Controlled Queueing Systems with Heterogeneous Servers

Dmitry Efrosinin

Abstract

Many real-life phenomena, such as computer systems, communication networks, manufacturing systems, supermarket checkout lines as well as structural military systems can be represented by means of queueing models. Looking at queueing models, a controller may considerably improve the system's performance by reducing queue lengths, or increasing the throughput, or diminishing the overhead, whereas in the absence of a controller the system behavior may get quite erratic, exhibiting periods of high load and long queues followed by periods, during which the servers remain idle. The theoretical foundations of *controlled queueing systems* are led in the theory of Markov, semi-Markov and semi-regenerative decision processes.

In this thesis, the essential work consists in designing controlled queueing models and investigation of their optimal control properties for the application in the area of the modern telecommunication systems, which should satisfy the growing demands for quality of service (QoS). For two types of optimization criterion (the model without penalties and with set-up costs), a class of controlled queueing systems is defined. The general case of the queue that forms this class is characterized by a Markov Additive Arrival Process and heterogeneous Phase-Type service time distributions. We show that for these queueing systems the structural properties of optimal control policies, e.g. monotonicity properties and threshold structure, are preserved. Moreover, we show that these systems possess specific properties, e.g. the dependence of optimal policies on the arrival and service statistics.

In order to practically use controlled stochastic models, it is necessary to obtain a quick and an effective method to find optimal policies. We present the iteration algorithm which can be successfully used to find an optimal solution in case of a large state space.