Polling systems in heavy traffic: Higher moments of the delay

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We study an asymmetric cyclic polling model with general mixtures of exhaustive and gated service, and with zero switch-over times, in heavy traffic. We derive closed-form expressions for all moments of the steady-state delay at each of the queues, under standard heavy-traffic scalings. The expressions obtained provide new and useful insights into the behavior of polling systems under heavy-load conditions.

Keywords: polling systems, heavy traffic, delay, higher moments

1. Introduction

The basic polling system consists of a number of queues attended by a single server that visits the queues in cyclic order to render service to the customers waiting at the queues. Polling models occur naturally in the modeling of systems in which different user classes compete for access to a common resource. Polling models find many applications in the areas of computer-communication networks, where service capacity (CPU, bandwidth) has to be shared among different users, each having specific traffic characteristics and Quality of Service (QoS) requirements. Other applications of polling models are found in areas like production, manufacturing and maintenance (cf. [16] for an overview). During the last three decades, the analysis of polling models has received much attention in the literature (cf. [24,25] for overviews). The vast majority of the available literature is devoted to the analysis of the expected delay at the queues, while relatively little attention has been given to the analysis of higher moments of the delay, knowledge of which is very important to operate the system properly. Exact analysis of polling models is only possible in some cases, and even then numerical techniques are usually required to obtain performance measures of interest, like the moments of the delay incurred at each of the queues. However, the use of numerical techniques for the analysis of polling models has several drawbacks. First, numerical techniques do not reveal explicitly how the system performance depends on the system

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