정지위성 TCP/IP 네트워크 전송 성능 향상

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Performance enhancement of GSO FSS TCP/IP network

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ABSTRACT

This paper studied the transmission control protocol over IP network to enhance the performance of the GSO satellite communication networks. The focus of this study is how to reduce the long round trip time and the transmission data rates over satellite link in the bidirectional satellite network. To do it, this study applied the caching and spoofing technology. The spoofing technology is used to reduce the required time for the link connection during communication. The caching technology is to improve the transmission bandwidth efficiency in the high transmission data rate link. The tests and measurements in this study was performed in the commercial GSO communication satellite network and the terrestrial Internet network.The results of this paper show that the studied protocol in this paper highly enhance the performance of the bidirectional satellite communication network compare to the using TCP/IP satellite network protocol.

key Words : VSAT; Spoofing; Caching; connection time; throughput; TCP/IP

Ⅰ. Introduction

Traditionally the configuration of the TCP/IP satellite communication network is unidirectional network that is consisted with satellite link in uplink and with terrestrial link in downlink. Recently this trend has been changing to unidirectional network that is consisted with satellite links in both up and down link. This paper studied the protocol of satellite communication TCP/IP to improve the network performance. To do it, this study applied the Caching and Spoofing technology. The spoofing is used to reduce the required time for the link establishment. Caching is used to improve the transmission bandwidth efficiency. We considered five cases of satellite internet and one case of terrestrial internet to test the studied protocol.

Ⅱ. Study concept

When we use the bidirectional network for satellite communications, the connection time between the earth station terminal and Internet web sites is increased to over two time compare to unidirectional network. And the traffic in the satellite network also is increased in the uplink because the terrestrial link in unidirectional satellite network is replaced to satellite link.

Therefore this paper considered the concept to reduce the connection time and improve the traffic transmission efficiency. So we took the Caching and Spoofing technology. The function of cache server is to save the webpage, FTP and other files which are frequently used by users. When users access webpage, FTP, etc., within any fixed time the access call will be connected to

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the cache server which subsequently gives access to related website, FTP. Cache server compares received data with saved data, and the difference only will be sent to user. Therefore caching can reduce the line cost and use efficiently the bandwidth.

Spoofing is performed in both IP gateway (IPGW) of the hub station and IDU of VSAT. In TCP spoofing, a router (gateway) near the source sends acknowledgements for TCP segments to give the source the illusion of a short delay path which speeds up the TCP sender's data transmission. The gateway then suppresses the actual acknowledgement stream from the satellite host and sends any missing data due to link errors or congestions spoofing.

Ⅲ. Improved TCP/IP satellite communication protocol

3.1. Improved protocol applied with Spoofing technology

Figure 1 shows the improved protocol applied with Spoofing technology. In case of Figure 1, total required time in satellite links will be 0.25s x 11 = 2.75s when Spoofing technology is not applied. But when Spoofing technology is applied to network as shown in Figure 1, the total required time become 0.25 x 6 = 1.5s. That is, the total required time in satellite links reduces by 46% compare to not apply the Spoofing technology. In Figure 1, the distance between IDU and HUB IPGW is satellite links in Figure 4.

NOTE - Dashed line denotes an ACK message that is locally generated by the IDU, HUB or Internet Website and not transmitted over the satellite link.

3.2. Improved protocol applied with Spoofing plus Caching technology

Figure 2 shows the improved protocol applied with Spoofing plus Caching technology. In case of Figure 2, total required time in satellite links will be 0.25s x 19 = 4.75s when Spoofing plus Caching technology is not applied. But when Spoofing plus Caching technology is applied to network as shown in Fig. 3, the total required time become 0.25s x 8 = 2.0s. That is, the total required time in satellite links reduces by 58% compare to not apply the Spoofing plus Caching technology.

In this case, Spoofing technology is implemented in both IP gateway (IPGW) of hub station and IDU of VSAT. The cache server is connected to the internet through the gateway.

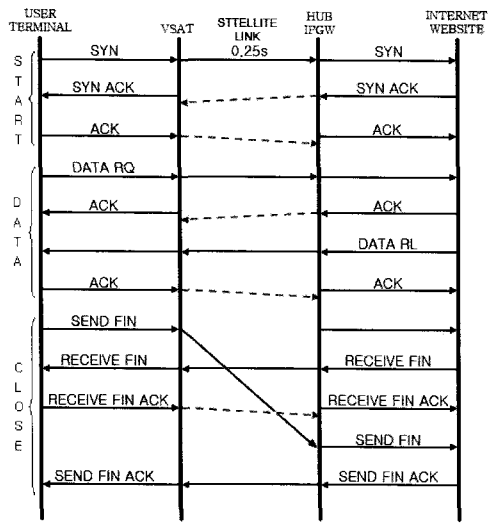

Fig. 1. Improved protocol applied with Spoofing technology

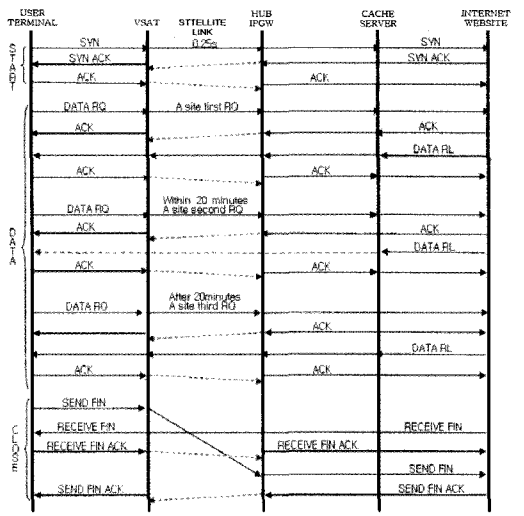

Fig. 2. Improved protocol applied with Spoofing plus Caching technology

The effectiveness of spoofing is not enough to overcome the satellite transmission delay and improve the performance of satellite TCP networks. Usually the saved data in cache server is periodically deleted with a 20-minute interval to protect overflow of data in the cache server memory.

NOTE - Dashed line denotes an ACK message that is locally generated by the IDU, HUB or Internet Website and not transmitted over the satellite link.

Ⅳ. Improved protocol test

4.1. Test system specifications of improved protocol

Tables 1 through 3 show the specifications of the system employed for test and measurement. Table 1 is specifications for terrestrial system, Table 2 for satellite system and Table 3 for VSAT terminals.

4.2. Improved protocol test network configuration

We used four satellite test networks and one terrestrial test network configurations as shown in Figs. 3 and 4 respectively to test the improved protocol shown in Figs. 1 and 2. The satellite networks are connected to the internet website using 45 Mbps dedicated line. A star topology of satellite network is used with four internet websites selected for test and measurement as follows

A: www.naver.com, portal site
B: www.google.com, text based site
C: www.hansei.ac.kr, university site
D: www.kbstar.co.kr, bank site.

Case 1 in Figure 3 is to test the improved protocol not to apply Caching and Spoofing technology. In this Figure 3, the satellite test network in is directly connected to internet website via the hub station. Case 2, Case 3 and Case 4 in Figure 3 are to test with Caching technology, with Spoofing technology and with Spoofing plus Caching technology. In Case 2 in Figure 3, the satellite network is connected to internet website via cache server in the hub station. In Case 3, the satellite network is connected to internet websites via IP gateway in the hub station. And in Case 4, the satellite network is connected to Internet websites via

Table 1 Terrestrial system specifications

Hub earth station	1 station with 9 m antenna	
VSAT terminal station	2 stations with 1.2 m antenna	IDU/ODU ACQ: 191.0 PING: 1.686 ms PTS: VSAT_141b_uts
HUB-INTERNET connection line	45 Mbps	

Table 2 Satellite system specifications

Orbit	GSO 116°E
Satellite name	Mugunghwa-3
Transponder	Bandwidth: 36 MHz. Inbound: 11.040 MHz (480 kHz 23 group) Outbound: 24.8 MHz
Frequency band	Ku-band (14 GHz/12 GHz)
Link bit rate	Inbound: 128Kbps ~ 256Kbps Outbound: 23.58 Mbps

Table 3 VSAT terminal specifications

Clarification	Items		Specification
INTERNET option	Start page		No confirmation
	Space		1 MB
	LAN connection establishment		NO
	Security level		Normal
	Image dithering		Delete
	Smooth screen moving		Delete
Registry	H_C_U	Max-1	15
		Max-2	15
	H_C_M	Max-1	15
		Max-2	15
Virtual memory	Min		384 MB
	Max		768 MB
	Registry size		64

IPGW and Cache server.

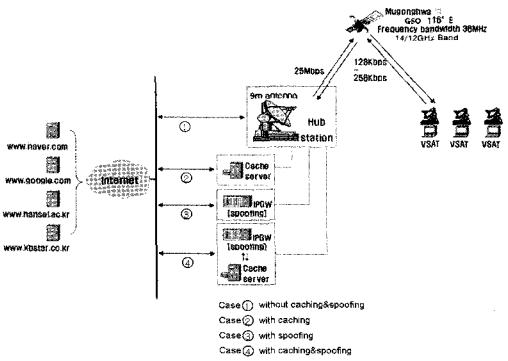

Fig. 3. Satellite test network configuration for improved protocol

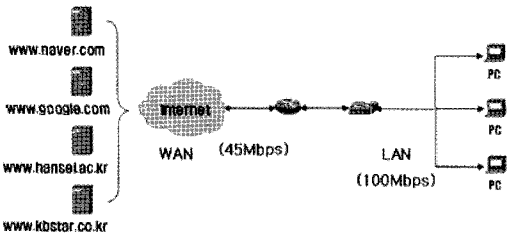

Fig. 4. Terrestrial internet test network configuration for improved protocol

Figure 4 shows the configuration of test terrestrial internet network for the improved protocol. In the terrestrial network for test, we also used the same four websites as in the case of the satellite test network.

V. Test results of Improved protocol

The improved protocol test were performed 3 times in 20 minutes intervals totalling 15 times. Case 2 and Case 3 in Figure 3. Case 1 and Case 4 in Figure 3 also were tested with the same improved protocol test procedure. In case of the improved protocol applied with Spoofing technology in Figure 1, total required time in satellite links reduces by 46% compare to not apply the Spoofing technology. In case of the improved protocol with Spoofing plus Caching technology

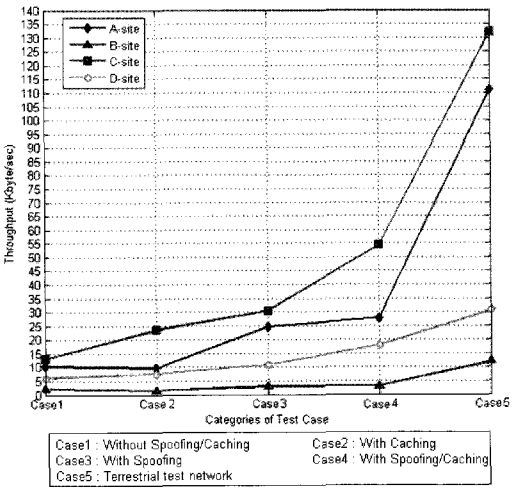

Fig. 5. Comparison of the received average throughput (kbyte/sec)

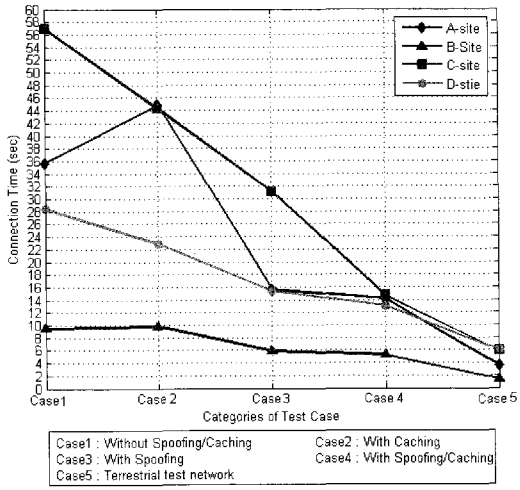

Fig. 6. Comparison of average connection time (sec)

in Figure 2, total required time in satellite links reduces by 58% compare to not apply the Spoofing plus Caching technology. Figure 5 and 6 show the test results for the received average throughput(Kbyte/sec) and connection time (sec) in VSAT terminal respectively. When the improved protocols were applied to the satellite network, the received average throughput(Kbyte/sec) and the average connection time (sec) in VSAT terminal increased to maximum 4.2 times in C-website and minimum 1.5 times in B-website, the average website connection time (sec) in VSAT terminal

is reduced to maximum 3.9 times for C-website and minimum 1.8 times for B-website.

Ⅵ. Conclusion

This paper studied the protocol of satellite communication TCP/IP to improve the network performance. Test results for five networks to assure the performance improvement of satellite TCP/IP network with caching and spoofing function are discussed in this section. The spoofing is used to reduce the required time for the link establishment. Caching is used to improve the transmission bandwidth efficiency. We considered five cases of satellite internet and one case of terrestrial internet to test the studied protocol.

When the improved protocol with the spoofing plus caching technology are applied to the satellite TCP/IP network, the performance for throughput (Kbyte/sec) and connection time (sec) is always improved for all four websites. However in case of the improved protocol with the Caching technology only, the throughput (Kbyte/sec) is rather lower and the connection time (sec) is rather longer in A website and B website than without not to apply the improved protocol. It can be concluded that the improved protocol with the Caching technology only does not provide the enough effectiveness to the moving picture-based website and the only text based website. When the improved protocol with the Caching plus Spoofing technology is applied, the throughput(Kbyte/sec) in VSAT terminal increased to maximum 4.2 times in C-website and minimum 1.5 times in B-website. When caching plus spoofing is applied, the website connection time in VSAT terminal is reduced to maximum 3.9 times for C-website and minimum 1.8 times for B-website.

Therefore the result of this paper shows that the improved TCP/IP satellite communication protocol can be used to TCP/IP satellite network to improve the throughput and the connection time.

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