

Approximate Analysis of Arbitrary Configuration Open Queueing Networks with Blocking

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Abstract

We consider an open queueing network consisting of servers linked in an arbitrary configuration with exponential service times and intermediate finite buffers. The model allows any number of saturated servers(never starved) and exit servers(never blocked). The considered blocking mechanism is blocking-after-service: the service discipline at each node(a server and its preceding buffer), is assumed to be FIFO(First In First Out) and routing between nodes is supposed to be probabilistic. In case of simultaneously blocking, we assume that the blocked customers proceed to the destination node in a First Blocked First Enter Basis.

In this paper, we present an approximation method to analyze this kind of network. The method decomposes the original network into subsystems. Each subsystem is associated with a buffer in the original system and models the behavior of the customers in the buffer. Each subsystem is composed of one or many upstream servers, and one downstream server, separated by a finite buffer. The upstream servers represent the part of the original model upstream of the buffer, and the downstream server represents the part of the original model downstream of the buffer. The upstream and downstream servers are characterized by exponential distributions. The goal is to determine the parameter values corresponding to each subsystem. It was proved by Dallery and Frein that in tandem configurations three systems of equations can be developed to determine the unknown parameters of each subsystem. Therefore, decomposition methods can be classified into three main approaches according to which system of equations is used. These three approaches yield same results if subsystems are characterized and solved in the same way. One of these approaches, which offers a symmetrical view of decomposition, is of special interest because the algorithm based on this symmetrical approach is, in general, faster than those based on the other approaches. In this paper, we extend this symmetrical approach to arbitrary configurations. The system of equations we obtain in this paper yields the same results as that proposed in Lee and Pollock because subsystems are characterized and solved in the same way in these two approaches. However, our algorithm takes less CPU time than the one in Lee and Pollock because our algorithm exploits the properties associated with symmetrical approach. In particular, for the case of merge configuration, we could prove properties of existence and uniqueness of the solution of this system of equations, as well as properties of convergence of the associated algorithm, which to the best of our knowledge has never been done previously.