A network-based mobility management scheme for future Internet

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ABSTRACT

The current Internet was originally designed for "fixed" terminals and can hardly support mobility. It is necessary to develop new mobility management schemes for the future Internet. This paper proposes an Identifiers Separating and Mapping Scheme (ISMS), which is a candidate for the future Internet mobility management, and discusses the basic principles and detailed message flow. ISMS is a network-based mobility management scheme that takes advantage of the identity and location separation. The mobility entities in the core network are responsible for the location management. ISMS is designed to satisfy the requirements of faster handover, route optimism, advanced management, location privacy and security. The average handover delay of ISMS is on the order of milliseconds only, which is far smaller than that of Mobile IPv6. Analyses show that ISMS can reduce packet overhead on wireless channels. We build a prototype and perform some experiments. Results verify the feasibility of ISMS.

1. Introduction

With the boom of wireless technology in all its forms, wireless has becoming one of the most transforming network technologies to come along. The most obvious consequence of wireless is mobility. However, the current Internet was originally designed for end-to-end communications between fixed terminals and cannot support mobility well. In order to support mobility, Internet Engineering Task Force (IETF) has proposed plenty of protocols such as Mobile IPv4 (MIPv4), and Mobile IPv6 (MIPv6).

MIPv6 [1] is the de facto standard for IP mobility in IPv6 networks. It is a host based mobility scheme. That is, in MIPv6, a mobile node (MN) must support MIPv6 protocol and be involved in the mobility management procedures. For example, an MN must acquire a globally unique care-of address (CoA) whenever it moves to a foreign network. The MN also participates in the location management by sending binding updates to its home agent (HA) and corresponding nodes (CN).

The host based MIPv6 protocol has several drawbacks such as slow handoff [2], triangle routing, disclosure of location privacy [3], disclosure of mobility management node's address, i.e., HA, to MN and 3rd parties, and packet overhead on wire/wireless links between MN and HA.

In this paper, we present an Identifiers Separating and Mapping Scheme (ISMS) to solve these problems. ISMS separates customer networks from transit providers, and decomposes Internet addresses into Accessing Identifiers (AIDs) and Switching-Routing Identifiers (SRIDs) to decouple the "locator/identifier overload" of IP address. AIDs are network layer identifiers to be used by transport layer. On the other hand, SRIDs serve as routing tags in the core network. For flexibility, AID to SRID mapping is used to bridge the customer networks and the core network. As a result, we obtain a network-based mobility management scheme which provides lower handoff latency and highly efficient mobility management.

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The rest of this paper is organized as follows. Section 2 describes the related work. Section 3 describes the ISMS architecture and its working schemes. Section 4 analyzes the performance of ISMS, and compares it with MIPv6 and PMIPv6. Section 5 shows our prototype and the experimental results. Finally, Section 6 concludes this paper.

2. Related work

Several approaches have been proposed to address the IP mobility problem. The most well-known ones include Fast Handovers for Mobile IPv6 (FMIPv6) [4], Hierarchical Mobile IPv6 (HMIPv6) [5], Host Identity Protocol (HIP) [6], Cellular IP (CIP) [7], Handoff-Aware Wireless Access Internet Infrastructure (HAWAII) [8], Cellular Universal IP (CUIP) [9], Proxy Mobile IPv6 (PMIPv6) [10], Proxy Mobile IPv4 (PMIPv4) [11] and IP-based International Mobile Telecommunications Network Platform (IP^2) [12].

FMIPv6 and HMIPv6 are extensions of MIPv6. With the aid of L2 signallings, FMIPv6 specifies a protocol to improve handover latency caused by MIPv6 procedures. HMIPv6 designs a hierarchical mobility management scheme to improve the performance of MIPv6 in terms of handover speed. Although these two approaches can reduce the handover latency, they inherit all the others flaws of MIPv6.

CIP and HAWAII are micro-mobility oriented approaches. They reduce the handoff delay at the micro-mobility scale, and leave the macro-mobility for the traditional MIPv6 to handle. The major problem of these approaches is that the MN still requires the acquisition of CoA in macro-mobility. Hence, the overall delay caused by CoA acquisition is only reduced, rather than eliminated. In addition, some other issues, such as disclosure of location privacy, still remain unsolved.

In CUIP, a mobile node is assigned a universal IP address regardless of its location, making CoA and tunneling unnecessary in micro-mobility and even macro-mobility handoffs. CUIP incurs an expected network layer handoff delay on the order of milliseconds only. However, CUIP makes an impractical assumption that all the Top Level Core Routers (TLCRs) are directly connected in a meshed manner. Furthermore, CUIP brings more serious routing scalability [13] problems.

PMIPv6 is a network-based mobility management protocol. It enables IPv6 mobility for a host without requiring its participation in any mobility-related message. The network is responsible for managing IPv6 mobility on behalf of the IPv6 device. The mobility entities in the network are responsible for the location management of the IPv6 device and initiating the required mobility signalling on its behalf. PMIPv4 is also a network-based mobility management scheme. It provides mobility support for an unaltered and mobility-unaware IPv4 host based on mobility entities in the network. However, PMIPv6 and PMIPv4 are local mobility management protocols, and leave global mobility for traditional MIPv6/MIPv4 to handle.

HIP introduces a new method to handle mobility management taking advantage of the mentioned identity and location separation. It introduces a new name space, the Host Identity name space, between the IP layer and the TCP layer. The major drawback of HIP is that it still needs to obtain a new IP address when a host moves. The delay caused by IP Duplicate Address Detection (DAD) [14] cannot be reduced, although it is a major cause of excessive handoff delay.

IP^2 is a mobility scheme for the next generation mobile network architecture beyond International Mobile Telecommunications 2000 (IMT-2000). IP^2 separates the IP host address (IPha) which identifies the mobile terminal from the IP routing address (IPra) which routes a packet on an optimum route. However, IP^2 is mainly designed for the third-generation mobile system and not suitable for the Internet. For example, it does not consider the case that a customer network has many routers.

3. Identifiers separating and mapping scheme

3.1. Requirements

We have proposed the Universal Network architecture [15] for the future Internet. To design a good mobility management scheme for the future Internet, the following requirements must be considered.

(1) *Fast handover:* Compared to the current mobility management schemes, such as MIPv6, the new scheme must support faster handover to satisfy the needs of various real-time applications.
(2) *Route optimization:* To minimize the packet transmission delay, it is desirable to achieve route optimization. This is especially important if an MN roams into a visited network far away from its home.
(3) *Scalability:* For cost efficiency, a good mobility management scheme should be scalable such that it can be scale to large networks.
(4) *Advanced Management:* It is important for the Internet Service Provider (ISP) to manage the core network easily and efficiently.
(5) *Location privacy:* In the current 2.5G and 3G mobile networks, the location of an MN is hidden from the others. Location privacy is one of the important requirements for mobile users.
(6) *Security:* A new mobility management scheme must eliminate possible security attacks.
(7) *Reduce packet overhead:* Due to the resource limitation of wireless tunnels, a new mobility management scheme should minimize the message overhead and packet overhead on wireless links.

ISMS can address all these problems to a large extent.