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Cost Analysis of Short Message Retransmissions

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Short Message Service (SMS) is the most popular mobile data service today. In Taiwan, a subscriber sends more than 200 short messages per year on average. The huge demand for SMS significantly increases network traffic, and it is essential that mobile operators should provide efficient SMS delivery mechanism [1, 2]. Due to user behavior and mobile network unavailability (e.g., the user moves to a weak signal area such as a tunnel, an elevator, a basement, and so on), a short message may not be successfully delivered at the first time. If a short message transmission fails, the SM-SC retransmits the short message to the terminating UE after a waiting period. SMS retransmission may result in huge mobile network signaling traffic and long elapsed times of short message delivery. Therefore, it is essential to exercise an efficient SMS retransmission policy to determine when and how many times to retransmit a short message to the terminating UE. To address this issue, we propose analytic and simulation models to investigate the performance of SMS retransmission in terms of the expected number of retransmissions and the message delivery delay. We also collect measured data from a commercial UMTS system to further analyze the performance trends on SMS retransmission.

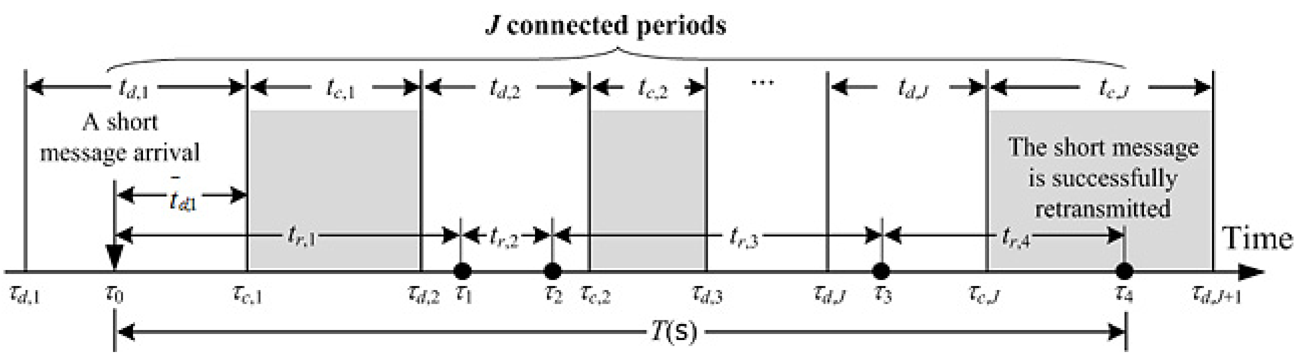

Fig. 1. Timing diagram for the short message retransmissions（1≦j≦J）

To simulate the status of the UE availability, a variable UE_STATUS is maintained in the model. When UE_STATUS is set to “On,” the UE is connected to the mobile network (i.e., the $t_{c,j}$ periods in Fig. 1) and can receive the short message successfully. When UE_STATUS is set to “Off,” the UE is disconnected from the mobile network (i.e., the $t_{d,j}$ periods in Fig. 1) and the message transmission fails. The gamma random number generator is used to produce the connected period $t_{c,j}$, the disconnected period $t_{d,j}$. The SM-SC performs the ith short message retransmission after an Exponential random time $t_{r,i}$ with mean 1=1/λ. Let the expected values for $t_{c,j}$ and $t_{d,j}$ be m_c and m_d, respectively. In an experiment, we simulate N short messages (excluding retransmissions) delivered to the terminating UE. We propose an analytic model to investigate the short message retransmission performance in terms of the expected number of short message retransmissions E[N(s)] and the message delivery delay E[T(s)]. Details can be found in [3].

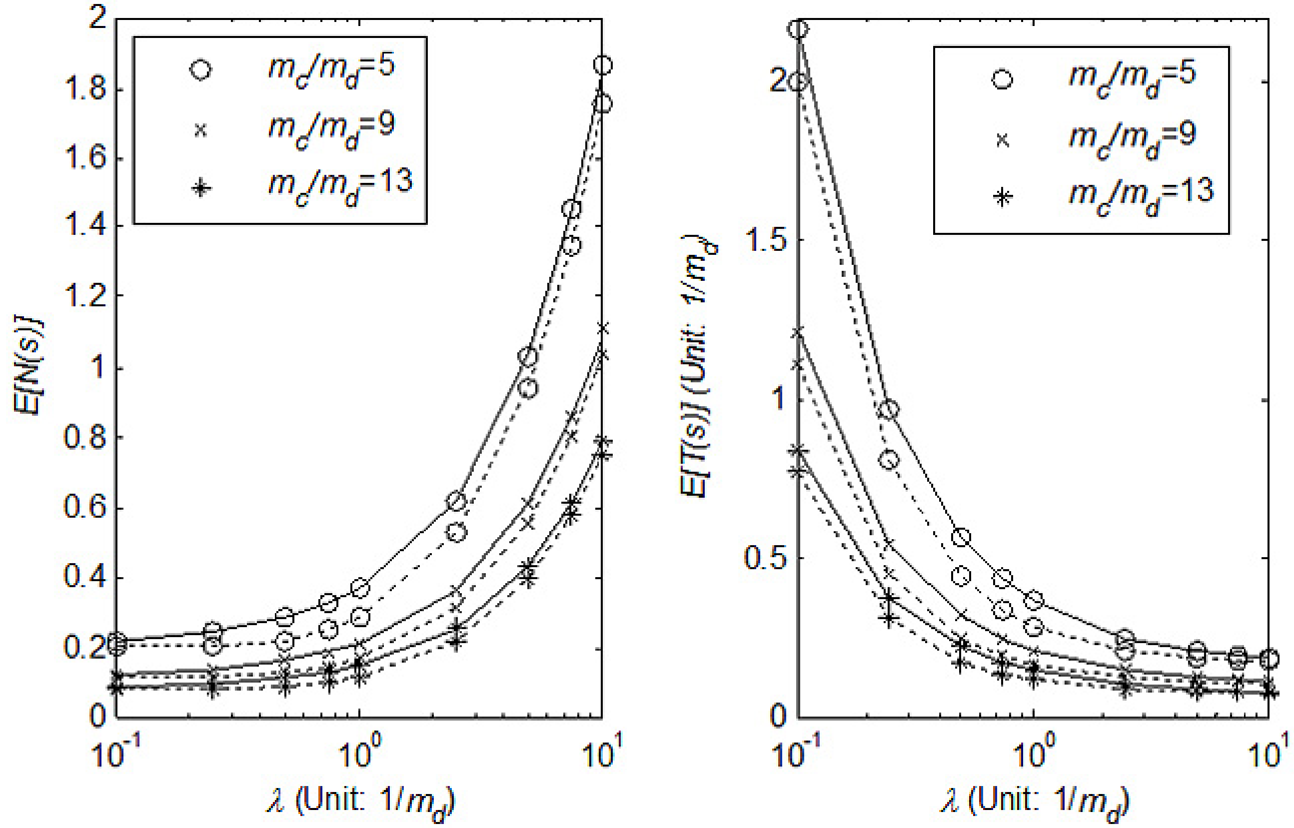

Fig. 2. Effects of λ and m_c/m_d

Fig. 2 shows that E[N(s)] is an increasing function of λ. E[T(s)] is a decreasing function ofλ. When $\lambda<1/m_d$, E[T(s)] significantly decreases as λ increases. Conversely, when $\lambda>1/m_d$, increasing λ significantly increases E[N(s)], but only has insignificant effect on E[T(s)]. We observe that $0.5/m_d<\lambda<5/m_d$ is the range that both E[N(s)] and E[T(s)] do not degrade significantly when λ changes.

From the commercial UMTS system of Chunghwa Telecom (CHT), we obtained the output measures Pr[N(s)=n] for several retransmission policies. Define s_{20} as a policy where a short message is retransmitted for every 20 minutes. We have collected the statistics for more than 400,000 SMS deliveries (100,000 deliveries for each policy). Fig. 3 plots the probability mass function Pr[N(s)=n]. Our study indicates that the performance trends for the analytic/simulation models and the measurements from the CHT commercial SMS network are consistent. A useful conclusion is that our analytic model can be used to quickly and roughly estimate the SMS network performance for network planning.

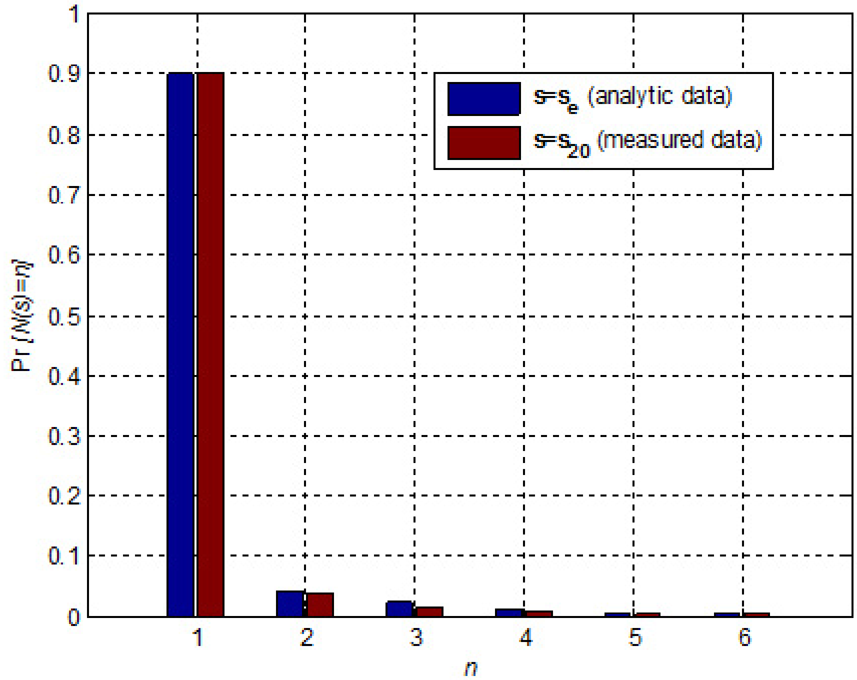

Fig. 3. Performance trends of the analytic data and the measured data

In this paper, we showed how the retransmission rate, the expected values, and the connected/disconnected period distributions affect the SMS retransmission performance, in terms of the expected number of short message retransmissions E[N(s)] and the message delivery delay. Our study indicates that by selecting appropriate retransmission policy (in particular, the retransmission frequency), the SMS delivery cost can be significantly reduced.

References

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