On Design Issue of LAN Topology Using a Dual Path Ethernet Module

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1. Introduction

There were a lot of efforts to achieve high performance and guarantee High Availability (H/A) on the LAN environments. It requires various technologies from the physical layer to the application layer. In this paper, we suggest the physical-level LAN path-duplication method, which can improve the availability, transmission bandwidth, and security, similarly but more efficiently to the work of [1]. Specifically, a Dual Path Ethernet Module (DPEM) is developed to construct an effective dual LAN structure. The DPEM locates at the front end of any network-connected machine that can be a server, a client, or a router. Since the DPEM is thoroughly transparent to neighborhood devices, it can be applied regardless of network topologies, devices, and operating systems.

2. Performance Enhancements of the Dual LAN with the DPEM

The DPEM is constructed to modify the network packets in the network layer of Open System Interconnection (OSI) 7 layers. However, since a DPEM locates at the front end of any device as a transparent add-on, it doesn't incur complicated reconfiguration of the network. This independent and simple design scheme enables the DPEM to be applied for any OS and network topology types with flexible scalability

Generally, the CSMA/CD cannot prevent the congestion, in which data transmission is overloaded. By reducing the frequency of data collisions, the dual network-paths can improve the transmission rate or the throughput more than linear summation of each bandwidth [2, 3].

Though either of two network paths fails, the other path can still continuously deliver packets to maintain a half speed of transmission by the designated aging-time. After the routing table has been updated, the entire network can be automatically reconfigured to isolate the failed one, while keeping the system run without stopping.

A DPEM implements the dual LAN structure using a scheme of transparent proxy. This unique structure of the network with the DPEM can handle each network frame. It can not only detect abnormal accessing but also block the data stream from a specific remote host. Moreover, since dual paths can divide one packet stream into two partitioned ones, packet-sniffing is thoroughly prevented.

3. Architecture of the DPEM

Figure.1 shows a DPEM applied LAN structure, where the DPEM locates at the front end of a server as an independent device. All packets of each server that is physically connected to the DPEM are distributed into two different subnets.

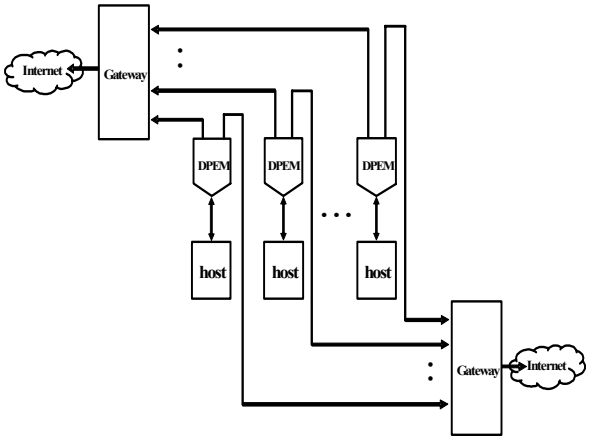

Figure 1. LAN structure with the DPEM

Figure.2 shows the internal function units of the DPEM. These are built in the Linux kernel to reduce the functional overheads of the application level processes. A packet from a host is transmitted into the DPEM via the port 0. After some internal transactions, it is separated and exits via port 1 or port 2.

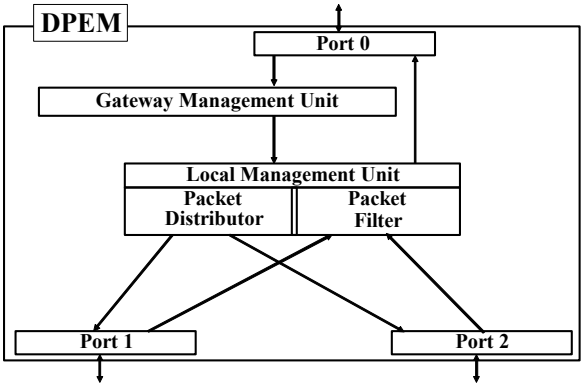

Figure 2. Internal units of the DPEM

The Gateway Management Unit (GMU) is intended to modify the MAC address of the gateway to divide the packet streams. When a packet is passing through the DPEM, The GMU forwards it to either path available. The hash-type routing table is statically or dynamically updated per the specified aging-time [4].

The Local Management Unit (LMU) is in charge of controlling the packet between the host and the LAN, and consists of two submodules as: the Packet Distributor transmitting the packet that was modified by GMU and the Packet Filter preventing the internal loop as well as blocking the packet between ports 1 and 2

4. Evaluation of the DPEM

To evaluate the DPEM's performance in general circumstances, we implement the following test conditions with three computers as follows. One is a file server and the other is a client or a data requester. Another is attached to the router monitoring the data-transmission rate as a controller. Each router works as a gateway as well.

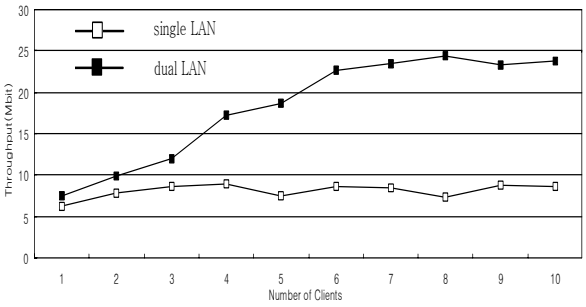

Figure 3. Throughputs of the single and the dual LAN

Figure 3 compares total throughputs of a single LAN with those of dual LAN's. The data request rate of the client increases every interval until reaching the bandwidth limit. The throughput of a single LAN path is limited below 10 *Mbit*. It follows the physical specification limit of a normal UnTwisted Pair (UTP) cable. However, one of the dual LAN paths is shown to have significantly-improved performance achieving higher speed better than numerical summation of two 10 *Mbit* cables.

Also, Figure 4 Validates improved performance of dual LAN paths. 10 *seconds* are set to be the aging time. The test begins with a normal status. After 10 *seconds*, an error occurs to drive one path to fail. In this case, since the DPEM cannot detect the failure by the next aging time, the throughput becomes lower than 10*Mbit*. However, eventually after 20 *seconds*, the DPEM detects the failure of one path, and then the GMU changes the entry to transmit the data through a healthy path. After 30 *seconds* both paths become available, but the DPEM cannot detect yet. After 40 *seconds* the dual LAN regains its stable condition.

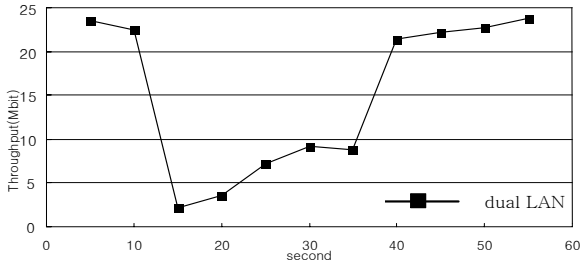

Figure 4. Throughput variations in the presence of an error

5. Conclusion

We developed a scheme called the DPEM constructing a dual-path LAN and evaluated the performance improvement in the presence of the DPEM. The test result demonstrates that the duplication of the network path achieves higher performance in such aspects as H/A, bandwidth, and security.

References

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