Dan Grigoras · Alex Nicolau
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NATO Advanced Research Workshop, IWCC 2001
Mangalia, Romania, September 2001
Revised Papers

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Preface

Started by small group of well-known scientists with the aim of sharing knowledge, experiences, and results on all aspects of cluster computing, the initiative of a workshop on cluster computing received more attention after IFIP WG 10.3 and IEEE Romania Section accepted our request for sponsorship. Moreover, the application for a NATO ARW grant was successful, leading to a greater interest in the workshop. In this respect, we have to say that we chose Romania in order to attract scientists from Central and Eastern European countries and improve the cooperation in the region, in the field of cluster computing.

We had an extremely short time to organize the event, but many people joined us and enthusiastically contributed to the process. The success of the workshop is wholly due to the hard work of the organizing committee, members of the program committee, key speakers, speakers from industry, and authors of accepted papers. The workshop consisted of invited and regular paper presentations, followed by discussions, on many important current and emerging topics ranging from sheduling and load balancing to grids. The key speakers devoted their time and efforts to presenting the most interesting results of their research groups, and we all thank them for this . All papers were peer reviewed by two or three reviewers.

The proceedings published by Springer-Verlag include 8 invited papers and 24 regular papers, in that benefited from discussions during the workshop. We once again thank the authors for their efforts in preparing high-quality papers.

The workshop was generously sponsored by NATO Scientific Affairs Division, and co-sponsored by the IFIP Working Group 10.3, and IEEE Romania Sections. The "Gh. Asachi" Technical University, "Al. I. Cuza" University, and Black Sea University Foundation greatly contributed to the organization of the event. We also received generous support from the Romanian Ministry of Education and Research, Microsoft Romania, BRD-GSG, and Romaqua Group.

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March 2002

Dan Grigoras
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Invited Papers

Papers

Grid Computing: A New Technology for the Advanced Web

Wolfgang Gentzsch

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Abstract. The aim of our Grid Computing team at Sun is to take Cluster and Grid computing onto the next level of widest acceptance. For this purpose, we present a three-tier Grid architecture which relates to an intuitive model, including Cluster, Campus and Global Grids, which allows users to embrace Grid Computing starting with their current compute clusters, and moving to the next level of Grid implementation in an evolutionary way. In addition, we present a complete Grid software stack for all three Grid stages, which contains modules developed at Sun and by our partners.

1 Grid Components: Networks, Computers, Software

Mankind is right in the middle of another evolutionary technological transition which once more will change the way we do things. And, you guessed right, it has to do with the Internet. It's called "The Grid", which means the infrastructure for the Advanced Web, for computing, collaboration and communication.

The Internet itself has dramatically changed over the last three decades. While, in the late Sixties, it was built mainly to provide scientists with an infrastructure for faster communication via electronic mail, it has rapidly grown and improved since then, mainly because of three driving elements: networks, computers, and software.

In the mid Nineties, George Gilder predicted the "Network Abundance". Every nine months, total network bandwidth doubles. For many years, every day, thousands of miles of fiberoptic cables are laid down, ready for deployment in private and business applications. While many of us still suffer from 56 bps (Bits/sec) telephone modem speed, researchers and enterprises have already access to networks with a bandwidth of 10 million bps, and some even up to one billion bps. Soon, we will see 100 billion bps and more. Thus, network bandwidth will grow by a factor of 5000 over the next 10 years. Just this July, the US National Science Foundation approved the $53 million DTF Distributed TeraScale Facility project, a network with 40 billion bps, connecting research centers in San Diego (SDSC), Pasadena (Caltech), Urbana-Champaign (NCSA), and Chicago (ARNL). It seems that there is no limit.

Another building block of the Internet are the computers. Today, for example, there are over one hundred million PCs in homes and at work, plus some 10 million powerful compute servers, from midrange to high-end, used at ISP Internet Service Providers, or for high-performance scientific, engineering and commercial appli-

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cations. Their performance doubles every 18 months, which was observed and predicted by former Intel Chairman Gordon Moore in 1965. Thus, computer performance will grow by a factor of 100 over the next 10 years, then breaking the Petaflops Performance Barrier. This will make today's handheld electronic devices soon very powerful nodes in the Internet.

The third and most complex Internet building block is software, either for running the networks and the computers and their intercommunication - then called the *middleware*, or for solving our day-to-day problems and running our business, called *application* software. The ever increasing benefit, resulting in the combination of the networked computers, the software to run them, and the people who use them, is called Metcalfe's Law, after Bob Metcalfe, who developed Ethernet at Xerox Parc, in 1973: "The usefulness of a network equals the square of the number of users."

These three laws of Gilder, Moore, and Metcalfe, respectively, and the technological evolution they describe, are currently converging into and enabling the Advanced Web, on top of the Internet infrastructure. Past Internet and World Wide Web mainly enabled information provision, retrieval and exchange, and some e-commerce.

The new Advanced Web adds a wide variety of opportunities, based on computing, collaboration and communication, for individuals, groups, research and engineering teams, and for the whole community. It will provide great services in our private, community, and business environments. Universal connectivity gives users immediate and easy access to any kind of information and service they want, helps them in solving problems and in making personal and business decisions, and allows them to easily offer their own services to anybody. The new Advanced Web changes the way we live and work.

Enter *The Grid*. The term has been derived from the "Power Grid" infrastructure which provides electricity to every wall socket. In our context, The Grid describes the technology infrastructure for the Advanced Web, for computing, collaboration and communication.

2 Distributed Computing and the Grid

In the early Nineties, research groups started exploiting distributed computing resources over the Internet: scientists collected and utilized hundreds of workstations for parallel applications like molecular design and computer graphics rendering. Other research teams glued large supercomputers together into one virtual metacomputer, distributing subsets of a meta-application to specific vector, parallel and graphics computers, over wide-area networks, e.g. the computer simulation of multi-physics applications like the interaction of a fluid with a rotating propeller blade. Additionally the scope of many of these research projects was to understand and demonstrate the actual potential of the networking, computing and software infrastructure and to develop it further.