COMPUTER SCIENCE
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DISTINGUISHED LECTURE SERIES 2009/10

Parallelism and the Exascale Challenge

By

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29th APRIL 2010

School of Physics and Astronomy, North Haugh
Lecture Theatre A
University of St Andrews

Biography

Arthur Trew, Director of EPCC, University of Edinburgh.

Originally an astrophysicist, Arthur Trew became increasingly interested in the use of computers to solve problems in physics and astronomy which were not amenable to traditional techniques. In 1990 he worked with a small group in the Department of Physics and Astronomy at Edinburgh to found EPCC as a research institute for novel computational science research and development. Today, EPCC has 75 staff and is one of the leading centres in Europe, undertaking a wide range of collaborative projects with academic researchers and industry. In 1995, Arthur became Director of EPCC; in this role one of his key aims is exploiting computational science linkages between academic disciplines and between
academia and industry.

In 2001, he became the Deputy Director of the National e-Science Centre (NeSC) which aims to understand better how to manage, and extract information from, large scientific sets. He is also a Director of UOE HPCx Ltd, a wholly-owned subsidiary of the University of Edinburgh, which was formed to manage the £54M HPCx, and more recently the £113M HECToR, projects. As the Service Director, he is the main link to the Research Councils for both facilities.

Today, he holds a wide range of Research Grants and contracts, and, since 2006, has the Chair of Computational Science at the University of Edinburgh.

Program

Abstract

Work is underway to develop computers able to perform a million, million, million basic numerical operations per second (1 exaflops, in the jargon) and manage a million, million, million bytes of date (1 exabyte). By enabling expensive, dangerous or impossible experiments to be replaced by computer simulations, these computers will be central to the development of many scientific fields in the 2020s. These computers will inevitably be massively parallel, dividing their work among vast numbers of "ordinary" microprocessors. This short course of lectures will review the challenges of building, managing and, especially, programming these giant future computers, and explore some of the approaches currently being developed to meet the "Exascale Challenge".

Thursday 29 April 2010

10.30am	**Lecture 1:** Computer Simulation: Setting the Scene
School of Physics & Astronomy, North Haugh (Lecture Theatre A)	Computer Simulation is now generally regarded as the third scientific paradigm, complementing theory and experiment and of particular use when the system is too complex for theoretical investigation and too large, too small, too fast, too slow, or simply too expensive to experiment on. Meeting the computational needs in many fields has already driven us towards parallel computing approaches, but scientific needs are continuing to outstrip our ability to deliver fast enough computers - especially now that microprocessor clock frequencies have peaked. This lecture will review the scientific drivers and the challenges we face in achieving increasing performance.
11.30am	Coffee & Tea with Biscuits
School of Physics & Astronomy, North Haugh Outside Lecture Theatre A	

12.00noon	**Lecture 2:** The Exascale Challenge
School of Physics & Astronomy, North Haugh (Lecture Theatre A)	Today, the fastest computers in the world struggle to deliver petaflops (10E15 flops) performance but there is already design work underway to design an exaflops (10E18 flops) computer and the applications to run on it. Achieving such an increase in performance will require a quantum leap in computer technology and hence research into a wide variety of computer science problems from fault-tolerance, to power-aware system software, from new progamming paradigms to validation methods. This lecture will consider the key challenges to be faced over the next 5 - 10 years if we are to build a workable exascale computer.
15.30pm	Coffee & Tea with Biscuits
School of Physics & Astronomy, North Haugh Outside Lecture Theatre A	
16.00pm	**Lecture 3:** The Exascale Solution(?)
School of Physics & Astronomy, North Haugh (Lecture Theatre A)	Building a useable exascale computer will require us to face some challenges on a scale which are unprecedented. In other cases, problems, such as fault tolerance, which have been considered solved for many years recur. In all cases, the solution must be accomplished within extremely tight limits on bandwidths and power consumption. This lecture will review recent studies into exascale computer design.