Markovian polling systems with an application to wireless random-access networks

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Abstract

Motivated by an application in wireless random-access networks, we study a class of polling systems with Markovian routing, in which the server visits the queues in an order governed by a discrete-time Markov chain. Assuming that the service disciplines at each of the queues fall in the class of branching-type service disciplines, we derive a functional equation for (the probability generating function of) the joint queue length distribution conditioned on a point in time when the server visits a certain queue. From this functional equation, expressions for the (cross-)moments of the queue lengths follow. We also derive a pseudo-conservation law for this class of polling systems. Using these results, we compute expressions for certain system parameters that minimise the total expected amount of work in systems that arise from the wireless random-access network setting. In addition, we derive approximations for those same parameters that minimise a weighted sum of mean waiting times in these systems. Based on these expressions, we also present an adaptive control algorithm for finding the optimal parameter values in a distributed fashion, which is particularly relevant in the context of wireless random-access networks.

Keywords: queue lengths, binomial service disciplines, Markovian routing, random routing, wireless random-access networks