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Optimization between security and delay of quality-of-service

Jianyong Chen*, Huawang Zeng, Cunying Hu, Zhen Ji

Shenzhen City Key Laboratory of Embedded System Design, College of Computer Science and Software Engineering, Shenzhen University, Shenzhen 518060, China

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ABSTRACT

Quality of service (QoS) and security have been considered as two independent entities. However, they always impact each other in various kinds of scenarios and it is necessary to study the optimization between them. This paper proposes algorithms to evaluate security level with three main features, i.e., authentication, data integrity and confidentiality. Based on that, a novel model is proposed to measure the interaction between delay of QoS and security in different application scenarios, heterogeneous users and disparate services. Furthermore, immune algorithm is used to get optimal parameters for both delay and the security level. Simulation results show that the proposed model can balance delay and security level well under diverse traffic loads of network. The model is useful to get better performance for network service, especially in rigorous network circumstance.

1. Introduction

In communication networks, security and quality of service (QoS) have been two important issues to be studied independently. On one hand, network transmission and services always face many malicious attacks (Tiliute, 2007). In order to get secure network, various security protocols are presented to address security issues (Da Fonseca, 2009), including wired equivalent privacy (WEP), 802.1X port access control with extensible authentication protocol (EAP) and IP security protocol (IPsec) (Lee et al., 2008; Tang and Wu, 2008). On the other hand, QoS is one of the key factors for various services that include diverse important parameters, i.e., delay, throughput and dropping probability of packets. Different types of services always need different requirements of QoS. For example, delay is very sensitive to performance of real-time multimedia applications (Estevez-Ayres et al., 2009).

It is evident that every kind of service has a certain requirement on both security and QoS to get good performance. Even for the same customer and service, the requirements might also be different in a different circumstance or time. However, it may be impossible to satisfy requirements from both security and QoS simultaneously due to limited network resources. Therefore, the interaction between security and QoS should be considered together.

With the development of research, it is discovered that both security and QoS are strongly interactive with each other (Fathi et al., 2005; Chen et al., 2009). On one hand, stable QoS requires effective security service to resist diversified attack and avoid congestion of traffic (Hejmo et al., 2006). Taking wireless network, for example, especially ad hoc network, the transmission channel is exposed to the air. It is easy for attackers to intrude the transmission information (Wang and Lee, 2009). If network security is not strong enough, it is easy to be harmed by warm virus with spam and then a lot of bandwidth is consumed, which is one of the key factors of QoS. On the other hand, security can obviously affect QoS, such as additional delay by proceeding of encryption or authentication. Moreover, the limited bandwidth of wireless channel makes its impact on QoS more serious. In this paper, only delay of QoS is considered since security mainly impacts delay.

The impact on delay has been investigated from security level, mobility and traffic patterns on overall system performance, respectively. Security can always evidently increase the delay of QoS. Regarding the three main elements of security, i.e., authentication, integrity and confidentiality, delay of QoS increases with improvement of security level. Although authentication process is always executed before the start of a service, authentication rate during the service can increase the delay time of QoS. For the integrity, it is necessary for the sender to calculate check sum of thr transmitted data and the receiver should validate the check sum. The process needs much of calculation at both the sender and the receiver and thus increases the delay time. For confidentiality, data encryption and decryption need much additional computation assumption. It can sharply increase the delay time between end-to-end data transmission. Several papers have reported the interaction between delay and security in communication networks (Wei and Wan, 2005; Lindskog et al., 2006; Shen and Thomas, 2008). A group-based security model is presented and the issue of optimizing quality of security in real-time systems is addressed (Lin et al., 2009). Security options are presented for session initiation protocol (SIP) based multimedia over IP architecture and their impact on delay is also analyzed (Callegari and Garroppo, 2009). A trade-off between security and delay is presented on the basis of the choice of the available security configurations (Qu and Srinivas, 2005). An integrated solution, which addresses with

* Corresponding author. Tel.: +86 13823278100; fax: +86 755 26534078.
E-mail address: cjyok2000@hotmail.com (J. Chen).

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