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RESEARCH ARTICLE

PROXY MOBILE IPv6 AND SOLUTION FOR PMIPv6

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Abstract- *Proxy Mobile IPv6 (or PMIPv6, or PMIP) is a network-based mobility management protocol. It is a protocol for building a common and access technology independent of mobile core networks, accommodating various access technologies such as WiMAX, 3GPP, 3GPP2 and WLAN based access architectures. Proxy Mobile IPv6 is the only network-based mobility management protocol standardized by IETF.* ***Proxy Mobile IPv6 is a promising specification that allows network operators to provide localized mobility support without relying on mobility functionality or configuration present in the mobile nodes, which greatly eases the deployment of the solution. This paper presents Proxy Mobile IPv6 and the different extensions that are been considered by the standardization bodies to enhance the basic protocol with interesting features needed to offer a richer mobility experience, namely, flow mobility, multicast and network mobility support.***

Index Terms- *Proxy Mobile IPv6, flow mobility, multicast and network mobility support*

1. INTRODUCTION

Mobility support in IP networks is a topic that has received considerable attention. This topic has gained more importance as IP networks are starting to be used to offer services, previously reserved for circuit[1] switched ones, such as voice, and also because the role of IP in the evolution of the 3G mobile communication networks. Traditional IP mobility support mechanisms, for example Mobile IPv4 or mobile IPv6, are terminal based, meaning that terminals are aware of their mobility and have to do operations in order to be able to maintain their ongoing communication sessions. Nevertheless, an interest in network based solutions has appeared recently.[3] The main objective was to develop a solution to provide, using functionality residing only in the network, mobility support to terminals moving and changing their point of attachment within a particular area. In this paper we are discussing Proxy Mobile IPv6 Operation, Flow Mobility, Flow Mobility for PMIPv6, Flow Mobility for PMIPv6, Network Mobility and PMIPv6.

2. Mobility Management

When the IPv4 protocol was designed, mobility was not considered a requirement, because user mobility was simply unthinkable in the Internet at that time. Without this requirement, a design decision was made to use the IP addresses for two different roles: locators and identifiers. More recently, IPv6 took the same design decision of not separating the two roles. This is advantageous because if we know the name (identifier) of a node, we automatically have the locator for that node, which the routing system uses to reach it. Therefore, we do not need translation mechanisms nor a secure binding between identifiers and locators. Unfortunately, mobility requires separating the identifier role from the locator role: as an identifier, the address of a node should never change, but as a locator, it needs to change each time the node moves to a new location (IP subnetwork).

Most of the mobile nodes today are equipped with multiple interfaces using different access technologies such as WiFi, WiMax, and LTE.To best utilize this capacity the network should be extended to support simultaneous connections from multiple interfaces of the mobile node. It also has to be able to optimize the data distribution over multiple interfaces. e.g, mobile node equipped with two interfaces using two different access technology, 3GPP and WiFi.

3. Operation in Proxy Mobile IPv6

When we design a network-based mobility protocol, the main goal to achieve is that IP mobility operations should not involve the Mobile Node at all, so all the functionality has to be moved towards the network. Therefore, PMIPv6 [3] adds some extra functionality to existing network nodes to compensate for the absence of functionality in the MN.

3.1*Mobile Access Gateway (MAG)*

This functional block is required for detecting the triggers related to mobile node's attachment, detachment, address configuration and router discovery related events. The network triggers, ARP message for the default-router's MAC address, Gratuitous ARP message, DHCP Request message, IPv6 ND messages are the potential triggers for the MAG to initiate PMIPv6 signaling. In some cases, trigger can also be based on detecting a new MAC address on the access link by other link-layer specific means. The identity of the mobile node in these triggers is always the Mac address, except for DHCPv4,[13] where the client-identifier option can potentially be the mobile node identifier. MAGs have to track MNs movements within the LMD and typically there will be several MAGs inside the same LMD.

3. 2 *Local Mobility Anchor (LMA)*

This entity is the anchor for the addresses used by the MNs in the LMD. It stores all the routing information needed to reach each of the MNs in the corresponding LMD by associating the MN with the MAG that the MN is using. A tunnel between the LMA and the MAG an MN is using allows the transfer of traffic from and to the MN.

As we already mentioned, PMIPv6 is totally transparent to the MN that is able to move within the LMD without changing its IP address, being the IP layer of the MN unaware of the mobility. So, when an MN connects to an LMD, it just has to send a standard IPv6 Router solicitation2, perhaps after performing some authentication operation to gain access to the network. The access router that in PMIPv6 acts also as a MAG will perform all the mobility related signaling on its behalf.[15]

When the LMA receives the PBU message it checks if the MN already has an active registration inside its Binding Cache (BC) using the MN's identifier. When an MN first enters the PMIPv6 domain, the LMA will not find any entry inside its BC, so it creates a new one. The PMIPv6 BC entry is an extended version of the MIPv6 one that includes MN related information such as the MAG serving it. When the LMA accepts an MN inside a PMIPv6 domain, the LMA has to assign one or more network prefixes to it. The address(es) that the MN will eventually use inside the PMIPv6 domain will be configured from these prefixes (called Home Network Prefixes, HNPs).

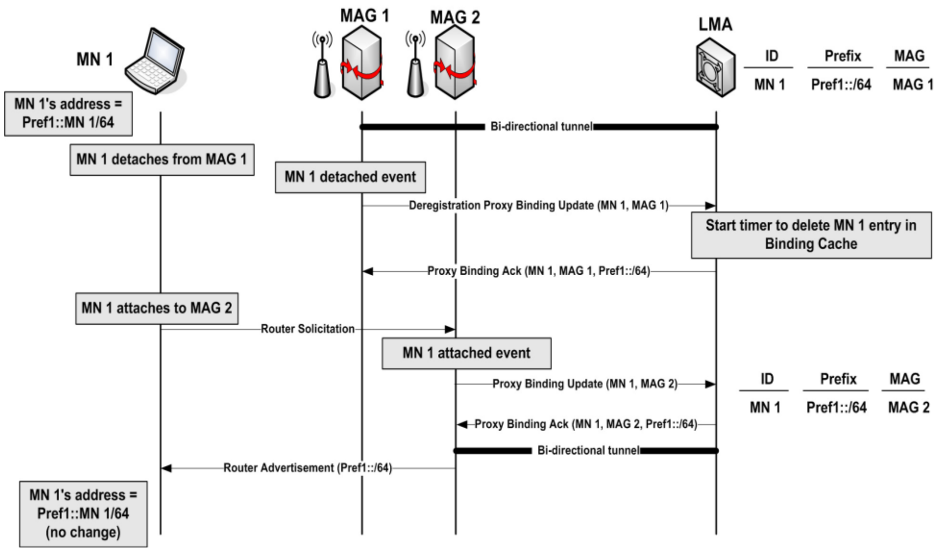

Fig.1 Signaling when an MN changes point of attachment

The MN identifier, the Proxy CoA, and the HNPs allocated to the MN are used to create a new BC entry. The LMA also has to set up the right configuration to serve the MN traffic. So, in order to convey all the traffic destined to the MN, routes for the HNPs are set accordingly to point to an IPv6-in-IPv6 tunnel from the LMA to the corresponding MAG. The LMA procedure is finished with a Proxy Binding Acknowledgment (PBA) that is sent from the LMA to the MAG, containing the HNPs allocated to the MN.

The main advantages of PMIPv6 compared with the standard MIPv6 solution are:

• *Reduced handover latency:* The LMA is a local network entity and sending signaling to it produces less delay than sending signaling to a remote HA.

• *Reduced overhead:* The tunnel ends at the MAG instead of at the MNas in MIPv6. Packets inside the access link are sent without any extra header. This is relevant because access links are likely wireless and bandwidth resources are scarcer over the air interface than in the wired backhaul network.

• *Reduced complexity and configuration requirements in the MNs:* Terminals do not require any mobility related configuration nor new specific software, greatly simplifying the deployment.

• *Improved location privacy:* Keeping the MN's IP address fixed over the PMIPv6 domain considerably reduces the chance that an attacker can deduce the exact location of the MN.

4. Flow Mobility

It allows moving selected flows from one network to another in mid-session without any interruptions while keeping the other flows on the current network. Figure 2 shows an example in which the mobile node equipped with two interfaces, WIFI and 3GPP. At first time the mobile user transfer both voice and video flow via 3GPP interfaces. When the mobile user moves from 3GPP[12-15] service area to the overlapping area of 3GPP and WIFI network, the video flow can be moved to WIFI interface in order to get higher bandwidth while the voice flow is still transferred via 3GPP interface. The key advantage of network based mobility management is that it does not require any modification of the MN.[14] The network will perform mobility management on behalf of the mobile node. The client just involves in minimal proportions. This design results in a simple mobile device with minimal software requirements. It was standardized by IETF in PMIPv6, and also adopted in 3GPP and WiMAX architecture. There was many extensions of the network-based mobility management are being planned. One of them is the network-based flow mobility management stated in the re-charter of the NETEXT working group

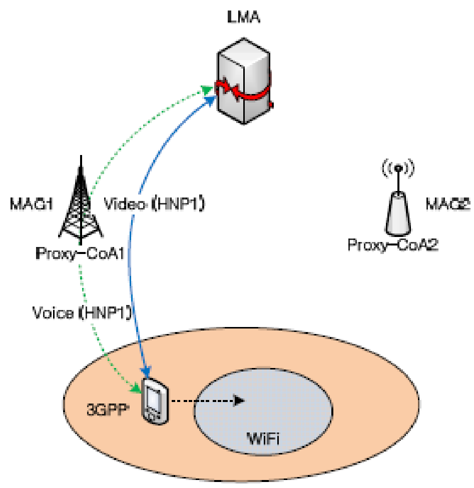

Fig. 2 IP flow mobility

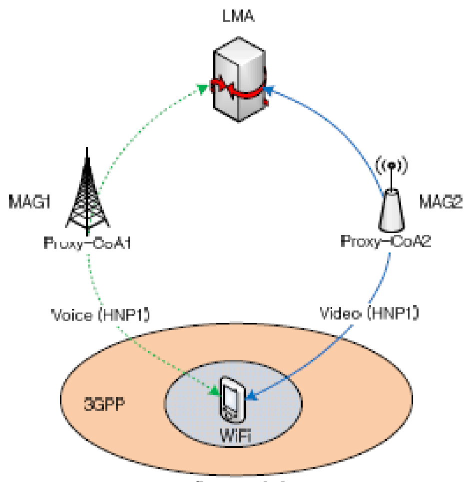

Fig.3 IP flow mobility

4.1 Problem Statement

The number of wireless mobile subscribers accessing data services does not stop increasing. This is motivated by a variety of different reasons: 3G access is widely available (coverage reaches almost 100% of dense populated areas in developed countries) and affordable by users (most mobile handsets are 3G capable3, USB modems are quite cheap and operators offer flat rates to their customers). Besides, the number and popularity of applications designed for smart-phones that make use of Internet connectivity is getting higher every day,[11] contributing to the amplification of the penetration of these devices (e.g., iPhone, Android, Blackberry and Windows Mobile phones), which results in bigger demands for 3G connectivity everywhere. Due to the huge connectivity needs from users, 3G operators are challenged to enhance their network deployments to be able to cope with the users' traffic load.

A much richer solution can be achieved by enabling true flow mobility. Flow mobility refers to the movement of selected flows from one access technology to another, minimizing the impact on the users' [16]Quality of Experience (QoE).

4.2 Solutions for PMIPv6

The PMIPv6 allows mobile nodes to connect to the network through multiple interfaces for simultaneous access. The Mobile Node (MN) can send and receive simultaneously packets to the PMIPv6 domain over multiple interfaces. A first step required in order to support flow mobility is the capacity to use several physical network interfaces. Proxy Mobile IPv6 allows an MN to connect to the same PMIPv6 domain through different interfaces, though in a very limited way. There are three possible scenarios:[16]

• *Unique set of prefixes per interface*

This is the default mode of operation in PMIPv6. Each attached interface is assigned a different set of prefixes, and the LMA maintains a mobility session
per MN's interface. PMIPv6 only allows to transfer all the prefixes assigned to a given interface to another one attached to the same PMIPv6 domain, and does not fully specify how a MAG can figure out if a new mobile node wants to get a new set of prefixes assigned (i.e. having simultaneous access via multiple interfaces) or if the mobile node is performing a handover.

• *Same prefix but different global addresses per interface*

In this case the same prefix is assigned to multiple interfaces, though a different address is configured on each interface. This mode is not completely supported by PMIPv6. It either requires two different mobility sessions or only one but two separate host route entries. In any case, this scenario creates a multi-link subnet as the same prefix is advertised over different point-to-point links.

• *Shared address across multiple interfaces*

In this scenario, the MN is assigned the same IP address across multiple interfaces. This enables applications on the terminal to see and use only one address, and therefore the MN could be able to benefit from transparent mobility of flows between interfaces. This scenario is not supported by current PMIPv6, it requires one mobility session per terminal and some kind of flow filters/routes at the LMA to be able to forward packets via the appropriate MAG. Besides, ensuring that multiple IP interfaces of the same device configure the same IP address is not easy to achieve nor to operate One approach to mitigate this is to make use of link layer implementations that can hide the actually used physical interfaces from the IP stack
.For instance, the *logical interface* solution at the IP layer may enable packet transmission and reception over different physical media

The mobile node behavior needs also to be considered. In the plain PMIPv6 scenario, the IPv6 addresses assigned to if1 (addr1) and if2 (addr2) are different Packets addressed to addr1 will always arrive via if1 (and the same for packets addressed to addr2, arriving via if2). In a flow mobility-enabled scenario, addr1 and addr2 may belong to different prefixes, belong to the same one, or even be the same IP address. Moreover, packets addressed to addr1 may arrive at if2 (and the other way around), and should be processed by the MN normally.

5. Multicast Support

IP multicast allows to support efficiently group communication services (one-to-many or many-to-many) over existing IP networks. Applications like video-conference; distant learning, interactive gaming or TV distribution may take advantage of this extension of the IP protocol which basically facilitates the delivery of a single copy of a data stream to multiple listeners or receivers interested in receiving the same content simultaneously. Multicast enabled routers in the network are in charge of replicating the data packets to reach the receivers, usually spread around the whole network, creating then a multicast distribution tree over the network. Thus, IP multicast helps to save resources in terms of both data source processing and network bandwidth. The increasing generalization in the use of multicast has triggered the need for supporting a multicast receptor which is mobile or attached to a network that is moving. Group communication is out of the scope of the PMIPv6 standard specification. This fact produces inefficiencies when distributing contents to multiple receivers in these scenarios as well as when supporting MN mobility.

6. Network Mobility and PMIPv6

The NEMO Basic Support protocol extends Mobile IPv6 to enable Network Mobility. In this protocol, a mobile network is defined as a network whose attachment point to the Internet varies with time. The router within the NEMO that connects to the Internet is called the Mobile Router (MR). It is assumed that the NEMO has a Home Network where it resides when it is not moving. Since the NEMO is part of the Home Network, the Mobile Network has configured addresses belonging to one or more address blocks anchored at the Home Network: the

Mobile Network Prefixes (MNPs).When the NEMO is away from home, packets addressed to the Mobile Network Nodes (MNNs) will still be routed to the Home Network. Additionally, when the NEMO is away from home, i.e. it is in a visited network, the MR acquires an address from the visited network, called the Care-of Address (CoA), where the routing architecture can deliver packets without additional mechanisms. The goal of the network mobility support mechanisms is to preserve established communications between the MNNs and external Correspondent Nodes (CNs) despite movement. Packets of such communications will be addressed to the MNNs addresses, which belong to the MNP, so additional mechanisms to forward packets between the Home Network and the NEMO are needed. The basic solution for network mobility support essentially creates a bi-directional tunnel between the Home Agent and the Care-of Address of the MR

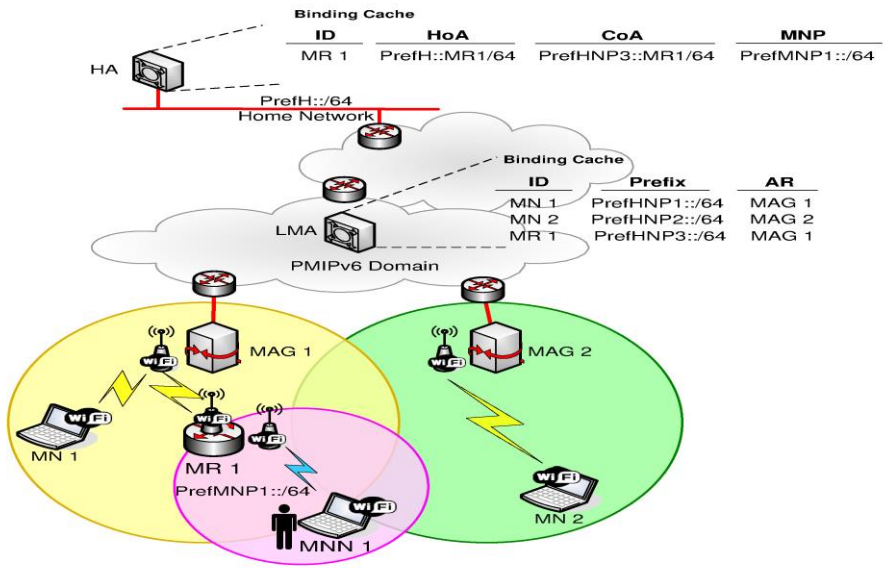

Fig.4 NEMO visiting a PMIPv6 domain

7. Conclusion

In this paper we present how network based localized mobility management takes place and the various operations performed over IPv6 . In this paper we present an end-to-end system design featuring flow mobility extensions for the Proxy Mobile IPv6 protocol. As network-based solutions for mobility has shown to be the most interesting for deployment in the next generation all-IP mobile architectures. Our future work will concentrate on intercluster communication, on route optimization as well as on QoS support. We also foresee the use of MPLS instead of IP-in-IP.

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