Papers on the Next Step of UNIVERGE : Toward the Future

Session Traceability Technologies

By Hideyuki SHIMONISHI,* Tutomu MURASE,* Yohei HASEGAWA* and Yasuhiro YAMASAKI*

ABSTRACT In this paper, we discuss “Session Traceability Technologies,” which realize high quality and high reliability communication that up until now was difficult to experience within a legacy IP network. With this technology, we can provide network node system that handles sessions’ behavior (either TCP or UDP, or whatever) by utilizing end-to-end information from network, servers and hosts, as well as IP and link level information that reflects network local status. Some of the benefits of the system are as follows. For example, 1) attacks, malfunctions and performance bottlenecks over entire business system consisting of clients, servers, storages, and variety of network elements can be quickly identified, 2) application execution quality is increased by eliminating any possible obstacles to the performance, 3) a broader decentralization of such an environment is supported by increased throughput and quality of long distance communications. By incorporating these technologies into the UNIVERGE product line, it will improve communication quality and service availability of dynamic collaboration systems over broadband networks.

KEYWORDS **Session, TCP, UDP, Traceability, Overlay network, Communication quality, Service availability**

1. INTRODUCTION

Traditionally, in order to gain network capacity and application flexibility, networks providing a simple packet transmission scheme and end hosts loaded with variety of functions are considered to be desirable[1]. However, today, due to diversification in users and user environments, many problems are arising that cannot be solved with end host driven communications. Some issues to be urgently solved from these problems are given below:

(1) Measuring, Monitoring and Management Problems

A network only stores information that pertains to link/network level packet transmissions and does not hold session level information such as transmission quality between end hosts, making it difficult to grasp what is going on within the network. For this reason, when attacks, malfunctions or performance degradations occur, or when large portions of the network resources are being used up by unwanted traffic, it is becoming more and more difficult to pinpoint the source or cause with a traditional NMS (Network Management System) and the time it took to solve the problem was becoming a greater problem. Likewise, it was difficult to monitor or measure the end-to-end communication quality provided to users, which in turn created SLA (Service Level Agreement) management problems.

(2) Communication Quality Problems

The speed of networks has exponentially increased along with the diversification and broadening of the network environment including wireless, wired, satellite, and long-distance continental connections. Nowadays, over-provisioned network resources are no more a better solution. For example, TCP session throughput cannot be improved by merely increase the bandwidth because of the communication distance or packet losses. Furthermore, because networks are becoming collective entities with various types of policies, protocols and technologies having a variety of characteristics, the conventional quality control methods or path management methods such as Differentiated Services[2] or MPLS[3], have the difficulty of not being able to provide a uniform end-to-end service throughout the network for quality-aware applications, for example voice/video communications or mission-critical communications.

In this paper, we discuss “Session Traceability Technology” that resolves the above problems. By adding the node groups that use this technology onto existing networks, as shown in **Fig. 1**, 1) any session performance are monitored and any session behaviors are traced, which help to increase the reliability

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and improve quality (traceability technology); and 2) terminate communication sessions and then relay these with appropriate modification within the network, which will increase quality and reliability of communication sessions (session control technology).

2. THE ELEMENTAL TECHNOLOGIES OF SESSION TRACEABILITY

2.1 Traceability Technology

In this subsection, we will provide some fundamental technologies that enable behavior tracing and quality monitoring of a large number of communication sessions in high-speed and complexly organized networks.

(1) Session Monitoring Technology

In high-speed and complexly organized networks, a key technology is to monitor individual qualities of a large number of sessions at a single point. It enables various analyses including 1) discovering and tracking abnormal session behaviors that may indicate attack to the network or hosts, 2) capturing unique/extraordinary behaviors of malicious or misbehaved users, and 3) SLA management of each user. The technology for monitoring the packet in discarding rates or the throughput for each TCP session has been proposed in some literatures. However, the processing cost has become a heavy burden making it extremely difficult to monitor the behaviors of a large number of sessions in high-speed networks. Therefore, we are proposing an all-day yet large-scale quality monitoring technology through sampling measurement. With this proposed method, not all packets on the links will be monitored, but rather only specific packets randomly chosen will be monitored. The sampling scheme can reduce the processing cost over ten times; with the trial system, a 3.2GHz Pentium 4 system simultaneously monitors over 1,000 active sessions at a speed of 1Gbps.

(2) Bottleneck Tracing Technology

The bottleneck tracing technology is the technology to track the causes for when quality degradation is detected or when network damage has occurred. This technology will aid in determining where in the performance degradation of a specific session is occurring. It will also determine whether the bottleneck may be in the server or in the network, or whether the bottleneck may come from a problem with parameter settings of end hosts.

Firstly, this bottleneck tracing technology has the technology to analyze whether the bottleneck is located in the server or in the network. With traditional technologies, monitoring points have to be set in all the pertinent servers and networks being monitored, which results in large installation cost. In addition, a user can use them only when the user manages entire network equipment. On the other hand, with our proposed method[4], the network facilities and servers do not need to be touched, as shown in **Fig. 2**. This method monitors TCP packets being transmitted on the network links and identifies the bottleneck location by analyzing the behavior of TCP congestion control.

Secondly, the bottleneck tracing technology has the technology of identifying the location of the quality degradation within the network. With traditional technology, there was not a means of explicitly analyzing where the degradation was occurring within the network for a specific session but rather the

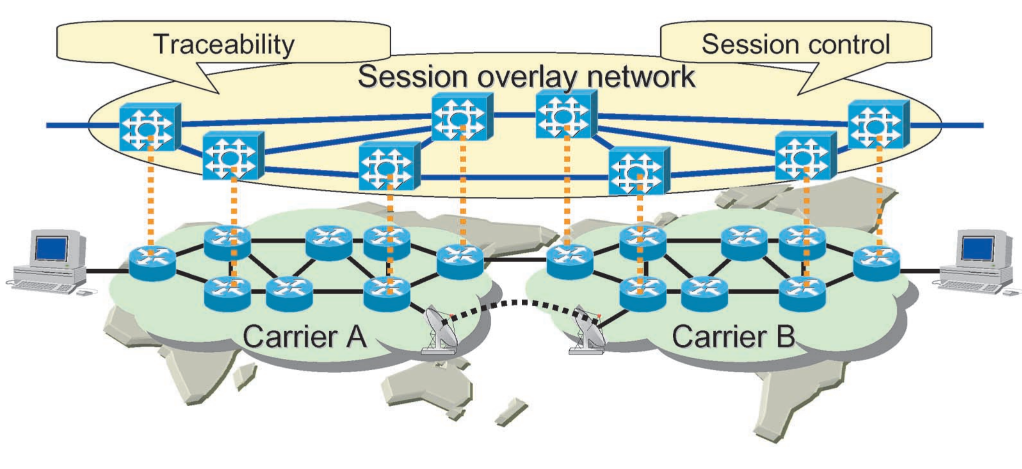

Fig. 1 An overlay network placed on top of legacy IP networks.

administrator had to struggle to estimate the location of the session degradation from the statistics over the entire network. Compared to this, with this proposed method, as shown in **Fig. 3**, by monitoring the behavior of the packet discards of the TCP sessions within the network, it enables analysis of the degradation points for the sessions[4]. For example, when this method is applied between carrier interconnecting-points, it is possible to determine in which carrier the packet discard is arising with an accuracy of 98%.

2.2 Session Control Technology

With this session control technology, high quality communication can be attained without modifying the underlying IP networks. As shown in **Fig. 4**, the technology is based on relay TCP sessions having intended behaviors, i.e., a user TCP session is terminated in the network and it is relayed by specialized TCP sessions providing specific services. For instance, some examples are given below:

(1) The Technology for Acceleration of TCP Sessions

This relates to the problem that arises due to the “bandwidth delay product” of networks when using broadly distributed applications. The problem limits TCP throughputs even if high-speed links are used. Therefore, by placing relay functions for the TCP sessions between the end hosts from within the network, the RTT (Round Trip Time) of the TCP session is shortened, and also the TCP transmission buffers are expanded at the relay nodes. Assuming for a broadly distributed environment where, for example, the link bandwidth is more than 100Mbps and

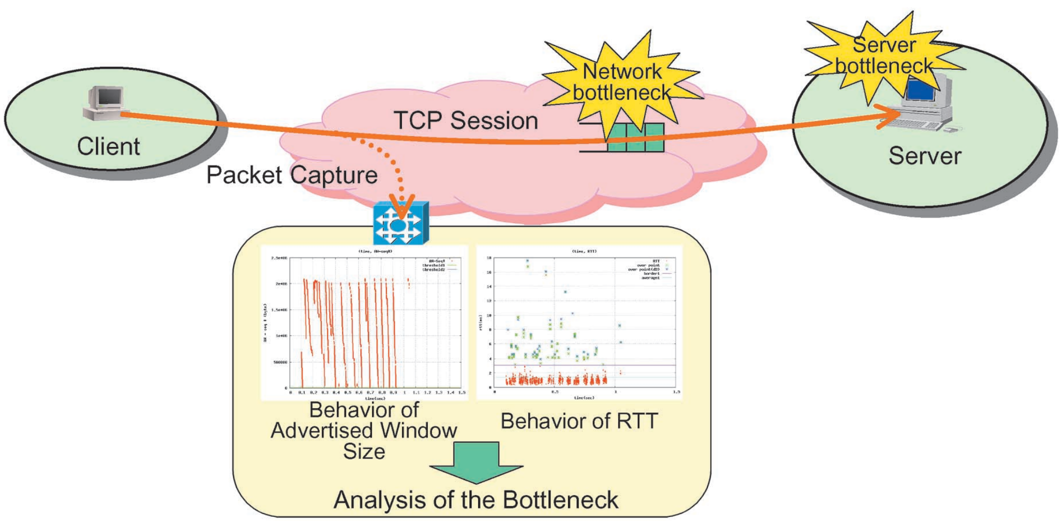

Fig. 2 Traceability technology: determining the bottleneck location.

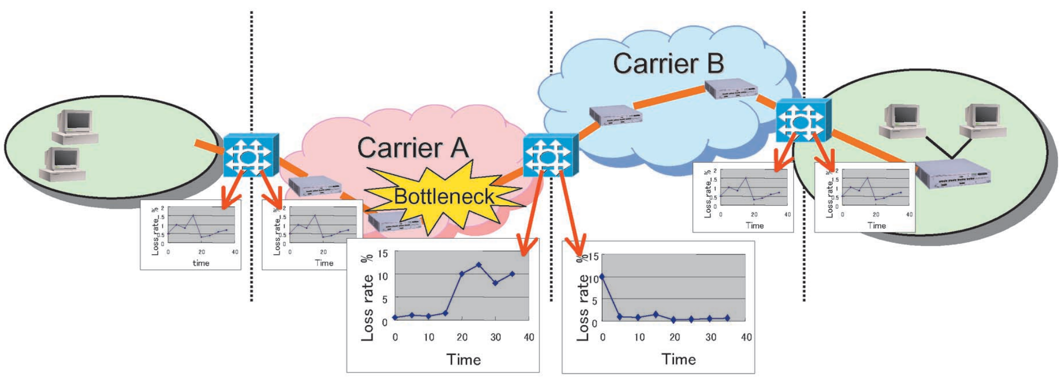

Fig. 3 Traceability technology: analysis of quality degradation points.

roundtrip propagation delay is more than 50msec, the TCP throughput can be potentially increased by up to ten times[5-7].

Again, with wireless connections with random packets losses that are not related to congestion or ultra high speed lines, the problem of decreased TCP throughput should be pointed out. However, by using a specially tuned version of TCP that has a congestion control method with resistance to random packet losses, the TCP throughput can be improved against these losses. For example, TCP-Westwood BBE[8] can improve throughput over three times than that from currently TCP, TCP-Reno, under the conditions of a 1% packet discard rate.

(2) Quality Control Technology

In methods that provide QoS (Quality of Service) on lower levels such as the Differentiated Services[2], it is necessary to put a control at all of the nodes in the pathway, which has hampered their wide deployment. On the other hand, with our session control technology, quality control of each session is possible without having changing either existing network facilities or operating policies by using a specially tuned version of TCP congestion control method[9,10]. User TCP sessions are terminated at the relay point and they are relayed by the TCP sessions with arbitrary quality control to differentiate or guarantee service levels among different applications.

(3) Multi-Path Communication Technology

When using multiple paths for communication, one can increase the availability of the network by using other paths when there is a malfunction in one of the paths. In addition, an increase in the overall bandwidth can be attained through load balancing among these paths. However, with traditional methods, the data divisions between the paths could not be adequately made when the bandwidths or quality differed between the paths.

With our proposed method[11], while providing a single end-to-end TCP communication for the user, as shown in **Fig. 5**, communication takes place by dividing it into multiple TCP sessions in areas where multiple paths are available. In such cases, with our data division method the data are divided so that it arrives at the convergent point roughly at the same time from each path and thus the data are merged at the convergent point efficiently without any throughput degradations.

3. CONCLUSION

In this paper, we have discussed the session

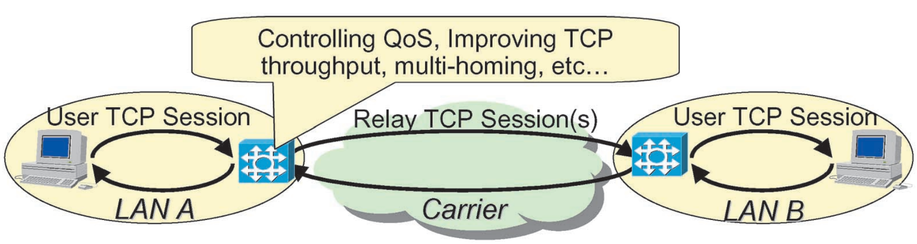

Fig. 4 Session control technology: TCP session relays.

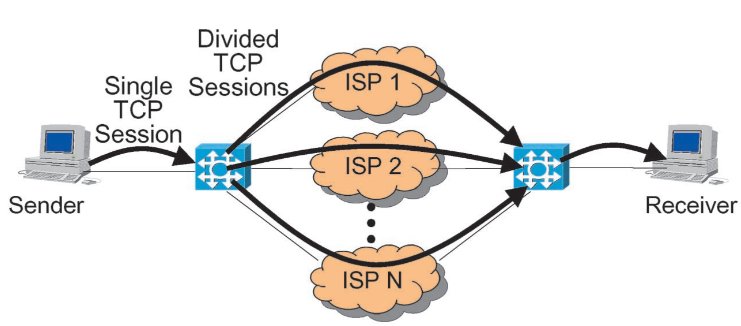

Fig. 5 Session control technology: increased reliability and load balance using multiple paths.

traceability technology that can achieve high quality and high availability communication for the UNIVERGE products, and have simply presented each elemental technology that we are currently researching.

We plan to continue a deeper pursuit in the session traceability technology in the future. Especially we are going to conduct a more detailed research in areas including the technology to detect and trace back attacks such as DDoS attacks or malicious users, the technology for optimizing resource use of nuisance traffic related to various applications, the technology to further improve the quality of real-time applications such as VoIP and video streaming, the precise tracing technology for tracking quality degradation, and so on.

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Received September 6, 2004

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