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STUDY THE HANDOFF MANAGEMENT OF MOBILE IPV6 NETWORK BASED ON MPLS

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Abstract

According to handoff management problem of mobile IPv6 network, when the mobile node accesses field network and leaves home network, to switch link, it will appear the decline of quality of service or business interruption. Accordingly, the paper proposed a hierarchy of handoff management scheme for the integrated multi-protocol label switching in mobile IPV6 network. With analysis on architecture and working principle of the MPLS technology, we listed common switching methods for the current mobile IPV6 network, switching process and performance for the standard mobile IPV6 network. By introducing the regional anchors, the burden of end node registration information processing for the home agents and communication on hierarchical switching optimization was reduced, thereby the registration delay and handoff delay was reduced, and the switching performance was improved. The theoretical analysis and computer simulation show that, the switching delay of proposed scheme is smaller than that of a standard mobile IPV6, which will better support high speed mobile for the host.

Key words: Multi-Protocol Label Switching, Mobile IPv6,Switching Delay , MAP

Introduction

3G is a network communication technology with capability to combine the real-time, non-real-time, and broadband services, and meets the needs of the development of multimedia and video services. Currently,

The scale and number of the mobile devices are increasing rapidly, which with needs to connect to the Internet. How to ensure that these mobile devices can get high-quality communication services, and to better support end-to-end and multimedia services, has became to be the hot issue for the researchers in relative field. The mobile IP technology is to access the network in the case of communication was interrupted for the mobile host. Due to the high frequency of the movement of the mobile node, packet loss will occur if the registration to the home agent of the new care-of address was untimely. Such situation can be resolved by smooth handoff of internets.

The integration of multiprotocol label switching into the mobile IPv6 can improve network packet forwarding speed and quality of service, but after the integration, the switching delay of the host not only includes the delay introduced by the mobile IPv6 protocol operation, but also re-establish delay of the label switched path (LSP). When the user switches frequently, there will be a sharp decline in quality of service and even business interruption. Therefore, the study of IPv6 mobile network switching management scheme with low-latency and low packet loss rate is particularly important.

Ref. [1] - [3] have put forward a working mechanism and key technologies of mobile IPv6, and analyzed the problems brought by the direct application of mobile Ipv6 to the mobile network, then put forward a scheme of supporting the mobile network through improving the mobile IPv6. Ref. [4] studied the working principle of the mobile IPv6 and t a variety of mobile IPv6 experimental systems currently developed in Windows, BSD and Linux operating systems, and established the experimental environment and tested the MIPL mobile IPv6 under Linux operating system; Ref. [5] - [8] mainly researched on the mobile management technology with combination of mobile IP with the MPLS. ITU-T is also actively involved in the combination research of Mobile IP and MPLS technology, and has proposed a series of draft standards, initially established a basic framework and implementation way orienting to the combination of Mobile IP and MPLS technology for the next-generation networks, provided a new way to achieve more effective network mobility management.

The architecture and working principle of MPLS

MPLS technology is a connectionless-oriented IP network introduced in connection oriented communication mecha-nism , constructing label switched path (LSP) through label distribution protocol (LDP) using a short, fixed-length tag, and achieving the data packet forwarding by utilizing label switching mechanism. The core technology is: edge routing and core switching. The flexibility of IP routing protocols and the speediness and efficiency of the second layer label switching in MPLS can support traffic engineering and active routing, and provide a simple, high-speed data exchange to guarantee QoS and security of network communication.

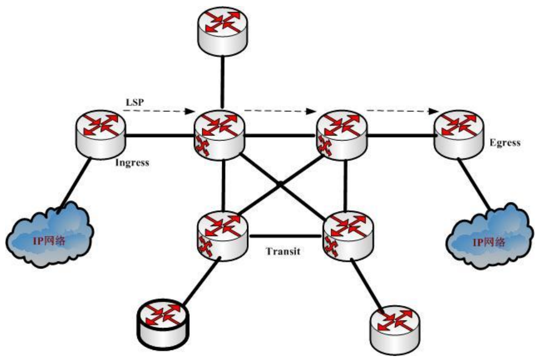

Figure 1. The flow chart of MPLS architecture

The flow chart of MPLS architecture is shown in Fig. 1. The basic unit of MPLS is label switching routing - LSR and a network called MPLS domain constructed by the LSR. LSR is located in the edge of the MPLS domain. LER connected with other networks are called LER (Label Edge Router), and LSR within the region known as core LSR. The core LSR supports MPLS router, which can be generated by upgrade of the ATM switchboard. MPLS communication is used to communicate LSRs within the domain, and the edge of MPLS domain is adapted by traditional IP technology. After LER are pushed onto the label, the packet was transited along the LSP constructed by a series of LSR, where the entrance LER is called ingress, export LER is called Egress, and intermediate nodes called Transit.

The label is a format and length fixed datagram header. When IP packets goes into the IP / MPLS backbone from the ingress LER, the label is inserted in the IP packet between the second layer header and the third layer header. To access the ATM backbone network, labels are mapped to ATM PVC VPI / VCI field. Transmission of packets in IP / MPLS backbone is no longer need hop by hop routing selection process from LSR, but by the interface on each LSR deciding the transmission path based on the tag information table (Label Information Base - LIB). LIB is a dynamic label switching table maintained by each interface on the LSR, which is generated from the MPLS signaling process. Each of the entries in the LIB has the same format: ingress interface + entry tags + export label + egress interface.

The working principle of MPLS is as follows:

- First, together the label distribution protocol and traditional routing protocol, create a routing table and LIB for the FEC with service needs for each LSR;
- Ingress LER receives a packet, completes the third layer functions to determine the FEC that packet belongs to, and labels the packet, grouping MPLS labeled packet;
- In a network comprised of LSR, LSR forwards according to the labels and label forwarding table, without third layer processing;
- LER removes packets labels at the MPLS export, and then process IP forwarding.

It can be seen that MPLS is not a service or application but a tunnel technology; it is also a routing and switching platform with combination of label switching and network layer routing technology. This platform not only supports multiple upper layer protocols and services, but also to some extent guarantees the security of information transmission.

Mobile IPv6 switching technology and performance

A Mobile IPv6 switching technology

In mobile IPv6 network, when the mobile node moves from one subnet to another subnet, it’s required to switch. Mobile node binds its care-of address to the home agent HA after leaving home agent, and builds bi-directional tunnel between the home agents. Then the data packets between communication end nodes CN are forwarded by the HA. For the reasons of high error rate and signal stability of the wireless transmission link, the switching process will cause the mobile nodes can’t receive and send data. Switching is a mobile node moves in cellular network, a mechanism of communication system and to maintain an ongoing communication link transfer conversion. Switching control as an important means of the wireless link, it can reduce the packet loss rate, provide better communication quality.

In order to reduce the impact of switching on Qos, Mobile IPv6 defined basic procedures such as motion detection, care-of address access and rebind and so on, and divided the switching technology into four major types [2-4]:

- Smooth switching

Smooth switching is a switching scheme aimed at reducing the rate of IP packet loss, also known as low packet switching. It is characterized by almost no packet loss during switching the mobile node. Because of the use of the mobile IPv6 caching mechanism, when the mobile node moves to a new network and without a complete registration, since the originally transmitted data packet is not finished, the mobile node requires that the current subnet router caches its packet to complete the registration process to the new network router. After the registration is completed, the mobile node in the new network will have a legitimate care-of address, and the data packets previously cached at the atomic network can be

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forwarded directly over, reducing the possibility of packet loss in the process of moving.

- Fast switching

Fast switching is also known as the low latency switching, which is an extension to the Mobile IPv6 protocol. It requires a fast switching process of the mobile node, and the packet delay to be small as possible. Adopt pre-switching and tunnel-based switching mechanism to achieve fast switching by keeping communications to the previous network before the switching of the new foreign network pre-registered is completed.

- Seamless switching

The seamless switching combines features of the smooth switching and fast switching technology, is a good switching method with low latency, low packet loss.

- Hierarchical fast switching

Hierarchical fast switching combines hierarchical mobile IPv6 technology and fast switching technology. With utilization of hierarchical mobile IPv6, it can significantly shorten the registration delay of the mobile node's home and communication end, and fast switching can reduce the connection interrupt time during the switching process of the mobile node, ensuring the real-time transmission of the communication flow.

B switching performance

The measure of switching performance is the handoff delay due to the different switching method of the mobile node has different switching mechanism, resulting in different handoff delay. Standard Mobile IPv6 node switching, for example, we analyze the performance of its switching.

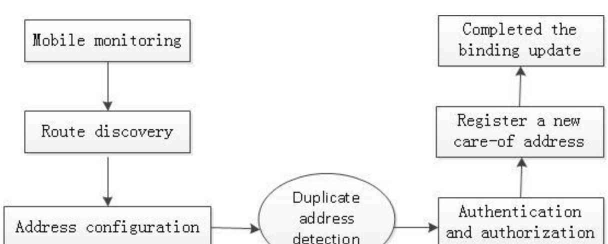

Figure 2. The flow chart of handoff process

Assume $T_{handoff}$ to be Mobile IPv6 handoff delay, T_{md} to be the movement detection delay, T_{2h} to be the Layer 2 switching delay, T_{rad} to be the repeated address detection delay, T_{reg} to be the registration delay, $T_{handoff} = T_{md} + T_{2h} + T_{rad} + T_{reg}$ ..

Where: T_{md} depends on the interval sending router advertisement, that is to say, the delay brought about by the new access router sends the router advertisement is received;

T_{2h} is a delay linking mobile node to another foreign network;

T_{rad} is the maximum component in the latency of mobile IPv6 switching, the mobile node repeatedly send detection request to its neighbors that whether the subnet hosts use a host with the same address to avoid conflicts, this will generate a delay;

T_{reg} is a delay of registering the home agent and the correspondent node to the mobile node.

The switching management scheme of hierarchical IPv6 mobile network based on MPLS

A Scheme description

The Scheme is based on hierarchical mobile IPv6 (HMIPv6), which is a micro-mobility protocols extended from standard mobile IPv6, dividing the entire network to different regions, then access router and register the bottom MAP. By the simple extension of the MAP, we cascade n MAP domain to a regional RAP. Moreover, accompanied by the movement of the MN, the regional switching can be done by dynamically alternating. This layered scheme limits small-scale switching in its MAP domain, to reduce the signaling overhead.

In hierarchical mobile IPv6 network using MPLS technology, when the mobile node enters a foreign network, the mobile node using IPv6 neighbor find and address auto-configuration mechanism to get care-of address. Then sent hop-by-hop binding update message to the home agent (HA) and communication peer node (CN). MPLS-based hierarchical mobile IPv6 network structure is shown in Fig. 3.

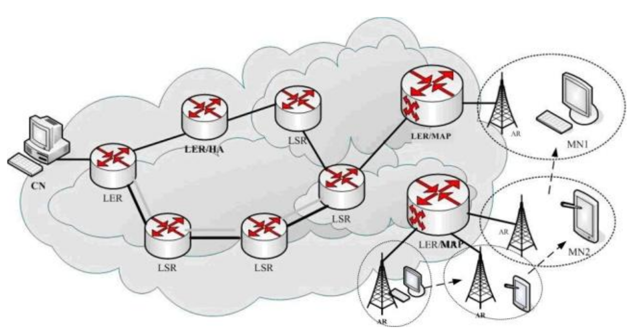

Figure 3. MPLS based HMIPv6 access hierarchical network

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RAP in optimization scheme is to serve as a temporary home agent HA, but manage a greater range than the mobile anchor MAP. In this case, the care-of address of the mobile node is comprised of care-of address of the link anchor (MN temporary address stored in the MAP), anchor care-of address (MN temporary address stored in the MAP and RAP, that is prefix of subnet where the MAP is in) and domain care-of address (MN address stored in the HA and CN, that is prefix of subnet where the RAP is in). Now the switching mode when the mobile node to access the network has two cases.

- The mobile node RAP domain at the same, the mobile node (equivalent to III.A above referred to fast switching hierarchy switching mode when the mobile node moves within the same MAP, it is not to be discussed);
- The mobile node is moved in the different RAP domains.

After HMIPv6 and MPLS are combined, not only makes the mobile node improved mobile performance in a wide range, but also guarantees small-scale quick and seamless move for a mobile node.

B mobile node mobile models

The mobile node in the process of moving speed and direction, the size is not fixed, so the motion trajectory model also vary, generally the mobile node's movement pattern is divided into the following:

- Linear movement

In the linear motion mode, the traces of the mobile node complete a switch is a straight line.

- Random movement

In the random motion mode, the mobile node to complete a switch along the path there is no certain rule, every move direction may change, so the formation of the trajectory is disorganized.

- table tennis movement

Table tennis movement is a special mobile mode mobile nodes form in many of the switching process, and also the important base for improvement of mobile IPv6 handoff process and method. In this mobile mode, the mobile node frequently between the two access router to switch back and forth, and move every switching node needs a certain delay, signaling cost, frequent switching consequences may cause serious communication interrupt. Mobile IPv6 handoff method of the original did not join the special mobile mode are considered, resulting in ping-pong movement mode communication performance is poor, therefore, is of great significance to improve the communication performance of mobile nodes in mobile mode.

C To reduce the handover delay strategy

The main step of mobile IP handover is the mobile detection and switching judgment before the switching. When the handover decided, the mobile node requests that a new foreign agent or directly to the foreign agent known to register, and further to the home agent location update. In general, the delay switch is mainly divided into two parts: change detection and registration delay. Among them, change detection delay including mobile detection and handoff delay, and registered transmission and processing time delay including registration message. Therefore, the mobile $T_{handoff} = T_{md} + T_{reg}$ handover delay, IP here, T_{md} for the movement detection delay, T_{reg} for the registration delay. In IETF, puts forward some methods for reducing the switching delay mainly:

(1) Registered in advance (PRE-REGISTRATION) switching method

This method allows the third layer switching the switch priority and second layer. As follows, the mobile node of the original foreign agent to obtain proxy broadcast messages come from the new foreign agent, the new foreign agent is the network inside the roaming mobile nodes in the original foreign agent, get this message, this message in its own subnet broadcast, the mobile node receiving this message later perceived their mobile, and before the second layer switch to switch the third layer by the new foreign agent.

(2) Subsequent registration switching method

This method is the third layer switching after the second layer switching, the foreign agent and the foreign agent by receiving the source and target excitation link layer information to build a temporary tunnel, those coming from the mobile node to the mobile node or send data packets to the new foreign agent and the foreign agent through the tunnel.

(3) The combination of the two methods

This method combines the above two methods, the mobile node first switch try the first method, if it fails, try to use second methods to switch. The suggestion that made the link layer information is very convenient and possible, so it does not specify how to obtain the link layer information. In fact, in the IEEE 802.11b\/a, the information is more difficult, and the third layer exchange and second layer network different entities to participate in, such word, so that they work together is not an easy thing. But we should realize that, these methods are more or less need to change the existing mobile IP specification, so if they are introduced into the existing deployed in the real network, will be more difficult.

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Switching process

A MN switching process in the same RAP domain

When the mobile node moves in the same RAP domain, the mobile for the RAP is equivalent to the MN. In this case, the regional care-of address of the mobile node remains unchanged, while the link care-of address and anchor domain care-of address both changes. The switching process is shown in Fig. 4.

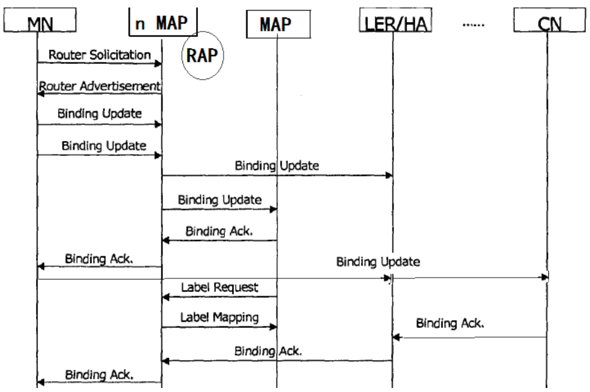

Figure 4. The switching process in the same RAP domain for MN

(1) MN get anchor care-of address and link care-of address through LSR. Then, MN sends to the MAP a Binding update, whose source address is to change as link care-of address.

(2) MAP repeatedly do the address detection in its own link for the MN's anchor care-of address, and move the anchor according to the binding update message to judge whether the previous MAP is in the same RAP domain. If yes, then the MAP quickly sends a binding update message to the regional anchor RAP. The binding update message including the link of the MN care-of address, anchor care-of address, and domain care-of address.

(3) Regional anchor RAP acts as a home agent, repeatedly do address detection in its link for domain care-of address of the MN, and return Binding Ack news to mobile anchor MAP.

(4) MAP receives Binding Ack message returned from REP, and then returns a binding acknowledgment message to the MN, confirming that the message contains the mobile node's regional care-of address.

(5) MN sends a binding update request to the HA and CN, to register a new care-of address.

(6) Data packets will be transmitted through the tunnel from the MAP to the address of the link care-of address, then complete the switching process.

B The switching process for MN in different RAP domain

When the MN moves to a new RAP domain, MN constitute the anchor care-of address through ingress LER. MN sends a Binding Update message to the MAP, and binds link care-of address of the MN and anchor care-of address. MAP sends a Binding Update to the REP, and constitutes the anchor care-of address through ingress LER, binding the three care-of addresses. And send the Binding Ack to MAP, then sends the binding acknowledgment message to the MN after the MAP received RAP Binding Ack, while the MN regional care-of address has changed. As a result, we send a Binding Update to the HA and CN request to register a new care-of address.

Simulation and analysis

In order to evaluate the switching performance of the proposed scheme and compare different switching methods, we first construct a simple simulation environment, as shown in Fig. 5. In the topology map, assuming that the AR coverage area does not overlap, and there is no vacuum region covered by the AR. Moreover, we assume the wired link rate is 100 Mbps, each link delay is fixed at 1 ms, wireless link rate is 20Mbps, whose delay is 5ms. The link switching process is out of packet loss. Data are sent from the CN to the MN, with UDP data packet type suitable for real-time business, where each packet size to 50KB and the send interval for UDP is 10ms. At the same time, we set MN wireless start access to AR1, move from AR1 to AR4. MN receives packets sent from the CN; the MN care-of address is comprised of link care-of address, anchor care-of address, and domain care-of address, which are from AR, MAP and RAP respectively.

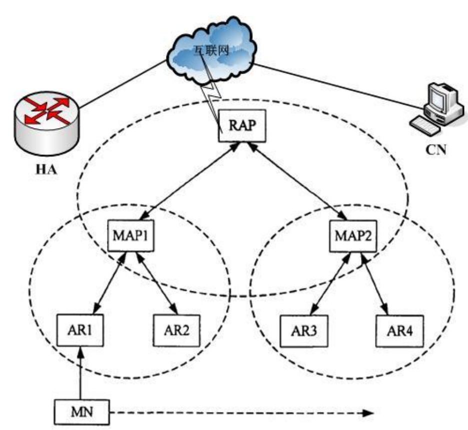

Figure 5. The flowchart of simulation topology

During the simulation process, MN moves as description at VI, wherein the AR1-AR2 movement is anchor domain

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switching, AR2-AR3 movement is the switch of regional anchor domain, AR4-RAP movement is out-of-domain switch. For comparison analysis, we removed the same switching delay in the simulation. We test 10 times to check the MN switching delay, taking the average value, and the simulation results are shown in shown in Fig. 6.

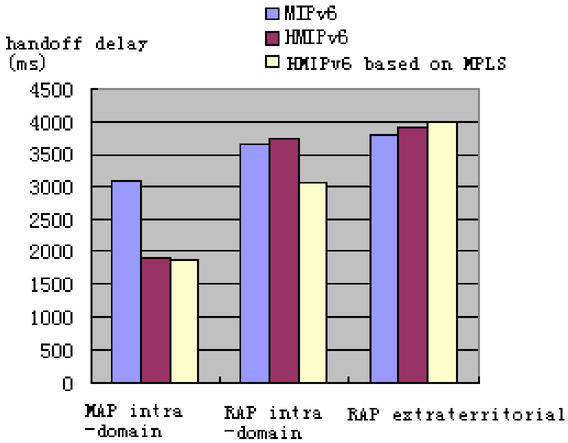

Figure 6. Average handoff delay

From Figure 6 it can be seen, MN is appropriate for moving in a certain area, and when it moves beyond the scope of the certain area the switching performance degrades sharply. The reason is that when the MN across RAP domain it's required to spend a lot of time to repeatedly do the address detection, the possess the largest proportion in the handoff delay.

CONCLUSIONS

Nowadays, MPLS technology system has covered the multi-service IP backbone network, IP transport on ATM / fiber-optic network backbone, the transition from ATM backbone to IP backbone and so on. The combination of hierarchical mobile IPv6 with MPLS network structure not only has the basic features and advantages of combined network structures, but MIPv6 can effectively support the mobile management of adjacent Ars for mobile node. Moreover, it greatly reduces the signaling load among the mobile node, the HA and the CN, and supports the fast-moving switch.

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Biographies

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