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Dynamic scheduling in manufacturing systems using Brownian approximations

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Abstract. Recently, Brownian networks have emerged as an effective stochastic model to approximate multiclass queueing networks with dynamic scheduling capability, under conditions of balanced heavy loading. This paper is a tutorial introduction to dynamic scheduling in manufacturing systems using Brownian networks.. The article starts with motivational examples. It then provides a review of relevant weak convergence concepts, followed by a description of the limiting behaviour of queueing systems under heavy traffic. The Brownian approximation procedure is discussed in detail and generic case studies are provided to illustrate the procedure and demonstrate its effectiveness. This paper places emphasis only on the results and aspires to provide the reader with an up-to-date understanding of dynamic scheduling based on Brownian approximations.

Keywords. Brownian networks; dynamic scheduling; manufacturing systems; multiclass queueing networks; heavy traffic approximations; weak convergence; functional cental limit theorem.

1. Introduction

Scheduling as a research area is motivated by important resource allocation questions that arise in manufacturing systems, computer systems, computer communication networks, and in general, in all situations where scarce resources have to be allocated to activities over time to appropriate servers (processors, machines, communication channels, material handling devices, etc.) so as to optimize a performance criterion, while satisfying a set of given constraints. Scheduling problems can be classified as *static* scheduling problems when the jobs to be scheduled comprise a fixed set and *dynamic* when jobs can arrive into the facility in an ongoing and usually, in a random fashion. Another usual way of classifying scheduling problems is to consider them as *deterministic* or *stochastic*. In *deterministic* scheduling, job characterstics such as processing times, due dates, and release dates are known with certainty to the scheduler before the actual processing occurs. In *stochastic* scheduling, the scheduler cannot observe the processing times in advance, but only has knowledge