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Performance analysis of the CSMA/CA MAC protocol in the DBORN optical MAN network architecture

Guoqiang Hu, Christoph M. Gauger and Sascha Junghans

University of Stuttgart, Institute of Communication Networks and Computer Engineering
Pfaffenwaldring 47, D-70569 Stuttgart, Germany
e-mail: {hu, gauger, junghans}@ikr.uni-stuttgart.de

Abstract: In this paper, we present a detailed performance analysis of the MAC protocol of the DBORN metro network architecture. We introduce an exact analytical model for the slotted mode and models for the unslotted mode which yield good upper and lower bounds. Also, we introduce a new moment analysis approach to derive the mean waiting time of preemptive repeat identical priority systems. Then, we validate the analytical model by simulation and assess important architectural options regarding delay and admissible network load. In order to consider realistic burst traffic characteristics, we extend the evaluation towards general arrival processes and finally employ a burst assembly module with self-similar IP traffic.

1. INTRODUCTION

With the continuously increasing traffic demand, MANs are becoming the bottleneck of the network infrastructure, in comparison to the current over-dimensioned core networks. Internet service providers today ask for equipment with higher bandwidth but lower cost. This motivates the application of optical solutions with WDM technology. In consideration of the high cost of active optical switching elements, an optical network architecture without active optical switching elements is desirable. The DBORN (Dual Bus Optical Ring Network) architecture is a MAN technology suitable under these constraints [4,16]. For this aim, a new MAC protocol and interface card was designed [4,16] which we survey in more detail in Section 2.

In this paper, we present for the first time our detailed teletraffic theoretical analysis [8] as well as a comprehensive performance evaluation based on analysis and simulations. First, we describe the exact mean waiting time model for the slotted mode as well as upper and lower bound models for unslotted mode based on the Preemptive Repeat Identical (PRI) priority system. Second, a new moment analysis approach is derived for PRI systems for Poisson arrivals. This new method not only simplifies the derivation of the mean waiting time by only using first and second moments of busy period and completion time, but also explains its exact relation to the busy period of high priority customers. Third, we validate the analytical models and bounds by simulation for a Poisson arrival process. The applicability of the Poisson traffic model is then further validated by comparing the results with general independent (GI) traffic models of different variability. We then extend our work to realistic aggregate burst traffic that is assembled from self-similar IP traffic. Following this systematic approach, we show that under most practical circumstances Poisson traffic can be a good approximation or act as a useful worst case traffic model.