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Grid Computing: An Overview

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Abstract*—Grid computing is an infrastructure involving collaboration of computers, databases & network resources available, to perform manipulation of intensive and large scale data set problems. This paper presents an introduction to Grid computing providing insight into the essential features, architecture, applications of grid computing.
***Keywords*— Grid computing, architecture, applications, security, resource sharing**

I. INTRODUCTION

In the last few years there has been a rapid exponential increase in computer processing power, data storage and communication. But still there are many complex and computation intensive problems, which cannot be solved by supercomputers. These problems can only be met with a vast variety of heterogeneous resources. This new method of pooling resources for solving large-scale problems is called as grid computing. Grid Computing is based on the philosophy of information and electricity sharing, allowing us to access to another kind of heterogeneous and geographically separated resources. Grid provides the sharing of: Computational resources, Storage elements, Specific applications, Equipment, etc. Thus, Grid is based on: Internet protocols and Ideas of parallel and distributed computing. "A Grid is a system that coordinates resources that are not subject to a centralized control. Grid uses standard, open, general-purpose protocols and interfaces. Grid is a system that delivers nontrivial qualities of services." Grid computing is the federation of computer resources from multiple administrative domains to reach a common goal. A grid computer is multiple number of same class of computers clustered together. A grid computer is connected through a super-fast network and shares the devices like disk drives, mass storage, printers and RAM Grid Computing is a cost efficient solution with respect to Super Computing. What distinguishes grid computing from conventional high performance computing systems such as cluster computing is that grids tend to be more loosely coupled, heterogeneous, and geographically dispersed.

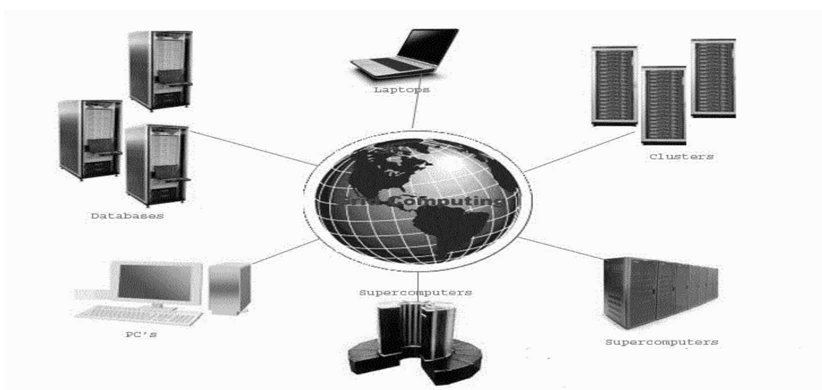

Fig: Introduction of Grid computing

II. HISTORY

The term grid computing originated in the early 1990s as a metaphor for making computer power as easy to access as an electric power grid. The power grid metaphor for accessible computing quickly became canonical when Ian Foster and Carl Kesselman published their seminal work, "The Grid: Blueprint for a new computing infrastructure" in 1999. The ideas of the grid (including those from distributed computing, object-oriented programming, and Web services) were brought together by Ian Foster, Carl Kesselman, and Steve Tuecke, widely regarded as the "fathers of the grid". They led the effort to create the Globus Toolkit incorporating not just computation management but also storage management, security provisioning, data movement, monitoring, and a toolkit for developing additional services based on the same infrastructure, including agreement negotiation, notification mechanisms, trigger services, and information aggregation.

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III.CHARACTERISTICS OF GRID COMPUTING

The essential characteristics that a grid is supposed to have in order to be considered are as follows:

A. *Large scale:* a grid must be able to deal with a number of resources ranging from just a few to millions. This raises the very serious problem of avoiding potential performance degradation as the grid size increases.

B. *Geographical distribution*: a grid's resources may be located at distant places.

C. *Heterogeneity:* a grid hosts both software and hardware resources that can be very varied ranging from data, files, software components or programs to sensors, scientific instruments, display devices, personal digital organizers, computers, super-computers and networks.

D. *Resource sharing:* resources in a grid belong to many different organizations that allow other organizations (i.e. users) to access them.

E. *Resource coordination:* resources in a grid must be coordinated in order to provide aggregated computing capabilities.

F. *Transparent access:* a grid should be seen as a single virtual computer.

G. *Multiple administrations:* each organization may establish different security and administrative policies under which their owned resources can be accessed and used. As a result, the already challenging network security problem is complicated even more with the need of taking into account all different policies.

H. *Scalability:* The grid should be tolerant to handle a large number of nodes without any performance degradation.

I. *Adaptability or Fault Tolerant*: In a grid unexpected computational aborts, hardware or software faults etc. are high. These faults are generally handled by Resource Managers.

J. *Security:* All the user participating computers should be protected from any malicious manipulations or interventions.

IV.GRID ARCHICTURE

Grid consists of a layered architecture model providing protocols and service at five different layers as follows:

A. *Fabric layer:* Grids provide access to different resource types such as compute, storage and network resource, code repository, etc. Grids usually rely on existing fabric components, for instance, local resource manage. : Fabric layer sits at the bottom of this layered architecture; it provides shareable resources such as network bandwidth, CPU time, memories, scientific instruments like sensors, telescope, etc. Data received by sensors at this layer can be transmitted directly to other computational nodes or can be stored in the database over grid.

B. *Connectivity layer:* Connectivity layer defines core communication and authentication protocols for easy and secure network transactions. Protocols related to communication and authentication required for transactions are placed in this layer. These communication protocols permit the exchange of data between resource layer and fabric layer.

C. *Resource layer:* Resource layer defines protocols for the publication, discovery, negotiation, monitoring, accounting and payment of sharing operations on individual resources. Resource layer build on the connectivity layer's communication and authentication protocols to define Application Program Interfaces (API) and software development kit (SDK) for secure negotiation, accounting, initiation, control, monitoring and payment of sharing resources.

D. *Collective layer:* This layer consists of general purpose utilities. Any collaborative operations in the shared resources are placed in this layer and it coordinates sharing of resources like directory services, co-allocation, scheduling, brokering services, monitoring and diagnostic services, data replication services.

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E. *Application layer:* This layer comprises whatever user applications built on top of the above protocols and APIs and operate in VO environments. This layer consists of application which the user will implement. Moreover, this layer provides interface to the users and administrators to interact with the grid.

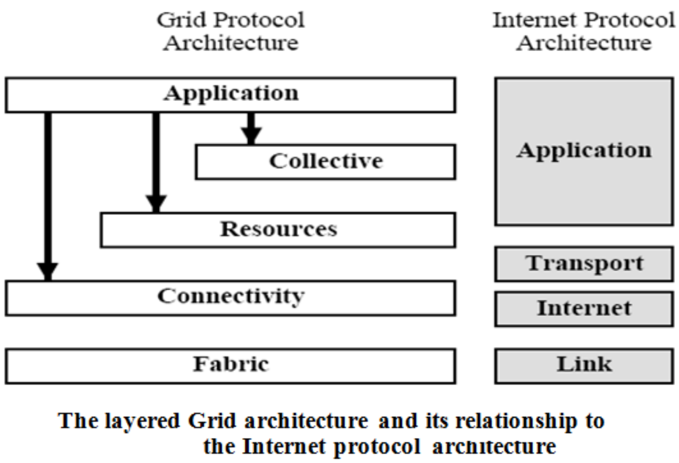

Fig: Grid Architecture

V. APPLICATIONS OF GRID COMPUTING

Grid Resources can be used to solve complex problems in many areas like high-energy physic biophysics, nuclear simulations, weather monitoring and prediction, financial analysis, chemical engineering etc. Projects, such as SETI@Home and Distributed.Net, build grids by linking multiple low end computational resources, like PCs, from the Internet to detect extra-terrestrial intelligence and crack security algorithms respectively.

The Search for Extra-terrestrial Intelligence (SETI) project is one of the earliest grid computing systems to gain popular attention. The mission of the SETI project is to analyse data gathered by radio telescopes in search of evidence for intelligent alien communications. A similar program is the Folding@home project administered by the Pande Group, a non-profit institution in Stanford University's chemistry department. The Pande Group is studying proteins. The research includes the way proteins take certain shapes, called folds, and how that relates to what proteins do.

Grid computing provides a way for computation of high data intensive problems like financial modelling, protein folding, climate/weather modelling, image rendering, earthquake simulation, etc.

The various domains in which grid computing is utilized are the following:

A. *Engineering Design and Automation:* Computational aerodynamics, artificial intelligence and automation, finite-element analyses, remote sensing applications, pattern recognition, computer vision, image processing, etc.
B. *Medical, Military and Basic Research:* Polymer chemistry, medical imaging, nuclear weapon design, problem of quantum mechanics, etc.
C. *Predictive Modelling and Simulation:* Flood warning, socio-economic and government use, numerical weather forecasting, astrophysics (Modelling of Black holes and Astronomical formations), semiconductor simulation, Oceanography, human genome sequencing, etc.
D. *Energy Resource Exploration*: Plasma Fusion power, seismic exploration, nuclear reactor safety, reservoir modelling, etc.
E. *Visualization:* computer-generated graphics, films and animations, data visualization, etc.

VI. SECURITY IN GRID COMPUTING

Grid computing provides high computing power, enormous data storage, and collaboration possibilities to its users. In the networked access to computation with a single-sign-on system as the portal to the possibilities of world wide computing grids security plays an important role. As one might imagine, security in a computer grid is an important and difficult issue. Connecting your computer to a grid and executing your applications remotely exposes yourself and other grid users to numerous

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security risks which must be addressed. To address these issues, a computer grid must concern itself with the following three basic security services; Authentication, Authorization, and Encryption. First a grid node must be authenticated prior to allowing access to any grid resources. Once authenticated, a node can be authorized to execute an application on the grid (or use some other resources), but this does not prevent data transmitted between nodes from being intercepted, spoofed, or altered in any way. Encryption technologies would be required to mitigate that risk.

VII. CONCLUSIONS

Grids make research projects possible that formerly were impractical or unfeasible due to the physical location of vital resources. Grid computing is cooperation of different computers, for a specific task, so that the user acquires better performance for that specific task Today Grid computing has been utilized by most of the scientific domains like astronomy, biological science, climatology, and much more. But the prime requisite for using grid is high speed internet, if one does not have a high speed internet one cannot get the best benefits from grid. This has been holding back grid for long. It is being speculated that grid computing through dedicated fibre optic links, might change the current scenario of broadband and other services providing bandwidth ranging from gigabytes to terabytes..

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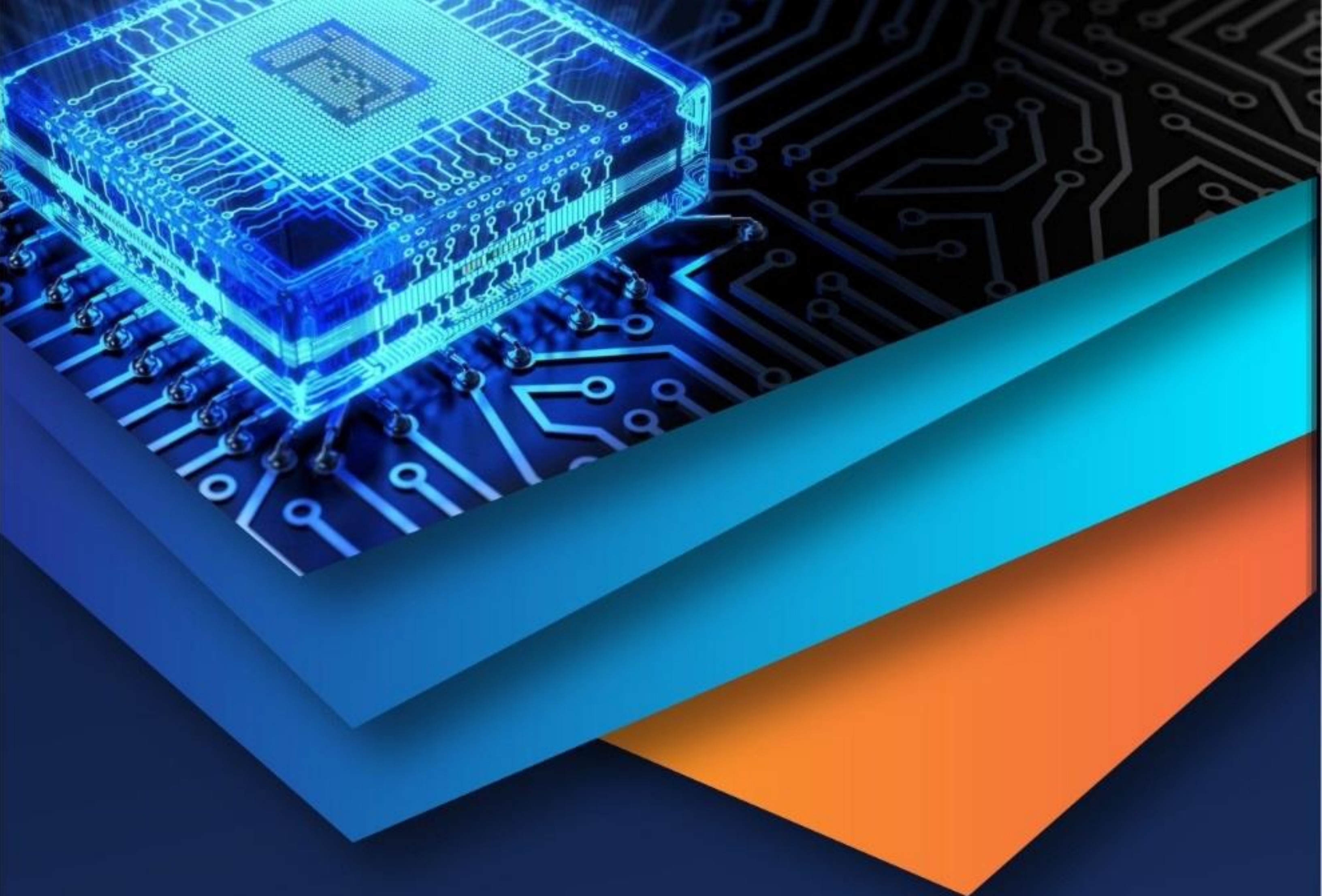

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