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Performance Analysis of the PR-SCTP by Lifetime

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Abstract: This paper analyze the performance of the PR-SCTP by the "lifetime" parameter in a variety of network environments. Adjustment of lifetime can improve the performance and quality of services of the PR-SCTP. In this paper we sugggest the optimal values of lifeitme by evaluating the goodput performance in the various network conditions.

1. Introduction

Stream Control Transmission Protocol (SCTP) [1] provides the distinctive multi-streaming and multi-homing features. Partial Reliable SCTP (PR-SCTP) [2] is an additional extension of the SCTP that can be used to provide "timed reliability" services with its partial-reliable semantics. In order to support "timed reliability" services, the PR-SCTP adopts the concept of "lifetime" for the upper layer application message.

Through the several researches, it is proved that the adjustment of lifetime parameter may give a significant impact on the performance of PR-SCTP. The work in [3] suggests the mechanism of transmitting MPEG-4 over PR-SCTP. By assigning different lifetime to each type of MPEG-4 frames such as I, P and B, the quality of service of multimedia traffic can be improved in the wireless lossy network environment. On the other hand, the authors in [4] propose a scheme to apply the PR-SCTP to transport the Session Initiation Protocol (SIP) traffic. By using assigning the different lifetime to SIP messages according to its reliability requirements, the lost traffic could be retransmitted efficiently. However, these researches are limited to a particular network environment or protocol. Therefore, more general approaches are required to improve the performance of the PR-SCTP.

In this paper, we will analyze the performance of the PR-SCTP by "lifetime" parameter. We will consider several network factors that can influence the determination of an optimal lifetime. Especially, we will focus on how these factors influence the transmission goodput performance and the relationship between the optimal value of the lifetime and the performance of the PR-SCTP.

The rest of this paper is organized as follows. Section 2 describes a variety of network factors that influence the determination of an optimal lifetime parameter of the PR-SCTP. In Section 3, we perform the performance evaluation of the PR-SCTP by "lifetime" parameter. Finally, Section 4 concludes this paper.

2. Lifetime for PR-SCTP

The most noticeable feature of PR-SCTP is that user applications can transport both reliable and unreliable within a single SCTP session. Moreover, it provides the TCP-friendliness with the upper layer applications. For this reason, PR-SCTP makes the SCTP more attractive as the next generation transport layer protocol.

The PR-SCTP operates in a very simply way. Each application message is valid only within the given lifetime. If the lifetime expires, the PR-SCTP abandons the transmission of corresponding user message and sends the FORWARD-TSN chunk to the peer. Then, the peer SCTP moves the cumulative ACK point forward. The only consideration is to determine whether to transmit or abandon the user message according to its lifetime, and the only way to adjust the value of lifetime is to use "send" primitives of SCTP sockets API [5].

Despite its simple operation, it is very hard to construct a deterministic model for finding an optimal lifetime. There is a variety of factors to influence the lifetime parameter for each application messages, such as network bandwidth (bps), Round Trip Time (RTT) in the network (seconds), packet loss rate (PLR) of the communication link (%), average bit-rate of application data (bps), the length of application buffer (seconds), and so on. These variables may change over time.

In this paper, we will analyze the relationship an optimal value of the lifetime for PR-SCTP and a variety of environmental factors by evaluating the performance and the quality of services, instead of theoretical analysis. Especially, we concentrate on the relationship between the optimal values of lifetime and PLR and RTT.

3. Performance Analysis

3.1 Experimental Environment

For the experiment, we construct a test network with the following assumptions:

i. The average bit-rate of application data is a constant value (i.e., CBR traffic).
ii. Influences of application buffer and network bandwidth are ignored.
iii. The message size of each SCTP DATA chunk is a constant value of 1024 bytes.

Figure 1 shows the experimental testbed used for evaluating the performance of PR-SCTP.

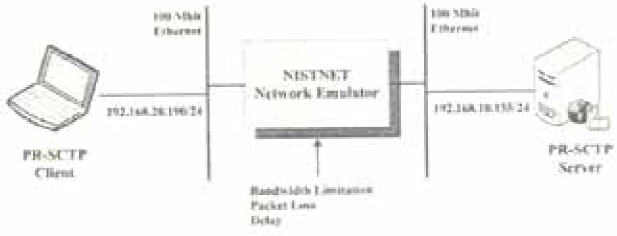

Figure 1. Testbed for experimentation of PR-SCTP

The testbed consists of three nodes: a server, a client and a PC router. Every node runs over the Linux kernel 2.6.21. For the evaluation of the PR-SCTP, sctplib-1.0.6 and socketapi-1.9.0 are used [6]. On the other hand, the NISTNET 3.0a [7] is used to emulate network environment.

3.2 Test Scenarios

In order to evaluate of the performance and quality of services of the PR-SCTP, we defines following two observations:

i. Goodput (bps): total size of the application data that successfully transmitted to the client per unit time.
ii. Transfer-to-reception ratio (%): the successful reception percentage of application data.

The performance evaluation of the PR-SCTP is accomplished in the following aspects:

i. We compare the goodput and the transfer-to-reception ratio of PR-SCTP for different lifetime and PLR.
ii. We compare the goodput and the transfer-to-reception ratio of PR-SCTP for different "lifetime" parameter and the network RTT.

For each scenario, we use MPEG-TS movie data with the size of 10Mbytes, which is transmitted over the bandwidth of 100Mbps.

3.3 Results and Discussion

Following figures are the result of the first test scenario, i.e., the performance comparisons for the optimal lifetime value of PR-SCTP according to different PLR.

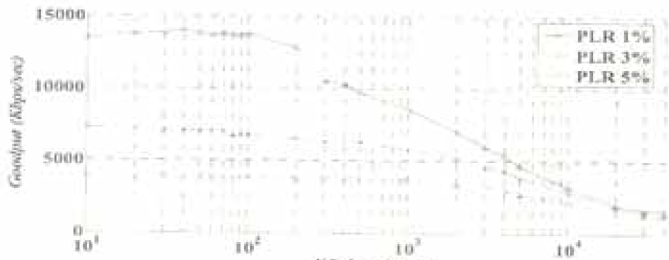

Figure 2. Performance of PR-SCTP by lifetime and PLR.

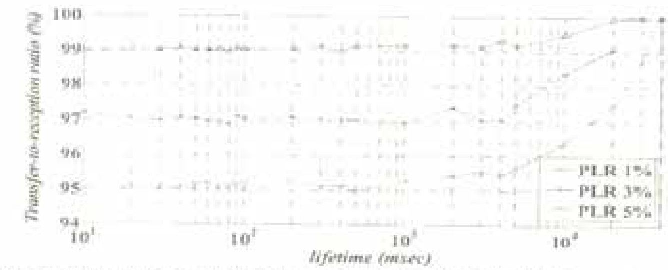

Figure 3. Transfer-to-reception ratio of PR-SCTP by lifetime and PLR.

Figure 2 and 3 show the goodput and the transfer-to-reception ratio respectively for different lifetime and PLR. For this experiment, the network RTT is set to 30 ms.

From the figures, we can see that the performance of PR-SCTP decreases while the transfer-to-reception ratio increases as the lifetime increases. In particular, the goodput begins to decrease as soon as the lifetime exceeds 100 ms; still the transfer-to-reception ratio keeps the constant value unless the lifetime exceeds 4 seconds.

From the result, we can easily conclude that the best choice of the lifetime is the value between 30 and 50 ms in most delay-sensitive applications. However, if the application needs more reliability, the lifetime must be increased appropriately.

Figure 4 shows the result of the second test scenario, i.e., the performance comparisons for the optimal lifetime value of PR-SCTP according to different network RTT.

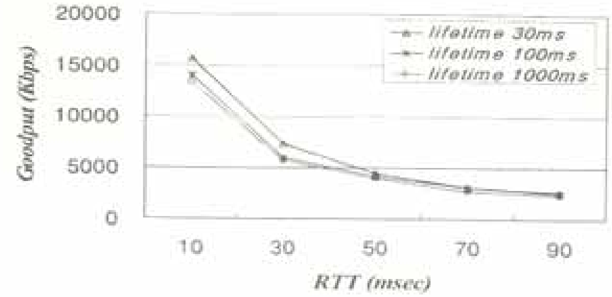

Figure 4. Performance of PR-SCTP by lifetime and RTT.

For this experiment, the PLR is set to 3 % and all the other test environment is equivalent to the first one.

In the figure, we can see that the smaller lifetime gives the better goodput, given a fixed value of RTT. In addition, we can also see that the goodput of PR-SCTP decreases exponentially as the network RTT increases but the order of three goodput lines never change although the value of RTT varies. In this experiment, the transfer-to-reception ratio keeps almost the same value.

4. Conclusions

The PR-SCTP can transport both reliable data and unreliable application data within one SCTP session. To enhance the PR-SCTP performance and quality of services, the adjustment of the "lifetime" parameter needs to be considered. From the results of the evalution, an optimal value of the lifetime may depend on the network conditions such as pcket loss rate and network round trip time. In particular, the smaller lifetime gives the better performance of PR-SCTP. For the more reliability, however, the larger lifetime is needed.

Acknowledgement

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