

# Grid Computing: Status of Technology In Current Perspective

Surendra Kumar Patel<sup>1</sup>; Anurag Seetha<sup>2</sup>; Anil Kumar Sharma<sup>3</sup>

<sup>1</sup>Department of Information Technology and Computer Application  
Dr. C.V. Raman University, Kota, Bilaspur, Chhattisgarh, India;

<sup>2</sup>Department. of Computer Science and Engineering, Dr. C.V. Raman University, Kota ,Bilaspur,  
Chhattisgarh, India;

<sup>3</sup>Department of Information Technology and Computer Application  
Dr. C.V. Raman University, Kota, Bilaspur, Chhattisgarh, India

## ABSTRACT

*Modern computer industry is operating with very large amounts of data which utilizes more processing power and high storage volumes of data. Grid computing is proposed as effective resource management to the organization, since it involves using resources from different spaces, from different ownerships and with different individual performance. It requires a highly complex resource management procedure for effective result. This paper presents an overview of grid computing, basic grid technologies, challenges, emerging trends, Grid Security issues, future prospects and the potential for Computational Grid system.*

## Keywords

**Distributed Computing, Resource Sharing, Grid Computing, Gridsim.**

## 1. INTRODUCTION

Recent progress in internet and high-performance wide-area network has made it possible to construct large-scale, high performance distributed computing environments, or computational grids, which provide dependable, consistent and pervasive access to enormous computational resources [1]. Grid computing enables virtual organizations to share geographically distributed resources as they pursue common goals, assuming the absence of central location, central control, omniscience, and an existing trust relationship.

Grid computing provides various mechanisms like resource sharing, maximization of resource utilization and virtualization of resources. A computational Grid consists of a set of resources, such as computers, networks, on-line instruments, data servers or sensors that are tied together by a set of common services which allow the users of the resources to view the collection as a seamless computing or information environment [2, 3].

## 2. BACK HISTORY OF GRID COMPUTING

The ancestor of the Grid is Metacomputing. This term was coined in the early eighties by NCSA Director, Larry Smarr [4]. The idea of Metacomputing was to interconnect supercomputer centers in order to achieve superior processing resources. The concept of a "computing utility" providing "continuous operation analogous to power and telephone" can be traced back to the 1960s and the Multics Project [5], the origins of the current Grid revolution can be traced to the late 1980's and early 1990's and the tremendous amounts of research being done on parallel programming and distributed systems.

As growing the technology, One of the first infrastructures in this area, named Information Wide Area Year (I-WAY), was demonstrated at Supercomputing 1995 [6]. The I-WAY sought to demonstrate the potential of distributed, virtual supercomputing by hosting over sixty applications on a national testbed [7, 8]. This testbed was cobbled together in a matter of months across many different institutions and included relatively primitive tools for the scheduling of machines for different applications and for security for their access [9].

In early 1996, the Globus Project officially got under way after being proposed to ARPA in November 1994. The process and communication middleware system called Nexus [10, 11] was originally built by Argonne National Laboratory to essentially be a compiler target and provide remote service requests across heterogeneous machines for application codes written in a higher-level language. The goal of the Globus project [12] was to build a global Nexus that would provide support for resource discovery, resource composition, data access, authentication, authorization, etc. The first Globus applications were established at Supercomputing '974. The Condor project [13] was already harvesting cycles from the growing number of desktop machines that a typical institution was now

deploying. The UNICORE project (UNiform Interface to Computing REsources) [14] was started in Germany in 1997.

After this, The Foster-Kesselman duo organized in 1997, at Argonne National Laboratory, a workshop entitled “Building a Computational Grid” [15]. At this moment the term “Grid” was born.

In 2002 Oracle introduced the Oracle Globus Development Kit (OGDK) which allows a Globus 2.0/2.2 user to employ an Oracle9i database as a computation resource in a Grid [16, 17].

### 3. FUNCTIONAL COMPONENTS IN GRID COMPUTING

An overview of the main components of a Grid Computing is provided in Figure-1:

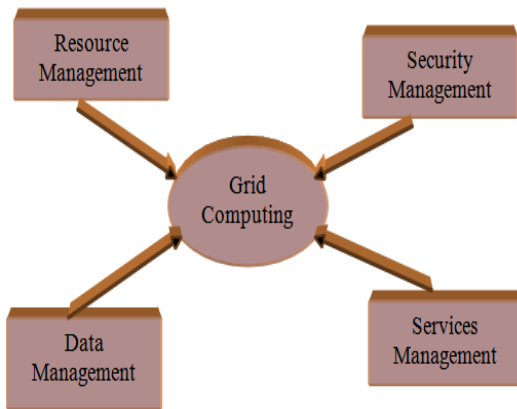


Figure-1: Functional components of Grid Computing

In any grid the functional elements are:

- **Resource Management:** The ability to keep track, allot and remove grid resources.
- **Security Management:** To ensure authenticated and authorized accessed to grid resources, from the users in the external world.
- **Data Management:** The ability of transporting, cleaning, parceling and processing the data, between any two nodes in the grid, without the knowledge of the user.
- **Services Management:** The ability of the users and applications to query and obtain response from the grid efficiently

### 4. TYPES OF GRID ENVIRONMENTS

Grid computing can be used in a variety of ways to address various kinds of application requirements. Often, grids are

categorized by the type of solutions that they best address. The three primary types of grids and are summarized below [18]

#### 4.1 Computational Grid

A computational grid is focused on setting aside resources specifically or computing power. In this type of grid, most of the machines are high-performance servers.

#### 4.2 Scavenging grid

A scavenging grid is most commonly used with large numbers of desktop machines. Machines are scavenged for available CPU cycles and other resources. Owners of the desktop machines are usually given control over when their resources are available to participate in the grid.

#### 4.3 Data Grid

A data grid is responsible for housing and providing access to data across multiple organizations. Users are not concerned with where this data is located as long as they have access to the data.

### 5. GRID LAYER

Basically the nature and the various components of grid architecture can be organized into layers, as shown in Figure 2 Components within each layer share common characteristics but can build on capabilities and behaviors provided by any lower layer. In specifying the various layers of the Grid architecture, it follows the principles of the “Hourglass model”. The narrow neck of the hourglass defines a small set of core abstractions and protocols (e.g., TCP and HTTP in the Internet), onto which many different high-level behaviors can be mapped (the top of the hourglass), and which themselves can be mapped onto many different underlying technologies (the base of the hourglass) [19].

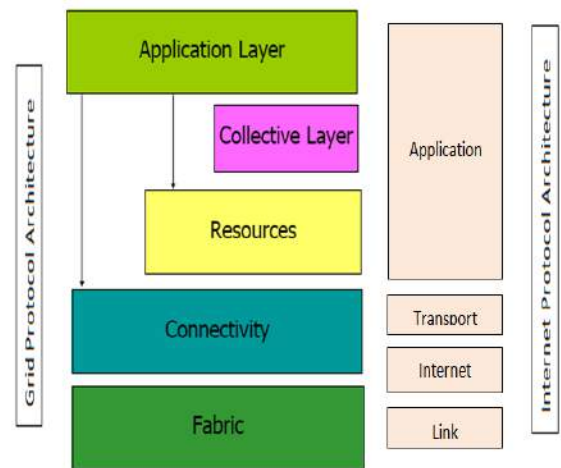


Figure 2: A Layered Grid Architecture & Relationship to IP Architecture.

### Fabric layer

The fabric layer comprises the resources in the grid. This resource can be either a logical (such as a computer cluster or distributed computer pool) or a physical resource (such as a computational resource, storage system, catalogue, network resource or sensor). This layer provides the lowest level of access to actual native resources, and implements the low-level mechanisms that allow those resources to be accessed and used [20].

Fabric allows user to ask about available resources and provides resource management mechanism. For example:

- Computational resources: How fast is the
- Hardware? Start, monitor, and stop.
- Storage: Can I read/write? How much? How fast? Read, write.
- Network: What is the load? Reserve bandwidth.
- Catalogs: relational databases.

### Connectivity

The connectivity layer provides the core communication and authentication protocols required for grid-specific network transactions. These protocols provide cryptographically secure mechanisms by which to verify the identified grid users and resources. Many communication protocols in the connectivity layer are drawn from TCP/IP protocols stack such as IP, ICMP, TCP, UDP and DNS.

### Resource

This layer builds on the connectivity layer in order to implement protocols that enable the use and sharing of individual resources such as the Grid Resource Access and Management protocol (GRAMP) used to allocate and monitor resources. More specifically, two fundamental components of this layer are information protocols, for querying the state of a resource by calling fabric layer functions to control and access resources, and management protocols, used to negotiate access to a shared resource.

### Collective Layer

This layer provides protocols such as the Grid Resource Information Protocol (GRIP) [21] for interacting across collections of resources. In other words, it focuses on the coordination of multiple resources. It includes directory, coallocation, scheduling, brokerage, monitoring and diagnostics, data replication, software discovery, community accounting and payment services.

### Applications

This is the final layer in grid architecture, and contains the user applications that operate in a grid environment. It includes languages and frameworks. These frameworks may themselves define protocols such as Simple Workflow Access Protocol (SWAP) [22], services, and/or an Application Program Interface (API).

## 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[23]. 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 appliance – 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 Linux World [24].

### 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 [25].

### 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 32 CPUs, 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 [26].

### 6.6 Australia, China, United Kingdom come together via Grid

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

Sun Microsystems 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. GRID SECURITY ISSUES

Security is one of the important issues that usually arise when considering a grid environment. Since the goal of grid is resources sharing, computer resources will be accessed by a lot

of different virtual organizations (VOs). The security requirements are fundamental to the Grid security design. The high level grid security requirements include following aspects [27, 28]

**Authentication:** Providing interfaces to plug-in different authentication mechanisms and means to convey the mechanism used Authorization: Ability to control access to grid components based on authorization policies.

**Delegation:** Providing mechanisms to allow delegation of access rights from requesters to services while ensuring that the access rights delegated are restricted to the tasks intended to be performed within policy restrictions.

**Message integrity:** Ensuring unauthorized changes made to message content or data can be detected at the recipient end.

**Single logon:** This refers to relieving an authenticated entity from re-authentication for a certain period of time when subsequent access to grid resources are requested while taking multiple security domains and identity mappings into account.

**Confidentiality:** Protecting confidentiality of underlying transport and message content and between OGSA-compliant components in either point-to-point or store and forward mechanisms

**Privacy:** Allowing both a service requester and a service provider to define and enforce privacy policies.

**Policy exchange:** Allowing security context negotiation mechanism between service requesters and service providers based on security policy information.

**Credential life span and renewal:** Ability to refresh requester credentials if a grid application operation takes longer to complete than the lifespan of a delegated credential

**Secure logging:** Providing a foundation for nonrepudiation and auditing that enables all services to time-stamp and log various types of information without interruption or information alteration by adverse agents.

**Assurance:** Providing means to qualify the security assurance level that can be expected of a hosting environment. The security assurance level indicates the types of security services provided by an environment. This information is useful in deciding whether to deploy a service in the environment.

**Manageability:** This requirement mainly deals with various securities service management issues such as identity management, policy management, and so on.

**Firewall traversal:** Ability to traverse firewalls without compromising local control of firewall policy to enable cross-domain grid computing environment.

Securing the OGSA infrastructure: This refers to securing core OGSA components. The security challenges faced in a Grid environment can be grouped into three categories [27, 28, 29].

## 8. GRID APPLICATIONS

- **Automotive and aerospace**
  - For collaborative design and data-intensive testing
- **Financial services**
  - For running long, complex scenarios and arriving at more accurate decisions
- **Life sciences**
  - For analyzing and decoding strings of biological and chemical information
- **Government**
  - For enabling seamless collaboration and agility in both civil and military departments and agencies
- **Higher education**
  - For enabling advanced, data and compute intensive research.

## 9. Conclusion

Grid Computing will be the major area of focus in the future days. Many research works have been reported in grid computing to address different issues, but still it has to reach its maturity level by implementing various commercial and industrial applications in different fields.

Grid computing has recently enjoyed an increase in popularity as a distributed computing architecture that is becoming highly suitable for corporate computing. Grid computing solutions are being employed in many areas to address critical business requirement. In this article, we explained status of Grid Technology in current perspective which will be helpful for researchers and developers.

## 10. ACKNOWLEDGEMENT

I am thankful to my guide Dr. Anurag Seetha, Dr. Gupteshwar Gupta, and Mr. Anil Sharma for their encouragement and valuable support.

## 11. REFERENCES

- [1] [http://jfli.nii.ac.jp/medias/wordpress/?page\\_id=10](http://jfli.nii.ac.jp/medias/wordpress/?page_id=10) (last accessed: 05-03-2013).
- [2] Foster, Ian; Kesselman, Carl, "The Grid: Blueprint for a New Computing Infrastructure", 2nd Edition, Elsevier, 2004.

- [3] Komal Vashisht, Shefali, Karishma Shukla "A Survey On Grid Computing Approach" International Journal of Computer Science and Technology; Vol. 1, Issue 2, December 2010.
- [4] TheMetacomputer:OnefromMany,NCSA(1995)<http://archive.ncsa.uiuc.edu/Cyberia/MetaComp/MetaHome.html>.
- [5] F. J. Corbat and V. A. Vyssotsky, "Introduction and overview of the Multics system", Proc. AFIPS 1965 FJCC, 27(1), 1965, 185-196.
- [6] SUPERCOMPUTING '95 I-WAY Project Develops "Internet of the Future",SDSCwire(1995)<http://www.sdsc.edu/SDSCwire/v1.15/7037.iway.html>.
- [7] H. Korab and M. Brown, eds., Virtual Environments and Distributed Computing at SC'95: GII Testbed and HPC Challenge Applications on the I-WAY, ACM/IEEE, 1995.
- [8] C. Lee, C. Kesselman and S. Schwab, "Near-real-time Satellite Image Processing: Metacomputing in CC++", IEEE Computer Graphics and Applications, 16(4), 1996, 79-84.
- [9] I. Foster, J. Geisler, W. Nickless, W. Smith and S. Tuecke, "Software Infrastructure for the I-WAY High Performance Distributed Computing Experiment," in Proceedings of 5th IEEE Symposium on High Performance Distributed Computing, IEEE Computer Society Press 1996, 562-571.
- [10] R. Stevens, P. Woodward, T. DeFanti and C. Catlett,"From the I-WAY to the National Technology Grid", Communication of the ACM, 40(11), 1997, 51-60.
- [11] I. Foster, C. Kesselman and S. Tuecke, "The Nexus Task-Parallel Runtime System," in Proceedings of First International Workshop on Parallel Processing, 1994, 457-462.
- [12] Foster and C. Kesselman. The Grid: Blueprint for a Future Computing Infrastructure.MORGAN-KAUFMANN, 1998.
- [13] D. H. J. Epema, M. Livny, R. v. Dantzig, X. Evers and J. Pruyne, "A Worldwide Flock of Condors: Load Sharing among Workstation Clusters", Journal on Future Generations of Computer Systems, 12, 1996, 53-65.
- [14] "Unicore Forum", <http://www.unicore.org>; (last accessed: 08-03-2013).

- [15] Parallel Computing Research Newsletter, Volume 5 - Issue4(1997)<http://nhse.cs.rice.edu/CRPC/newsletters/fal97/index.html>.
- [16] Oracle and the Grid, Oracle Corporation (2002)[http://otn.oracle.com/products/oracle9i/grid\\_computing/OracleGridWP.pdf](http://otn.oracle.com/products/oracle9i/grid_computing/OracleGridWP.pdf)
- [17] <http://www.gridalliance.org> (last accessed: 08-03-2013).
- [18] Prof Mr. Vijay A Tathe, Prof Ms Deepavali P Patil "Next Generation Computing on the Internet (GRID)" International Journal of Scientific and Research Publications, Volume 2, Issue 2, February 2012.
- [19] Ms. Deepanjali Joshi<sup>1</sup>, Prof..Shishir K. Shandilya<sup>2</sup> "Analytical Survey on Grid Computing " Published in International Journal of Advanced Engineering & Applications, Jan. 2010.
- [20] <http://www.faqs.org/rfcs/rfc768.html>, visited on 15, January, 2013.
- [21] Transmission control protocol," Information Sciences Institute, University of Southern California, RFC: 793, 1981.
- [22] <http://www.faqs.org/rfcs/rfc768.html>, visited on 15, January, 2013.
- [23] Sirajul Haque , Riaz Ahmed Memon ,Akram Shaikh "Grid Technology and its Application Developments in Perspective " International Journal of Independent Research and Studies - IJIRS ISSN: 2226-4817; EISSN: 2304-6953 Vol. 1, No.3 (July, 2012).
- [24] De Sterck, H., Markel, Rob., & Knight, Rob. (2005). A lightweight, scalable grid computation framework for parallel bioinformatics applications, Proceedings of the 19th International Symposium on High Performance Computing Systems and Applications, 251-257.
- [25] K., Foster, I., & Kesselman, C. (2005). Agreement-based resource management. Proceedings of the IEEE, 93(3), 631-643.
- [26] Paul K. (2005). Information and events on Grid and service-oriented IT. TechNewsWorld.
- [27] Nataraj Nagaratnam, Philippe Janson, John Dayka. Anthony Nadalin, Frank Siebenlist, Von Welch, Ian Foster, Steve Tuecke, "The Security Architecture for Open Grid Services," 2002.
- [28] Bart Jacob, Michael Brown, Kentaro Fukui, Nihar Trivedi, "Introduction to Grid Computing," December 2005.
- [29] The Globus Security Team, "Globus Toolkit Version 4 Grid Security Infrastructure: A Standards Perspective," 2005.