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On Deadlock in Queueing Networks

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Open restricted queueing networks give rise to the phenomenon of deadlock, whereby some customers may be unable to ever leave a server due to recursive upstream blocking. This paper explores deadlock in restricted queueing networks, presents a method of detecting deadlock in these systems, and builds Markov chain models of these deadlocking networks. The five networks for which Markov models are given include single and multi-server networks for one and two node systems. These models are compared to results obtained using a simulation and the developed deadlock detection method. Finally a bound on the time to deadlock of the two node single-server network with loops is derived by comparing its properties with other queueing networks that are embedded within it. This paper aims to address the apparent gap in the literature on the deadlocking properties of open restricted queueing networks and will be of value to simulation modelling of queues.

Key words: queueing networks, deadlock

1. Introduction

The study and modelling of queueing networks with blocking is an important tool in many aspects of operational research, both analytically and through simulation. These models have applications in many varied settings such as healthcare, supply chains, manufacturing and communications systems. However, these types of models have their limitations, due to their potential to become permanently blocked in deadlock, or a deadly embrace of resources. These deadlocks can be real in which case accurate modelling of deadlock is needed, or they can occur in models where deadlock