

Grid Technology and its Application Developments in Perspective

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Abstract

Since the last decade, Grid computing has been the prefecture of academic researchers and software vendor companies who have been hooking together individual computers around the world to perform compute-intensive tasks. This emerging technology is deemed as future technology of tomorrow. Currently substantial research is going on the different aspects of the Grid computing technology. In this research paper we have described the research activities carried out on the different aspects of the Grid computing. These research activities is classified the into the three areas of Grid computing .i.e Grid applications, Grid computing tools, Grid Architecture and Models, which provides a comprehensive look of the development carried out to date. The development in these mentioned three areas has brought substantial progress in the field of grid technology. Finally, the research paper has highlighted current developments and future challenges in the field of grid technology.

Keywords: Grid computing, Grid applications, Grid tools, Grid Architecture, Grid Models.

1. Introduction

In the early, 1990s, the term “Grid computing” has emerged as a metaphor for making computer power as easy to access an electric power grid. Foster, Carl Kesselman and Steve Tuecke brought the idea of grid computing together. They are called “Fathers of Grid”. Their efforts towards implementation of Grid concept in the field of computer have developed a Globus Toolkit. The term Grid has much further reaching implications than the general public believes. The Globus Toolkit is the de facto standard for building Grid solutions (Buyya & Venugopal, 2005).

Grids were borne out of the research and academic communities’ real need to collaborate. A crucial component of research is the ability to disseminate knowledge. The more efficiently you can share not only vast amounts of information but also the computational resources that help you create this data. Grid computing is an emerging computing model that provides the ability to perform higher throughput computing by taking advantage of many networked computers. It models a virtual computer architecture which is capable to distribute process execution across a parallel infrastructure. Grids use the resources of many separate computers connected by a network (usually the Internet) to solve large-scale computation problems. By using a set of open standards and protocols, grids enable organizations to access data, processing power, storage and other heterogeneous computing resources over the world-wide Internet or their own intranets. . Today grid computing is commonly used in the scientific and academic arenas. Grids offer a way of using the information technology resources optimally inside an organization. They also provide a means for offering information technology as a utility bureau for commercial and non-

commercial clients, with those clients paying only for what they use, as with electricity or water (Buyya & Venugopal, 2005).

Grid computing has serious social consequences and is going to have revolutionary affect as railroads did in the America Midwest in the early of 19 century. The effects of Grids are going to change the world so quickly that mankind will struggle to react and change in the face of the challenges. Therefore at some stage in future our computing needs will be satisfied in the same pervasive and ever present manner that we use the electricity power grid (Darema, 2005).

The research paper has classified research activities into three areas of Grid computing technology, such as Grid Applications, Grid tools and middle wares and Grid Models and Architecture. The developments in above three aspects of grid computing have been synthesized from various sources of grid technology related documents and presented in this research paper.

2. Grid applications

There is large numbers of projects and diverse range of new and emerging Grid developmental approaches are being pursued. These projects rang from Grid framework to application test beds and from collaborative environment to batch submission mechanism. It has been highlighted that java technology can be used for wide area distributing computing. It is stressed that, Java technology can successfully addresses several key issues that can accelerate the development of Grid environment, such as heterogeneity and security. It also removes the need to install programs remotely. Researchers have aimed to present the state of art of the Grid computing and attempts to survey the major international efforts in developing this emerging technology. Grid technologies has started with group of papers giving concrete description of current Grid and Grid applications deployed in various disciplines of science and Engineering , such as deployment of Earth System Grid that addresses the management , discovery , access and analysis of very large distributed datasets associated with the modeling and simulation of the earth climate (Baker, et al, 2002).

Grid enabled Engineering Application has allowed the use of Grids in the aero engine health monitoring Domain. The signal data explorer application developed in the “DAME” project. The explorer application uses advanced neural-networks based methods to search for matching patterns in time-series vibration data originating from Rolls- Royce aero-engine. Japanese Computational Grid Project: NAREJI”, describes one of the major Japanese national IT projects “National Research Grid Initiatives” based on collaboration among industry, academia and the Government. The effort consists of research and development in the high performance, scalable Grid middleware technologies as well as research on Grid enabled Nano-science and Nano-technology simulation applications (Chetty & Bhuyya, 2002).

3. Grid Computing Tools

In the domain of the Grid computing tools, various tools have been developed such as programming paradigms, problem solving environment, and application development and management tools and data management and exploration systems. Grid application Toolkit: towards Generic and Easy Application programming interface for the Grid” has developed a high level application programming toolkit. Grid application toolkit (GAT) provides unified programming Interface to the Grid infrastructure tailored to the need to the Grid application developers. Building Grid Portal Applications from web service component Architectures has deliberated application workflow as Web services and web services resources. These services are visible through family of Grid portal components which can be used to configure, launch and monitor complex applications built from the services. The researchers have identified key areas of research which are important in the design and implementation of a national computing and data grid. These challenges are both technical and socio-political and Grid related issues (Gentzsch, 2005).

The work has been done on developing the basic functionality of the Grid computing. It is stressed that in order to have extensive use of Grid, it is very important that Grid must possesses basic functionality. Before we can have successful Grid, it must have functional Grid”. There is need of more Grid Application developers and users. There is development in domain of software tools which are required to aid the application developers and security issues of the Grid. It has described as to how deployment can be made easier. It is concluded that if the deployment and setup of software is not seamless than it is very difficult for the user to adopt their system to be Grid compatible (Haynos, 2005).

The development of “Dynamic Data Driven Application” addresses the new capabilities, technology challenges and opportunities of DDDAS in Grid environment. There has been development in Grid computing at Hong Kong: Research and Development” is written by Fracis C.M. The research has been being carried out on Grid computing at the various Hong Kong universities such as development of Hong Kong (HKgrid), a test-bed that link up a host of High power computing facilities in the local institutions. The real aim of HKgrid project is to construct and make available a Grid test beds to facilitate the development of Grid middleware and applications by local industry and institution in Hong Kong. The HKgrid form a real Grid environment for supporting the research and development projects as pilot applications in the participating institution. The development of Data Grids, Digital Libraries and Persistent Archives: An integrated approach to sharing, publishing and Archiving data”, examines the synergies between data management systems including Grid , Data Grid and Grid digital libraries. It also examines the Grid infra-structure required for the generation, management sharing and preservation of information (Hualiang, et. al., 2005).

4. Grid Architecture and Models

In the domain of Architecture and Grid adoption Models has presented technology standards that are driving major Grid initiatives. The work has is also done on how these standards and technologies are aligned with the IBM on demand business concepts. In addition, the recent development of web service specification is related to stateful resources and how these standards relate to Grid computing. The core initiatives that will enable Grid computing to evolve into a service-oriented computing platform are based on the concept of merging Grid Architecture with the web Service-oriented Architecture. It is concluded that there is a natural convergence of Grid services and web-services. This convergence is occurring right now and it is happening in all industries. It can be observed in the evolutionary thinking of those people who are members of Virtual organizations and or participating in this transformation. The building of a Grid Operating System” has described the legion operating system like Grid middleware, which provides a virtual machine interface layered over the Grid (Hanif & Cao, 2006).

The work on “Co-ordination in intelligent Grid environment” explores the construction of intelligent computational Grids”. The research on Agreement-based Resource management” has presented a general agreement model and current resource management. The Cyber-infrastructure for Science and Engineering has established the ever-present (ubiquitous) and accessible Cyber infrastructure that has potential for revolutionizing all areas of Science and engineering research challenges (Bai, et al., 2005).

The initiatives on “Conceptual and implementation Model for the Grid” have focused on the models adopted from distributed computing systems as a basis for defining and characterizing Grids and their programming models. This has emphasized on the need for self-managing Grid computing paradigm and analyzes existing Grid programming system that addresses this need (Parashar & Browns, 2005).

The concept of “Grid Economy” has proposed computational economy as metaphor for effective management of resources and application scheduling in Grid environment. This has presented a service-oriented Grid Architecture driven by Grid economy and commodity and auction model for resource allocation. Ian Foster has focused on the Grid Architecture that has described fundamental system components of Grid Architecture and elaborated that, how these components interact each other. Thus interoperability is the central issue to be addressed (Buyya, et al., 2005).

The work on “Grid Services for Distributed System Integration” has focused on how Open Grid services Architecture enables the integration of services and resources across distributed, heterogeneous, dynamic virtual organizations. It is concluded that Grid concepts and technologies are transiting from scientific collaboration to industry. It is believed that Open Grid service Architecture (OGSA) will help to accelerate the transition by recasting the Grid Technologies that Globus Toolkit provides in a uniform service-oriented architecture and integrating those technologies with emerging web services standards. OGSA thus represents a natural evolution of both Grid technologies and web services. OGSA facilitates the realization of Grid concept in practical settings by adopting an industry standard interface definition language and enabling the use of web service tooling. OGSA abstractions and services provide building blocks that developers can use to implement a variety of higher level Grid services for example data and resource management (Ramaswamy & Malarvannan, 2006).

The grid research and development in Hong Kong has presented research being carried out on Grid computing at the various Hong Kong universities. The work has described Hong Kong (HKgrid), a test-bed that link up a host of High power computing facilities in the local institutions and the research and development activities which are being carried out to address the various challenges in Grid computing. The real aim of HKgrid project is to construct and make available Grid test-beds to facilitate the development of Grid middleware and applications by local industry and institution in Hong Kong. HKgrid form a real Grid environment for supporting the research and development projects as pilot applications in the participating institution. The projects, such as Integration of P2p with Grid Computing, Fault tolerance in Grid computing, An Advance Grid Platform have been carried out by various universities in Hongkong (Hualiang, et al., 2005)

The initiatives on “Security for Grids” have illustrated the security challenges of Grid Environments. It has characterized security activities, examines the current state of the art and introduces new technologies that promise to meet the security requirements of Grid more completely. The architecture and global standards serve as a major role in determining the adoption rate of Grids in the commercial world. These standards are still evolving. Their approach enables a transformation by applying the full power of traditional distributed systems to grids, including naming and binding techniques, across the widest possible set of Web services. The grid adoption models provide an innovative means for accomplishing this transformation, while shortening the time required delivering grid computing and other capabilities of grid services (Humphrey, et al., 2005).

5. Grid Problem and Relation with other Technologies

The real and specific problem of Grid is “Coordinated resource sharing and problem solving in dynamic and multinational virtual organization. The resource sharing in not only concerned with the file exchange but rather direct access to computers , software , data and other resources required for problem solving in industry , science and engineering. He concludes that enterprise distributed computing system can use Grid technologies to achieve resource sharing across the institutional boundaries (De Roure, et al., 2005).

The relation of Grid Technology with other technologies such as World Wide Web, Application and storage service providers, Enterprise computing systems, internet and peer – to- peer computing concludes that distributed approaches do not provide a general resource sharing frame work that addresses virtual organization requirements. This situation points to numerous opportunities for the application of Grid Technology (Gentzsch, 2005).

6. Current developments in the Grid technology

6.1 M-grid

The developed of light weight grid called M-grid, is a teaching tool that provides a system for building computational grids which allows students to grasp the concept of Grid Computing before they move on real system. The security is a big issue in Grid applications but this M-grid will allow us to explore some of these issues further in a safe environment. The company namely rPath has developed one of the important Grid computing Solution called rBuilder. It provides the best virtualization solutions. rBuilder allows the organization to package their applications as a virtual appliances – decoupling the applications from the underlying grid infra-structure. The virtual appliances are the ideal way to deploy applications in a grid environment. The product rBuilder has won the best award of best system Management tool at Linus World (De Sterck et al., 2005).

6.2 Latest access Grid toolkit

A new version of Access Grid Toolkit has been developed at Department of Energy’s Argonne national laboratory, United States. It is software that uses audio, video, data and text to enable distributed researchers to work together. It provides a seamless access as if they are at the same location working together. This software has been deployed in wide range of applications at worldwide such as in academic applications like college courses where student and their instructors are located at the different places, scientific applications that provide interaction between scientists and experimental facilities and doctors and specialists providing the ability to diagnose or scan the patients at the multiple sites simultaneously. This new version includes streamlined user interfaces, robust middleware and low level services that enable participants to share experiences through the digital media (Foster, et al., 2005).

6.3 Singapore extends its national Grid

Richard Lim, chairman of the National Grid Steering Committee, revealed the development of new Grid computing infrastructure called AStar Digital Nervous System (ADNS) at the opening of Grid Asia 2006. The AStar Digital Nervous System (ADNS) comprises advanced IT networks, high performance computers, data storage, sensors, sophisticated lab equipment, visualization facilities and specialized software. AStar, Singapore's agency for science, technology and research, is funding the new infrastructure. The ADNS will enable data generated from large-scale lab equipment to be streamed to high-end computers for analysis (Grid today, 2010).

6.4 Grid discovery zone

Grid computing Zone is the computing and storage facility infrastructure which enables developers to create and test grid ready applications readily. The Grid Discovery Zone offers a fully enabled commercial grids and possibly best ways for researchers and developers to share ideas and technology. It will be made available to several industries to test their applications. The industries like life sciences and education will be key beneficiaries from its launch. The Grid Discovery Zone is equipped with grid-enabled applications. It consists of 32CPUs, 12 tera bytes storage, Sun N1 Grid Engine and Sun java System portal server. The Grid Discovery Zone will be hosted and managed by Frontline Technologies at the Frontline Grid Infrastructure in Singapore. The Asia Pacific Science and Technology Center (APSTC) and the Asia Pacific Bioinformatics Network (APBioNet) will be one of the first groups of users to use the Grid Discovery Zone to develop bioinformatics applications (Grid today, 2010).

6.5 Grid computing everywhere

IBM recently installed a grid system at Charles Schwab. The system reduced the processing time on a wealth-management application from more than 4 minutes to 15 seconds. The hardware model at the center of IBM's technology strategy is called grid computing, a high-end architectural strategy of making multiple computers work on the same computational problem simultaneously. For example, IBM's Distributed Terascale facility is a grid-computing project designed to allow researchers to perform 13.6 trillion calculations per second, making the series of connected computers 1,000 times faster than IBM's chess-playing Deep Blue machine (Paul, 2005).

6.6 Australia, China, United Kingdom come together via Grid

The research project initiated with the efforts of Curtin Business School, Australia and Sun Microsystem has got major breakthrough in forming the links between three continents through Grid computing. The Grid links between the three continents are at Edinburgh Parallel Computing Centre (EPCC) in the United Kingdom, Curtin University of Technology in Western Australia and Chinese Academy of Sciences in Beijing (Grid today, 2010).

Sun Microsystem SPARC technology is being used in all three nodes of the Grid. This is first of its kind and also the largest Grid in the world. Sun support in linking to China at The University of Edinburgh Management School, which has been running a Grid between Western Australia and Edinburgh since 2003. Sun has more recently also donated SPARC-based equipment and resources to Curtin and the Chinese Academy of Sciences. The Leading Source for Global News, Information and Events on Grid and Service-Oriented IT (Grid today, 2010).

7. Future challenges

The future of developing self-managing Grid computing paradigm and analyzes existing Grid programming system that addresses need of the future. The concept of developing semantic Grid is an extension of the current Grid in which information and services are given well- defined meaning. The requirements of semantic Grid have identified the research challenges. The work on Cyber-infrastructure for Science and Engineering: promises and challenges” has describes the NSF’s vision for ever-present (ubiquitous) and accessible Cyber infrastructure that has potential for revolutionizing all areas of Science and engineering research challenges. The introduction of Dynamic Data Driven Application and requirements of DDDAS addresses the new capabilities, technology challenges and opportunities of DDDAS in Grid environment (Liaotis, et al., 2006).

The paper has presented the research initiatives carried out in the field of Grid technology. This research paper has provided comprehensive view on the various developments in the grid technology on the different aspects of Grid computing. Currently besides research in academic institutions, the big companies like HP, Sun, IBM, United Devices and other well renowned companies has also launched research projects on the Grid computing to make it viable in the business industry.

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