



Enterprise Grid Computing: A Potential IT Infrastructure for Small Business Enterprises

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ABSTRACT

Grid computing technology provides effective enterprise solution in aggregating distributed resources within the organization and allocating resources according to priority of tasks. These type of solutions capable the enterprises in saving the cost of business operations. Due to the increasing interest of business community in the Grid Technology, the Grid computing is rapidly moving from academic and scientific research towards the mainstream of enterprise application. Today, the Enterprise Grid involves a range of applications which are used for data centers and application clusters to distributing workloads of applications.

This research paper discusses the major initiatives made in the area of Enterprise Grid computing. The paper has focused on the development of various types of Enterprise Grids systems for the Enterprises solutions, during the different period of times and also describes the major feature of each type of Enterprise Grids. Finally it concludes with the future prospects of Enterprise grid computing as a viable infrastructure for public and private enterprises for achieving competitive advantage by harnessing unutilized IT resources within the enterprises.

Keywords : Grid technology; enterprise grid systems; enterprise solutions; virtual private network

1. INTRODUCTION

The term Enterprise Grid computing is used to capture the notion of a Grid that is managed by a single entity or business. It is very specific type of Grid in which there is a clear scope of control and responsibility for managing the Grid to meet a specific set of business goals. The extent of an Enterprise Grid is defined in terms of organizational responsibility. The concept of Enterprise Grid computing emerges with the concept of using Grid Technology in the business enterprises. Since past few years, the popularity of Grid technology draws an attention of enterprise owner and vendors. As they become aware of the benefit of this technology, they took a keen interest to learn this technology and vendors has launched a grid projects especially for the enterprise solutions. The successful projects have yielded the benefits of remote access, improved resource utilization, collaboration in virtual organizations and increased productivity (Ian and Kesselman, 1999)

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Enterprise Grid computing can be defined as a distributed system that dynamically aggregate and co-ordinate various computing resources across the organization to improve their utilization and increase productivity. Since very long time business enterprises has been using integrating enterprise computing centers for performing their computing tasks. These distributing computing systems were being operated through command -and-control mechanism, such as reservation systems and internet domain name were most popular.

The advance technology growth in the field of internet and e-business has motivated the entrepreneurs to encompass external network, resources and services with Information technology infrastructure of the organization. The developers also started to focus on developing the intelligent networks that may be interconnected with the enterprise networks. For instance, Virtual private network server connects enterprise network to service provider resources. But these attempts overall did not produce any substantial result to solve the complexity of integrated networks (Luther et al., 2005).

As business were expanding the scope and scale of their enterprise, it has become very necessary for them to achieve better integration with the customer relationship management, integrated supply chain and existing core systems. These developments made the main frame host-centric computing essential for the effective conduct of e-business across distribute computing resources. This existing vertical integration of platform specific components and services can not work in today's distributed environment. There are two main Phases of building Enterprise Grid computing. One is to optimize the resources that already exist within the departments. And second is to optimize the overall enterprise by adding central services based on the concept of server consolidation (Nadiminiti & Buyya, 2005).

2. ENTERPRISE GRID SYSTEMS.

2.1 Alchemi: Enterprise Desktop Grid Framework

Most of the Grid enabled software has been written for UNIX operating system. The UNIX operating system remained very successful where all the desktop computer were having installed UNIX operating systems but on other hand it has been found ineffective where desktop computers were having installed windows operating systems in the enterprises. This problem has severally underutilized the computer resources in the enterprises having a window based desktop computers. This challenge draws the attention of researchers and vendors and it become very vital for them to address this problem. Microsoft Company made a major breakthrough by developing a Microsoft.Net framework. The Microsoft framework has become the ideal platform for implementing commercial distributed system for window based platform.

Alchemi is a core Middle ware and it provides runtime machinery and programming environment required to construct Grids and develop Grid applications. Due to the large scale deployment of window based desktop computers, the interest on developing commercial Enterprise Grid computing is increasing rapidly. In this regard a Microsoft window based Grid computing infrastructure can play a major role in adoption of Grid computing in public and business enterprises. The Microsoft.Net Framework provides powerful tool sets to support remote executions, web services, multithreading, security, asynchronous programming, disconnected data access, across language development and managed execution. This framework provides a ideal platform for Grid computing middleware like Alchemi. The Alchemi platform was developed with the aim of constructing Enterprise Grids as easy as possible, possessing flexibility, scalability, reliability and extensibility characteristics. This platform has been used in constructing and deploying several science and commercial applications on the Enterprise (Luther et al., 2005).

2.2 Grenade: A Grid enabled Desktop environment.

The GRENADE is developed with the purpose of making the Grid environment user-friendly. This environment provides transparent and user-friendly interface. This Grid enabled desktop environment provides desktop user-Interface paradigm which seamlessly extend the interactions with the Grid resources. This desktop paradigm does not only provide a suite of GUI based tools to get rid from complex command line tools but also provides close integration with the user's every day desktop environment. This integration enables inter-operability with existing desktop and use all the familiar desktop metaphors of drag and drop, cut and past etc.

This Grenade is in initial stage of the development and it only performs number of common tasks on desktop environment such as browsing a directory of resources, browsing shared data repository and defining and submitting a remote job. Its structure was designed to be portable. Its primary platform is UNIX based and Microsoft window based prototype has also been developed.

GRENADE relies on two types of desktop objects, Resource Manager and Jobs. Resource Manager provides the capability of Jobs handling on the desktop Grids. Jobs are submitted by dragging and dropping the Job description on the relevant resource Manager. On KDE Job description is stored in "desktop" application and on windows this is accomplished using a Drop handler shell extension. Dropping the Job on resource manager causes a new file with a unique file name containing the contents of both files to be created and placed in Grenade's job queue directory. Having created this new request file, a second empty lock file is created with a ".new" extension signifying that the file is ready for submission. When the job is submitted successfully, the job ID is stored in the original file and the lock file is renamed to have .pending extension (Marsh et al., 2004).

2.3 Harmony: A desktop Grid for Delivering Enterprise Computation.

Harmony is virtual machine-based Grid infra-structure. It is developed to optimize the world transactions and harnessing the underutilized computing resources in the Enterprise. Harmony is the name of Grid infrastructure that is developed for desktop computers used in the Enterprises. This infrastructure isolates the Grid computation from the desktop computation by its virtual machine. It addresses the key concerns of information technology enterprises such as automat workload management. Its layered resource management architecture automatically shifts Grid workload to underutilized desktop resources. Now days in most modern organization the desktop computers and mobile computers are attached with the networks. Though these attached computers are rich in resources but they are underutilized in contrast to their capacity (Naik et al., 2003).

The main purpose of developing Harmony Grid infrastructure is to harvest unused desktop resources in the enterprise and make availability those in an aggregated form to enhance existing back-end resources for performing enterprise computation. It is estimated that average CPU utilization for Intel Pentium -III machine running windows OS is less than 10% during working hours and close to zero during non-working hours. The Harmony infrastructure differs from conventional Grid infrastructure in two aspects, one it supports the transactional workload and second, it uses desktop resources to run the transactional workload. For instance Enterprise's Financial, accounting, billing, customer relation and supply chain management related applications are highly transactional in nature and they need to exhibit high degree of interactivity with the user, database and other applications. Harmony is consisting of three layers and its layered approach allows addressing workload and desktop related policies. Each layer is associated with control and management components (CMC). It has got three major layers, Grid service layer, Logical resource layer and physical resource layer (Naik et al., 2003).

2.4 Condor Grid System.

This Enterprise Grid System was developed for the purpose of work load management system. It is a special kind of workload management system for compute intensive job. Firstly, it was installed as a production system in the Department of Computer Science, University of Wisconsin Madison, 15 years ago, and it was major source of computing cycles to the faculty members of the university and as well as students. The Condor manages more than 1000 workstations only in the Department of Computer Science. This Enterprise Grid system offers job queuing mechanism, scheduling policy, priority scheme, and resource monitoring and resource management. Its functionality is more like functional batch queuing system. As user send the job, it places in queue, find the location and time run as per policy and monitor the program and finally inform the user. Its novel architecture succeeds where traditional scheduling system fails. Condor can be used to build a Grid style computing environment. Its technology allows multiple condor computing installations to work together. It also incorporate with many of the emerging Grid based computing methodology and protocols. For instance Condor-G is fully inter-operable with resource managed by Globes. This enterprise Grid system helps the business which has long running Jobs. It helps the business to save the time and efforts it take user to get job execute within a few moments. The Condor can also be used on small and large network sizes. It works as a monitoring tool on a single a machine. It pause the Job when machine is used by the user and it starts the Job when machine reboots. It functions well on a small dedicated cluster as a Cluster submission tool (Eric, 2006).

2.5 XTermweb Grid System.

This is another kind of Enterprise Grid System. It is a light weight type of Grid System. It provides free open source software platform, which can be used to explore scientific issues and applications of desktop Grid, Global Computing and peer-to-peer distributing systems. Like other software platforms, it provides access to remote pole of resources connected to the Internet. It is a software platform designed to serve as substrate for Global computing experiments. It is composed of client, server and worker architecture. This platform possessed the capability of connecting several servers and result collectors on a single project. The Xterm Web can be used to build a Global computing system with centralized control, job scheduling and result collection. And it also can be used to build centralized Peer-to-Peer systems. During the execution the workers contact the server to get jobs. In response, the server sends a set of parameters and application to workers. When workers finish their jobs, they contact the Result Collector to send their results (Cecile et al., 2000).

2.6 SETI@Home Grid System.

It stands for "Search for Extra-Terrestrial Intelligence". It is a Grid Computing project using internet-connected computers. The purpose of building SETI@Home is to detect the intelligent life outside earth. It is distributed computing software. It is available for all major operating systems. It was the first popular Grid computing application. It is quite useful as a stress testing tool for computer workstations. It is also used to check on the reliability of computer configuration when over clocking (David et al., 2002).

SETI@home completed the process of transferring its computing software to a new software platform called Berkeley Open Infrastructure for Network Computing(BOINC) on15- 12- 2005. The original software platform, referred to as SETI@home Classic, has since been discontinued. BOINC will allow testing for more types of signals as well as let users contribute to other grid computing projects running on the BOINC platform (Sullivan et al., 1997).

2.7 Grid MP Grid System.

It is a commercial distributed computing software package. It has been developed by United Devices Company based in Austin, Texas. Officially, the letters MP in Grid MP do not stand for anything. Grid MP can be used to manage computational Devices. These devices can consist of corporate desktop PCs, departmental servers, or dedicated cluster nodes. Computational Devices can be arranged into Device Groups for organizational security, and administrative control. Grid MP Platform provides a single grid solution for entire IT infrastructure within the enterprise. All resources including clusters, servers, workstations and desktops can be enabled as part of the Grid. Grid MP Platform harnesses the latent processing power of existing resources (including clusters, servers, and workstations) to create a virtual, on-demand compute infrastructure. Grid MP delivers vastly increased compute power without the hardware costs, maintenance, dedication of space, and rapid depreciation. The Grid MP solutions facilitate the clients to address their business computing needs without incurring a heavy investment in high-performance hardware. Grid MP is a market leading solution for creating a dynamic virtual infrastructure to transform existing systems, storage and networks into a powerful collective resource. Grid MP can be used for creating enterprise-wide grids that consolidate heterogeneous computing resources including servers, clusters and other HPC resources- across the Global enterprise (Cobb, 2007).

Grid MP Devices and users can be grouped with maximum flexibility in a decentralized pattern. An Administrator can set up allocation and provisioning policies for each device group to favor one or more user groups and applications. It leverages the underutilized computing resources on a network and harnessing them to virtualized critical research and business applications. Grid MP is an easy-to-administer platform for creating and managing a grid. The Grid MP platforms provide fast and easy deployment and manageability. The Grid MP platform is the most secure, scalable, and unobtrusive grid solution available today. The platform makes teraflops of power available at a fraction of the traditional cost, enabling previously impossible research and analysis projects (Cobb, 2007).

2.8 Entropia Computing System.

The Entropia is a type of distributed computing system that exploits the idle cycles of pervasive desktop computers systems to increase the available computer power by order of magnitude (10 x - 1000x). Desktop computers are widely used in the enterprises. Desktop distributing computing allows companies to exploit the idle cycle on pervasive desktop PC system. Applications are submitted, distributed and run on a grid of desktop PCs. Entropia is a robust, flexible, high performance computing system which is in use in number of enterprises for supporting wide range of applications. It is made of combination of number of technologies. It includes, web /database technology for system management, network tunneling for logical connectivity and sandboxing for security and unobtrusiveness. The Entropia is consisting of three layers e.g Job Management, Resource scheduling and physical node management. Its three layers modularity of provides higher level of abstraction to the users and administrators for executing tasks on the desktop PCs, also enhancing overall system capability and usability (chien, 2002).

Table - 1
Characteristics comparison table of various Enterprise Grid Systems.

Enterprise Grid System	Characteristics
Alchemic	<ol style="list-style-type: none">1. Window-based operating system2. Open source environment for developing grid applications and constructing grids.3. It relies on Manager and Executer
Grenade	<ol style="list-style-type: none">1. Developed with the purpose of making grid environment user friendly.2. Provides transparent and user-friendly environment.3. It relies on Resource Manager and Jobs.
Harmony	<ol style="list-style-type: none">1. It is virtual machine-based Grid Infrastructure.2. It isolate the Grid computation from the desktop environment by its virtual machine.3. Supports transactional workload. By using desktop resources
Condor	<ol style="list-style-type: none">1. Developed for the purpose of workload management system.2. It can manage more than 1000 workstations in the organization.3. It can be used to build grid style computing environment.
XTermWeb	<ol style="list-style-type: none">1. It is light weight type of Grid system.2. It can be used to explore scientific issues and applications of desktop grid.3. It is composed of Client, Server and worker architecture..
Seti@Home	<ol style="list-style-type: none">1. SETI (Search for Extra-Terrestrial intelligence) is distributed computing software.2. Developed mainly to detect the intelligent life outside earth.3. It is quite useful in a stress testing tool for computer workstations.
MP Grid System.	<ol style="list-style-type: none">1. It is commercial distributed computing software package.2. It can be used to manage computational devices.3. It provides a single grid solution for entire IT infrastructure within enterprise.
Etropia	<ol style="list-style-type: none">1. Developed mainly to exploit idle cycles of pervasive desktop computer systems.2. It is made of combination of technologies i.e web, database for system management, network tunneling for logical connectivity, sandboxing for security and unobtrusiveness.3. It consists of three layers e.g Job management, Resource scheduling and physical node management.

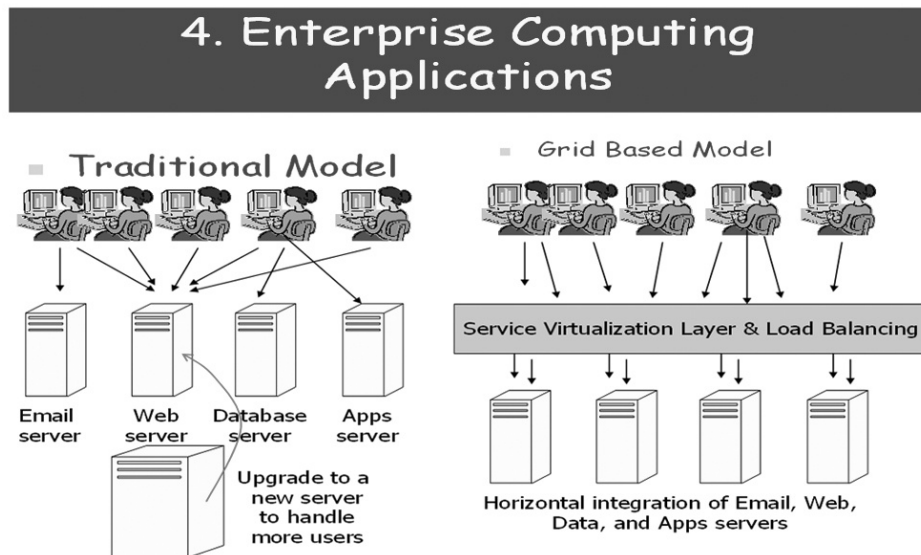
Potential IT infrastructure for medium and small Enterprises.

Enterprise grid computing platforms allow organizations to harness the unused computing power of their existing desktop computers to build virtual supercomputers with no additional investment. Enterprise Grid computing allows companies to utilize numerous machines to perform a process or run an application, acting as a single machine. The following figure-1 provides a view of grid-based model and traditional model, through

which we can gauge a concept that how a grid-based model can provide a potential IT infra-structure to medium and small business enterprises.

Traditional Model and Grid-based Model infrastructure.

Figure - 1



It can reduce the cost of hardware by improving utilization rates while increasing compute power without the need to add new CPUs. Currently, private sector is more inclined to use immediate competitive advantage type of grid solutions; whereas the public sector is more interested in large scale infrastructure for longer-term benefits.

The leading industries that run large commercial grids are investment banks and companies like JPMorgan, Citigroup, Credit Suisse and pharmaceutical industry running discovery applications and manufacturing industry running product development applications.

The study shows that there are six areas of major concern, by the enterprise users about grid operation and management. 1. What is grid and how it works, 2. Cross-vendor interoperability, 3. Accounting and billing for CPU and application usage, 4. Security and user authentication, 5. standards, 6. Global enterprise grids across international boundaries.

CONCLUSION.

We have discussed the emergence of enterprise grid system that how it evolves and inter into the mainstream of business field. We have illustrated different types of Enterprise Grid systems developed to date and also have described the main features of each enterprise grid systems. Finally, we have distinguished the each enterprise grid system by providing a comparative analysis in table 1 shown above

Grid Systems offers an economy of scale access to one common High Power computing service for all the departments. This information technology infrastructure has brought up reliability and quality of service and also proved to be helpful in reducing hardware, software and operational cost and increased productivity.

Based on literature, it is analyzed that all types of Enterprise Grid Systems are based on UNIX environment except Alchemi, which is window based on .Net platform. These all enterprise grid systems provides super computational power capability by aggregating networked connected processors into a one super virtual computer but does not provide the database connectivity. Our research work is focused on to determine the appropriate mechanism to provide database connectivity to enterprise Grid system specially Alchemi.

Alchemi Enterprise Grid System provides windows environment to construct a Enterprise Grid and develop grid applications. The success in providing the database access using Alchemi based on windows environment would open the new avenue for commercial and public enterprises in the use of grid technology infrastructure in the commercial organization. This potential grid based platform provides the benefit of low cost IT infrastructure and increased productivity, provided that six major area of concerns stated may be addressed in a effective manner.

REFERENCES

- Cecile Germain, Vincent Neri, Gille Fedak and Franck Cappello,eds, 2000 "*XtremWeb: building an experimental platform for Global Computing*", Proceedings of the 1st IEEE/ACM International Workshop on Grid Computing (Grid 2000), Bangalore, India, Dec. 2000.
- Chien, A. A, 2002 "Achitecture of the Entropia Distributed computing System" ., *proceeding of the International parallel and Distributed processing symposium* , IEEE.
- Chien, A. A, Brad Calder, Stephen Elbert, and Karan Bhatia, eds, 2003"Entropia: *architecture and performance of an enterprise desktop grid system*," , Journal of Parallel and Distributed Computing, Volume 63, Issue 5, Academic Press, USA.
- Cobb, J., 2007., "Intel Corporation, *United Devices' Grid MP on Intel Architecture*" <http://www.ud.com/rescenter> (accessed , August, 2007)
- David Anderson, Jeff Cobb, Eric Korpela, Matt Lebofsky, Dan Werthimer,eds , 2002 "*SETI@home: An Experiment in Public-Resource Computing, Communications of the ACM*," Vol. 45 No. 11, ACM Press, USA, November 2002.
- Eric Korpela.,2006, Condor :High through put computing ., <http://www.cs.wisc.edu/condor/>. (accessed on August, 2007)
- Ian Foster and Carl Kesselman 1999, *The Grid: Blueprint for a Future Computing Infrastructure*, Morgan Kaufmann Publishers, USA.
- Luther Akshay, Buyya Kummar, Ranjan Rajiv and Venugopal Srikumar ,eds, 2005 "*Alchemi: A.Net-based Grid Computing framework and its intergration into Global Grids*. ." Department of computer Science and Software Engineering, University of Melbourne, Oct, 2005.
- Luther Akshay, Buyya Kummar, Ranjan Rajiv and Venugopal Srikumar ,eds, 2005" Alchemi: A .NET-based Enterprise Grid Computing System". Department of computer Science and Software Engineering, University of Melbourne.
- Marsh, J., Pettifer, S., Hanlon, D., Pickles, S., Maclaren, J. and Foster. M., eds, 2004 " *GRENADA: A Grid Enabled Desktop Environment*" , proceedings of the 13th International workshops on Enabling Technologies.
- Nadiminiti Krishna, Buyya Rajkumar, eds, 2005., "*Enterprise Grid Computing: State of- the-Art*." Department of computer Science and Software Engineering, University of Melbourne.
- Naik, K., Vijay. Sivasubramanian, Swaminathan.,Bantz Davic., Kirshana Sriram,eds, 2003 "*Harmony: Desktop Grid for Delivery Enterprise Computations*"., proceedings of the Fourth International workshop on Grid computing, IEEE.
- Sullivan, W. T., D. Werthimer, S. Bowyer, J. Cobb, D. Gedy, D. Anderson, eds,1997 "*A new major SETI project*.