Dynamic Load Balancing in Heterogeneous Interfaces

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Abstract Due to the recent supplement of mobile devices, the requirements for internet service at anytime and anywhere have been increased. This paper proposes a dynamic load balancing approach in order that the multi-network mobile router (MNMR) distributes its traffic to one of several heterogeneous wired/wireless interfaces. For high utilization of networks, the MNMR distributes traffic dynamically by reflecting each network state. To evaluate the performance of the proposed approach, experiments is performed on real commercial networks consisting of the MNMR.

Keywords*: Heterogeneous Mobile Router, Mobility, Load balancing.*

1. Introduction

Due to the recent supplement of mobile devices, the requirements for Internet service at anytime and anywhere have been increased. Especially, the development of network mobility (NEMO), vehicular ad hoc networks (VANET) and telematics technology have made mobile routers play an important role in communication between mobile users and networks. Multi-homing mobile router supports internet service with various heterogeneous wireless interfaces. Especially, the load balancing technology received a lot of attention to improve network utilization. Existing load balancing are mostly considered in IP network [1]. Load balancing ratio should be updated dynamically by considering network performance of end-to-end and mobility with the characteristics of wireless heterogeneous 3G network (e.g., EDGE, WCDMA, HSDPA, HSPA+) and LTE. This paper, in order to balance traffic effectively by utilizing various wireless interfaces, proposes a dynamic load balancing approach for a MNMR which can support existing IP based mobility.

The rest of this paper is structured as follows. Mobile IP and load balancing technology are described in section 2. Section 3 proposes load balancing approach in a MNMR and a load balancing ratio calculated from signal strength, round trip time (RTT) and network type. Section 4 evaluates the performance on areal commercial network and finally section 5 concludes this paper.

2. Related Works

For IP based mobility, technological standardization has been progressed in IETF mobile IP working group and SEAMOBY working group. Hand off standardization for IPng (IPv4/IPv6) mobility has been completed. Existing mobile IP technology was standardized by dividing it to IPv4 and IPv6. Usually, mobile IP technology indicates host based mobility, and terminal processes the information for its own mobility directly when MN (Mobile Node) in home network moves to other network. FMIP (Fast Mobile IP) and HMIP (Hierarchical Mobile IP mobility) are additionally required to support mobility effectively. However, PMIP (Proxy Mobile IP) is network based mobility protocol. This MNMR provides various wireless networks in order to guarantee seamless mobility service. Existing load balancing technology considered IP network [2].

3. MNMR: Multi-Network Mobile Router

MNMR is composed of interface for subscribers and several interfaces connected to network core for Internet service in hardware. Moreover, this is composed of multiple interface quality monitoring program to check the state of each interface and multiple interface control program to control IP mobility with the state of interface in software, and also composed of virtual tunnel driver, virtual interface to execute

tunneling for IP mobility. Tunnel driver executes tunneling in order to transmit multiple interface control program and subscriber's traffic usually entered by Wi-Fi interface to network core through each interface. Load balancing of MNMR calculates load balancing ratio, based on connected interface state and transmission, and distributes and transmits traffic by the ratio. Load balancing ratio is decided by RTT (Round-Trip-Time) using tunnel between IP mobility control servers such as signal strength and HA of each interface.

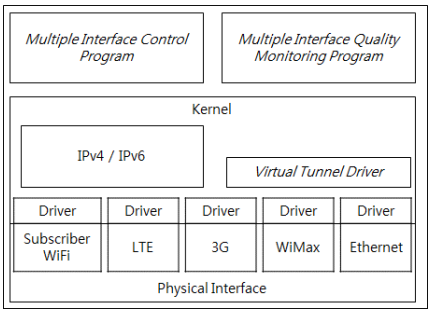


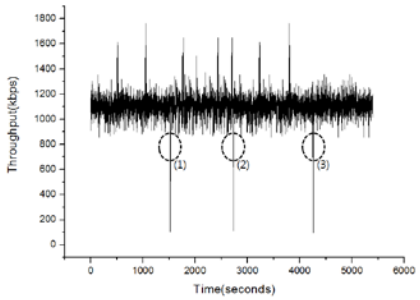
Figure 1 Multi-Network Mobile Router

MNMR which supports IP based mobility should provide dynamic load balancing by traffic flow unit. Dynamic load balancing indicates a mechanism which allocates data to a specific interface and transmits it, based on flow. Flow indicates the smallest unit to distinguish services. That is, 5-tuple of source IP address destination IP address, source port, destination port and protocol type. Existing router simply transmitted data based on the destination of data packet, by referring to the same routing table entry for same destination. However, flow based data is transmitted by referring to routing Table entry and using different interface for each service, based on 5-tuple [3].

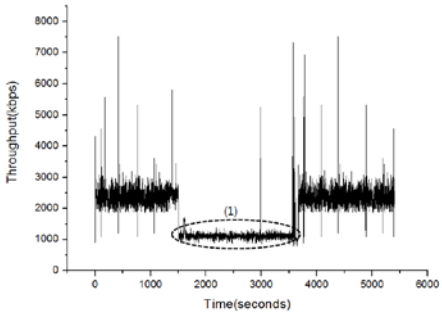
4. Implementation and Evaluation

The performance of the MNMR with the proposed load balancing approach was verified at real network in Korea. For the verification, several 3G and LTE interfaces are equipped in our MNMR. FTP was used, including Images for the verification.

Figure 2 shows the performance of load balancing in Korea with two 3G network interfaces. (1), (2), (3) indicates each section to distribute load by computing load balancing ratio again due to the degradation of wireless network interface. Finally, this shows that throughput is improved as about 120 % by load balancing in the same network environment.



(a) Disable load balance function



(b) Enable load balance function

Figure 2 Two 3G networks in Korea

5. Conclusion

This paper proposes a load balancing approach of a MNMR of multiple heterogeneous interfaces. The proposed approach distributes traffic load depending on each network state. To evaluate the performance, local commercial network was used in Korea and the result showed that the throughput is improved as about 250 %, depending on load balancing.

Acknowledgement

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