PERFORMANCE ANALYSIS OF QUEUEING NETWORKS WITH COMPLETE BUFFER PARTITIONING

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ABSTRACT

This paper presents the analysis of networks of queues under repetitive service blocking mechanism by considering a buffer management scheme, namely, complete buffer partitioning (CBP). This analysis considers the networks with arbitrary configuration where each node in the networks employs an active queue management (AQM) type buffer management scheme to guarantee certain quality of service for multiple class external traffic. The analysis is based on a queue-by-queue decomposition technique where each queue is modeled as a GE/GE/1/N queue with single server, R ($R \geq 2$) distinct traffic classes and $\{N = N_1, N_2, \ldots, N_R\}$ buffer partitions for each class under first-come-first-serve (FCFS) service rule. The external traffic is modeled using the Generalised Exponential (GE) distribution which can capture the bursty property of network traffic. The analytical solution is obtained using the Maximum Entropy (ME) principle. The forms of the state and blocking probabilities are analytically established at equilibrium via appropriate mean value constraints. The initial numerical results demonstrate the credibility of the proposed analytical solution.

Keywords: Queue thresholds; Queueing networks; Performance evaluation

INTRODUCTION

Queueing Network Models (QNMs) with Finite Capacity provide powerful and realistic tools for the performance evaluation and prediction of discrete flow systems such as computer systems, communication networks and flexible manufacturing systems. Over recent years, there has been a great deal of progress towards the analysis and application of QNMs with finite capacity, and high quality research work has appeared in diverse scientific journals of learning and conference proceedings in the fields of Operations Research, Computer Science, Telecommunication Networks, Management and Industrial Engineering. However, there are still many important and interesting finite capacity queues and QNMs to be resolved, such as those involving multiple-job classes, bounds and theoretical properties, exact analysis, numerical solutions and approximate methods, as well as application studies to computer and distributed systems, high-speed networks and production systems.

Analysis of networks of finite capacity queues plays an important role for the effective congestion control of network traffic and quality of service (QoS) protection in fixed and wireless networks. Because of finite capacity blocking in such networks arises as the network traffic through one queue may be temporarily halted if the destination queue is full. Exact closed-form solutions for queueing network models (QNMs) with blocking are not generally attainable except for some special cases such as two-station cyclic queues and 'reversible' queueing networks (i.e., networks with finite capacity whose corresponding infinite capacity networks are reversible (Baskett *et al.*, 1975; Kelly, 1975). As a consequence, numerical techniques and analytic approximations have been proposed for the study of arbitrary QNMs with non-Markovian (external) inter-arrival and service times under various types of blocking mechanisms (Akyildiz and Huang, 1992; Balsamo *et al*, 2003). However, relatively little work has been