ITC19/ Performance Challenges for Efficient Next Generation Networks 173-182
LIANG X.J. and XIN Z.H.(Editors)
V.B. IVERSEN and KUO G.S.(Editors)
Beijing University of Posts and Telecommunications Press

A Scheduling Algorithm in a Core Optical Router with Heterogeneous Traffic

Rose Q. Hu*, Robert Best[#], Yi Qian[+], Mingzhou Jin[†]

[*]Department of Electrical and Computer Engineering
Mississippi State University
Mississippi State, MS 39762-9571, USA
Email: hu@ece.msstate.edu
Phone: 662-325-1529, Fax: 662-325-2298

[#]Award Solutions, Inc.
Richardson, TX 75081, USA

[+] Department of Electrical and Computer Engineering
University of Puerto Rico at Mayagüez
Mayagüez, Puerto Rico 00680, USA
Email: yqian@ece.uprm.edu
Phone: 787-833-3338, Fax: 787-833-3331

[†]Department of Industrial Engineering
Mississippi State University
Mississippi State, MS 39762, USA

Abstract: Recent advances in optical networking reveal that large-scale optical networks supporting heterogeneous traffic may soon become economical as the underlying backbone in wide area networks, in which optical routers play a key role. One big challenge in the design of future large-scale optical systems is packet scheduling for the core optical routers. The optical router essentially is a delay system with packets waiting at its ingress queues. A scheduler is necessary to allocate resources so that satisfactory delay and jitter performance of different types of traffic can be achieved and system capacity is efficiently utilized. This paper develops a non-blocking scalable scheduling algorithm and presents related performance evaluations in a multi-service high capacity core optical router. The proposed algorithm is based on a heuristic approximation of a Linear Integer Programming model. It is shown that the heuristic solution is 'close' to the optimal solution 'most of the time', yet it is much easier to implement.

Keywords: Scheduling, WSA, WSD, integer linear programming/optimization, QoS, heterogeneous traffic.

1. INTRODUCTION

Internet traffic has explosively grown in the past few years. It has triggered significant research in the design of large-scale optical systems with very high-speed core optical switches and routers (e.g., [1-4]). One big challenge in design of a large-scale high-speed optical system is packet scheduling for core routers. A dynamic scheduling mechanism is necessary to control the switching fabric of the optical router, for the purpose of providing non-blocking transmission and dynamic adaptation to varying traffic patterns and volumes over time. The adaptation must be fast enough to support fairness and Quality of Service (QoS) requirements as measured in terms of delay, Bit Error Rate (BER), throughput, etc. On the other hand, frequent schedule changes may cause network instability on bandwidth control. An effective and ideal scheduling design is needed to offer a good balance among these factors.

Much research work has been conducted on scheduling optical switches and routers. A scheduling algorithm was proposed in [5,6] to provide best-effect services in the Birkhoff-von Neumann switch. The problem was formulated as a resource sharing problem that can be optimized with respect to efficiency and fairness. Since it dealt with the best-effort services only, the QoS issues for different types of traffic had not been addressed in [5, 6]. A fair scheduler was presented in [7] that suitable in buffer-less circuit-switched blocking networks operating with distributed, asynchronous controllers and variable length messages. The tradeoffs and performance limitations of the fair scheduler were discussed. The circuit-switched optical networks rather than the packet-switched or IP based networks were studied in that paper. In [8], a hierarchical scheduling framework was introduced in a class of photonic packet switching systems based on WDM, in which the flow scheduling was separated from the