A Real Inter-Continental Mobile IPv6 Demonstration between China and Japan for Mobility Enhancement

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Abstract - Mobile IPv6 is considered to be one of the key technologies for realizing mobile Internet which enables seamless communication between fixed line and wireless access networks. In this paper, we introduce the basic concept of Mobile IPv6 and describe the detail procedure of handoff of mobile terminal. We analyze its effectiveness of Mobile IPv6 handoff by using Network Simulator 2 and constructed Mobile IPv6 testbed based on Wireless LAN IEEE802.11b. Finally, we connect two Mobile IPv6 testbeds and test video transmission each other. This is the first test that three nodes of the Mobile IPv6 located separately in China and Japan.

I. INTRODUCTION

Recently the advances in wireless communication network and Internet are tremendous, and 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. Meanwhile, wireless telecommunication is not good at circuit switching, packet transmission, packet correction, error correction, and error detection. These two cases will bring some obstacle in technology for integration of the Internet and wireless communication. In the early 1990’s, 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. IPv6 is expected to replace the current IPv4 in the near future and it is most probably that mobile communications will use IPv6 at the network level because 3GPP (The Third Generation Partnership Project) has adopted IPv6 for third generation cellular hosts.

Since IPv6 is designed for stationary hosts in the Internet, Mobile IPv6 protocol extensions have been proposed for the mobile, wireless environment. The Mobile IPv6 protocol is currently being specified by the IETF IP Routing for Wireless/Mobile Hosts working group [1]. Mobile IPv6 is a routing protocol designed to provide seamless connectivity for mobile devices roaming between next generation IP networks. There have been some Mobile IPv6 testbeds in the world, but most of them are independent testbeds. We’d like to do Mobile IPv6 simulation and establish a Mobile IPv6 testbed based on WAN which will cross China and Japan.

This paper is structured as follows: Section 2 reviews the Mobile-IPv6 protocol for mobile nodes. Section 3 explains the network simulator procedure and result of the Mobile IPv6 handoff. Section 4 describes our approach to construct a Mobile IPv6 testbed and test Mobile IPv6 handoff between two countries based on IEEE802.11b wireless LAN. And finally Section 5 concludes this paper.

II. MOBILITY MANAGEMENT OF IPV6

Mobile IPv6 allows a node MN (Mobile Node) to change its point of attachment from one link to another, while still being reachable via its home address. While a MN is at home, packets addressed to its home address are routed to the mobile node’s home link using conventional Internet routing mechanism. That’s to say, packets from CN (Correspondent Node) are directly delivered to the Home Address of MN. As soon as a MN detects that it has moved from one link to another and it has discovered a default router, it will send Address Solicitation message to AR (Access Router). Meanwhile, AR periodically advertises the address advertisement Prefix in the foreign link. After the MN get address advertisement prefix, it will form a new care-of-address using address advertisement prefix advertised by the new router and its MAC address. This procedure is called stateless autoconfiguration. By which, the MN is very easy to find new access router and acquires care-of-address.

After the MN acquire care-of-address, it must register this care-of-address with it’s HA (Home Agent). The association between the MN’s home address and care-of-address is known as a “binding” for the MN. The MN sends packet to it’s HA containing a Binding Update with Acknowledge big set. The MN should retransmit this Binding Update to it’s HA until it receives a matching Binding Acknowledgement. If HA accepts the Binding Update, it must
create a new entry in its Binding Cache for this MN or update its existing Binding Cache entry. The HA must mark this Binding Cache entry as a home registration to indicate that the node is serving as a HA for this binding. While a HA is serving as the home agent for mobile node, it must attempt to intercept packets on the mobile node’s home link that are addressed to the MN, and must tunnel each intercepted packet to the MN’s care-of-address using IPv6 encapsulation. This tunneling is called Triangle Routing in Mobile IPv4. Triangle Routing cause lots of problem. If Mobile Node is away from home link, all traffic to MN will through HA, so HA will be the bottleneck of the network and crash down if there are too much packets to the MN.

In order to prevent the impact of any possible failure of the HA or networks on the path, Route Optimization has been used to eliminates the congestion at the MN’s HA and home link in Mobile IPv6. In this mode, MN will register its current binding at the CN. Packets from the CN can be routed directly to care-of-address of the MN. When sending a packet to any IPv6 destination, the CN checks its cached binding for an entry for the packet’s destination address. If a cached binding for this destination address is found, the node uses a new type of IPv6 routing header to route the packet to the MN by way of the care-of-address indicated in this binding. Routing packets directly to the MN’s care-of-address allows the shortest communications path to be used.

III. SIMULATION

A. Simulation environment

NS2 (Network Simulator 2) has been chosen for our simulation. Meanwhile, we referred Mobile IPv6 simulator tool MOBIWAN [2] to do simulation about testbed. This simulator tool has some bug inside, so we have to modify the source code to let it work normally. The Mobile IPv6 Simulation Node Figure of NS2 is as follows:

In this figure, Binding Cache Classifier means Binding Cache of the Mobile IPv6; it keeps home address and care-of-address of the MN. When the destination address of one packet can be found in Binding Cache record, then this packet can be transferred to Source Classifier, otherwise it will be passed to Classifier, find a right routing and sent to transmission network. Source Classifier will compare the source address with node’s address. If the result is true, Source Classifier will deliver the packet to Routing Header; otherwise the packet will be sent to Encapsulator and encapsulated with IPinIP. When the packet received was sent by node itself, Routing Header will add a routing header in front of the packet, then this packet will be sent to care-of-address firstly, then it will reach home address of the destination node. If the packet received was delivered by other nodes, then Routing Header will handle this packet and deliver to the next destination address. Lastly, MIPv6 Agent module was used for realized Mobile IPv6 basic function. For three kinds of Mobile IPv6 nodes, there have three inherited classes BSAgent, CNAgent and MNAgent which realized three nodes’ function (HA, CN, and MN).

B. Simulation of the handoff

The network topology of the simulation is as follows:

Fig. 2 Network Topology of the Mobile IPv6 handoff

In order to simulate the realistic network, the setting environment of simulation is as followings:

1) AP1 and AP2 periodically advertise router subnet prefix in every cell in order that MN can receive this advertisement;

2) UDP will be used for communication between CN an MN;

3) The MN moves to and from between two cells.

The following figure 3 is simulation result about handoff latency and Advertisement period.
Here, handoff latency means the disruption time of UDP communication between MN and CN when handoff. Because simulation can easily control the Router Advertisement Interval (second), so we can decrease this value to any value and MN can receive two advertisement address prefixes from two APs meanwhile, so the handoff latency is quite small in the Fig. 3. It can be easily found that handoff time grows up with router advertisement interval.

IV. MOBILE IPV6 TESTBED

The merit of the Mobile IPv6 testbed is the provision of an operational Mobile IPv6 network environment supporting real user communities and a wide range of demanding applications. There are several implementation based on Mobile IPv6. Lancaster University and Microsoft have jointly developed Mobile IPv6 implementation based on Windows 2000 and Windows CE. MIPL (Mobile IPv6 for Linux of Helsinki University of Technology) [4] is an implementation of Mobility support in IPv6 Internet Draft. MIPL has been released under GPL and is available to anyone for free. In Japan, KAME (BSD operating system) [5] of the WIDE project also has developed the Mobile IPv6 implementation. USAGI (Linux operating system) of the WIDE project use MIPL Mobile IPv6 implementation directly with some small modifications.

In this testbed, we chose MIPL implementation to establish testbed. The topology of the network is as Figure 4. IEEE 802.11b Wireless LAN has been adopted for wireless communication. HA, MN and CN are based on Linux operating system. We are focus on research on Mobile IPv6 handoff technology. During the experiment, the HA of the MN located in subnet 1, when MN roaming across from subnet 1 to subnet 2, packets from 3ffe:302:11:4::2/64 (CN) to 3ffe:302:11:2::2/64 (MN) reached home link: 3ffe:302:11:2::0/64 firstly, then HA encapsulated those packet and tunneled them to the care-of-address 3ffe:302:11:3:3453:21FF:FE32:4362 of the MN, after route optimization has been established, packets will be directly delivered to 3ffe:302:11:3:3453:21FF:FE32:4362 rather than 3ffe:302:11:2::2.

Finally, we connected this testbed with Hitachi Central Research Lab. Mobile IPv6 testbed. The topology of this connection is as following figure 4:

The HA, MN, and CN have been assigned in two countries. MN and HA were located in Hitachi CRL side, CN was set in Tsinghua University. We used real time video transmission to test the Mobile IPv6 handoff between two continents. The result is video transmits well each other.

![Fig. 4 Network Topology of two Mobile IPv6 testbeds](image)

V CONCLUSION

In this paper, we have briefly introduced the Mobile IPv6 ability to support mobile networks. After modifying the source code of the MOBIWAN, Mobile IPv6 simulation has been done by using NS2. The result of testbed is that handoff latency is more than 2 seconds. Finally the two Mobile IPv6 testbeds joint test has been taken by assigning MN, HA, and CN in China and Japan. During the experiment, we find Mobile IPv6 still has handoff latency problem. Fast handoff and hierarchical mobility management will be useful to improve the problem.

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