# A Survey on Grid Computing and its Applications

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## Abstract

*Grid computing is the act of sharing tasks over multiple computers. Tasks can range from data storage to complex calculations and can be spread over large geographical distances. This paper emphasis on grid computing basic features, difference between cloud computing, grid computing, cluster computing and distributed computing. In addition this paper highlights the various applications of grid computing for prominent fields both in India & abroad.*

## 1. Introduction

Grid computing links disparate computers, forming a single unified infrastructure. This facilitates the provisioning of computing resources, much like a public utility that can be "on" or "off." Grid computing relies on software (middleware) that divides and directs pieces of a program as one large image to a number of different computers. For these reasons, it is common to describe grid computing using an electrical grid analogy. In an electrical grid, wall outlets link users to an infrastructure of resources that generate, distribute and billing for electricity. With grid computing, middleware coordinates varied IT resources across a network. Grid computing links the disparate parts as a virtual whole. The objective of grid computing is to give users access to IT resources when they need them [1].Grid Computing aims to "enable resource sharing and coordinated problem solving in dynamic, multi-institutional virtual organizations". With grid computing, tasks are divided into smaller ones and are sent to different servers connected to a main machine. Once a particular server is done with its computing task, the results are sent to the main machine. As soon as all the other computing tasks are received by the main server, the result is then provided to the user [2]. Grid computing systems link computer resources together in a way that lets someone use one computer to access and leverage the collected power of all the computers in the system [3]. The keyword Grid computing was introduced by Carl Kesselman and Ian Foster during 1990. But Grid computing gained real fame in 2007 [4].

Grid computing is commonly defined as

i. A service for sharing computer power and data storage capacity over the Internet.

ii. An ambitious and exciting global effort to develop an environment in which individual users can access computers, databases and experimental facilities simply and transparently, without having to consider where those facilities are located [5].

iii. Grid computing is a model for allowing companies to use a large number of computing resources on demand, no matter where they are located [6].

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 are summarized below [7].

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

ii. 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.

iii. 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. For example, there may be two universities doing life science research, each with unique data. A data grid would allow them to share their data, manage the data, and manage security issues such as who has access to what data.

This paper brings out the difference between grids, cloud, cluster and distributed computing in Section 2 followed by applications of grid computing in Section 3. The advantages of grid computing are discussed in Section 4 followed by conclusions in Section 5.

## 2. Grid, cloud, distributed and cluster computing

### 2.1. Grid and cloud computing

Grid computing allows organizations to meet two goals:

i. Remote access to IT assets.
ii. Aggregated processing power.

Grids are made up of processors, sensors, data-storage systems, applications and other IT resources, all these are shared across the network. Grid computing systems have made it possible to carry out a number of resource-demanding projects that had previously been impossible or highly challenging, due to the physical location of vital IT assets.

Cloud computing is a development on grid computing. It requires three fundamental components:

i. Thin clients **(**alternatively, clients with a thin-thick switch may be used**)**.
ii. Grid computing.
iii. Utility computing (i.e. paying for resources used from shared servers, similar to paying for a public utility, such as electricity)

Grid computing, on the other hand, is a backbone of cloud computing. It allows provision of on-demand resource. Cloud computing and grid computing differ in the method they use in computing. For grid computing, a huge task is divided into smaller tasks and distributed to various servers. When the tasks are completed, the results are sent back to the main machine which will then provide a single output. Cloud computing offers various services to users which grid computing can't offer like web hosting. The vision for Clouds and Grids are similar, details and technologies used may differ [1]. Grid computing is where more than one computer coordinates to solve a problem together. Often used for problems involving a lot of number crunching, this can be easily parallelizable.

Grid computing and cloud computing are scalable. Scalability is accomplished through load balancing of application instances running separately on a variety of operating systems and connected through Web services. CPU and network bandwidth is allocated and de-allocated on demand. The system's storage capacity goes up and down depending on the number of users, instances, and the amount of data transferred at a given time.

Both computing types involve multitenancy and multitask, meaning that many customers can perform different tasks, accessing a single or multiple application instances. Sharing resources among a large pool of users assists in reducing infrastructure costs and peak load capacity. A cloud would usually use a grid. A grid is not necessarily a cloud or part of a cloud. [8].

### 2.2. Grid computing and cluster computing

Grid computing is something similar to cluster computing, it makes use of several computers connected is some way, to solve a large problem. The big difference is that a cluster is homogenous while grids are heterogeneous.

Characteristics of Grid Computing are:

i. Loosely coupled (Decentralization)
ii. Diversity and Dynamism
iii. Distributed Job Management & scheduling

When two or more computers are used together to solve a problem, it is called a computer cluster. The major difference is that a cluster is homogenous while grids are heterogeneous. The computers that are part of a grid can run different operating systems and have diverse hardware whereas the cluster computers all have the same hardware and OS. A grid can make use of spare computing power on a desktop computer while the machines in a cluster are devoted to work as a single unit and nothing else. Grids are inherently distributed by its nature over a LAN, metropolitan or WAN. On the other hand, the computers in the cluster are normally contained in a single location or complex. In case of Cluster, the whole system (all nodes) behaves like a single system view and resources are managed by centralized resource manager. In case of Grid, every node is self-governing i.e. it has its own resource manager and behaves like a self-governing entity.

Characteristics of Cluster computing are:

i. Tightly coupled systems
ii. Single system image
iii. Centralized Job management & scheduling system [8].

### 2.3. Grid computing and distributed computing

Distributed Computing is an environment in which a collection of independent and geographically isolated computer systems take part to solve a complex problem, each by solving a part of solution and then combining the result from all computers. These systems are loosely coupled systems coordinately working for a common objective. It can be defined as a computing system in which services are provided by a pool of computers collaborating over a network. It is also defined as computing environment that may involve computers of differing architectures and data representation formats that share data and system resources.

Some of the major differences between grid and distributed computing are: Distributed Computing manages pooling the hundreds or thousands of computer systems which individually are more limited in their memory and processing power. On the other hand, grid computing is concerned to efficient utilization of a pool of heterogeneous systems with optimal workload management utilizing computational resources (servers, networks, storage, and information) acting together to create one or more large pools of

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computing resources. Grid computing is focused on the ability to support domains that sets it apart from traditional distributed computing. Its concept of support for several administrative policies and security authentication and authorization mechanisms enables it to be distributed over a local, metropolitan, or wide-area network [9].

## 3. Applications of grid computing

In reality the work on the grid computing was started with the aim of making such a network consisting of computers which will be independent of the server connected to its central point, but unfortunately that dream has not been able to come into being yet. In starting grid computing was only made for the purpose of science related fields but now a day it is believed that industrial and commercial zones can be grown by use of grid computing. Grid computing is now being used for other applications that include biology, medicine, earth sciences, physics, astronomy, chemistry, and mathematics [4].

### 3.1. Few of the applications of grid computing

i. Search for Extra Terrestrial Intelligence (SETI): It is One of the applications of radio astronomy is the observation of radio signals as part of Searches for Extra Terrestrial Intelligence [10].

ii. Globus software: It is used by The *Southern California Earthquake Center* uses to visualize earthquake simulation data [11].

iii. *Earth System Grid (ESG):* It facilitates producing, archiving, and providing access to climate data that advances our understanding of global climate change. ESG uses Globus software for security, data movement, and system monitoring [11].

iv. The Australian Virtual Observatory (Aus-VO): It facilitates & provides a distributed, uniform interface to the data archives of Australia's major astronomical observatories and to archives of astrophysical simulations.which provides facility which will link the archives of the world's major astronomical observatories into one distributed database [12].

v. Climateprediction.net: which improves the understanding of how climate models are sensitive to small changes in the models, and to changes in carbon dioxide and other atmospheric chemicals? These simulations should improve confidence in climate change predictions that have long term effects on the global economy.

vi. NEES grid: It links earthquake researchers across the U.S. with leading-edge computing resources and research equipment, allowing collaborative teams (including remote participants) to plan, perform, and publish their experiments [13].

vii. Nimrod-grid: It supports users' quality-of-service (QoS) requirements driven brain activity analysis application scheduling on the Grid. In this system, it attempted to reduce analysis time (deadline) and cost (budget) and to seamlessly integrate resources (computational, data, and MEG instrument).Their evaluation results show that the system is highly efficient in reducing the analysis time and cost. The results demonstrate that grid technology is effective and promising for real-life medical and scientific problems [14].

viii. The Virtual Laboratory project: It is engaged in research, design, and development of Grid technologies that help in solving large-scale compute and data intensive science applications in the area of molecular biology. The virtual laboratory environment provides software tools and resource brokers that facilitate large-scale molecular studies on geographically distributed computational and data grid resources [15].

ix. China's The Knowledge Grid: It supports e-science & makes accurately sharing research resources and knowledge more convenient, but it also supports cooperative research and scientific discovery. The cooperation between intelligent application services and the Knowledge Grid forms an Intelligent Grid Environment that in turn provides intelligent and active services [15].

x. *EGI-InSPIRE* project: *The* ultimate goal of EGI-InSPIRE is to provide European scientists and their international partners with a sustainable, reliable e-Infrastructure that can support their needs for large-scale data analysis [17].

xi. Mammo Grid: Aim is to deliver a set of *evolutionary prototypes to demonstrate the* mammogram analysts, specialist radiologists working in breast cancer screening who can use the grid information infrastructure to resolve common image analysis problems [17].

xii. DDGrid (Drug Discovery Grid): This project aims to build a collaboration platform for drug discovery using the state-of-the-art P2P and grid computing technology the field of medicine chemistry biology [17].

xiii. GRIDCC project: It demonstrates that the PSSimulator is a sophisticated software

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application that simulates the realistic operational modes of conventional large electricity generators plus a network model of transmission lines, transformers and other components. Generators can be in a number of states; Not Generating; Synchronizing; Running etc. and their delivered power and AC frequency will vary with time [18].

xiv. TeraGrid: There are many scientific areas that will benefit from use of the TeraGrid .A few of them are real-time weather forecasting bio-molecular electrostatics electric and magnetic molecular properties [19].

xv. GriPhyN Project: It is developing grid technologies for scientific and engineering projects that must collect and analyze distributed, peta-byte-scale datasets [19].

### 3.2. Applications of Grid computing in India

Some of the grid computing applications in India:

i. Health grid project: It is developed at VECC Kolkata; an initiative has been taken to expand the Grid Computing Facility to the medical community for Research, Diagnosis and early detection of diseases. "Distribution and Processing of Biomedical data and images using Health-Grid" [20].

ii. GARUDA: It is a collaboration of the Scientific, Engineering and Academic Community to carry-out research and experimentation on a nationwide grid of computational nodes, mass storage that aims to provide the distributed data and compute intensive High Performance Computing solutions for the 21st century.

iii. The EU-India Grid project [21]: It is funded by the European Commission, is to build a networked collaborative e-Science community between Europe and India by developing a common Grid infrastructure to support data processing for scientific application areas such as Atmospheric and Earth Sciences, Biology, High Energy Physics, and Material Science.

## 4. Advantages of grid computing

i. Provide transparent access to remote resources

ii. Allow on-demand aggregation of resources at multiple sites.

iii. Reduce execution time for large-scale, data processing applications.

iv. Provide access to remote databases and software Take advantage of time zone and random diversity. (in peak hours, users can access resources in off-peak zones)

v. Provide flexibility to meet unforeseen emergency demands by renting external resources for a required period instead of owning them.

## 5. Conclusion

In summary, Grid computing is cooperation of different computers, for a specific task, so that the user acquires better performance for that specific task. The Grid aims ultimately to turn the global network of computers into one vast computational resource**.** Grid computing is more service oriented than application oriented. Grids are a form of distributed computing whereby a "super virtual computer" is composed of many networked loosely coupled computers acting together to perform large tasks. The significance of grid computing can be clearly observed by its applications in various fields including biology, medicine, earth sciences, physics, astronomy, chemistry, and mathematics.

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