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Procedia Computer Science 32 (2014) 77 – 84

Procedia Computer Science

The 5th International Conference on Ambient Systems, Networks and Technologies (ANT-2014)

# A cross-layer loss discrimination scheme for DCCP over the wireless network

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**Abstract**

DCCP (Datagram Congestion Control Protocol) is a transport layer protocol that provides congestion control for unreliable data transmission. The congestion control mechanism embedded in DCCP adjusts the packet sending rate according to network condition. However, DCCP does not discriminate congestion losses and wireless link errors resulted from fading and thus it leads to unnecessary rate adjustment. In this paper, we proposed a mechanism to enhance bandwidth utilization of DCCP over wireless network. We employed a cross-layer loss discrimination scheme to distinguish congestion loss and fading loss. The cross-layer based mechanism detects frame loss in the data link layer in real-time to infer the actual fading loss rate. Thereafter, the fading loss can be excluded from the packet loss observed in the transport layer. Once the accurate congestion loss rate is calculated, the sender can make appropriate adjustment on the transmission rate that reflects the current congestion state along the transmitting path using the DCCP rate control procedure. Simulation results show that DCCP with our proposed CCID 3 rate control scheme can discriminate fading loss and achieve from 4.7% to 15.5% improvement on transmission throughput when the fading loss rate varies from 5% to 15% in wireless network.



*Keywords:* Datagram Congestion Control Protocol (DCCP); Rate Control; Wireless; Cross-layer Loss Discrimination

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doi:10.1016/j.procs.2014.05.400

## 1. Introduction

DCCP (Datagram Congestion Control Protocol) is a new transport layer protocol that is designed for providing higher transmitting capacity for real-time streaming service, e.g., video on demand and Internet telephony. DCCP implements congestion control for unreliable data transmission in the transport layer. Three built-in congestion control schemes are CCID 2, CCID 3 and CCID 4. A congestion control scheme can be selected during connection setup and dynamically altered, e.g., from CCID2 to CCID3 in real-time, according to the feature negotiation of both DCCP endpoints.

However, DCCP encounters challenges while adapting to the wireless network environment. The congestion control schemes of DCCP suffer inappropriate sending rate reduction because of the following two main reasons. Firstly, the situation of wireless congestion occurred on an Access Point (AP). It means that the allocated channels on the AP are in a highly competition status. In this situation, the total amount of required bandwidth that is needed from the connected mobile nodes may exceed the capacity of the AP. Therefore, incoming packets should be temporarily stored in AP's buffer. However, if the arrival rate of incoming packets exceeds the service rate of the AP, AP's buffer may be overflown and some packets should be dropped. It is the so-called wireless congestion that leads to significant performance bottleneck during transmission. Secondly, the situation of signal fading error occurred during transmission over wireless networks. Signal fading error results from the attenuation of signal strength and the effect of multipath fading. The signal fading error affects the integrity of packet delivery and then degrades the transmitting throughput. When the situation of signal fading error occurs, some segments of transmitted packets cannot be successfully received on the mobile node, and packets are dropped by the node.

In order to demonstrate the impact of signal fading error, we designed and simulated the situation of wireless fading loss particularly. In Fig. 1, it demonstrates that DCCP has performance degradation when the wireless fading loss exists. The designed experiment runs DCCP over a wireless network using CCID 3 as the congestion control mechanism, and fading loss rate refers to the probability of a packet gets lost due to signal fading error. At the startup time, the network has no fading effect and thus the value of the wireless signal fading loss rate is equal to zero, on which situation the DCCP's sending rate is equal to 34.8KB/s. Then we started to add fading loss effect to the network. When the fading loss rate grows to 5%, the average sending rate reduces to 31KB/s. Furthermore, we increased the fading loss rate from 5% to 40%. We can see that the sending rate degrades dramatically when wireless fading increases. In this experiment, we can obtain the result that the reduction of the sending rate isn't relevant to the situation of network congestion. Especially, the experiment result reveals that the rate control mechanism in DCCP unnecessarily reduces the transmission rate without the presence of congestion over wireless network.

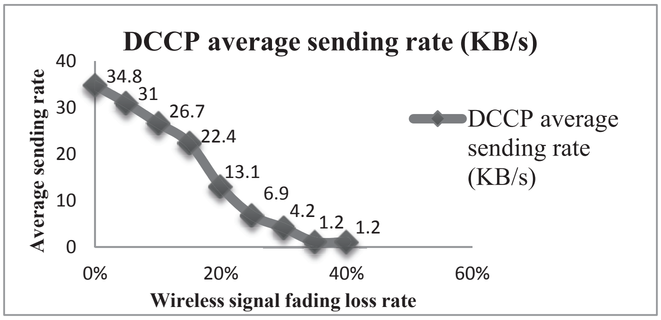


Fig. 1. Experiment result for DCCP over wireless links

From the view point of DCCP CCID 3 congestion control mechanism, the loss rate measurement is performed based on the detection of lost and marked packets. DCCP maintains a list of receiving history that includes received and lost packets. For an ECN-capable (Explicit Congestion Notification) DCCP connection, a marked packet is detected as a congestion event. However, in the wireless network domain, packet losses resulted from wireless fading are still marked as lost in the receiving list, which is used for calculating the loss event rate. DCCP CCID 3