significant advantages compared to unicast regarding overall resources consumption (e.g., bandwidth, server load and network load)and deployment cost to deliver the traffic, especially video traffic [4][5].

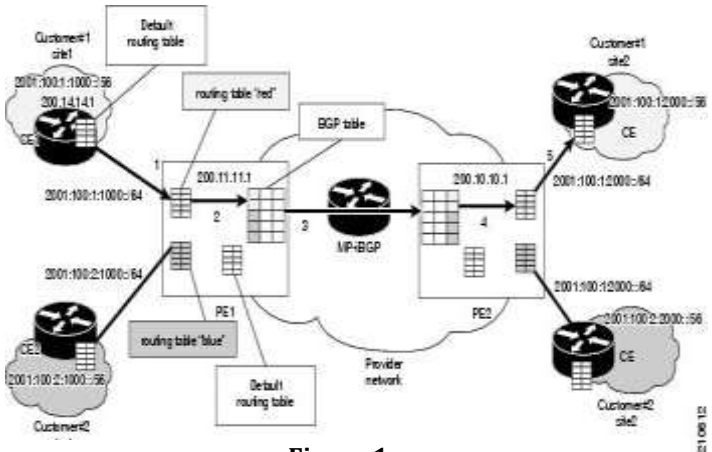

Figure 1

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2. Overview of Ipv4

Internet Protocol Version 4 (**IPv4**) is the fourth revision of the IP and a widely used protocol in data communication over different kinds of networks. **IPv4** is a connectionless protocol used in packet-switched layer networks, such as Ethernet. The address space is of 32 bits or 4 bytes. The length of IP header is 20–60 bytes depending on IP option Self-Configuration Manual or use DHCP based IP configuration Broadcast Technique to transfer the address to all nodes on its networks. Fragmentation Applied by host and router (destination) and used the following fields for fragmentation ID, flag and offset Map Addresses. To use node addresses recorded in Dynamic
Network Services (DNS) for mapping node names securely an IP security (IPsec) header is used as an optionally service for protecting the packets. Lifetime of datagram uses time to live (TTL) which is used to determine the lifetime of datagram on the network. Furthermore, IPv4 does not support packet identification. To overcome this problem IPv6 had introduced.

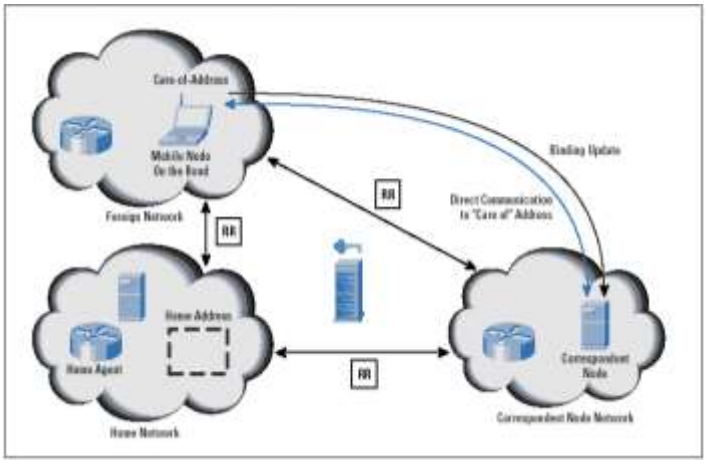

Figure 2

3. Overview of IPv6

IPV6 is an updated version of IPv4, proposed by IETF.IPv6 improves several features of IPv4, such as extend the address range, provides support for real-time application(e.g., audio/video streaming), more control on level of QoS, and integrating IP security (IPsec) and support the mobility through the mobile. IPv6 uses the term packet rather than datagram. The meaning is the same, although the formats are different. IPv6 uses the term node for any system that runs IPv6, that is, a host or a router. An IPv6 host is a node that does not forward IPv6 packets that are not explicitly addressed to it. A router is a node that forwards IP packets not addressed to it. The IP addressing model requires unique network numbers that can be assigned to all IP networks, while they are connected to the Internet .The growth of TCP/IP usage into new areas outside the traditional connected PC will shortly result in a rapid explosion of demand for IP addresses. For example, widespread use of TCP/IP for interconnecting hand-held devices, electronic point-of-sale terminals, or web-enabled television receivers (all devices that are now available) will enormously increase the number of IP hosts. The address space of IPv6 is 128 bits or 16 bytes' length size of address. The length of IP header Fixed length, which is 60 bytes and did not include IP. It uses Multi-cast ad (link-local scope) technique. It Use AAAA (Quad A) record in Domain Name System (DNS) to map node names to IPv6 addresses. Instead of TTL mechanism, hope limit used to determine the limit number of routers that must cross by the packet before it considered an invalid packet. Despite all the benefits of IPv6, it still has a critical issue with respect to the actual deployment in complete. This is correlatedto the time needed for mapping IPv4 to IPv6 which is largely attributed to the incompatibility with the old generation devices, for instance, the old generation infrastructure such as routers works on IPv4, which required changing their routing table.

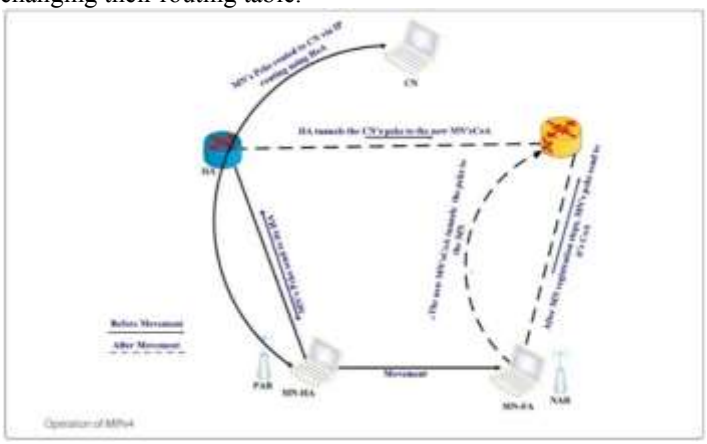

Figure 3

3.1 MIPv4

The MIPv4 architecture is the first breakthrough to address, the IP management, and was designed and produced by the IETF. The main aim of developing this protocol is to make the nodes continue connecting to the networks, even when they are in movement mode. The HA, FA, CoA, CN, MN, MBT, and VL are new terminologies introduced by MIPv4 which are already stated in the previous section as shown in **Fig. 2**

Despite there are benefits occurring as a result of using the MIPv4,however, there exist several drawbacks, such as long communication routing protocol (triangular routing)due to the dependency on the HA to send and receives the packets through it between MN's CN and MN. Therefore, extra time is needed to deliver the packets to their destination, due to the triangular routing problem ,putting extra burden on the network entities. Furthermore, all the packets on-the-fly will be lost during the handover process because the new visited network cannot inform the old visited network about the movement of the MN.

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3.2 MIPv6

MIPv6 protocol, developed by the IETF working group[6], helps to resolve the issues that arise inMIPv4.MIPv6is derived from MIPv4 architecture. The functionality ofIPv6 is more capable and easier to implement and solves numerous limitations existing in MIPv4 limitations, supporting the efficient mobility management forMN.MIPv6allows a MN to roam within the MIPv6 domain without losing or corrupting any of its connections with CN, whereas MIPv4 protocol suffers from the long routing protocol due to the dependency on the HA and FA to deliver the datagram between the MN and its CN. This is due to the fixed address home of address (HoA) given by the HA to the MN, to maintain the MN accessible by its CN at anytime, anywhere. Moreover, all the packets will reach to the MN by the normal routing protocol without any modification if the MN is still in its home network.

The MN will be reachable by the provisional CoA given by the new visited network that MN moves to, and the MN will not be accessible any more by the HoA. Moreover, in the MIPv6 the HA intercept all the flying packets to the MN's HoA and redirects the packets to the current MN's CoA. Thus, the MN must update its HA on its current visited network (CoA). Accordingly, all the MN's packets which are received by the HA are redirected via tunnel to the MN's HoA to its visited network (CoA).Therefore, directly tunnel ends are used to transfer the data between the MN and the MN's HA, unlike the MIPv4 that used the FA. Additionally, the MIPv6 solve several limitations in MIPv4 such as a triangular routing problem and enhance the performance of the network by introducing route optimization scheme. This can be done through exchange message query response between the MN and its CN, to establish a secure and direct connection, to improve the routing between the MN and its CN in theMIPv6. Thus, no more interception is experienced by the packets traveling between the MN and its CN by the HA. This improvement makes the network more secure and reliable and

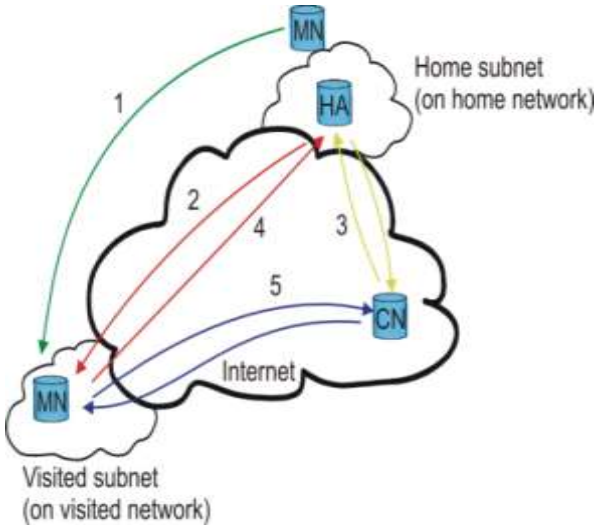

Figure 4

minimizes the network load [6]. Furthermore, the packets that are sent by the MN to its CN are delivered to the MN's CN address directly. In spite of the benefits associated with this protocol ,it is still not appropriate and desirable to be deployed in real implementation due to the following factors, including intense packet loss, intense signaling, and long handover latency. Furthermore, every time the MN moves to a new sub-domain, it must update its CoA to its HA and MN's CN without any consideration to the mobility if its local or global. Moreover, building an IPv6 tunnel cause extra overhead and as a result requires an additionalIPv6 header [7]. Due to these limitations, that make the users dissatisfied, especially for the real-time applications such as VoIP and audio /video streaming, so several investigations [8] and mobility enhancement protocol appeared such as FMIPv6 [9] and HMIPv6 [10] to improve the MIPv6 performance.

3.3 FMIPv6

To overcome the weaknesses of MIPv6, an enhanced protocol was introduced by [9] and named as Fast handover for MIPv6. This protocol prevents the service disruption when the MN in motion and also helps to minimize the needed time for MN to move between the sub-domains during the handover associated with MIPv6 (handoff operation time). In the FMIPv6, the MN's are relieved from any mobility signaling by carrying out the handoversignaling burden through the FMIPv6 entities which are previous/old access point (PAR), new access point (NAR),and HA. The FMIPv6 have two kinds of handover operation, namely, Predictive handover and Reactive handover. In predictive handover, when the MN's change the link layer of attachment between the two access points, they are triggered by the link layer, whereas reactive handover is triggered by the network layer and it happens when the MN's moved out the current access network range (L3handover). In general, the main idea behind the development of FMIPv6 protocol is that when the MN initiates the L2 handover with NAR, the NAR will initiate theL3 handover with PAR. So, a bidirectional tunnel will be established between the NAR and PAR before completion of the L2 handover between the MN and the NA. This reduces significant time in the handover process. In the latter, a bidirectional tunnel will be established between the NAR and PAR, but this will happen after the completion of handover between the MN and NAR. In addition ,to reduce the packet loss during the handover operation, buffering technique is used in either NAR or PAR o both of them together. Thus, after completion of handover rprocess, the buffered packets are forwarded into the MN .Despite all the issues related to MIPv6 which are resolved by the FMIPv6, the FMIPv6 still suffers from some limitations such as reordering the packets due to using multi-paths to forward the packets into the MN.Despite the fact that packet tunneling and buffering techniquesminimize the packet loss during MN's movement,particularly for constant bit rate (CBR) services, however,they add extra processing and increases the load on thenetwork link between NAR and PAR. This is due to theconsecutive tunneling and de-tunneling of the

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bufferedpackets. The reliable and accurate tunneling between theNAR and PAR is dependent on the availability of a triggerand the appropriate handover decision timing. Someother well-known problems associated with this protocolinclude high handover latency and intense signaling.NEMOis another protocol extends theMIPv6 [11]. Themain objective of this protocol is to support the mobilityfor all MNs in the mobile network, by the mobile router(MR), as well as keep theMN's in themobile network continuityaccessible even when they are in movement. So, allthe signaling and tunnel configuration related to mobilitymanagement is taken care by the MR instead of theMNs. The nodes have their IP addresses associated with
the Mobile Network Prefix (MNP) of the NEMO which islocated at the home agent of the mobile router. For routeoptimization support, NEMO basic support (B.S) has nospecific standards. With respect to mobility, the NEMOB.S is based on mobility functionality comprised in themobile node which is a router in this scenario. In order tominimize the signaling cost between the 6LoWPAN MRand the 6LoWPAN access gateway, a compressed mechanismused by the Lightweight NEMO protocol was introducedby [12] to compress the mobility header. Nested[13] has been introduced to solve the MN movement,where it moves to another mobile or static network.

3.4 HMIPv6

A new scheme protocol called the HMIPv6 local mobilitymanagement was proposed by [10]. The aim of thisprotocol is to enhance the MIPv6 architecture so as to reduce

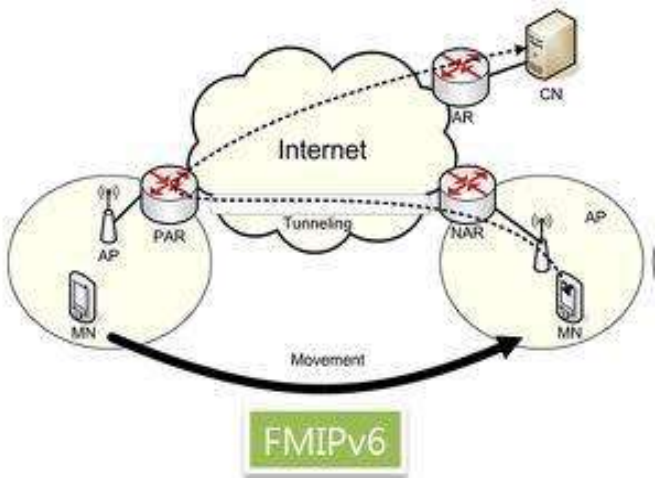
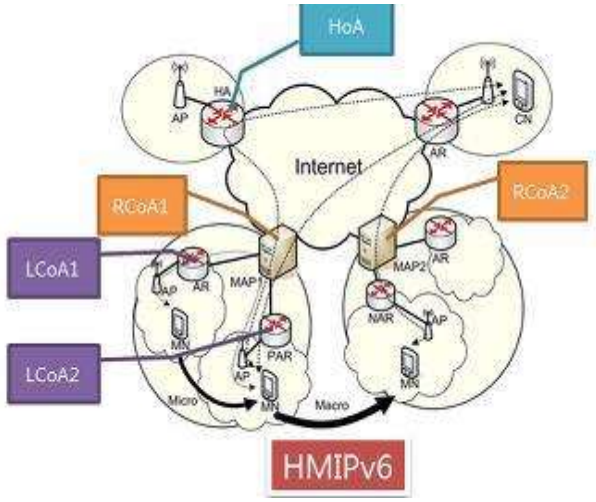


Figure 5

the signaling overhead and handover latency thatoccur during the handover mechanism. For this reason,the HMIPv6 architecture added a new entity named,Mobility Anchor Point (MAP). This new local entity whichaddressed by a Regional CoA (RCoA) has the capabilityto support several Access Routers (ARs). These ARsare responsible for determining the coverage area of theMAP and using the broadcast mechanism to announceitself continuously. Two CoAs associated with the MNsin the HMIPv6 protocol: RCoA and Local Care of Address(LCoA). The RCoA address is used to make the MNsaccessible, while MNs roam within the MAP network.On the other hand, the LCoA address is used to makethe MNs accessible when the MNs are inside the visitednetwork. Roams inside the MAP domain is called intracommunication(local mobility), whereas roams betweendifferent MAP domains is called the intercommunication(global mobility). The hierarchical addressing allows MNsto roam within the MAP domain, without the need toinform neither their HAs nor CNs.The sequence processes of the HMIPv6, are illustrated as follows. A handover process will beapplied by a MN to disconnect from a previous AR (PAR)and connect to a new AR (NAR). The MN must send abinding update (BU) message to its HA and CN to informthem with its new CoA, this message will go through aMAP to reach the HA/CN. The response message of BUfrom the HA/CN also will go through the same way toreach the MN. If the MAP located far away from theHA/CN, this will definitely cause time delay that requiredto deliver the BU message in both directions between theMAP and HA/CN. Due to the aforementioned drawback,it is logical to have a provisional HA on the MAP. Thus,when the MN roams in the same MAP domain, it onlyneeds to update the MAP, then the address of the MNs inthis case is LCoA. The time that was needed for travelinga BU message between the MAP and HA/CN is eliminated.In general, the HMIPv6 is more efficient and moredesirable for intra-communication than the MIPv6. Dueto this, the hierarchical addressing handles the MN registrationrather than the global IP communication in theMIPv6 network.In general, all the host-based protocols would not be apreference in selection for the IoT especially as the devicesare highly constrained in terms of power, memory size,and the processor. The lack of preference comes as aresult of the involvement of MN in the mobility processwhich leads to increase the MN complexity and wastageon air resources. Furthermore, these protocols suffer fromseveral issues such as intense signaling, long handover,and high packet loss

Figure 6



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which lead to degradation in thelevel of QoS.

3.5 FHMIPv6

Fast Hierarchical Mobile Internet Protocol version 6 (FHMIPv6) comprises in two parts that are, Inter network and Intra network. This study combines both the technologies and produces an enhanced Mobile Internet Protocol (MIP). It is the combination of Fast Handover Mobile Internet (FMIP) and Hierarchical Mobile Internet Protocol (HMIP). This combination combines advantages from both the Internet Protocol (FMIP & HMIP) that generates lower packet losses, lower handover delays and better throughput. The FHMIPv6 operation begins with L2 handover anticipation where the MN sends RtSolPr message containing information of NAR to MAP. Next, MAP sends out PrRtAdv message to the MN, which contains information of New Link Care of Address (NLCoA) for MN to use in NAR region. Then, theMN sends out Fast Binding Update (FBU) to MAP, whichencloses Previous Link Care of Address (PLCoA) and IPaddress of the NAR.Once MAP received FBU from MN, MAP sends outHandover Initiate (HI) to NAR. In response to the HI message,NAR sets up a host route for the MN's PLCoA and respondswith a Handover Acknowledge (HACK) message. A bi-directional tunnel between MAP and NAR is established.After that, MAP sends out Fast Binding Acknowledgement(FBAck) toward MN over PAR and NAR. Then, MAPbegins to forward data packets destined to MN to the NAR byusing the established tunnel. Once the MN is in NAR, it sendsout Fast Neighbor Advertisement (FNA) to the NAR and

NAR returns the FNA-ACK to the MN. Then, MN sendsLocal Biding Update (LBU) to MAP. Next, the HA performsDuplicate Address Detection (DAD) and updates the bindingcache. Then, MAP sends a Binding Acknowledgement (BAck)to MN. After this process, MN sends binding update to its HA and active CN's with NLCoA as its source address andHA, CN's address as destination address. Next, inter networkhandover begins, that is allowing the data to flow throughwithout having MN2 be in the radius of New Access Router(NAR). MN1 is able to reconfigure itself to be a mesh routerand MN2 connects to MN1 as mesh client to be able tocommunicate with each other as a mesh network. Byimplementing this hybrid internetwork connection, the datacan reach the designated destination in less time compared toconventional wireless network method.

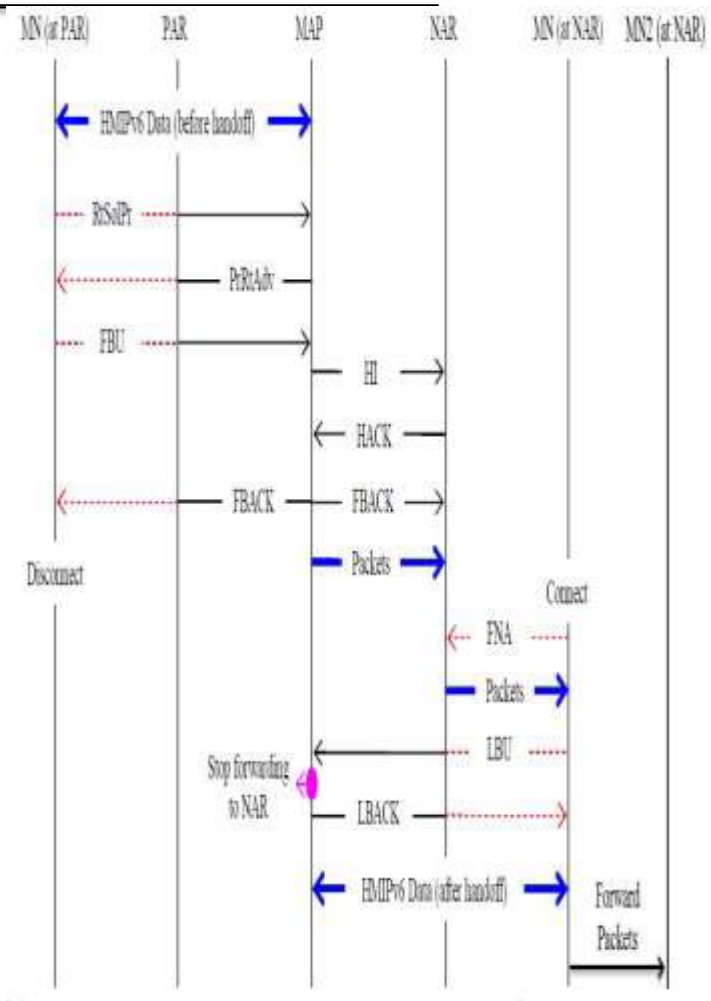

Figure 7

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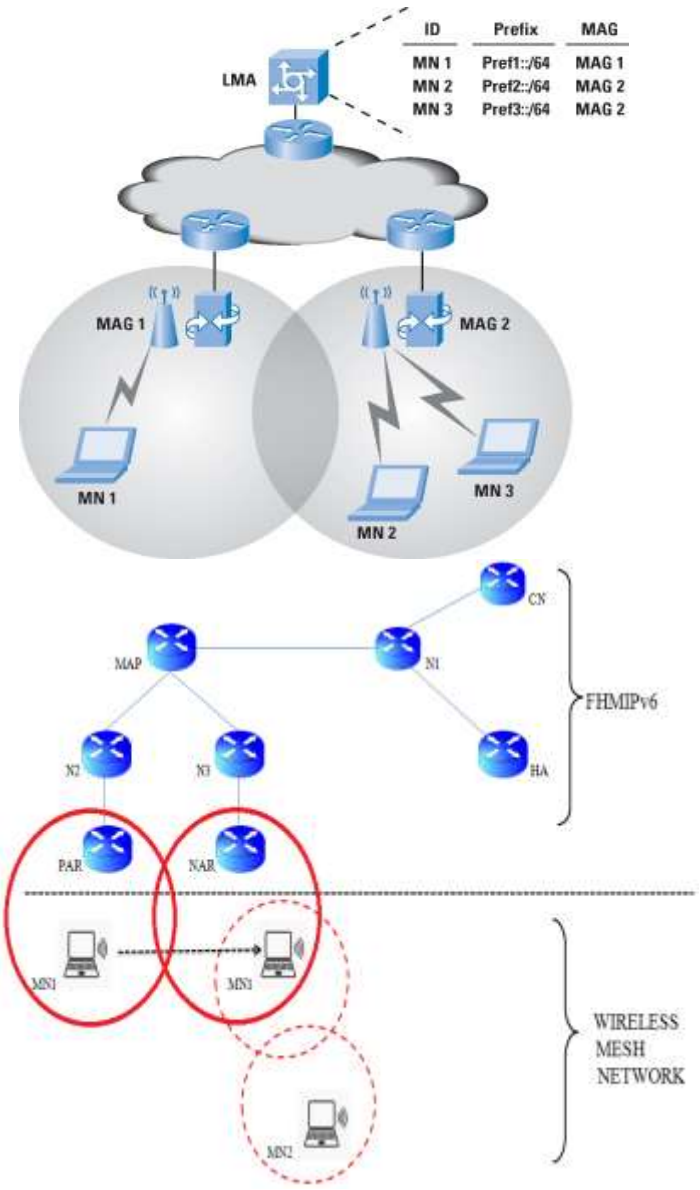

Figure 8

3.6 PMIPv6

To overcome the drawbacks associated with host-basedprotocols, proxy-based protocols are presented and proposed by the IETF working group such asPMIPv6 and its extension schemes and protocols suchas SPMIPv6 and CSPMIPv6. To meet energy efficiencyrequirements, proxy-based protocols relieve the sensornodes from any mobility-related management inhandoff process, in order to reduce the signaling overhead,signaling costs, and handoff registration duringthe HO process. These protocols are covered inthis section.

PMIPv6 is implemented and designed by IETF to settlemobility challenges associated with network managementat the network layer [14]. The standardized protocol iscreated to support network-based localized mobility management,which makes theMN free from any IP-mobilityrelatedsignaling when the MN roams, hence, the proxymobility functionality takes the burden of all the mobilityrelatedsignaling instead of MN, unlike the MIPv6 protocol.

PMIPv6 is derived from MIPv6 by reusing somefunctionality (ex. HA) and extending the signaling. Tomake the MN free from any involvement in mobilityrelatedsignaling when the MN in motion, the PMIPv6added two novel entities named, LMA and MAG. Thekey characteristic of LMA is to maintain the IP-interfaceof MN to continue connecting with the ongoing sessioneven when the MN roams between sub-domains. From the viewpoint of MN, the PMIPv6 domain seems it ashome network, while the key role of the MAG whichhas some capability is to support the interface connectivityin the PMIPv6 domain. Once the MN attaches theMAG domain to the PMIPv6 domain, the MAG (servingnetwork) triggering the required signals to register and authenticate the MNand allocates a unique home networkprefix (HNP) to everyMNusing per-MN-Prefix addressesmodel as illustrated in [14]. The good thing ofusing this prefix address is to make the MN feel alwaysthat the entire PMIPv6 domain is a home network andcan get its home-of-addresses (HoA) on any access network.

This is achieved by making the MN prefix followingthe MN wherever the MN roams in the PMIPv6 domain.It is unlike the MIPv6 in which there is no need to configurethe CoA in the MN. For more details about thePMIPv6 works and its terminologies the work by [14] canbe reviewed.

Despite the benefits that the PMIPv6 gives, like reducingthe handover and reducing the time needed for signalingupdate comparing to MIPv6, still, it suffers from severallimitations due to the triangle routing protocol betweenthe MN, LMA, and CN [15]. This centralization leadsto degradation of the quality of services (QoS) that is anecessity for sensitive applications such as video/audioapplications and VIOP. Furthermore, PMIPv6 suffers fromanother barrier which is the limitation of MN on itsdomain.This could be a problematic for IoT equipmentwhich uses diverse applications [16, 17].

3.7 DHMIPv6

Hierarchical Mobile IPv6 management (HMIPv6) [18] divides mobile node's (MN) mobility [19] into micro-mobility and macro-mobility. When a MN moves within a particularly hierarchical domain, then micro-mobility; In this case, HMIPv6 utilize local mobility management to reduce the amount of signaling generated by the registration to the correspondent nodes (CNs) and to the home agent (HA). when the MN moves out to a new domain, then macro-mobility, the mobility of the MN will be managed by the standard

Mobile IPv6 management (MIPv6) [20]. Mobile Anchor Point (MAP) is a substitute of "Home Agent" (HA) in each domain of the network which hides user's mobility from the outer domain.

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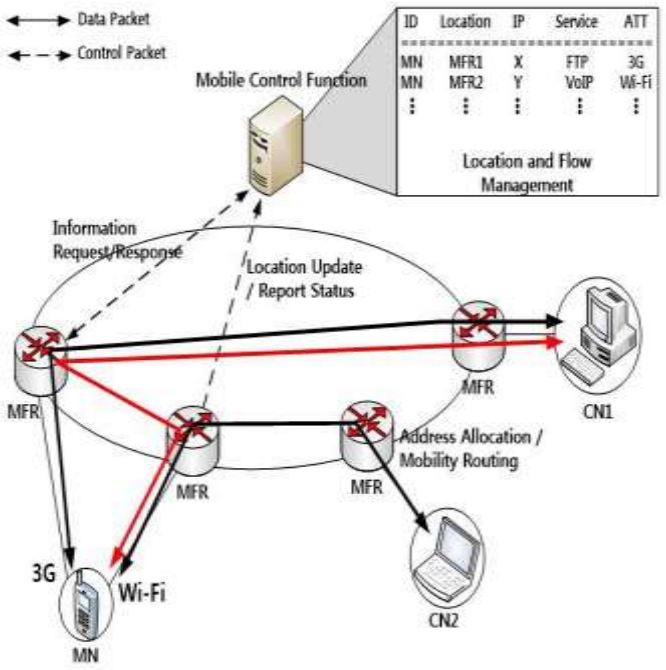

Figure9

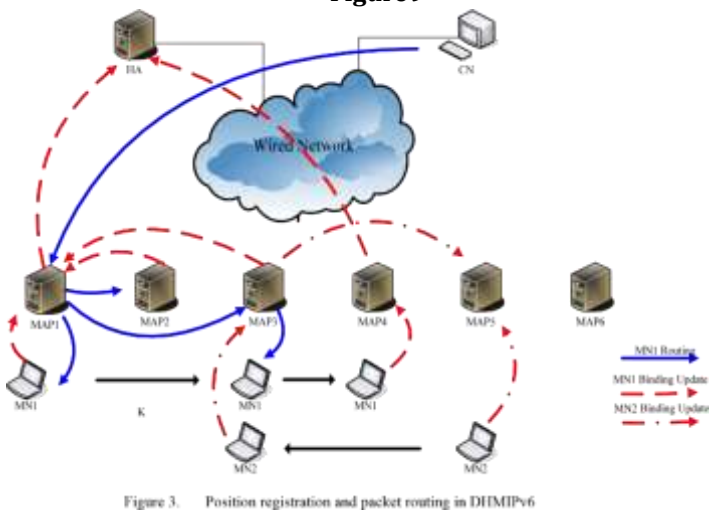

Figure 3. Position registration and packet routing in DHMIPv6

Figure 10

Then the binding updates are sent from MN directly to MAP rather than more distant HA or CNs when the MN stays in a specific region; meaning that MN's exact position is hidden from outer region and the signaling overhead is reduced. The MN needs to register its position to HA and CNs when it moves out of the specific region, just like the standard MIPv6.

Hierarchical Mobile IPv6 (HMIPv6) is an enhanced Mobile IPv6 for reducing signaling cost of location management. Multi-level Hierarchical Mobile IPv6 (MHMIPv6) can organize mobile region as a multi-level hierarchy architecture, which is more flexible to support scalable services. However, MHMIPv6 will bring additional packet processing overhead, and produce negative impact especially on some mobile nodes (MNs) with relatively low movement characteristics. This paper proposes a dynamic hierarchical Mobile IPv6 (DHMIPv6) management, in which different hierarchies are dynamically set up to minimize the total cost for different MNs according to their movement characteristics respectively. Under such management MNs can select the monolayer or two-layer mobility anchor point(MAP) structure when they occur the handover at any time.

4DMM

Current packet-based mobile architectures, such as the3GPP Evolved Packet System (3GPP EPS) and WiMAX, make use of IP as the enabling technology for both voice and data communications. This implies a key-role for IP mobility management in providing the ubiquitous always-on network access service. Even though today several applications do not requirethe network to provide IP mobility support (meaning IPaddress continuity), there are still many that do require it (e.g.,voice or virtual private networking, to just mention a few of them). Unfortunately, current IP mobility protocols rely on theuse of a centralized and hierarchical architecture, which posesseveral critical issues as explained in more detail next.Mobility management schemes standardized by IETF for IPv6 networks are extensions to or modifications of the well-known Mobile IPv6 protocol (MIPv6) [21], and can be classified into two main families: client-based mobility protocols, and network-based mobility protocols.

Client-based mobility approaches, such as MIPv6 and Dual Stack Mobile IPv6 (DSMIPv6) [22], enable global reachability and session continuity by introducing the Home Agent (HA), an entity located at the home network of the Mobile Node (MN) which anchors the permanent IP address used by the MN, called the Home Address (HoA). The HA is in charge of defending the MN's HoAwhen the MN is not at home, and redirecting received traffic to the MN's current location. When away from its home network, the MN acquires a temporal IP address from the visited network – called Care-of Address (CoA) – and informs the HA about its current location. An IP bi-directional tunnel between the MN and the HA is then used to redirect traffic to and from the MN.

CONCLUSION

In this paper, MIPv4, MIPv6, FMIPv6, HMIPv6, PMIPv6, DHMIPv6, FHMIPv6 and DMM have been discussed in details. The aim of this paper is to compare all the above protocols to reduce the delay in wireless communication. Additionally, it aims to increase the throughput. Having decreased the delayand increased the throughout, these can provide better service quality to the wireless Internet users. Thus, we believe that having developed this proposed protocol, this enhanced protocol is able to improve the service quality of wireless communication. encouraged not to call out multiple figures or tables in the conclusion—these should be referenced in the body of the paper.

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