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Heterogeneous Queuing-Inventory System with Class-Dependent Inventory Access

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Abstract

In this paper, we consider a queuing inventory system with heterogeneous customers of K types arriving consistent with a marked Markovian arrival process. Each class of consumers differs naturally of the service they seek and different priorities are assigned for every class leading to different levels of inventory admitted to exhaust for patrons of every class. one service node is provided for every class with exponential services having class-dependent service rates. All classes of consumers are served from one source of inventory replenished consistent with (s,S) policy with exponentially distributed time interval . Stability condition and steady state probabilities are obtained by matrix-analytic method. Some important performance measures also are derived. Inventory recycle time was analyzed intimately . Useful cost function and numerical illustrations also are given. The optimization problem is interesting and may be solved in similar real scenario.

Keywords: Heterogeneous Inventory Access • Multi-Server System • Queuing-Inventory • Matrix Analytic Model

Introduction

Queuing-inventory systems are within the focus of recent research thanks to practical applicability in many fields including social, biological and technical systems. Access to a finite consumable and refillable resource may be a natural way of modeling interaction with retail shop customers, office visitors, hospital patients, and even packages within the telecommunication network. In such systems, various sophisticated models arise, including the models with random demand and/or number of consumers served, random order grouping or duplicate ordering from several facilities. In research, queuing-inventory system may be a natural thanks to model load leveraging techniques, like the leaky bucket congestion avoidance scheme utilized in a good range of systems, from large scale routers to electric vehicle charging stations.

Queuing inventory systems with positive service time were first investigated in followed by the work of during which an optimal quantity of inventory to be ordered to attenuate the value rate was obtained. In queuing inventory framework with positive service time, customers' queue is made even when some inventory is out there. We point the reader to an in depth survey of inventory systems with positive service time given in which incorporates classical, retrial, and production inventory.

Many retailers and banks find it helpful to partition the purchasers into different categories (classes) consistent with specific characteristics and adopt a listing management policy supported this differentiation strategy. especially, long-term customers are often treated as high priority as compared to walk-in customers. Given a limited resource, the low priority customers may need to wait while some amount of resource remains available, reserved for patrons with higher priority. The reservation could also be made by imposing typical inventory levels for every class of consumers consistent with their priority level. When the inventory comes below the extent , customers from corresponding classes may need to wait until the inventory replenishment. Such a critical level policy is introduced and studied in Different classes experience congestion with one inventory; thus, customer sojourn times during a system are intrinsically correlated.

In most cases priorities are accompanied with heterogeneity of customer classes, e.g., in terms of service time distribution either in single-server or in multi-server case. As such, the arrival process also becomes heterogeneous, and therefore the promising candidate is that the so-called Marked Markovian Arrival Process (MMAP) used, e.g., within the works.

MMAP[K] may be a generalization of Markov arrival processes (MAP) which are studied and used extensively in queuing theory. MAP was introduced in to model non-Markovian point processes. While MAP may be a useful gizmo to model point processes with one class of consumers, MMAP[K] introduced by Neuts is beneficial when multiple sorts of customers are present, while the model remains analytically tractable. The essential characteristics of MMAP, like peakedness of the arrival process, the primary passage time to the arrival of an item of a selected type, and therefore the behavior of the MMAP during that first passage, are analysed. In this paper, we analyze a multi-server queuing-inventory system with K classes of consumers served from one inventory which is managed consistent with the (s,S) with a positive time interval. we use MMAP[K] to model the arrival process. The servers are class-dependent, each server dedicated to at least one specific class of consumers. Only the very best priority customers are allowed to attend in an infinite buffer. All other class customers can wait in respective finite buffers. The service for every class of consumers is administered with different exponential rates, and therefore the item is consumed at the top of service. A class-specific boundary level within the inventory is defined, causing customers of this specific class to attend for inventory replenishment when this boundary is down crossed. To the simplest of our knowledge, this model is new.

The structure of the paper is as follows. In Section 2, we provides a detailed description of the model. the instance of K=2 is additionally given for better illustration of the model. In Section 3, an intuitive stability criterion for the system has been derived. Section 4 analyzes the steady state of the system and expresses a couple of important performance measures. In Section 5, an in depth analysis of the inventory recycle time has been administered . Numerical illustrations

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are provided in Section 6, during which an optimization problem of practical importance has also been stated.We consider a multi-server queuing inventory system with heterogeneous customers. A K-server station provides service to K classes of consumers. Arrivals occur consistent with the Marked Markovian Arrival Process (MMAP) driven by an irreducible continuous time Markov chain (CTMC) $\{Z(t)\}t\geq 0$ with finite state space W. Let $|W|=W$. The sojourn time in each state $z\in W$ is distributed exponentially with rate σz and d.f.

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