A CROSS-LAYER APPROACH TO PACKET SIZE ADAPTATION FOR IMPROVED UTILIZATION IN MOBILE WIRELESS NETWORKS

KAI-TING YANG¹, WEI KUANG LAI¹ AND CHIN-SHIUH SHIEH²

¹Department of Computer Science and Engineering National Sun Yat-sen University 70 Lien-Hai Road, Kaohsiung 804, Taiwan terence.kaiting@gmail.com

²Department of Electronic Engineering National Kaohsiung University of Applied Sciences 415 Chien-Kung Road, Kaohsiung 807, Taiwan csshieh@cc.kuas.edu.tw

Received July 2008; revised December 2008

ABSTRACT. Packet losses can be a result of router congestions or inferior channel conditions. Different causes of packet losses should be dealt with by different strategies. For packet losses caused by router congestion, the TCP congestion control mechanism should be invoked to slow down the transmission rate. For packet losses due to inferior channel conditions, it is a promising direction in adapting packet sizes based on monitored channel conditions. A new network transmission framework highlighting the concept of cross-layer co-design for packet loss reduction is presented in this article. The proposed framework takes into account the correlation between the packet loss rates and the packet sizes under a given channel condition, and assigns different tasks to layers involved: physical/MAC layer for monitoring current channel statuses, IP layer for fragmentation, transport layer for bandwidth allocation, and application layer for the selection of coding method and compression rate. Our proposed scheme can detect current channel conditions, and then dynamically and rapidly adjusts parameters in each layer to match the changing channel status. Especially, when a mobile node is conducting a handover process, the radio signals and channel conditions will change rapidly. The proposed scheme can accommodate the variations quickly and prepares adequate data for corresponding node in advance, so that we can reduce the handover delay and make seamless handover possible.

Keywords: Wireless network, Packet size adaptation, Cross-layer approach

1. Introduction. Driven by the ambition for ubiquitous networking, wireless networks had gained substantial technical advances in recent years. Using radio signals in air as data links, wireless networks can get rid of the tangling of wired cables. However, due to the inherent limitations of wireless channels and legacy protocol design, users of wireless networks today still suffer from the problems on low bandwidth and high error rates.

The Internet Protocol Suite, TCP/IP, was originally designed with wired network environments in mind. Following the philosophy suggested by the 7-layer OSI (Open System Interconnection) model, TCP/IP adopted strictly-layered approach in its design. It is a good practice from the perspective of system engineering. However, the adequacy of a strictly-layered approach is a controversy in wireless environments, since wireless networks have completely different characteristics from its wired counterparts. For instance, packet losses in wired networks serve well as essential indicators for TCP retransmission mechanism and congestion control. However, in wireless environments, packet losses could be