ITC19/ Performance Challenges for Efficient Next Generation Networks 1673-1686
LIANG X.J. and XIN Z.H.(Editors)
V.B. IVERSEN and KUO G.S.(Editors)
Beijing University of Posts and Telecommunications Press

Analytical modelling of TCP file transfer times over 802.11 wireless LANs

F. Roijers[1], J.L. van den Berg[1,2], and X. Fan[1,2]

[1] TNO Information and Communication Technology, P.O. Box 5050, 2600 GB Delft, The Netherlands {f.roijers, j.l.vandenberg}@telecom.tno.nl
[2] University of Twente, P.O. Box 217, 7500 AE Enschede, The Netherlands

Abstract. This paper presents a modelling approach for analysing TCP flow throughputs and transfer times in IEEE 802.11 WLANs. The model captures the behaviour of TCP packets sent over the WLAN MAC layer and takes into account the system dynamics due to the initiation and completion of data flow transfers. In particular, at the flow-level the system is modelled by a Processor Sharing type of queue, reflecting both the IEEE 802.11 MAC design principle and TCP behaviour of sharing the transmission capacity fairly among the active flows. The modelling results are validated by simulations.

Key words: Wireless LAN • IEEE 802.11 • TCP • flow-level • transfer time • Processor Sharing

1 INTRODUCTION

Wireless Local Area Networks (WLANs) networks are taking an important position in providing internet access at public hot spots like airports, railway stations and conference centers. Many portable devices are nowadays equipped with WLAN interface cards based on the leading IEEE 802.11B standard. As the commercial deployment of WLAN continuously increases, WLAN performance becomes a critical issue.

WLAN performance is largely determined by the maximum data rate at the physical layer and the MAC (Medium Access Control) layer protocols defined by the IEEE 802.11 standards [7, 8]. The most widely employed WLAN MAC protocol is the Distributed Coordination Function (DCF). The DCF is a random access scheme based on Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA), which uses random backoffs in order to manage packet retransmissions in case of a destructive collision. If the DCF is used in its BASIC access mode, the aggregate WLAN throughput decreases drastically for a larger number of active stations, due to a rapidly increasing number of collisions. The occurrence of collisions is particularly significant in cases with so-called hidden stations, i.e. when stations cannot detect each other's activity simply by sensing the medium. In order to overcome this throughput degradation the Request-To-Send/Clear-To-Send (RTS/CTS) mechanism has been standardised, where a station sends a small control packet in order to reserve the channel for transmission of a data packet.