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SCIENCE DIRECT®
Future Generation Computer Systems 22 (2006) 571–587
FGCS FUTURE GENERATION COMPUTER SYSTEMS
www.elsevier.com/locate/fgcs

Examination of load-balancing methods to improve efficiency of a composite materials manufacturing process simulation under uncertainty using distributed computing

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Received 24 June 2005; received in revised form 14 October 2005; accepted 18 October 2005
Available online 5 December 2005

Abstract

Process simulations play an important role in guiding process understanding and development, without requiring costly manufacturing trials. For process design under uncertainty, a large number of simulations is needed for an accurate convergence of the moments of the output distributions, which renders such stochastic analysis computationally intensive. This paper discusses the application of a basic distributed computing approach to reduce the computation time of a composite materials manufacturing process simulation under uncertainty. Specifically, several load-balancing methods are explored and analyzed to determine the best strategies given heterogeneous tasks and heterogeneous networks, especially when the individual task times cannot be predicted.

Keywords: Load balancing; Distributed computing; Design under uncertainty; Pultrusion process simulation; Processing variability

1. Introduction

Stochastic analysis via sampling is an important approach for understanding process designs under uncertainty in materials manufacturing [1–3]. It involves quantifying the input parameters uncertainty in the form of appropriate distribution functions, sampling from the distributions, and using a deterministic numerical model to simulate the process or the system behavior for the combinations of input parameter samples, and to construct the output variability distributions. The

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doi:10.1016/j.future.2005.10.004