Web Server Cluster Load Balancing

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Abstract—This study designs a load balancer via direct routing that share a virtual service on a single IP address in the Linux system and suggests an efficient load balancing method to improve transmission speed in the web server cluster environment. It will increase performance and scalability with fast packet transfer and removing bottleneck problem by using TCP Splicing and Content-Aware Distributor method. This method is expected to be the noticeable technology that provides an important interface, which make application services for e-commerce effectively be applied to high-speed network infrastructure.

At this time, it is required to study further on the optimum balancing method in the web server cluster environment so as to apply the hybrid (optimum load balancing method by software and hardware) method and improve the reuse of security cession based on high-speed TCP connections.

Index Terms –Web Server, Traffic, Load Balancing

I. INTRODUCTION

As the e-commerce vitalizes, the demand of data service using the web is exploding. Especially, as a variety of functions that execute a special purpose add to the network, the loads of routers and switch systems in the network are gradually increasing. Given the fact, without considering transfer speed, the overall network transmit performance will naturally deteriorate.

As a way to increase system performance, there are two methods: processor performance increase and network performance increase. As the trend of network traffic increase is stronger than that of processor performance increase, the server performance will soon experience lack of performance to cope with the exploding increase of network traffic. Load balancing is one of the good solutions to this problem. Load balancing distributes traffic efficiently among network servers so that system scalability is heightened. It minimizes the service discontinuance so that system availability is increased.

Many of the current network services are implemented based on TCP/IP [1]. The existing routing process is difficult to have high transmission speed by handling longest prefix match in a way of software to perform it. In recent years, however, the routing process is simplified to perform a high-speed transmission and (forwarding engine) [2, 3] is developed to enable routing in a way of hardware, which allows high speed IP routing. However, as TCP exists at the Transport Layer and closely interconnects with Application Layer, it has a strong sense of software characteristics, which makes it difficult to adopt a high-speed method.

This study examines the high-speed method of TCP to prevent deterioration of transmission performance when TCP routing and content routing are implemented in the web server cluster environment.

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II. NETWORK STRUCTURE USING WEB SERVER CLUSTER

As the interest and demand on e-commerce using web server is increasing, the number of network with web server cluster structure is on the rise. Therefore, establishing a network environment of web server cluster that guarantees scalability becomes an important technical issue [4, 5, 6]. When clients connect the web server cluster, they need to be looked at as a single server so that it is important to implement such function that the balancer manages back-end servers. At this time, the balancer needs to efficiently perform session distribution policy so that back-end servers have load balancing.

To meet the network high-speed trend, in the web server cluster environment, the technology, which establishes and manages high-speed TCP connections based on the technology that manages existing back-end multiple servers, is gaining its importance. For this purpose, one of the TCP connection high-speed methods like TCP splicing is emerged, which will be introduced in the following chapter. In the web server cluster environment, such technology that efficiently creates and manages cessions with specific purpose in high speed will be a core technology that strengthens the current e-commerce service. Due to this reason, web server cluster becomes the target to consider the transmission performance optimization. The focus of the discussion is to implement high data transmission speed between client and server.

III. TCP SPLICING & CONTENT-AWARE DISTRIBUTOR

The exiting proxy server processes a header on the packet received from a client in order to create connections

between the client and the server, and puts the packet up to the Application Layer that resides in the main processor of the proxy. When this method is used, a flexible server is able to provide fit to a variety of application service because application layer softwares are different in the main processor when connecting. However, when packets are passed through the proxy, frequent data copies are made in various layers, resulting in slow transmission speed.

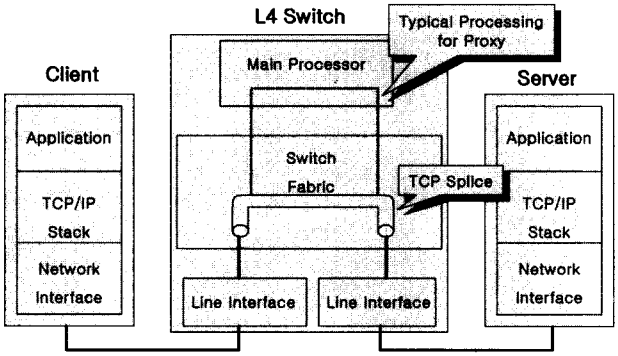
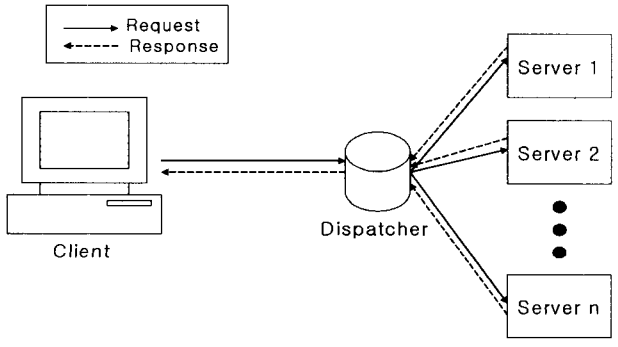


Fig. 1 Dispatching System with TCP Splicing

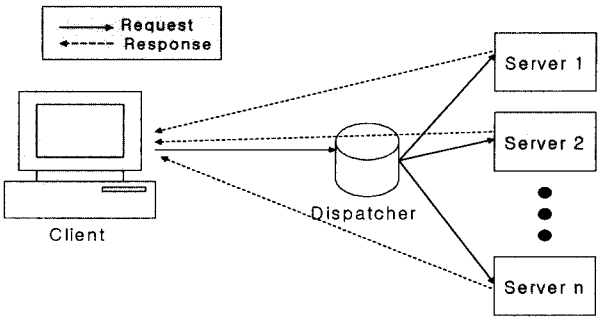
Due to this disadvantage, the exiting application layer proxy server is not a good solution as it goes against the trend that network equipment are getting faster using high speed backbone network.

Now it is emerging as the necessary network equipment in the server cluster environment. To improve transmission performance in the proxy is very much alike to improve service quality of network. In order to improve transmission performance, TCP Splicing is suggested [7, 8, 9, 10]. Its basic idea is to exclude a process that goes through the main processor in the entire path of packet data transmission as the client and the server directly connect in the line interface card of L4 Switch that is used for a cluster server proxy shown at Fig 1. By doing this, when packets are transferred to main processor of proxy switch, the data copying process is removed. Therefore, they can make a system so that the end to end data transmission speed between client and server maintains jute like a line speed.

To explain the Operation of Content-Aware Distributor (Relaying Front-end Method and TCP hand-off Method), we look at the sequence of events when a client requests a document from a Web server, and then show how the distributor operations fit into the packet exchange (see Fig. 2).



(a) Relaying Front-end Method



(b) TCP hand-off Method

Fig. 2 Operation of Content-Aware Distributor(a), (b)

IV. DESIGNING CLUSTER LOAD BALANCER

A. Linux Cluster Structure

The Linux Virtual Server [11] is a highly scalable and highly available server built on a cluster of real servers, with the load balancer running on the Linux operating system.

Fig. 3 shows one of the general virtual server architecture that has a load balancer and real servers. Real servers share a virtual service on a single IP address in the Linux system and its service contents duplicate in its local disk of each server or share with a distributed file system to provide service. Load Balancer sends client's request to a real server that is interconnected by adequate scheduling methods (eg. Round Robin) whenever a client requests a service to the real server.

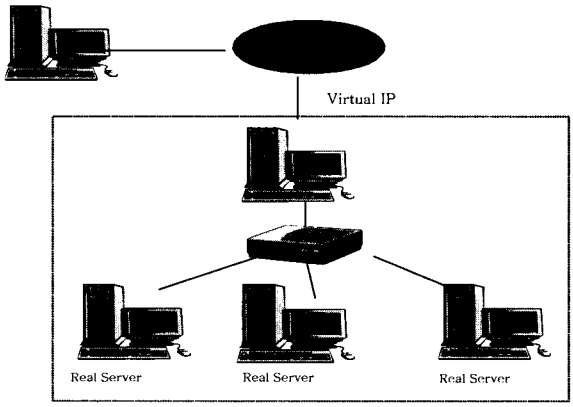


Fig. 3 Linux Virtual Server Structure

Up to now, Linux Virtual Server is developed to be seen as a virtual service on a single IP address that has cluster's parallel service with three IP layer balancing methods. The structuring methods of Linux Virtual Server are divided into three: 1) virtual server by Network Address Translation (NAT), 2) virtual server by IP Tunneling, 3) virtual server by Direct Routing.

As for the virtual server by Network Address Translation (NAT), a Load Balancer and real servers are connected with switch or hub. The real servers use private internet address system. However, only the virtual IP for service is used by the Load Balancer, which is connected to outside. Therefore, the users or clients see only a single virtual server on a single IP address.

The virtual server by NAT has an advantage that uses a private internet address system, which is not globally unique, but since the Load Balancer should handle both client's request packets and real server's reply packets, the load balancer becomes a bottleneck. To solve this disadvantage, IP Tunneling and Direct Routing are other options to take.

IP Tunneling forwards requested packets to a real server. When the packets are forwarded, they are encapsulated in an IP packet. The real server replies the request with its result to the client after processing the packets.

As for Direct Routing, a real server and a load balancer share a virtual IP for a single service. The load balancer has a single interface that is set by a virtual IP and direct routes the requested packets to the real server selected by the scheduling method. In this study, the Direct Routing is used for implementing a Linux Server for VOD streaming service.

B. Direct Routing Load Balancer of Linux Streaming Sever Cluster

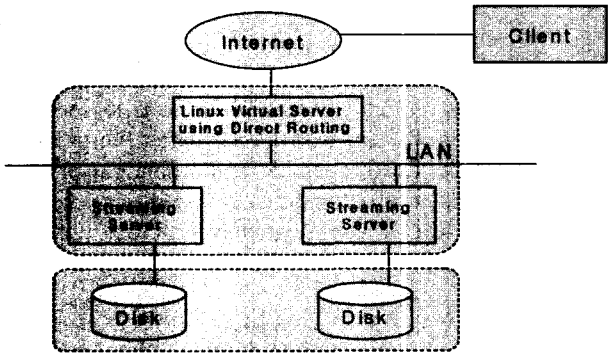


Fig. 4 Cluster Server by Direct Routing

This chapter designs a load balancer by direct routing that share a virtual service on a single IP address in the Linux system to improve packet transmission speed and overcome a bottleneck problem by using TCP Splicing and Content-Aware Balancer method.

In most internet services, replying packets are larger than requesting packets. In streaming service, a server should handle a large volume of information when replying a small requesting packet. Out of the load balancing methods in the Linux Virtual Server, the method using NAT gives the load balancer a heavy burden because the load balancer handles all the job allocations and replying packets. When the real servers increase, the load balancer becomes a bottleneck. The load balancing method using IP Tunneling and Direct Routing allows the real server to send the replying packets directly to the client. This will solve the bottleneck problem of the load balancer in the NAT method. In addition, Direct Routing has no overhead for tunneling, which enables the cluster system to have a better scalability.

V. LOAD BALANCING METHOD FOR HIGH SPEED AND SECURITY SESSION SERVICE

So far, the security features in the network have many troubles. Transmission is delayed during encrypting and authenticating processes and the Transport Layer Security (TLS, a new name for Netscape's Secure Socket Layer), an Internet service standard of the current security session does not guarantee a high speed. When using TLS Protocol, a security key for encryption and authentication should be set in advance between the two communicating parties for record protocol to create security cession. For this purpose, handshake protocol exists separately.

High speed transmission of dispatcher in the network depends on the state of each server. This partially enables due to adequate load balancing of each server. Because of this reason, it is necessary to implement a server monitoring system, which monitors a status of each server. It requires the following effective load balancing methods, the Hybrid method (a mixture of round robin and cache methods), and the load balancing method considering characteristics of each server (contents characteristics).

In addition, when using TLS Protocol, a security key for encryption and authentication should be set in advance between the two communicating parties for record protocol to create security cession. For this purpose, handshake protocol exists separately. And high speed processing method that improves handshake protocol is required. To realize this purpose, the following researches are further made.

1) Implementation of server monitoring system
2) Suggesting the Hybrid load balancing method that mixes round robin and cache methods
3) Suggesting the load balancing method considering characteristics of each server(contentscharacteristics)
4) Suggesting an improvement to prevent deterioration of transmission speed when structuring a security service
5) Analysis of TLS Protocol mechanism
6) Encryption and authentication for record protocol to create security cession
7) Application of TLS handshake protocol
8) Suggesting an improvement of TLS handshake protocol
9) Implementation of server selected algorithm considering load balancing

VI. CONCLUSION

In the web server cluster environment, it is necessary to implement router that performs routing using TCP information and requested content information, in order to process client's requests in connection with multiple servers. This study designs a load balancer via direct routing that share a virtual service on a single IP address in the Linux system and suggests an efficient load balancing method to improve transmission speed in the web server cluster environment. It will increase performance and scalability with fast packet transfer and removing bottleneck problem by using TCP Splicing and Content-Aware Balancer method. This method is expected to be the noticeable technology that provides an important interface, which make application services for e-commerce effectively be applied to high-speed network infrastructure.

As the demand of e-commerce using web servers increases, the demand of web server cluster is also on the rise. Therefore, establishing network environments using web server cluster becomes an important technical issue, since it provides a good scalability, reliability and serviceability. At this time, it is required to study further on the optimum balancing method in the web server cluster environment so as to apply the hybrid (optimum load balancing method by software and hardware) method and improve the reuse of security cession based on high-speed TCP connections.

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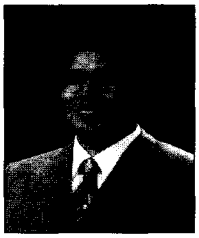

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