Spatial Queues

Lothar Breuer

Abstract

In the present thesis, a theoretical framework for the analysis of spatial queues is developed. Spatial queues are a generalization of the classical concept of queues as they provide the possibility of assigning properties to the users. These properties may influence the queueing process, but may also be of interest for themselves. As a field of application, mobile communication networks are modeled by spatial queues in order to demonstrate the advantage of including user properties into the queueing model. In this application, the property of main interest is the user's position in the network.

After a short introduction, the second chapter contains an examination of the class of Markov-additive jump processes, including expressions for the transition probabilities and the expectation as well as laws of large numbers. Chapter 3 contains the definition and analysis of the central concept of spatial Markovian arrival processes (shortly: SMAPs) as a special case of Markov-additive jump processes, but also as a natural generalization from the well-known concept of BMAPs. In chapters 4 and 5, SMAPs serve as arrival streams for the analyzed periodic SMAP/M/c/c and SMAP/G/infinity queues, respectively. These types of queues find application as models or planning tools for mobile communication networks. The analysis of these queues involves new methods such that even for the special cases of BMAP inputs (i.e. non-spatial queues) new results are obtained. In chapter 6, a procedure for statistical parameter estimation is proposed along with its numerical results. The thesis is concluded by an appendix which collects necessary results from the theories of Markov jump processes and stochastic point fields. For special classes of Markov jump processes, new results have been obtained, too.