



Available online at www.sciencedirect.com

SCIENCE @ DIRECT®

Parallel Computing 30 (2004) 1195–1216

PARALLEL
COMPUTING

www.elsevier.com/locate/parco

On performance analysis of heterogeneous parallel algorithms

Alexey Lastovetsky *, Ravi Reddy

Department of Computer Science, University College Dublin (UCD), Belfield, Dublin 4, Ireland

Received 5 March 2003; revised 15 April 2004; accepted 30 July 2004

Available online 15 September 2004

Abstract

The paper presents an approach to performance analysis of heterogeneous parallel algorithms. As a typical heterogeneous parallel algorithm is just a modification of some homogeneous one, the idea is to compare the heterogeneous algorithm with its homogeneous prototype, and to assess the heterogeneous modification rather than analyse the algorithm as an isolated entity. A criterion of optimality of heterogeneous parallel algorithms is suggested. A parallel algorithm of matrix multiplication on heterogeneous clusters is used to illustrate the proposed approach.

© 2004 Elsevier B.V. All rights reserved.

Keywords: Performance analysis; Parallel algorithms; Heterogeneous networks of computers

1. Introduction

Heterogeneous networks of computers are a promising distributed-memory parallel architecture. In the most general case, a heterogeneous network includes PCs, workstations, multiprocessor servers, clusters of workstations, and even supercomputers. Unlike traditional homogeneous parallel platforms, the heterogeneous

* Corresponding author. Fax: +353 1 269 7262.

E-mail addresses: alexey.lastovetsky@ucd.ie (A. Lastovetsky), ravi.reddy@ucd.ie (R. Reddy).

parallel architecture uses processors running at different speeds. Therefore, traditional parallel algorithms, which distribute computations evenly across parallel processors, will not balance the load of different-speed processors of the heterogeneous network. Faster processors will quickly perform their portions of computation and will wait for slower ones at points of synchronisation.

A natural approach to the problem is to distribute data across processors unevenly so that each processor performs the volume of computation proportional to its speed. Several authors have applied this approach to data parallel algorithms based on the two-dimensional block-cyclic distribution [1–4].

The methods of the performance analysis of homogeneous parallel algorithms are well studied. They are based on a number of models of parallel computers, including the parallel random access machine (PRAM) [5], the bulk-synchronous parallel model (BSP) [6], and the LogP model [7]. All the models assume a parallel computer to be a homogeneous multiprocessor. The PRAM is the most simplistic model. It assumes that all processors work synchronously and that interprocessor communication is free. The BSP allows processors to work asynchronously and models latency and limited bandwidth. Finally, the LogP is the most realistic model among them. It characterizes a parallel machine by the number of processors (P), the communication bandwidth (g), the communication delay (L), and the communication overhead (o). The LogP model has been successfully used for the performance analysis of parallel algorithms for (homogeneous) supercomputers. The theoretical analysis of a homogeneous parallel algorithm is normally accompanied by a relatively small number of experiments on a homogeneous parallel computer system. The purpose of these experiments is to show that the analysis is correct, and the analysed algorithm is really faster than its counterparts.

Theoretical performance analysis of heterogeneous parallel algorithms is a much more difficult task than that of homogeneous ones. While some research efforts in this direction have been made [8,9], there is no adequate and practical model of heterogeneous networks of computers yet, which would be able to predict the execution time of heterogeneous parallel algorithms with satisfactory accuracy. The problem of optimal heterogeneous data distribution has proved NP-complete even for such a simple linear algebra kernel as matrix multiplication on heterogeneous networks [4]. Therefore, most practical heterogeneous parallel algorithms are sub-optimal. A typical approach to assessment of a heterogeneous parallel algorithm is its experimental comparison with some homogeneous counterpart on one or several heterogeneous platforms. Different heterogeneous algorithms are also compared mostly experimentally. Due to the complex and irregular nature of heterogeneous networks, such experimental assessment of heterogeneous parallel algorithms is not as convincing as for homogeneous ones. One can easily argue that the demonstration of the advantage of one algorithm over other algorithm on one or several heterogeneous networks does not prove that the situation will not change if you run the algorithms on other networks of computers, with the different relative speed of processors, and the different structure and speed of the communication network.

In this paper, we present a new approach to the performance analysis of heterogeneous parallel algorithms. As a typical heterogeneous parallel algorithm is just a

متن کامل مقاله

دریافت فوری ←

ISIArticles

مرجع مقالات تخصصی ایران

- ✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
- ✓ امکان دانلود نسخه ترجمه شده مقالات
- ✓ پذیرش سفارش ترجمه تخصصی
- ✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
- ✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
- ✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
- ✓ دانلود فوری مقاله پس از پرداخت آنلاین
- ✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات