

# An analysis of a batch server with variable and class-dependent service capacity

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## Abstract

In many studies on batch service queueing systems, the service capacity is assumed to be constant. However, this service capacity often depends on the content of the queue. In this paper, we analyse a discrete-time single server batch server queue with general independent arrivals. We distinguish two different classes in the arrival stream and products of both classes are added to the tail of a single queue. The single batch server can group all waiting customers at the head of the queue that belong to the same product class up to a certain class-dependent maximum capacity. This results in a stochastic service capacity that depends on both the number of customers in the queue and their respective classes. Since it is clear that the length of a sequence of same-class customers will have a significant impact on the performance of the system, we also include correlation between the classes of consecutive customers. Applications of this type of batch server can, for instance, be found in the pacemaker loop of a Lean manufacturing system. In the course of the analysis, we calculate the probability generating function of the system occupancy at service initiation opportunities. In the numerical experiments, we will look at the impact of different parameters on both the mean system occupancy and the probability that the server is idle at a random service initiation opportunity. We also provide a number of guidelines to pick between the exact solution and an approximated approach with unlimited service capacities, by looking at the trade-off between accuracy and computational complexity.

**Keywords:** Queueing, Batch Service, Two-Class, Variable Service Capacity, Generally distributed service times, Correlated customer types

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