

A Design Methodology of Advanced-PEPs Architecture for TCP Satellite Connection and Bandwidth Management

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Abstract

In the network environment of the Internet and Intranet, Transmission Control Protocol (TCP) is Representative application of transport layer protocols. TCP based network specific environment and other upper-layer protocol performance should be limited according to link feature. To solve these problems for typical techniques is Enhanced-TCP based which use PEP. PEPs is placed between the degraded network segment complementary problems, and efficiently manage developed for efficient network environment. Because of these characteristics, PEPs in the satellite communications environment good solution has been Level risen. PEPs system is typical for a satellite-based network. However, because of the feature satellite network, has the disadvantage of high packet loss ratio and Long Return Trip Time (RTT). In addition, many problems remain, and various solutions are discussed. in this paper to solve these problems, an 'Advanced-PEP Architecture' based methodology of the new technique is proposed.

Keywords: *Performance Enhancing Proxies, Transmission Control Protocol, Enhanced TCP, Digital Video Broadcasting/Return Channel via Satellite*

1. Introduction

In case of TCP, the sender uses ACK to ensure that packet is transferred to the receiver. The reliability of packet transfer is ensured by sending packet continuously till the receiver sends ACK message to the sender. But, if the RTT is getting longer because of the feature that the transfer of the next packet is delayed till the ACK message returned, the communication efficiency is drastically reduced. The reasons of a lowering of performances are network routing problem and the problems that are occurred on links and subnet. The PEPs which is designed to solve these problems is protocol that finds the reason of a lowering of performance and solve it in normal operating environment.

It is also designed to work in End-to-End section separated from the existing network environment. Although the PEPs can work in every protocol layer, common technique for improving performance is optimized in transfer/application to improve performance.

In principle, the accelerator could be used in every network environment to improve application performance. Techniques like packing and caching could be applied to many cases like reducing bandwidth request and latency effect. Generally, PEPs was used in satellite environments that the significant delay and asymmetry of the link could be problems. But, satellite-connected-network essentially has more problems than wire/wireless network because of the feature of the satellite environment. Also, multimedia packet transfer through the satellite network is essentially not individual area but connected with wire/wireless network. Using satellite network is inevitable to increase quality of the service, but, for now, satellite network environment cannot come up to wire/wireless network environment.

The quality of the service is significantly reduced because of these problems. In this paper satellite communications environment of existing through the modification of the structure of the architecture, the PEPs advanced form of the model proposed to solve the problem. High packet loss rate and the RTT delay reduced the time that occurs in the satellite network more efficient data transmission possible, an integration module is proposed [1, 6].

The rest of this paper is organized as follows: Section 2 outlines the overview of the PEPs the related works and studies. Section 3 Analyze the problems of existing PEPs method and techniques, and a description of the proposed technique. The concluding remarks are discussed in Section 4.

2. Related Studies and Analysis

To solve the problems of the existing satellite network broadband satellite networks has been developed like Digital Video Broadcasting-Return Channel via Satellite (DVB-RCS) network. However, there are still many challenges to be solved. Unique Feature of the satellite network is high packet loss occurs than wire and RTT is longer. Causing the congestion of the network brings many challenges for efficient data transfer. One solution to solve this problem is the use of PEP. What follows is introduce type of PEP.

2.1 Performance Enhancing Proxies (PEPs)

The most important part when designing an Internet server is to optimize the throughput of the server. Efficient server designed to maximize the throughput of the server is important for users provide seamless service. However, because of these design criteria most of the Internet server is limited to individual sessions in the parallel transport connection. These limit the number of connections in parallel causes many problems use to End-to-End technology for optimal performance.

Also specific parameter is other access technologies cannot be optimized simultaneously. Example Bandwidth Delay Product (BDP) of Satellite network needed the delay time more than Universal Mobile Telecommunications System (UMTS). These latency differences not only cause problems with performance decline but also occur if the server does not recognize the techniques that are used in the client.

When users connect to a network, if it is not a permanent connection, downloading of web page should be executed in the step of TCP Slow Start at least once. A composition of the most Internet servers, however, attempts to minimize an amount of memory being consumed for each session. For these reasons, it might cause trouble that server actively does not maintain the current connection and do passively. If a number of entities would be hosted to other domain name, it can make unexpected overheads in checking a DNS by End-to-End

option. Also when a congestion of server is happened, it is correctly unable to understand the reason in the way of End-to-End.

For this reason, unnecessary congestion control mechanism could be occurred, and it degrades a performance of network. For the reason described above, performance of satellite network cannot be optimized through the current End-to-End system. PEPs have been developed to solve these problems and build more efficient network environment [1, 3].

2.2 Operation Procedures of PEPs

The PEPs manages the satellite network environment with End-to-End communication. Data of server is sent to a district center of satellite transmission through the Internet as addresses and other information that the sender and receiver are able to communicate are divided into packet unit on the TCP/IP layer. This packet is transferred to the PEPs layer making packets divided through the TCP/IP layer into one [5, 7].

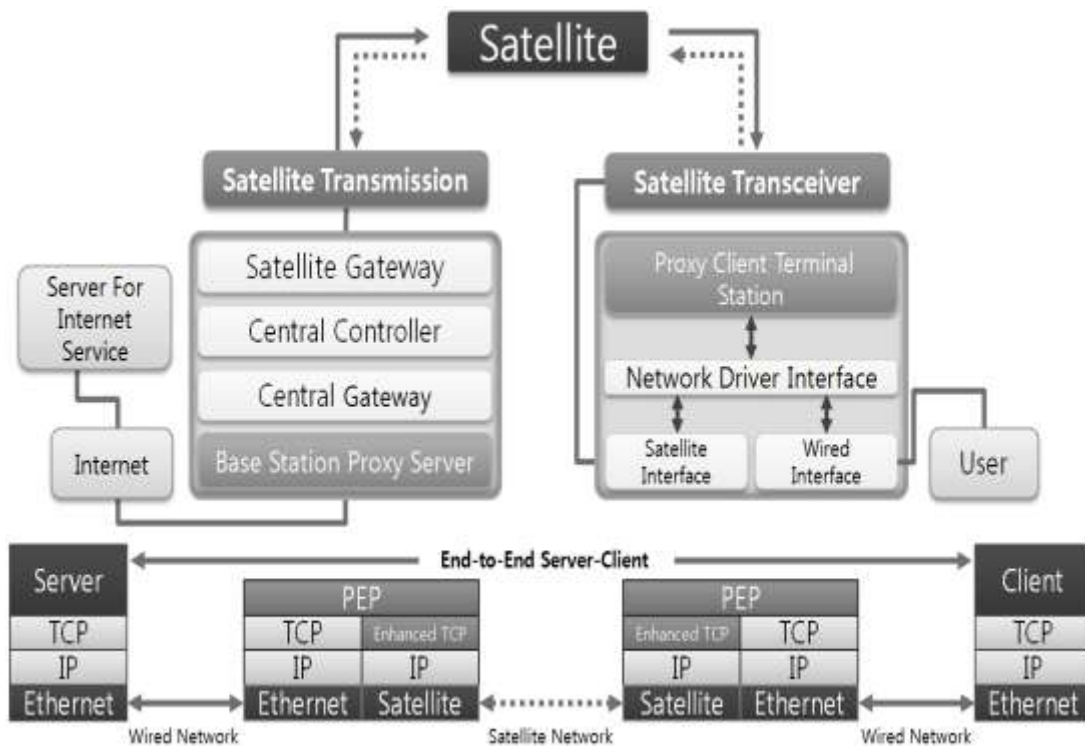


Figure 1. PEPs Layering, TCP Splitting Technique

In the PEPs, it is sent to the Enhanced TCP after a chain of processes for authentication, accounting, data compression and security so that it is suitably divided into packet unit to the satellite network. After that, it transmits packet through the satellite network and a transmitter-receiver which is received this packet is divided into an appropriate structure for the wire network environment with reverse order in the previous step. The packet is transmitted to user through the Internet. As PEPs manages both cable and communicating section of the satellite at a time, it is hard to find a point of occurred failure and the entire RTT becomes longer. Figure 1 shows an operating procedure of the PEPs.

2.3 Overview of the PEPsal

PEPsal as a TCP PEPs, multiple layer integrated for the satellite network, has been suggested to improve TCP performance able to be weakened by delay-time of different links, when transmitting packet by splitting a connection into two parts. Figure 2 shows a fundamental structure of PEPsal. As the purpose of PEPsal is to improve a connection of satellite link, it can use the TCP/IP stack which communicates with the satellite host directly.

This can settle problem caused by a long round trip time which arises over the satellite link. PEPsal is TCP-based PEPs, but it operates in different three layers such as IP, TCP, and Application. PEPsal on network layer basically uses a Netfilter to intercept a connection involving the satellite link on the way. Then TCP connection for each of two linked endpoints works on the transport layer as if it is on the opposite side. It conducts like a TCP receiver having resources by recognizing packets, while it configures new TCP connection to real endpoint the receiver at the same time. A variant TCP improved from the second connection can be used [4].

To exchange data between two connections as a result, it needs to use an application reproducing data between two sockets. The main features are as follows.

- Layering : PEPsal operates between transport and network layers as a multiple layer. On the hierarchical system, PEPsal can be regarded as a TCP PEPsal because it conducts TCP disassembly mechanism. Also it uses the IP and application layer.
- Distribution : PEPsal can be sorted into the united PEPs as operating only in a single box on the forward link satellite gateway considering a distribution. PEPsal is classified into the integrated PEPs, but it can send packet on two or more networks.
- Symmetry : PEPsal works on the basis of a distributed connection and also do symmetrically and asymmetrically depending on configuration of the network layer.
- Transparency : list of modifications for connection do not happen in Endpoint and are only conducted on the transport layer so that TCP user does not realize about a distributed connection.

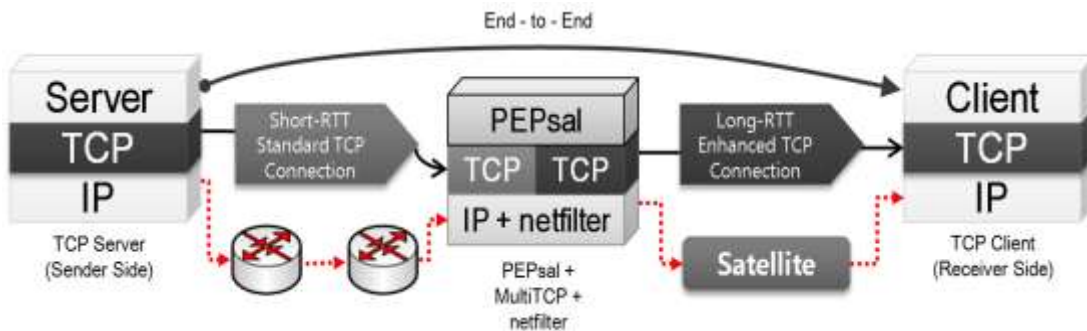


Figure 2. TCP Splitting Technique Based PEPsal Layering

2.4 Overview of the Interoperable PEPs (I-PEP)

I-PEP method has been suggested to improve a quality of DVB/RCS (Digital Video Broadcasting - Return Channel via Satellite) service provided by the satellite. I-PEP is able to supply easily without particular updates to the rapidly changing network technique, and it can provide a quality DVB/RCS service with limited CPU and memory resources. Also limitation of the hardware has a characteristic that is relatively less restricted than different techniques by the high compatibility of hardware. Figure 3 shows a fundamental structure of I-PEP, and structural features can be confirmed in it.

I-PEP's functional architecture detects an approach of split-connection that acts as two other roles. A valid section estimates a client and identifiable I-PEP server able to support the I-PEP protocol defined in this specification. The relative I-PEP client and server are each of applied client and server. The two I-PEP entities trade each other via the DVB-RCS link communicating between application and I-PEP on one side, and application and I-PEP server are proceeded through an arbitrary local or WAN(Wide Area Network) using a standard IP-based communication protocol such as a TCP on the other side. Application and I-PEP server usually communicate making a connection through a wide area Internet, but they are possible to run without direct physical connection to each other [2].

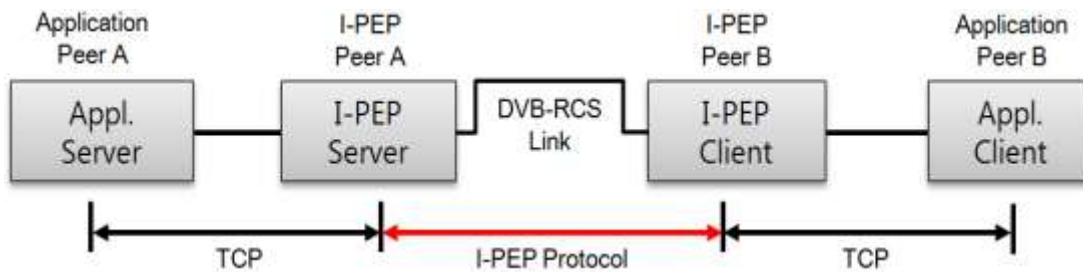


Figure 3. Basic I-PEP Protocol's Main Components

3. Design Method of Advanced-PEP Architecture

In this thesis, it suggests method to settle problems arising on the circumstance that an established PEP has Long RTT and packet loss. It has resolved the problems by forging Advanced-PEPs(A-PEPs) Architecture based on PEPsal, the united PEP system. For that, design methodology is proposed and the problem would be solved by an improved algorithm.

3.1 Architecture of the Proposed Methods

It constructs an integrated A-PEPs system between Kernel Space and User Space through Packet Control Module(PCM) which helps connect with Linux-based Netfilter and PEP system. It should have an advanced management system more than an existing method by organizing the system which manages QoS in QoS Management Group. PCM is composed of Traffic Manager, Packet Rearrangement, and Data Compressor. It manages the present condition for Maximum Transfer Unit (MTU) of network through Traffic Manager and should not make collision between bandwidths.

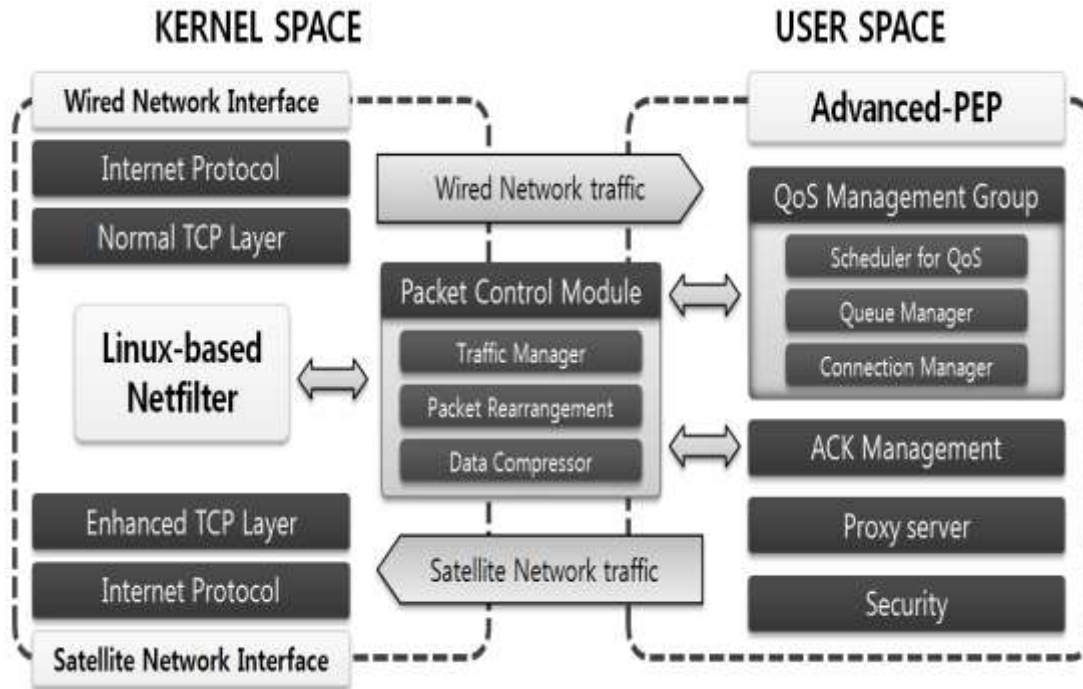


Figure 4. Advanced-PEPs System Architecture

Due to these procedures, bandwidth management of the satellite came hard and a waste of bandwidth's surplus space can be occurred on the satellite network. Also when the size of the multiple partitioned packet or a packet is too large than needs, it is difficult to respond in the situation that packet loss is caused. According to the bandwidth realized by Traffic Manager, communicating sections of the PEP would be rearranged in a certain size through Packet Rearrangement procedure.

After that, it has to go through the procedure which instructs packet to do a Compressor by adapting to a communicating circumstance. This process filters out lots of packets through connection with Netfilter, and it would be progressed after having a other filtering procedure. Figure 4 is the architecture of suggested method.

3.2 Scheme of Proposed Advanced-PEPs (A-PEPs) Algorithm

Figure 5 shows a simplified algorithm of the suggested method. PEPs handles a connection with TCP by three sections, TCP connection between Local Application and Local PEP, protocol to transmit data effectively on the satellite link and standard TCP connection between Peer PEP and Peer application, such as an established method. By these methods, PEPs manages the satellite more efficiently without modifying End System and Application. Also PEP can transparently administer an Application with End-to-End method.

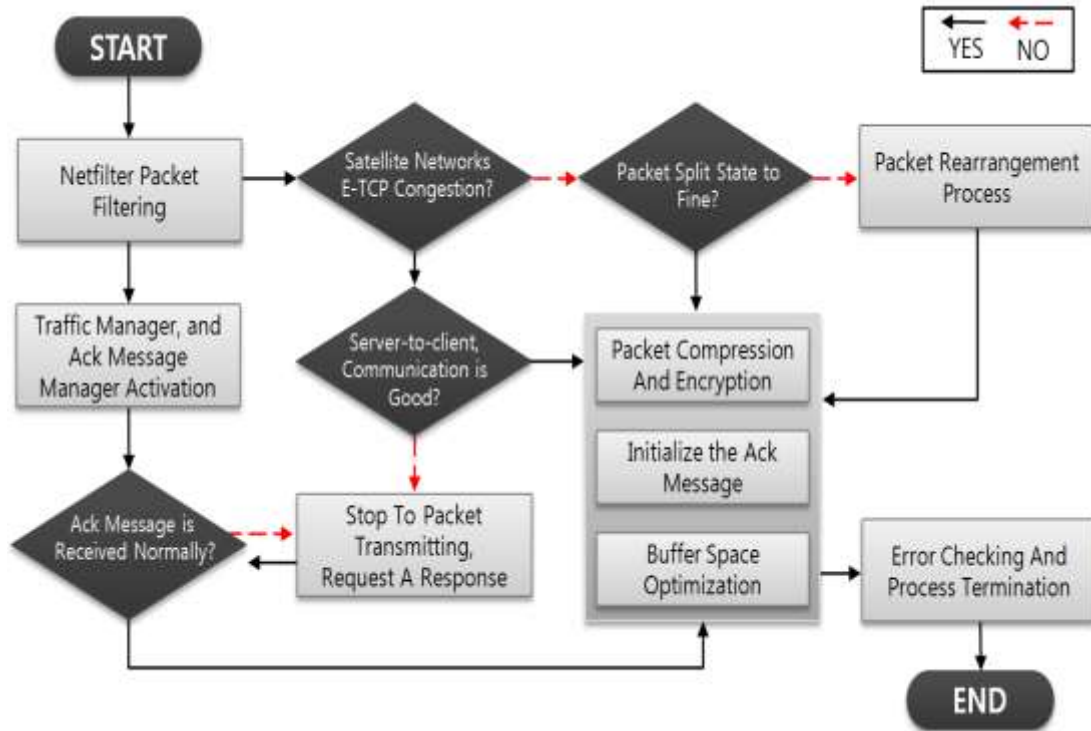


Figure 5. Process Algorithm of Advanced-PEPs

PEP is possible to realize by integrating to the single and distributed nodes. A distributed operation is used generally on specific link to request a improvement of performance, for instance, it supports the satellite connection locating on the two proxies, each end existing to the satellite link. It can be divided into symmetry and asymmetry implementation according to these criteria. Symmetry implementation is that two proxies run on each end of the link, and asymmetry implementation is that different two proxies work on it by using an asymmetry link. This method conducts the packet transmission and responding process independently between each module.

It temporarily saves packet to transfer through a buffer interacting and working with ACK Management, unlike an existing Snoop method. And it also transmits after splitting packet in accordance with situation of the satellite network. A general RTT is same with established PEPs, but it independently supervises the RTT of the section applied for PEPs through an interaction between intermediate ACK Management modules. By a connection with module on each step, it will be possible to improve QoS of the overall communication through the algorithm for conducting an efficient procedure.

4. Conclusions

The PEPs method is applied at a low communication quality section to solve these problems. Because of its specific feature, the satellite network has problems with high degree of packet loss and long RTT. During last few years, performance of PEP is significantly improved and from reinforcing system for high speed file transfer on the satellite-based TCT protocol to HTTP-based simple internet service, there are lots of improvements in most areas. But, using current satellite network and PEP technique for sending mass packet and managing

bandwidth has insufficiency and to solve this lots of researches which are concerned with connection between existing TCP network and PEP system are in progress.

That is, because of previous mentioned reasons, developing the system and module which can manage data transfer efficiently and stably is urgent question. For these reason, offering high quality multimedia service has lost of problems and restrictions. Not only service quality but also offering variety high quality contents to user has problem for these reason. To solve these problems, this paper presented constructing A-PEPs architecture based on existing PEPs system. Hereafter, the efficient communication environment can be constructed in form of advanced PEP architecture by research and development.

Acknowledgements

This research is performed with the support of the Korea Communications Commission.

References

- [1] J. Border, M. Kojo, J. Griner, G. Montenegro and Z. Shelby, "Performance Enhancing Proxies Intended to Mitigate Link-Related Degradations", IETF RFC 3135, (2001) June.
- [2] SatLabs, "Interoperable Pep (I-PEP), Transport Extensions and Session Framework For Satellite Communications: Air Interface Specification ", (2005) October.
- [3] C. Caini, R. Firrincieli and D. Lacamera, "A Linux Based Multi TCP Implementation for Experimental Evaluation of TCP Enhancements", SPECTS 2005, Philadelphia, (2005) July.
- [4] DLR: "Return-link Generic Stream Encapsulation", In Response to Next Generation DVBRCS Call for Technol., TM-RCS1021, (2009) May.
- [5] C. Caini, R. Firrincieli, M. Marchese, T. de Cola, M. Luglio, C. Roseti, N. Celandroni and F. Potort, "Transport layer protocols and architectures for satellite networks", in International Journal of Satellite Communications and Networking, (2006) October.
- [6] S. Dawkins, G. Montenegro, M. Kojo, V. Magret and N. Vaidya "End-to-end Performance Implications of Links with Errors", IETF RFC 3155, (2001) August.
- [7] Performance Enhancing Proxy (PEP) Request for Comments (RFC), <http://community.roxen.com/developers/idocs/drafts/draft-ietf-pilc-pep-04.html>.