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HANDOVER IN IPV6 & IN ITS OPTIMIZATION TECHNIQUES : A SURVEY

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ABSTRACT

Information access, information processing and information exchange has a remarkable impact in our changing lifestyle. When we talk about these terms: internet and mobile are the basic needs. Integrity of internet and mobile telecommunication promotes quick and reliable access o information and mobile facilities. In the convergence of internet and mobile communication technology bring some obstacles. This paper briefs the stepwise technological development towards the handling of these issues.

Keywords: IPv6, FHIPv6, HMIPv6, PMIPv6 and Handover.

1. INTRODUCTION

If we think about what has changed our lifestyle during the last 5 years, the most predominant answers are: Internet and Mobile Phones. On one side, the Internet is now the easiest way to fulfill the need for quick and reliable access to information. However, today, the Internet does not provide any means to handle mobility as there is no means to stay permanently connected to the internet while moving. On the other side, Mobile Phones provides the ability to communicate with people anytime and almost anywhere in the world, and offers us a reliable (i.e. no disruption) communication while moving . However, Mobile Phones are designed to carry voice, and do not allow us to exchange data easily.

Logically, the next idea is to combine the advantages of both the Internet and Mobile phones that is quick and reliable access to information, and mobility facilities. The ideal scheme would consist of smart wireless devices that are able to exchange all kind of traffic (voice, video and data) across an inter network; a new Internet where mobility is natively handled. Extensive research in the past and present has attempted to add mobility support in the Internet. The majority of the conceptual problems preventing the Internet to handle mobility have been solved and this will finally result into a new, upgraded version of Internet.

Now efforts are focused on the integration of mobile cell-phones with internet-based multimedia services. The convergence of internet and mobile telecommunications will create new problems. In the case of the Internet, how to guarantee mobility management, real-time QoS, handoff, roaming and security of communication will be the trouble. This can bring some obstacle in technology for integration of the internet and wireless communication.

Network mobility first saw support in the IP realm with the advent of Mobile IPv4. Mobile routing, part of the Mobile IPv4 standard released [1] is the one standard solution for IPv4 network mobility, but a number of other less researched possibilities. In the early 1990s, the Internet Engineering Task Force (IETF) began an effort to develop IPv6 as a successor to the IPv4 protocol and IPv6 specification was approved by IETF in 1997. Rest of the paper comprises the technological development from IPv6 to Proxy PMIPv6.

2. LITERATURE SURVEY

MIPv4

The first solution created from the efforts of IETF was Mobile IPv4. In MIPv4, a mobile node (MN) changes its addresses dynamically as it changes the points of attachment. MIP, the first viable mobility solution was not without drawbacks and limitations. MIPv4 may use long paths because of the triangle routing. In addition, it has problems such as security violations and depletion of available addresses.

MIPv6

Mobile IP based on the IPv6 protocol, was proposed in order to solve these problems. Because IPv6 is believed to replace IPv4 and IPv6 embeds mechanisms to easy adaptation of mobility requirements, recent research focuses on mobility support in the context of IPv6 networks. But this protocol is too prone to latency and packet loss limitations.

Schemes to Minimize the Delay In Mipv6

FMIPv6

The Fast Handover Protocol (FMIPv6) was an extension of Mobile IPv6 that allows an access router (AR) to offer services to an MN in order to anticipate the layer-3 handover [6]. The movement anticipation was based on the layer-2 triggers. MN has the possibility to prepare its registration with new access router (NAR) and obtain its new care-of-address (NCoA) while still connected to its previous access point (PAR). Moreover, MN can instruct the PAR to forward packets addressed to its PCoA to its NCoA.

HMIPv6

Hierarchical Mobile IPv6 (HMIPv6) divided the Internet into administrative domains which were managed by Mobility Anchor Points (MAP) [7]. HMIPv6 aimed to reduce the amount of signaling between the MN and its correspondent nodes (CN) during a handover, and to improve the performance in terms of handover speed. In HMIPv6, the MN sends Binding Updates (BU) to the local MAP rather than the home agent (HA) and CNs, which are typically further away. Moreover, only one BU message needs to be transmitted by the MN before traffic from the HA and all CNs is re-routed to its new location, regardless of the number of CNs that MN is communicating with.

S-MIP

Seamless Internet Protocol (S-MIP) provided a novel architecture that builds on top of the hierarchical approach and the fast handover mechanism, in conjunction with a newly developed handoff algorithm based on pure software-based movement tracking techniques [8]. S-MIP introduced a new entity in the network, the Decision Engine (DE) that was similar to a MAP in its scope and makes handover decision for its network domain. S-MIP provides improvement in both delay and packet loss, however, the operation of DE entity was difficult to simulate in test-bed and therefore the evaluation for this framework is not clear so far.

F-HMIPv6

The Fast Handover Protocol (FMIPv6) was an extension of Mobile IPv6 that allows an access router (AR) to offer services to an MN in order to anticipate the layer-3 handover [6]. The movement anticipation was based on the layer-2 triggers. MN has the possibility to prepare its registration with new access router (NAR) and obtain its new care-of-address (NCoA) while still connected to its previous access point (PAR). Moreover, MN can instruct the PAR to forward packets addressed to its PCoA to its NCoA.

OPTIMISTIC F-HMIPv6

Optimized smooth handoff proposed aimed to solve the route optimization problem in MIPv6 [13]. As soon as the MN has obtained its new regional CoA, it will register this address with its GFA. After Binding Update, when a packet arrives in the previous FA, the binding cache is checked and the packet is tunneled to the new FA, who delivers it to the MN. However, packets arriving at the previous FA after the MN left and before the binding update message from the new FA received are lost. In order to avoid this packet loss, FAs are provided with a circular buffer referred to as the Forwarding Buffer. When the previous FA receives a binding update originating from a previous foreign agent notification, these buffered packets are re-tunneled to the new FA and all packets arriving at the previous FA with destination the MN are immediately tunneled to the new FA.

In Optimistic F-HMIPv6 framework (referred to as oF-HMIPv6), we removed the DAD function from NAR and get it done by MN, by combining these together with some necessary modifications to the handover protocol, provides a significant enhancement to Mobile IP performance [14].

O-DAD, A-DAD, P-DAD

O-DAD, A-DAD, and P-DAD are the schemes proposed to reduce latency using DAD. O-DAD lets nodes use addresses before DAD has checked their uniqueness [17]. If the DAD procedure later reports that an address is already in use, the mobile node using it must immediately de configure it. This can penalize both the mobile node (by breaking ongoing connections) and the node that rightfully owns the address (because it will receive misdirected packets). O-DAD is beneficial if address collision probability is low.

A-DAD was proposed to automatically allocate a care-of IPv6 addresses (CoA) for the use of mobile nodes that want to be fast handover [18]. Each access router maintains 'Passive Proxy Cache' of which each address is in advance generated and tested for its uniqueness by the access router. Also, the access router acts as 'Passive Proxy' for an address reserved in 'Passive Proxy Cache' in order not to affect the destination cache and neighbor cache of its neighbor nodes and not to disturb the normal CoA configuration procedure of the nodes. During L3 handover, a mobile node requests one of the duplication-free addresses reserved by its target access router. After successfully acquiring the address, the mobile node assigns it on its interface which attaches to the new link, without the DAD. Consequently, the proposed scheme can completely take off the DAD procedure and hence the time involved in the existing L3 handover schemes is reduced.

The Proactive DAD approach uses the topology information and layer-2 signals to predict the new network domains prior to or in parallel with layer-3 hand off. P-DAD doesn't require a reserve of IP addresses and thus better utilizes address space [19]. Also P-DAD access routers need only maintain soft state. This scheme can significantly reduce both hand-off latency and packet loss as compared to O-DAD and A-DAD.

Proxy Mobile IPv6

A network based mobility management protocol called proxy Mobile IPv6 (PMIPv6) is being actively standardized by IETF. In PMIPv6 the serving network controls mobility management on behalf of MN. Thus MN is not required to participate in any mobility related signaling. And the proxy mobility agent in the serving network performs mobility related signaling on behalf of MN. Once an MN enters its PMIPv6 domain and performs access authentication the serving network ensures that the MN is also on its home network. The mobility scope of Proxy is local while that of MIPv6 and FMIPv6 is global. Proxy reduces the handover latency and stateless address autoconfigration is assumed for PMIPv6. The root optimization and fast handover issues in PMIPv6 is still under the scope of research.

Fast Proxy Mobile IPv6

As an extension protocol to PMIPv6, Fast Proxy Mobile IPv6 (FPMIPv6) has been later developed to further reduce the handover latency and to reduce the packet loss.

3. MOBILE INTERNET PROTOCOL

At the heart of mobile IP is the fact that the mobile device uses two addresses to ensure that a network connection is not disrupted as its user roams from one place to another. One is home address and the other one is care-of address which is used to reach the user at his current location. The home agent, or HA, is one of the key components of a network that implements mobile IP.

HA is a specially designated server that takes responsibility for intercepting and forwarding packets for absent subscribers. The mobile device uses a registration protocol to keep its home agent informed of its current location. As the user roams away from her home network onto a foreign network (or from one foreign network to another), it asks the foreign network to tell the home network where it is. This is where the foreign agent (FA) completes the magic. The FA is responsible for finding a visitor's home network and informing the home network that it has temporary care of that visitor by sending the registration message to its HA. Following a successful registration, any packets that arrive on the home network for an absent user are forwarded by the HA to the FA. The forwarding is achieved through encapsulation-the process of enclosing original packets as data inside of new packets, complete with a new IP header with the new IP address. The source and destination address fields in the header of the new packet correspond to the HA and FA, respectively. When the encapsulated packets arrives in the visited network, the FA strips off the temporary wrapping to reveal the original packet, which is then sent to the intended recipient [20]. The overall operation can be summarized in the Figures 3.1 and 3.2. Fig. 3.1 shows a couple of networks, both equipped with the two agents that support mobility. The instance where a user is at home network is illustrated. Figure 3.2 shows the instance where the user is visiting another network.

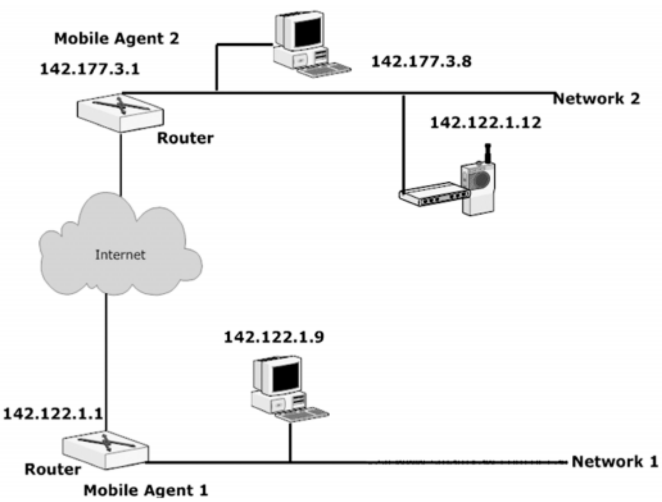

Figure 3.1: A Mobile Device Attached to its Home Network

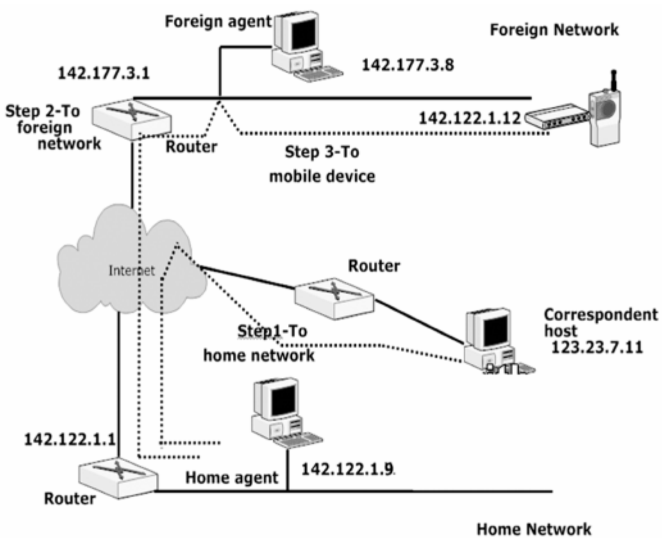

Figure 3.2: A mobile Device Visiting a Foreign Network

To have the basic overview of MIP, Fig. 3.3 shows how a packet gets to a mobile device hosted on a foreign network. In this, the mobile device (which has been allocated a static IP address of 142.122.1.12) is receiving a mail message from a computer (known as the correspondent host), which is on a remote network. The IP headers of the packets that form the mail message as it leaves the correspondent host, have a destination address of 142.122.1.12. The packets are, therefore, routed to the home network of the mobile device, as per conventional IP routing. At this point, the home agent picks up the packet and inserts an additional IP header and forwards it back into the network.

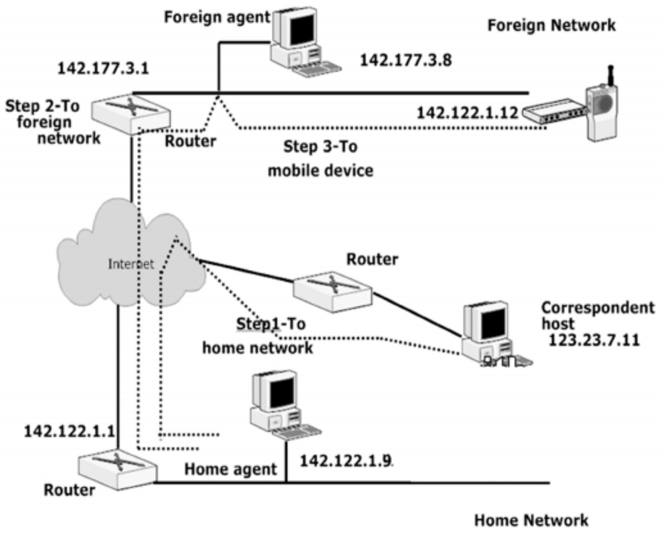

Figure 3.3: How a Packet Gets to a Mobile Device that is Visiting a Foreign Network

The new IP header has a destination address of 142.177.3.1, which routes it to the network being visited. Thus Registration has been done and this informs the foreign agent about the presence of the mobile device so that, when the encapsulated packet arrives, it knows to remove the outer header to reveal the original IP address and then forward the packet to its intended recipient. Thus packets pass from the foreign network into the internet and on their destination: the correspondent host.

Neighbor Discovery

This is the process by which a mobile device determines whether it is currently connected either to its home network or to a foreign network [15]. It is based on the established IP mechanism of advertisement, where a node will broadcast information to its neighbors who, in turn, broadcast information to their neighbors. In this way, up-to-date information propagates through the network so that routers know what routes are available and, of more immediate interest, mobile devices discover mobility agents.

Mobile IP discovery does not involve the modification of existing router advertisements-it simply extends them to associate mobility functions. Hence, a router advertisement can carry information about default routers, but can also carry information about one (or more) care-of addresses. The router advertisements that have been extended to care-of addresses are known as agent advertisement.

In operation, both home and foreign agents broadcast agent advertisements at regular intervals. Mobile node when to get a care-of address needs broadcast a request that is answered by any agent that is within range. This request takes the form of an established router solicitation. If an advertisement is no longer detectable by the mobile device, the assumption is made that the agent that offered it has gone out of range. In this case another care-of address is sought. Once a prospective care-of address has been found, the connection process can proceed to the next step-registration of the address.

Registration

In this the mobile node and the foreign agent both know about the care-of address, but the home agent is not yet privy to their agreement [20]. To bring the home agent up to date, the mobile node sends it a registration request that contains the care-of address. On receipt of this information, the home agent completes several actions.

First, it authenticates the registration request, which is digitally signed by the mobile nodes to preserve network security. Once authenticated, the home agent can examine the parameters in the request. These parameters define the way in which the home agent can reach the care-of address. At this point, the home agent is in a position to accept the registration request. This triggers it to associate the care-of address with the home address it has for the mobile node and to update its routing table so that any packet destined for the mobile node in question can be forwarded to the newly discovered care-of address.

Finally, it approves the registration request by sending a confirmation reply back to the mobile node, once a registration request has been accepted; it endures until a new registration request is received. If the mobile node fails to reach its home agent, it can attempt to register with another home agent on its home network. This is known as automatic home agent discovery.

4. CONCLUSION

In this paper, the existing IPv6 mobility management protocols developed by the IETF have been analyzed and compared in terms of handover latency. The above analysis concludes the following points:

1. In order to improve the handover performance, L2 information should be utilized. Predictive FMIPv6 and FPMIPv6 outperform other mobility management protocols because those protocols

allow an MN to prepare its handover before the MN performs its actual handover to the new access network. The reduced handover latency also results in the reduced handover blocking probability.

2. Wireless Link Condition: The wireless link condition over the wireless link, largely affects the handover performance of all mobility management protocols. With this point in view, the network-based mobility management protocols such as PMIPv6 and FPMIPv6 have an advantage thanks to removed mobility signaling from the MN.
3. DAD Latency: MIPv6 and HMIPv6 shows poor handover performance. This phenomenon is caused by the DAD process, which counts for a large portion of handover latency. Since the DAD process is performed over a wireless link, in a poor wireless link condition, it badly influences the handover performance of MIPv6 and HMIPv6. As a considerable solution for this, the optimistic DAD is recommended that eliminates the DAD completion time.
4. The handover performance is affected by a network topology configuration. The handover performance of fast handover protocols such as FMIPv6 and FPMIPv6 is largely affected by the number of hops.
5. PMIPv6 could be used as a localized mobility management protocol, whereas MIPv6 could be used as a global mobility management protocol.

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