Network Traffic Mitigation Method Using TCP Signalling Delay Algorithm

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Abstract— **In this paper, we propose the network traffic mitigation method using TCP signalling delay algorithm. By using proposed method, the TCP signalling response time is adjusted according to network traffic load status. Through the queuing analysis, we verify that the network traffic load can be mitigated.**

***Keywords*— Network traffic load, TCP signalling, Delay algorithm, Load mitigation, TCP response time**

I. Introduction

Over the past years, as the data service of the smartphone user is increasing, the 3G(Third Generation) network traffic load is sharply increasing. This is caused by the data unrestricted fees, popular SNS application, and multimedia service traffic.

Recently, there are the SNS applications like the KaKao-Talk, Google-Talk, and Facebook which are popular among the smartphone users. The SNS application is non real-time service. Although it generates the small-sized packets, the network traffic load increases from tremendous service requests.

Also, the user uses the VoD(Video on Demand) or multimedia streaming service as real time service via the smartphone. Though the request frequency of video traffic is little, the network traffic load increases due to the large traffic size.

For reducing the network traffic load, the network provider installs additional network equipment. The SNS service provider installs the related server and extends the period of the signalling message like the keep-alive message.

However, these are not fundamental solution for mitigating the network traffic load. Still, obvious solution is not presented.

For settling these problems mentioned above, we propose the network traffic mitigation method using TCP signalling delay algorithm. The proposed method can mitigate the network traffic load by adjusting the TCP signalling response time according to the network traffic load status.

This paper is structured as follows. In section II, we describe the related work. We describe network traffic mitigation method using the TCP signalling delay algorithm in section III. In section IV, we analyze the performance concerning proposed method. Finally, we conclude in section V.

II. Related Work

The existing studies for mitigating network traffic load are traffic shaping, traffic policing, and traffic priority control technology.

The traffic shaping provides the solution for unexpected traffic like the burst traffic by normalizing average rate of the data transmission.

When the traffic is transmitted by the traffic shaping, the traffic policing is technology which observes corresponding traffic flows. It observes whether SLA(Service Level agreement) between the user and the network is achieved.

However, when the traffic load of the network or the network equipment is overloaded, the application of the traffic shaping and the traffic policing for mitigating the traffic load is actually difficult since the traffic shaping drops much packets for processing fast-growing traffic. This results in the problems like the service suspension.

In traffic policing, when the traffic load of the network is overloaded, the SLA between user and network is not performed.

The traffic priority control is technology which determines the priority between the real-time traffic and the non real-time traffic and improves the service quality by processing the corresponding traffic on the queue.

However, the traffic priority control has the problem that it provides one-sided service quality regarding the real-time traffic. Therefore, the method mitigating adaptively the traffic according to the traffic load of the network and network equipment is required[5],[6].

III. Proposed Method

In this section, we describe proposed network traffic mitigation method using TCP signalling delay algorithm. Before describing the proposed method, first of all, we investigate the standard for classifying the signalling packet of

TCP. For this end, we analyse the characteristics of the TCP packet in various applications.

A. The analysis of various applications

Fig. 1 presents the captured packet of KaKao-Talk. We executed the KaKao-Talk application on the smartphone and captured the TCP packet using the wireshark. From the captured packets, we knew that the size of TCP SYN packet was 68 bytes. It includes the packet size of the network layer header(56 bytes) and the TCP header option(12 bytes). However, TCP SYN packet size is which may change according to IP header and TCP header option.

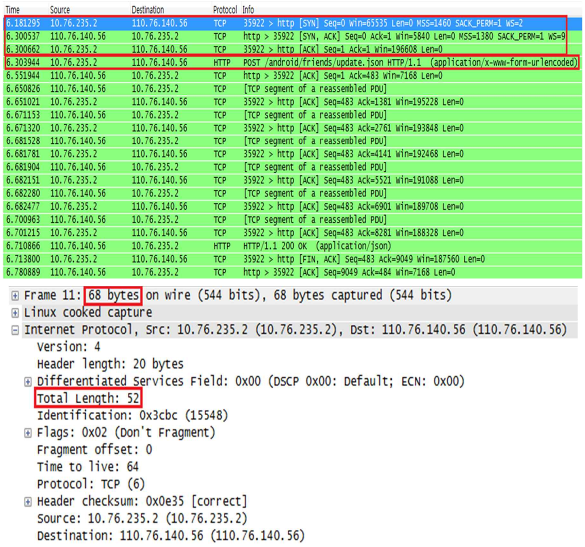

Figure 1. The captured packet of KaKao-Talk(Non Real-Time Service)

We analysed various applications for obtaining more certain result and summarized the results in the TABLE I.

TABLE 1. THE SUMMARY OF APPLICATION FEATURES

Name	Features of Applications		
	Message	**TCP Type**	**Size of Packet(byte)**
KaKao-Talk My-people Naver-Talk	Text Picture Voice Video Emoticon	SYN	56~68
		SYN, ACK	56~68
		ACK	56~68
		FIN, ACK	56~68
		Dup ACK	56~68
		RST	56
		Segment of a reassembled PDU	1392 ~ 1436
		Retransmission	93 ~ 1436

As shown in the TABLE I, from the experiment, we knew that most of the applications use the three-way handshaking of TCP for accessing to the application server. Also, the signalling packet(e.g., SYN, ACK, FIN) size of TCP is less than 68bytes. The different application(e.g., Google-Talk, Yahoo-messenger, Youtube, Twitter, Facebook, Google) not mentioned in the TABLE I has same features as presented in the TABLE I.

B. Network Traffic Mitigation Method Using TCP Signalling Delay Algorithm

In previous section A, through the analysis, we knew that the signalling packet(e.g., SYN, ACK, FIN) of TCP has constant size(less than 68bytes). Therefore, we regard the TCP signalling packet which is less than Threshold I (that is, 68bytes) among the TCP packets.

Fig. 2 shows the algorithm operating on network equipment(e.g., Access point, Edge Router, GGSN, etc.) for mitigating the network traffic load. The algorithm checks only the frame size of MAC header for verifying the TCP signalling packet.

The explanation regarding the Fig.2 is as follows.

First of all, as the network equipment receives the packets, it checks whether the size of packet is less than Threshold I. If the size of packet exceeds the Threshold I, the packet is regarded as non TCP signalling packet. And then, the network equipment operates to non delay operation.

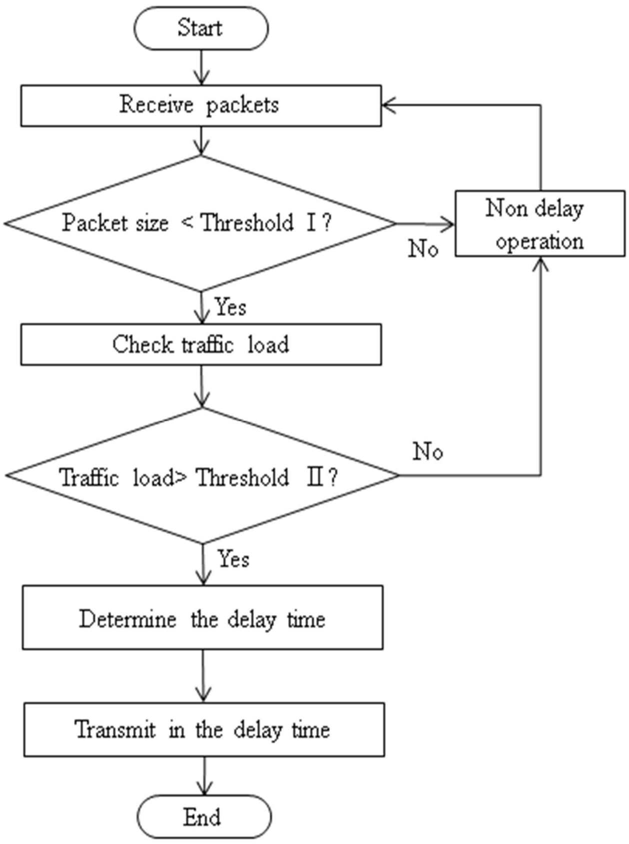

Figure 2. The flow chart of the proposed method

On the other hand, if the packet is identified to the TCP signalling packet, the network equipment checks it's traffic load.

If the network traffic load is less than the Threshold Ⅱ (the specific value indicating the traffic load status of the network equipment), the network equipment operates to non delay operation.

If the network traffic load is more than the Threshold Ⅱ, the TCP signalling packet is delayed during some times and transmits to the destination. At this time, the delay time is calculated within the time which the retransmission is not occurred. The network equipment impedes the corresponding packet and blocks the corresponding traffic related to the TCP signalling packet. By using proposed method, the delay time is varied according to the location of the network equipment and the traffic load status. From proposed method, the network traffic load can be effectively mitigated because the following data packets are also delayed in case the TCP signalling packets are delayed.

IV. Performance Analysis

In this section, we analyse the performance of the proposed method. In the network aspects, if the network load is increasing, the network equipment identifies the TCP signalling in case the size of arriving packets is less than Threshold I and the traffic load is more than the Threshold Ⅱ. And then, it impedes the corresponding packet and blocks the corresponding traffic.

The equation (1) and (2) are the average network load and the average processing time on the network (or network equipment). For simplifying the average network load and the average processing time, we use the M/M/1 queuing model.

$$L_n = (1-p)\sum_{k=0}^{\infty} k \cdot \rho^k \quad (1)$$

$$(\rho = \frac{n \cdot \lambda}{\mu}, \text{ n : user number }, \alpha = \frac{\lambda}{n})$$

$$T_n = \frac{L}{\alpha^2 n} \quad (2)$$

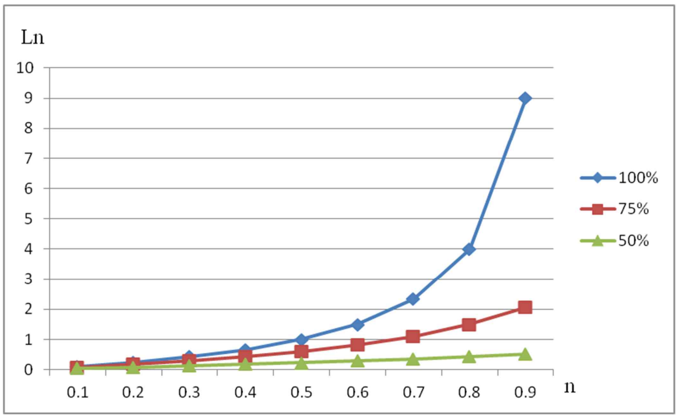

Figure 3. The average network load on the network

The Fig. 3 presents the average network load on the network. When the network is overloaded, it reduces the percentage of network load from 100% to 75% and 50% by delaying the corresponding packet and by blocking the corresponding traffic.

The Fig. 4 presents the average processing time on the network. As the percentage of network load is decreased, the average processing time also is decreased.

The equation (3) is the average load saved on the buffer of n users in user aspects.

$$L_u = \frac{\Delta\rho}{1-\Delta\rho} \quad (3)$$

$$(\Delta\rho = \frac{\Delta\lambda}{\mu}, \Delta\lambda = \Delta n \cdot \lambda)$$

The Fig. 5 shows the average load saved on the buffer of n users. The average load saved on the buffer of n users is varied according to the percentage of network load on the network. The Fig. 5 is the cases that the percentage of network load on the network is 50% and 75%.

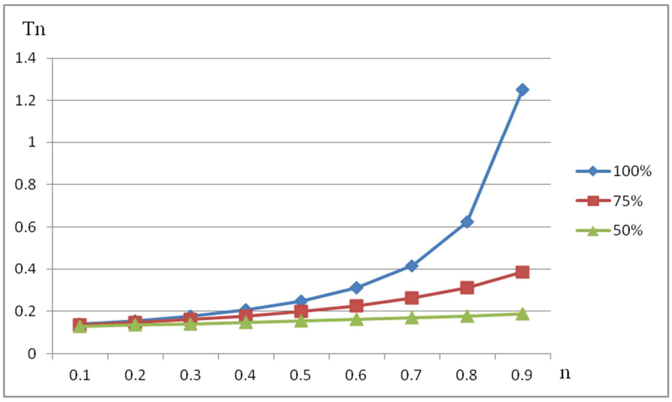

Figure 4. The average processing time on the network

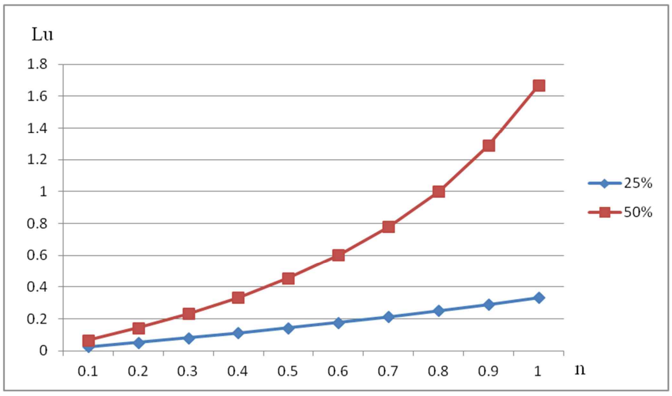

Figure 5. The average load saved on the buffer of n users

The equation (4) is the average waiting time on the n users. In equation (4), Δn is user number determined according to the proposed method. (Where is $\Delta n \leq n$)

$$T_u = \frac{\Delta n \cdot \lambda}{\mu - \Delta n \cdot \lambda} \quad (4)$$

The equation (5) is the average waiting time per one user.

$$\frac{T_u}{User} = \frac{\lambda}{\mu - \Delta n \cdot \lambda} \quad (5)$$

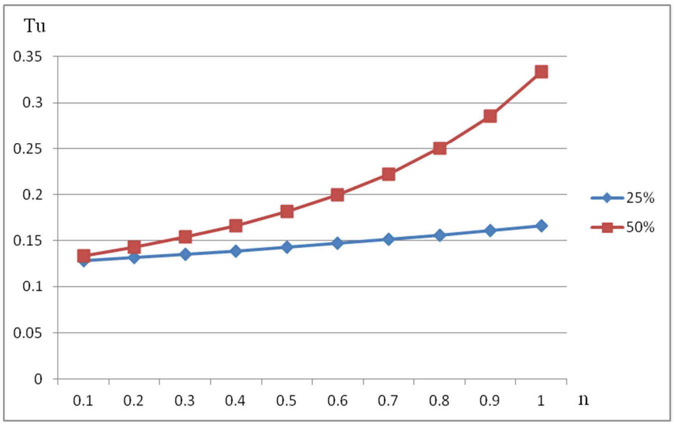

Figure 6. The average waiting time per one user

The Fig. 6 presents the average waiting time per one user. As the percentage of network load on the network is increasing, the average waiting time is decreased. The Fig.5 and Fig.6 are normalized graphs for obtaining the average load saved on the buffer of n users and the average waiting time per one user.

V. Conclusions

In this paper, we propose the network traffic mitigation method using TCP signalling delay algorithm. By using proposed method, when the network is overloaded, the TCP signalling response time is adjusted to according to network traffic load status. By delaying the TCP signalling packet during constant time, the network traffic load can be decreased. The proposed method is applied to the access point or bottleneck point which processes the TCP signalling packets. Through the queuing analysis, we verify that the network traffic load can be mitigated.

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