ITC-CSCC 2007

The 22nd International Technical Conference on Circuits/Systems, Computers and Communications

Final Program

July 8 - 11, 2007
Paradise Hotel, Busan, Korea

TB1: OFDM 2

TC1: IP Networks 1

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A New Scheme for SCTP Primary Path Switching based on Throughput Estimation

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Abstract: This paper proposes a new scheme for the primary path switching of the Stream Control Transmission Protocol (SCTP) based on the throughput estimation. The SCTP supports the multihoming feature that enables an SCTP host to use more than one IP addresses and select the path to transport the data packets among more than one path. This paper suggests a new mechanism to determine when to switch the primary path.

1. Introduction

The Stream Control Transmission Protocol (SCTP) is a transport protocol for IP network data communications similar to TCP and UDP. It supports the multihoming feature that enables an SCTP host to use more than one IP addresses. Each host has a single primary path and one or more alternative paths. The primary path is used to transport the data packets, whereas one of the alternative paths will be the primary path when the current primary path is detected to be failed [1]. This called 'primary path switching'. Such a scheme of the primary path switching could give a significant effect on the SCTP throughput performace. This paper deals with thean issue when the primary path is swithced, which will be based on the estimation of the throughputs for the current primary path and alternative paths.

The rest of this paper is organized as follows. Section 2 describes the related works. In Section 3, we propose a new scheme for the primary path switching of SCTP based on the throughput estimation. Section 4 presents the experimental results. Finally, Section 5 concludes this paper.

2. Related Work

The SCTP is a newtrasport layer protocol [1], which provides the multihoming features in the data transport. By checking the reception of the SCTP Selective ACK (SACK) packets, an SCTP host can realize that the primary path is active. On the other hand, each alternative path can be checked by exchanging HEARTBEAT and HEARTBEAT-ACK packets. If the primary path becomes to be inactive, an SCTP host can change the primary path to the alternative path [1, 2].

In the related study [2], the authors suggested that it is beneficial to switch the primary path, before the primary path is completely failed. In the study, the bandwidth of a physical link has mainly been considered as a criterion to determine the primary path switching, then a RTT has been considered later. That is, the link bandwidths of the candidate paths are measured and compared whether or not to switch the primary path. However, it is noted that the bandwidth of a physical link may not reflect on the actual SCTP throughput for the end-to-end path.

3. The Proposed Scheme

In this paper, we propose a scheme to estimate the end-to-end SCTP throughput so as to determine the primary path switching. To estimate the SCTP throughput, the Round Trip Time (RTT) and the packet loss rate are measured for the current primary and alternate paths. For using measured factors, the following well-known equation of TCP throughput [3] is employed to calculate the estimated SCTP throughput for a candidate path, in which MSS and p represent Maximum Segment Size and packet loss rate, respectively.

$$\text{Throughput } (\Theta) \le \frac{MSS}{RTT * \sqrt{p}} \quad (1)$$

The proposed algorithm of SCTP primary path switching is summarized as follows:

1) Measurement:
   By using the equation (1), the SCTP host measures the values of RTT and p periodically. The RTT can be measured using the information of SCTP SACK chunk for primary path and HEARTBEAT-ACK chunk for alternative path. The value of p is calculated by counting the number of packets that have experienced over the underlying network interface associated with the candidate path.
2) Throughput Calculation and Comparison :
   Based on the throughput equation, the SCTP throughputs for the primary and alternative paths, (Θ_P and Θ_A), are calculated from the measured RTT and p. We then compare these two throughputs.
3) Primary Path Switching:
   Let α be a weighting factor used to determine the primary path switching (e.g., α= 2). Then,
   If $\Theta_A \ge \alpha\Theta_P$, the alternate path is set to be the new primary pathOtherwise, the primary path is not switched.

4. Experimental Results

In this paper, the proposed scheme of SCTP primary path switching has been evaluated using the ns-2 network simulator [4], over a wide variety of network conditions. The network model for simulation is shown in Figure 1.

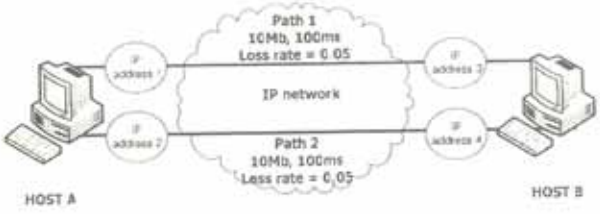

Figure 1. Simulation network model

In order to reflect a real nework enviroment, the simulation network model is designed that the transmission delays and loss lates (p) of paths are changed dynamically over the simulation time.

The proposed scheme has been compared with the simulation in which the 'RTT only' or 'loss-rate only' is considered in terms of the throughput performance.

The first experiment was done for networks with a variation of delay in the range of [100 – 1000ms]. In this experiment, the transmission delay of the 'path 1' changes over time.

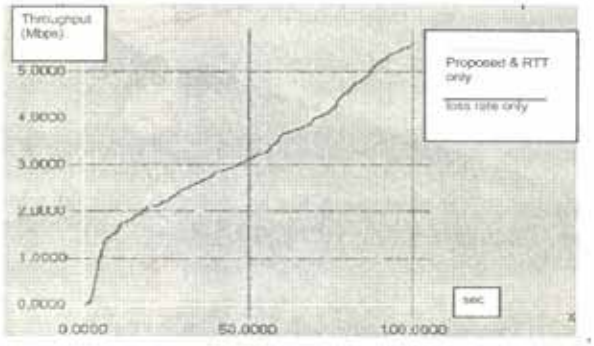

Fig. 2. Comparison of throughput by transmission delays

In Figure 2, as the delay of path1 changes randomly in the range of [0.05~0.1],

From the figure we see that the proposed scheme provides the same performance as the RTT-only primary path swiching, whereas the loss rate only scheme gives relatively worse throughput. This is because the loss rate only scheme cannot reflect on the change of transmission delay in the primary path swithcing process.

Figure 3 shows the experiemntal results in which the packet loss rates change in time, whereas the transmission delay is given to be fixed.

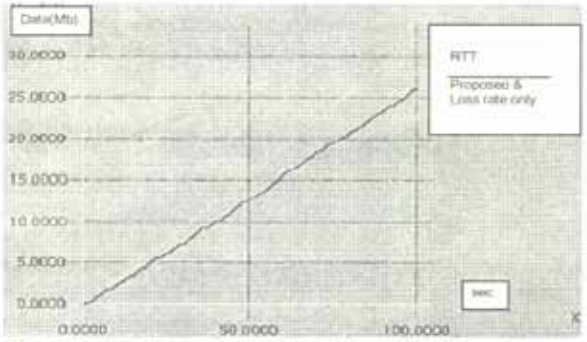

Fig. 3. Comparison of throughput by packet loss rates

In the figure we see that the propose scheme and the loss rate based scheme give better throughput than the RTT-based scheme.

Figure 4 shows the results of the experiments in which the delay and loss rates both are changed in time.

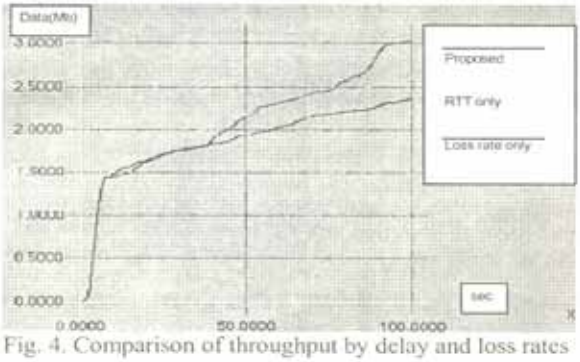

Fig. 4. Comparison of throughput by delay and loss rates

From the figure, the proposed scheme provides better performance than the RTT-only and loss rate-only schemes. This implies that the proposed scheme could be a robust performance in the network conditions where the delay and loss rate are changed dynamically in time.

On the other hand, Figure 5 shows the experimental results for the different weighting factor α that is ranged from 1.0 to 4.0.

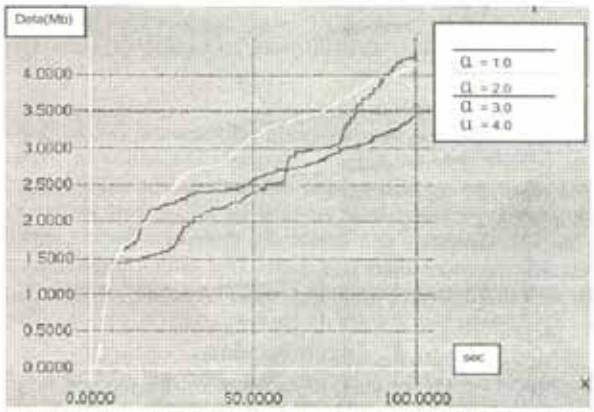

Figure 5. Throughput by different values of weighting factor α

From the figure, we can see that a larger α (e.g., α = 4.0) tends to give better performance for overall simulation time period. This implies that a strict rule for primary path changing is better in terms of the throughput performance.

5. Conclusions

This paper describes a new scheme for the SCTP primary path switching that is based on the estimated throughput using the measured transmission delay and packet loss rate. From some experimental results, we can see the the proposed scheme provides better performance than the RTT-only and loss rate-only scheme. In particular, the proposed scheme gives a robust performance in the network conditions that the tranmission delay and packet loss are dunamicaly changed in time.

In the future work, we need to investigate the correlation of the RTT and packet loss rate to the throughput performance of the SCTP primary path switching scheme.

Acknowledgement

This work was supported by the MIC of Korea, under the ITRC support program supervised by IITA(IITA-2006-C1090-0630-0026)

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