

Interoperability between Mobile IPv4 and Mobile IPv6 based on MPLS core network

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Abstract — Wireless network with its rapid development and widely using, will be the next investigation of researchers because there are many obstacles must be passed to completely deploy it at the present and on the future. This paper will focus on one part of wireless field, that is, the interoperability between Mobile IPv4 and Mobile IPv6. For better QoS services and how the proposal can be applied for large network on internet, we will develop our solution on MPLS network that now is used for QoS and high-speed core network.

Keywords — Interoperability Mobile IPv4 and Mobile IPv6, MPLS, QoS core network.

1. Introduction

Today, the problems that have specially been concerned with are how to develop from IPv4 Internet to the Next Generation Internet, IPv6. Because the transition can not be implemented immediately, it is only preformed by a step by step process. On early step, the IPv4 network will be the major part and IPv6 network will be the island among IPv4 networks. By the development, IPv4 network will be fewer and disappeared on far future. The IPv4 network and IPv6 network cannot exist independently and no communication among them, so we must develop new mechanisms about the interoperability between IPv4 and IPv6. We can list some complex mechanisms such as Dual-Stack, Tunneling, NAT-PT... [1][2][3].

The problem is not only in here, when deploying mobile services on both the IPv4 network and IPv6 network, the more and the more things will appear to be solved. Mobile IPv4 entities could be roamed on IPv6 network and on the contrary, Mobile IPv6 entities roam on the IPv4 network. The current Mobile IPv4 and Mobile IPv4 based on Internet Engineering Task Force (IETF) does not have fully worked-out mechanism to retain the IPv4 and IPv6 connectivity on these cases.

Another side we also mention in here is about MPLS protocol. From the requirement of real network, there must be a new protocol that is the combination between IP protocol and protocols on broadband networks such as Frame Relay, ATM... This protocol doesn't change entire existing architecture IP network and also not reduce the speed of broadband network. MPLS protocol is researched and developed. MPLS protocol is implemented by encapsulating a small header to IP package on MPLS domain, so that we don't have change so much. Each header has label, MPLS can use

label for switching technique to reduce the time delay package on each router and remain the speed of broadband network [4][5][6]. In MPLS, packets are encapsulated MPLS header at ingress point. Each header has 4 bytes, and the important part is the label used to switch packets into the label switched path (LSP) at each node. LSPs carry aggregate flows including packet flows that have common characteristics such as same source-destination address, destination address match a particular IP address prefix or have the same TCP port number... The set of these packets is called FEC, and an FEC will be associated with a LSP to forward packets. The labels of LSP from ingress to egress of MPLS domain are bound by signaling protocols such as RSVP-TE or CR-LDP.

MPLS, a proposal protocol first appeared for the combination between ATM and IP network but now is deployed widely on core network by its simplicity and efficiency. Rather than, MPLS network based on switching and label technique, can setup the explicit LSP paths that can forward packets that is not depend on higher network layer (IPv4 and IPv6) and guard QoS services. Above reasons lead us to find the way to combine these fields and figure our ideas on the interoperability between Mobile IPv4 and IPv6 on MPLS core network.

We will support some background knowledge about Mobile IPv6 and Mobile IPv4. When a Mobile Nodes move far a way from its home network, at foreign network, they will receive new address called Care-of-address (CoA). To the Correspondent Node can continue communicate to Mobile Nodes when it only know home address of MN, there must be a home agent in MN 's home network, that will forward the packets to CoA of MN.

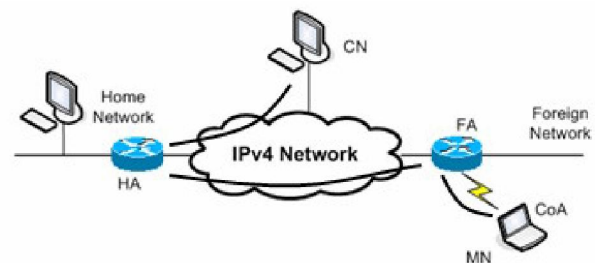


Figure 1. Mobile IPv4

Mobile IPv6 is improved to avoid triangle routing (the packet must go to Home Agent before to MN), by the way that

it will send Binding Update Messages (that map a home-address on to a care-of-address) and each node maintains a local Binding Cache of binding known to it, so that packets can be routed directly to a mobile node.[11]

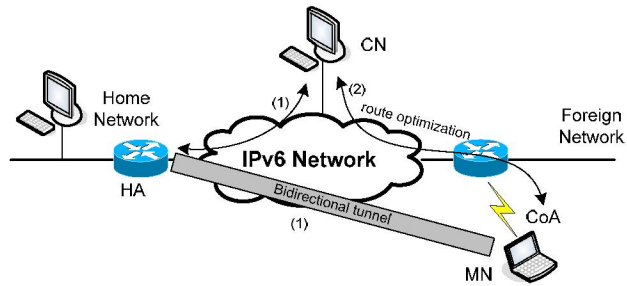


Figure 2. Mobile IPv6

Some articles have been researched about integrating Mobile IPv4 and Mobile IPv6 on MPLS by setting the LSP tunnel directly packets from CN to MN to get optimal route from CN to MN [7][8]. But they only mention about independent Mobile IPv4 or Mobile IPv6 networks. A new mechanism has also been proposed to solve the problems of transiting Mobile IPv4/V6 by using Home Agent as proxy implemented both IPv6 and IPv4 with two IPv4 and IPv6 addresses, and this proxy is used for the communication between CN and MN [9]. The authors of this paper will also admit that their mechanism still has triangle problems and must be researched further on future.

On this paper, we will deploy a model, that enables MIPv6 or MIPv4 nodes still connect with CN transparent on IPv6 or IPv4 network where Mobile Nodes move to. The model is archives with little addition function on MPLS border routers and also supports optimal routing between mobile nodes. On the next section, we will express the details of our proposal.

2. The interoperability between Mobile IPv4 and Mobile IPv6 on MPLS core network

On our proposal, the MPLS core network is used to connect different network including IPv4 and IPv6 domain. The model is pictured by figure 3. The LER routers of MPLS domain must support tunneling techniques. That means it can tunnel IPv6 in IPv4 packets to cross the IPv4 domain and same as IPv4 in IPv6 packets. The other technique used in here is using IPv6 address corresponding with IPv4 address, called IPv4-compatible form, generated by mapping an IPv4 address to IPv6 address space, the simple case is IPv6 address consist of 32 bit IPv4 address prefixed by 96 bit zeros.

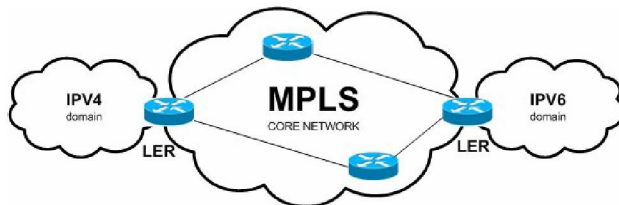


Figure 3. MPLS with different IPv4 and IPv6 domains

We will solve two different problems:

2.1 Mobile IPv4 nodes roam on Mobile IPv6 network

Normally, when a mobile IPv4 node moves to other foreign IPv4 networks, it uses the mechanism of combination between Mobile IPv4 and MPLS on [7]. That means first both MN and CN will use HA for communication but later, a LSP will be setup directly between them to forward packets.

When a Mobile IPv4 node moves to a foreign IPv6 network, it will be autoconfigured a new IPv6 CoA. Because of this new IPv6 address, it will be disconnected from its home network (IPv4 network) and CN.

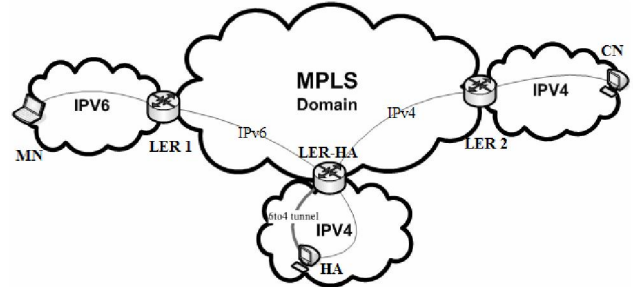


Figure 4. Communication between MN and CN by using HA as agent

Mobile nodes will try to reconnect Home Agent by using IPv6 address on IPv4-compatible form of Home Agent. And now, the border router LER-HA must be integrated additional functions, tunneling, that will permit it connect network on two different IP version domains. Since the Home Agent knows that MN roams on an IPv6 network, it will tunnel IPv6 on IPv4 packets to send to MN by using MN old IPv4 home address, because MN doesn't have new IPv4 CoA. After LER-HA receives these packets, it will check and if it knows these IPv4 packets tunnel other IPv6 header, it will remove IPv4 header, recover IPv6 datagram and send them to MN. If IPv4 packets don't tunnel IPv6 header and have IPv4 home address as destination, it means LER-HA will forward packets to its domain. Now the connection is established from MN to Home Agent and opposite direction, so CN, MN will use LER-HA as proxy to send packets between them.

To avoid the triangle problem that increase traffic, load on Home Agent, longer round-trip time, we will setup the direct connection between MN and CN, but we must use another binding update mechanism because, now, we must setup the connection between two different version IP network.

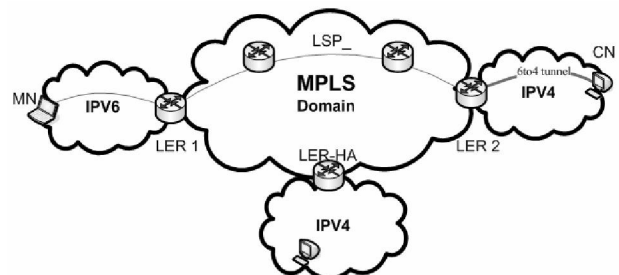


Figure 5. Communication between MN and CN after setup Label Switching Path LSP

MN can send the binding update message to map its home address with its new CoA and CN can use MN's IPv6 address on IPv4-compatible form to communicate with MN. At this time, LER2 must add tunneling function to tunnel IPv6 header on IPv4 packets. CN tunnel IPv6 header on IPv4 packets that

have destination as MN IPv4 home address. Since LER2 receives the packets and check that they have been tunneled, it will recover IPv6 header and send to MN, the opposite direction has the same mechanism.

Next step, LER1 send LSP request to LER2, and a Label Switching Path LSP_ is established between CN and MN. LSP_ has two FECs correlative with two IPv4 address, MN home address and CN address. When MN prepare to move out LER1 domain, it must send LSP release message to free LSP_ and the communication with CN will return to use Home agent proxy.

2.2 Mobile IPv6 nodes roam on Mobile IPv4 network

The integration of Mobile IPv6 and MPLS is preformed on the article [8]. By using this mechanism, the connection of MN and CN will be retained by MPLS core network since Mobile IPv6 nodes move to other foreign IPv6 networks.

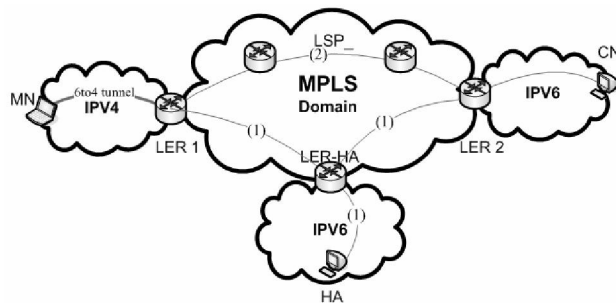


Figure 6. Communication between MN and CN after setup Label Switching Path LSP_

When Mobile IPv6 node roams on a foreign IPv4 network, it will lose connection with CN and Home Agent because of its new IPv4 CoA. We can also use similar mechanism mentioned on previous section to solve this problems, but on this case, we can map new IPv4 CoA of MN with an IPv6 address by IPv4-compatible form and the problem will be simpler. The mobile IPv6 is applied on this case. MN will send binding update message to CN, bind its old IPv6 address with its new CoA IPv6 address on IPv4-compatible form. LER1 has an intermediate role for tunneling the header IPv6 on IPv4 packets. On the next step, a similar technique, Mobile IPv6 on MPLS, also is applied, new LSP_ is established between LER1 and LER2 using CN IPv6 address and MN CoA as FECs.

Before moving to another domain, MN must send message to release the LSP and establish new LSP to domain it will come.

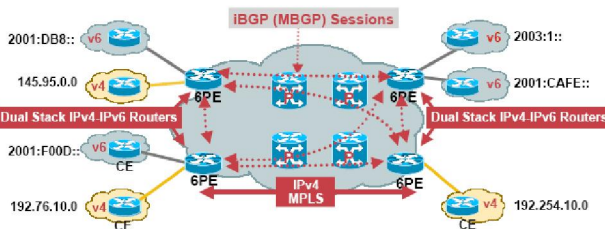


Figure 7. IPv6 provider Edge (PE) Router over MPLS

On the other hand, Cisco has given out many solutions of hardware and software, such as routers series 7200, 7300,

7500 which support IOS 12.2 and can be configured as dual stack routers, provider edge routers or virtual provider edge router [11], that can be used for transferring IPv4 packets to IPv6 routers and vice versa via MPLS core network (Figure 7).

Dual stack routers can be the core routers in an IP network. However, in an MPLS network, they are used as edge routers to change ipv4 packet format to ipv6 format and vice versa.

3. Implementation on network simulator

We are on the going way to build a project package on network simulation ns2 [12] that will support complete solution for Mobile IP services on MPLS core network and the transparence to the different mobile IP protocols. Our package inherits from some previous project have been implemented before on ns2. The MPLS implementation is available as a separate routing module in packages MNSv1.0 and MNSv2.0. The current MPLS module has been implemented by Gaeil Ahn and Woojik Chun [13]. Meanwhile, Mobile IPv4 is already integrated on ns2, but they can't work with MPLS because on ns2, Mobile IPv4 use hierarchy classifier address but MPLS is use only one classifier level. The HierMNS package [15] solves this problem by combining hierarchy MPLS package [14] and Mobile IPv4.

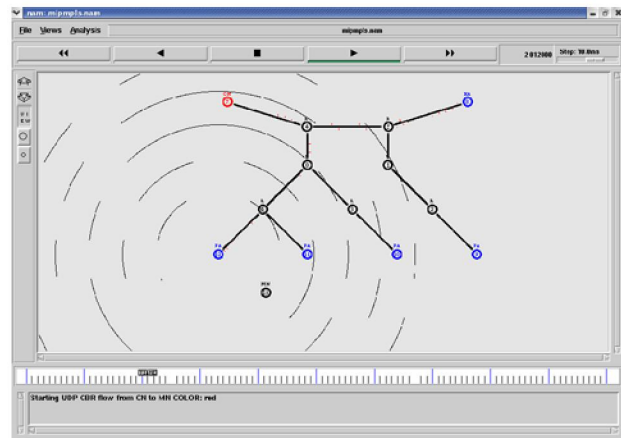


Figure 7. CN communicate with MN through HA

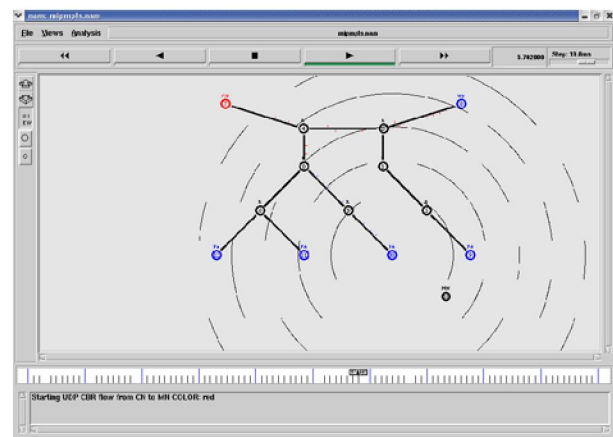


Figure 8. When MN roam to another network, it continues communicate with CN

Mobile IPv6 package[16] is also developed and brings more and more difficulty to combine all package together because it

use more classifier level than Mobile IPv4 and don't support MPLS. On the limitation of our project, we integrate all of them on ns2.27, build a combined mechanism so they can interact and work together, and then implement the interoperability between Mobile IPv4 and Mobile IPv6 on MPLS by our proposal.

From our research and implementation by using packet [15], we would like to describe the result of the simulation in case that a mobile IP node communicates with a correspondent node via a MPLS core network (Figure 7, 8).

4. Conclusion and future

In this paper, we have proposed the ways to support Mobile services for both IPv4 and IPv6 application even when mobile nodes roam on the domains that have different IP versions. Our ideas are developed on MPLS network by the widely use, fast switching speed and efficiency. The addition functions, tunneling packet, are also added to border routers of IPv4 and IPv6 domain, because they have a role as a gate to communicate between IPv4 and IPv6. We can observe obviously the advantages of our proposal model, the implementation will focus mainly on MPLS router, the mobile nodes router don't need two both IPv4 and IPv6 CoA addresses when they move to different IP version network and the strong point of MPLS to satisfy QoS LSP connect from CN to MN. But, rather than, our approach provides a simple mechanism to get transparency for IPv4/IPv6 interoperability that previous research can not provide a complete solution.

Today, with the rapid development of hard-ware devices and integrate chips, new generation routers that can support flow-based routing has been researched and developed. These routers can manage every flow of data and so that, it will support better QoS services and high speed by using hard-ware processing based. The next generation of IP network has the tendency to flow-based network by many advantages they bring. Our approach is implemented on MPLS core networks and it is easily developed on flow-based network routers because of the similarity on flow management of flow-based routers and LSP of MPLS. Our future plans will be investigated on the integration of mobile IPv4/IPv6 and the operability IPv4/IPv6 solution on flow-based network.

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