EXPERIMENTAL STUDY OF MPLS AND MIPv6 INTEGRATION TECHNOLOGY

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ABSTRACT

In this paper, the prototype system of the integration of MPLS and MIPv6 (mobile IPv6), and a test network supporting both MIPv6 and MPLS are presented; and the performance of the applications running on the test network is evaluated. The testing results indicate that the integrated network can achieve better RTT, jitter, loss rate, data transmission rate and handover delay than non-integrated network. Nevertheless, with the variation of the background payloads, the improvements on the performance of the integrated network are not obvious and in some cases even worse than non-integrated network.
Keywords: MIPv6, MPLS

1. INTRODUCTION

Mobile IP (MIP) [1] can serve as the basic mobility management method in the IP-based wireless networks. However, it presents several drawbacks, such as the long handover delay and the redundancy route tables as well as lacking in network scalability.

Multi-Protocol Label Switching (MPLS) [2] is a label switching technology. It integrates Layer 2 switching and Layer 3 routing technologies. It can realize faster routing algorithms. In addition, MPLS can also provide QoS guarantees. As the labels have only local significance between two adjacent LSRs (Label Switching Routers), MPLS has high network scalability.

Some works have been done focusing on how to integrate the two technologies effectively, such as [3, 4, 5, 6, 7]. However, these works have only presented solution schemes, and simulation results. No real network system has been implemented. And all of the aforesaid works have only discussed the integration of MIPv4 and MPLS, where the triangle-route problem exists. Furthermore, some issues like the performance of applications, QoS guarantee in the integrated network and the integration of MPLS and MIPv6 have not been studied in detail. In this paper, we discuss these issues through experimental methods. I.e., we implement a prototype system and an experimental network supporting both MIPv6 and MPLS, and evaluate the performance of the applications running on the experimental network.

2. PLATFORM IMPLEMENTATION

2.1. Prototype System Design

The prototype system is based on Linux OS (Operation System). We combine the MIPL with MPLS on the same Linux OS by modifying and compiling Linux kernel, which is Linux 2.6.8.1. And we implement MIPv6 function on MPLS network. The system structure of MIP/MPLS is shown as Fig.1. Main function entities are LER/HA and LER/AR. The middle is LSR, which is used as the MPLS router. Please refer to [8] for the detailed discussion.

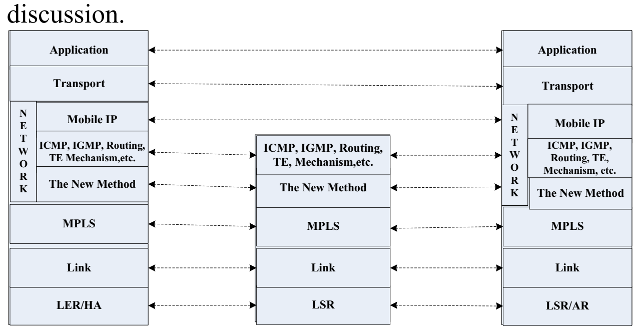

Fig. 1 MIP/MPLS structure

2.2. TEST NETWORK

The test network's topology is shown as Fig.2. The columns are PC routers, which are exploited on Linux platform. They all sustain MPLS. Thereinto, LER/HA and LER/AR sustain MPLS and MIPL synchronously. The type of the Juniper router is M7i, and that of the Cisco router is 7200 series.

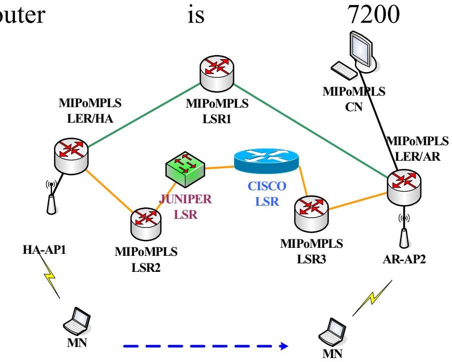

Fig.2 test network topology

There are two paths in the test network: path1 (LER/HA->LSR1->LER/AR) and path2 (LER/HA->LSR2->JUNIPER->CISCO->LSR3->LER/AR). The use of path1 is testing the performance; the use of path2 is validating the compatibility of PC routers with commercial routers. MN connects to the network by wireless access point (AP).

3. PERFORMANCE STUDY

We perform a practical performance study of the integration of the two mechanisms and obtain the performance parameters' value of the network in actual platform. The performance study consists of RTT, jitter, and loss rate. Network testing tool "iperf" is used to generate the background payload. There are two kinds of payload: light payload(20%) and heavy payload(80%).

3.1. RTT (ROUND TRIP TIME) TESTING

We use "ping6" command to test the RTT, and compare it between integrated network and non-integrated network.

Fig.3 is the RTT comparison without background payload. The mean RTT is 4.55893ms and 3.45603ms in non-integrated and integrated network correspondingly. It shows that when there is no background payload, the RTT of non-integrated network is bigger than that of integrated network. It illuminates data forwarding is faster in integrated network than in non-integrated network.

Fig.4 is the RTT comparison under light payload. The mean RTT is 5.95128ms and 7.66326ms in non-integrated and integrated network correspondingly. We can know from Fig.4 that when there is light background payload, the RTT of non-integrated network is smaller than that of integrated network. The last few data of curve possibilities occurred due to interferences in the same frequency of the wireless AP channel.

Fig.5 is the RTT comparison under heavy back-ground payload. The mean RTT is 72.71564ms and 108.13702ms in non-integrated and integrated network correspondingly. This figure shows that when there is heavy back-ground payload, the RTT of integrated network is bigger than that of non-integrated network. That is to say, payload affects the performance of the integrated network more seriously than that of the non-integrated network.

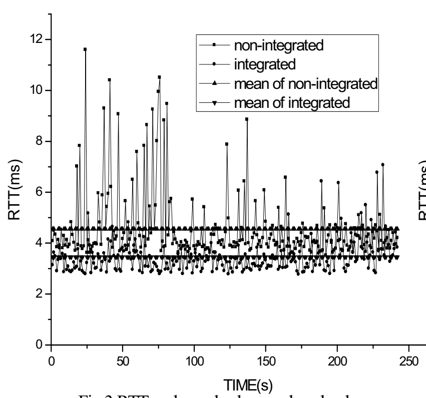

Fig.3 RTT under no background payload

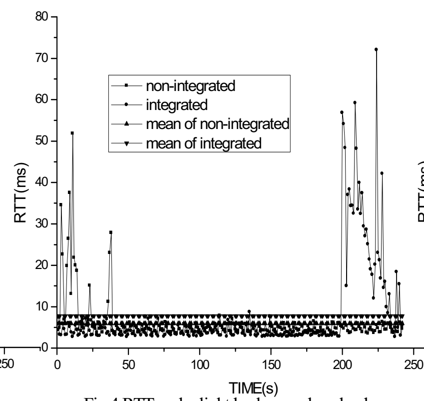

Fig.4 RTT under light background payload

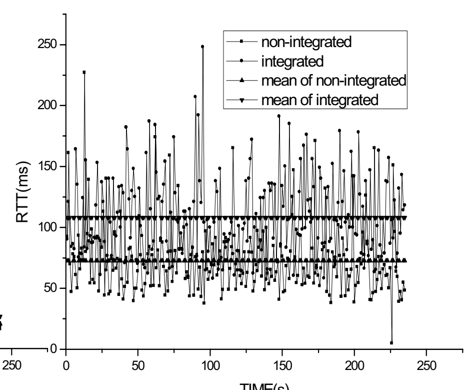

Fig.5 RTT under heavy background payload

3.2. JITTER AND LOSS RATE UNDER PAYLOAD

Network testing tool "iperf" is used to test jitter and loss rate of the two networks. Fig.6 is the jitter comparison

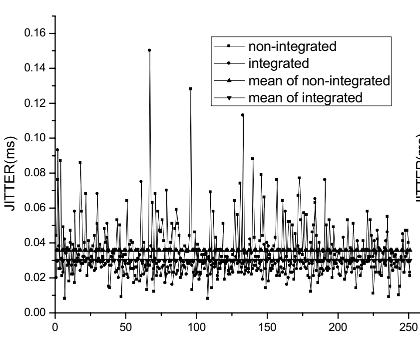

Fig.6 Jitter under light background payload

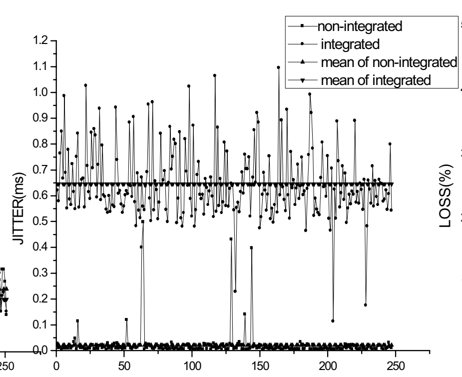

Fig.7 Jitter under heavy background payload

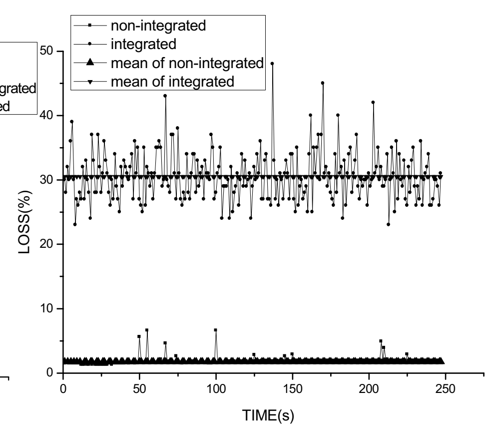

Fig.8 Loss rate under heavy background payload

under light background payload. The mean jitter is 0.03-576ms and 0.02954ms in non-integrated and integrated network correspondingly. Fig.6 shows that when the payload is light, the jitter is smaller in integrated network than that in non-integrated network.

Fig.7 is the jitter comparison under heavy background payload. The mean jitter is 0.02061ms and 0.64551ms in non-integrated and integrated network correspondingly. From this figure we can see that there is a major difference between the non-integrated network and the integrated network under heavy background payload; Payload affects more to the performance of integrated network than to non-integrated network.

More tests show that there is no loss when there is no background payload or light payload in both two kinds of networks; when there is heavy background payload, the loss rate comparison of the two networks is shown in Fig.8. The mean loss rate is 1.75477% and 30.54656% in non-integrated and integrated network correspondingly. Fig.8 shows that when there is heavy background payload, the loss rate of integrated network is bigger than that of non-integrated network.

3.3. HANDOVER DELAY TEST

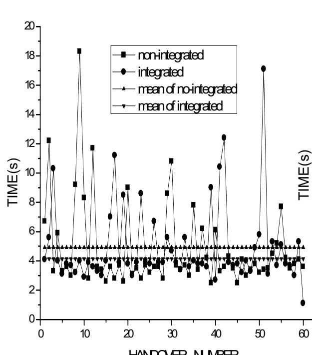

Fig. 9 Handover time under no background payload

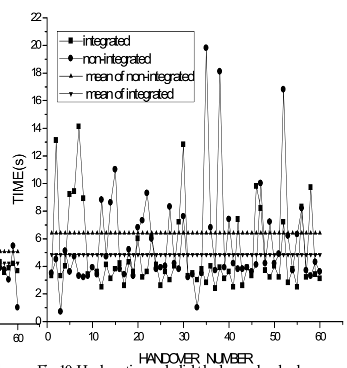

Fig. 10 Handover time under light background payload

The "crontab" tool of Linux is used to implement fast-handover automatically. And we collect 60 times' handover to analyze. Fig.9 represents handover delay compareson under no background payload. The mean handover delay is 4.91667s and 4.15167s in non-integrated and integrated network correspondingly. This figure depicts the difference of handover delay is not obvious. But handover delay of integrated network is smaller than that of non-integrated network.

There are two reasons for this phenomenon: one is that the topology of the test network is small, where data are transmitted through only a few hops before getting to the destination. In this case the advantages of MPLS can not be brought into play; The other one is that the test network consists of wireless environment, while MPLS will exert its advantages fully in wired environment.

Fig.10 is handover delay comparison under light background payload. The mean handover delay is 6.396-67s and 4.84576s in non-integrated and integrated network correspondingly. Fig.10 shows that when background payload is light, the handover delay of the two networks is obviously different, and the handover delay of integrated network is smaller than that of non-integrated network.

When there is heavy payload in integrated network, the loss is too seriously and communication becomes intermittence. There is no way to make MN do fast-handover for many times. So handover delay comparison under heavy background payload is not provided.

4. CONCLUSION

In this paper, we have implemented the prototype system supporting both MIPv6 and MPLS. Based on the prototype system, a test network was established which consisted of different commercial MPLS routers. We have validated the integration mechanisms of MIPv6 and MPLS, and also evaluated the performance of several applications in the test network. The test results indicate that the integrated network can achieve better RTT, jitter, loss rate, data transmission rate as well as handover delay than non-integrated network, which consists with the theoretic results. Nevertheless, with the variation of the background payloads, the improvements on the performances of the integrated network are not obvious and in some cases even more worse than non-integrated network.

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