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GRID COMPUTING V/S CLOUD COMPUTING*

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Abstract: From the last few years it's been observed that the computing technology need to be made more powerful and efficient regarding the usage of resources located at different geographical sites. Keeping this in mind, concept of Cloud computing and Grid computing came to an existence. Both the computing technologies are the synonym of distributed system over a network and have the ability to run a program or application on many connected computers at the same time. Systems involved in these methods are loosely coupled, heterogeneous and geographically dispersed. Both computing types are multi tenant and multitasking, meaning that many customers can perform different tasks, accessing a single or multiple application instances. Grid and Cloud computing demand robust resource allocation with security assurance at all resource sites. This paper narrates the basic idea behind the Grid and Cloud computing, their difference and similarities.

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1. Introduction

The major goal of distributed computing research was to give users an easy, simple and transparent method of access to a vast set of heterogeneous resources. This is generally known as metacomputing. Metacomputing done on local area networks (LAN) are typically known as Cluster Computing Environments and those, which are done on wide area networks (WAN), are known as Grid Computing. This paper deals with the later one Grid Computing.

A computational grid is a hardware and software infrastructure that provides dependable, consistent, pervasive and inexpensive access to computational capabilities [7]. Grid computing concepts were first studied and explored in the 1995 I-WAY experiment, in which high-speed networks were used to connect, for a short time, high-end resources at 17 sites throughout the USA. From this experiment a number of Grid research projects emerged that developed the core basic technologies for Grids in various communities and scientific disciplines. For example, the US National Science Foundation's National Technology Grid and NASA's Information Power Grid are both creating Grid infrastructures to serve university and NASA researchers, respectively. Across Europe and the United States, the closely related European Data Grid, Particle Physics Data Grid and Grid Physics Network (GriPhyN) projects plan to analyze data from frontier physics experiments.

(a) Grid Computing

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(b) Characteristics of a Computational Grid

There are many desirable properties and features that are required by a grid to provide users with a computing environment. They are as follows (see,e.g.[2],[8]):

- Heterogeneity-The grid involves a number of resources that are varied in nature and can encompass a large geographical distance through various domains.
- Scalability-The grid should be tolerant to handle a large number of nodes without any performance degradation.
- 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.
- Security-All the user participating computers should be protected from any malicious manipulations or interventions.

(c) Grid Components

The major components that are necessary to form a grid as are shown in the Figure1. The components are as follows [4]:

- User Level

This layer houses the Application and High level Interfaces. Applications can bevaried and encompass a vast variety of problems from chemistry to

NuclearEngineering. The high level interfaces implement an interface and protocolsallowing the applications and users to access the middleware services.

- Middleware level

The major functionalities of grid systems normally occur in this layer. This layerprovides many services like Resource discovery, resource scheduling andallocation, fault tolerance, security mechanisms and load balancing. It shouldprovide the users a transparent view of the resources available.

- Resource level

This layer typically provides local services that render computational resourceslike CPU cycles, storage, computers, Network infrastructure, software etc.

Applications
Chemistry Neuroscience Physics Nuclear Engineering

High Level Interfaces
Problem Solving Environments Portals Grid System APIsComputational Workbenches

Grid Services

SecurityInformation ServicesMonitoring Services
Resource Discovery Fault TolerancResource AllocationSchedulingDistributed Storage Infrastructure

Local Services
LsfDatabases Computers OS ServicesResourceManagement

Figure 1: Grid Components

(d)Grid Architecture

Computational grids have to be designed so as to serve different communities withvarying characteristics and requirements. Because of this reason we cannot have auniform single architecture. But in general we can identify basic services that almostall the grids will provide although different grids will use different approaches for therealization of these services [6].This description of grid architecture does not provide a complete enumeration of allthe required protocols and services but it identifies the requirements for general classof components. This architecture organizes the components into layers as shown in Figure 2.

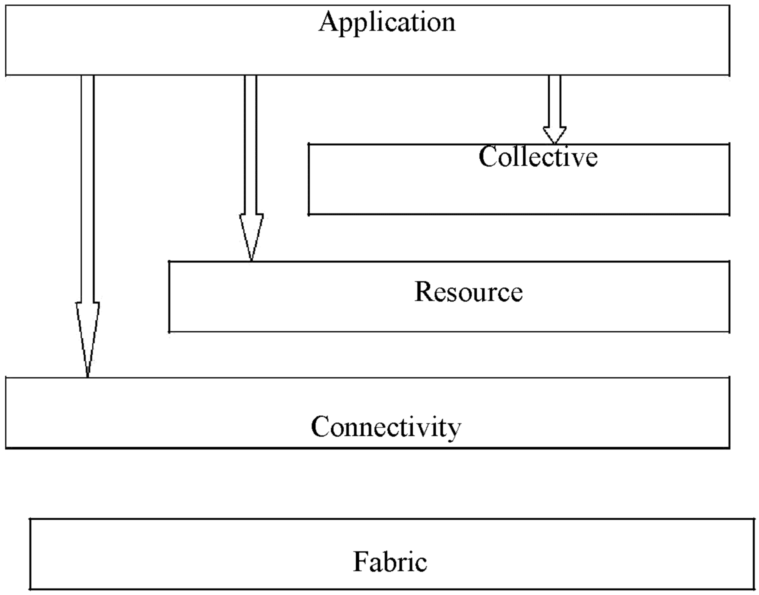

Figure 2: Grid Architecture

The layers of the grid are as follows [5]:

- Fabric layer

This layer provides the resources, which could comprise computers (PCs running Windows NT or UNIX), storage devices and databases. The resource could also be a logical entity such as a distributed file system or computer pool. Excellent fabric functionality could mean that sophisticated sharing operations can be accomplished. For this, it should support enquiry mechanisms to discover their state, structure and capabilities. It should also have resource management mechanisms that provide some control of delivered quality of service.

- Connectivity layer

This layer consists of the core communication and authentication protocols required for transactions. Communication protocols enable the exchange of data between fabric layer resources. Authentication protocols provide secure cryptographic mechanisms for identifications of users and resources. For communication transport, naming and routing are required. These protocols can be drawn from TCP/IP protocol stack.

- Resource layer

This layer builds on the Connectivity layer communication and authentication protocols to define Application Program Interfaces (API) and Software Development Kit (SDK) for secure negotiation, initiation, monitoring, control, accounting and payment of sharing operations. The protocols, which the resource layers implement to achieve the above functionality are implemented with the help of functions provided by the Fabric layer. Resource layer protocols can be distinguished primarily into two classes, which are Information Protocols and Management Protocols

1. Information protocol-This protocol is used to obtain the necessary information about the structure and the state of the resource

2. Management protocol-In order to negotiate the access to the shared resources this protocol is used.

• Collective layer

This layer is different from the resource layer in the sense, while resource layer concentrates on interactions with single resource; this layer helps in coordinating multiple resources. Its tasks can be varied like Directory Services, Co-allocation and scheduling, monitoring, diagnostic services, and software discovery services.

• Application layer

This layer consists of the user applications and programs and which call upon another layer.

2. Cloud computing

Cloud computing represents a novel and promising approach for implementing scalable ICT systems for individual, communities, and business-use. Resources are pooled and offered on-demand with ubiquitous network access to rapidly configurable and elastic IT capabilities. Resources are delivered following three basic delivery models: access to applications (SaaS), provision of platforms to create applications (PaaS), and provision of infrastructures for processing, storage, and networking (IaaS). The key benefits of providing computing power using Clouds are:

1. Avoidance of expensive computer systems configured to cope with peak performance;

2. pay-per-use solutions for computing cycles requested on-demand, and

3. Avoidance of idle computing resources, resulting in novel business models.

Cloud computing can be defined as the convergence and evolution of several concepts from virtualization, distributed application design, and enterprise IT management to enable a more flexible approach for deploying and scaling applications (see e.g.[1],[9]). From the technological point of view Grid computing is considered as the most related predecessor technology of Cloud computing.

(a) Characteristics

Cloud computing has a variety of characteristics, with the main ones being:

• **Shared infrastructure** — uses a virtualized software model, enabling the sharing of physical services, storage, and networking

capabilities. The cloud infrastructure, regardless of deployment model, seeks to make the most of the available infrastructureacross a number of users.

• **Dynamic provisioning**— Allows for the provision of services based on current demand requirements. This is done automaticallyusing software automation, enabling the expansion and contraction of service capability, as needed. This dynamic scalingneeds to be done while maintaining high levels of reliability and security.

• **Network access** — Needs to be accessed across the internet from a broad range of devices such as PCs, laptops, and mobiledevices, using standards-based APIs (for example, ones based on HTTP). Deployments of services in the cloud includeeverything from using business applications to the latest application on the newest Smartphone.

• **Managed metering** — Uses metering for managing and optimizing the service and to provide reporting and billing information.In this way, consumers are billed for services according to how much they have actually used during the billing period.

(b)Deployment models

Deploying cloud computing can differ depending on requirements, and the following four deployment models have been identified,each with specific characteristics that support the needs of the services and users of the clouds in particular ways (see Figure 3).

• **Private Cloud** — The cloud infrastructure has been deployed, and is maintained and operated for a specific organization. Theoperation may be in-house or with a third party on the premises.

• **Community Cloud** — The cloud infrastructure is shared among a number of organizations with similar interests and requirements.This may help limit the capital expenditure costs for its establishment as the costs are shared among the organizations. Theoperation may be in-house or with a third party on the premises.

• **Public Cloud** — The cloud infrastructure is available to the public on a commercial basis by a cloud service provider. Thisenables a consumer to develop and deploy a service in the cloud with very little financial outlay compared to the capitalexpenditure requirements normally associated with other deployment options.

• **Hybrid Cloud** — The cloud infrastructure consists of a number of clouds of any type, but the clouds have the ability throughtheir interfaces to allow data and/or applications to be moved from one cloud to another. This can be a combination of privateand public clouds that support the requirement to retain some data in an organization, and also the need to offer services inthe cloud.

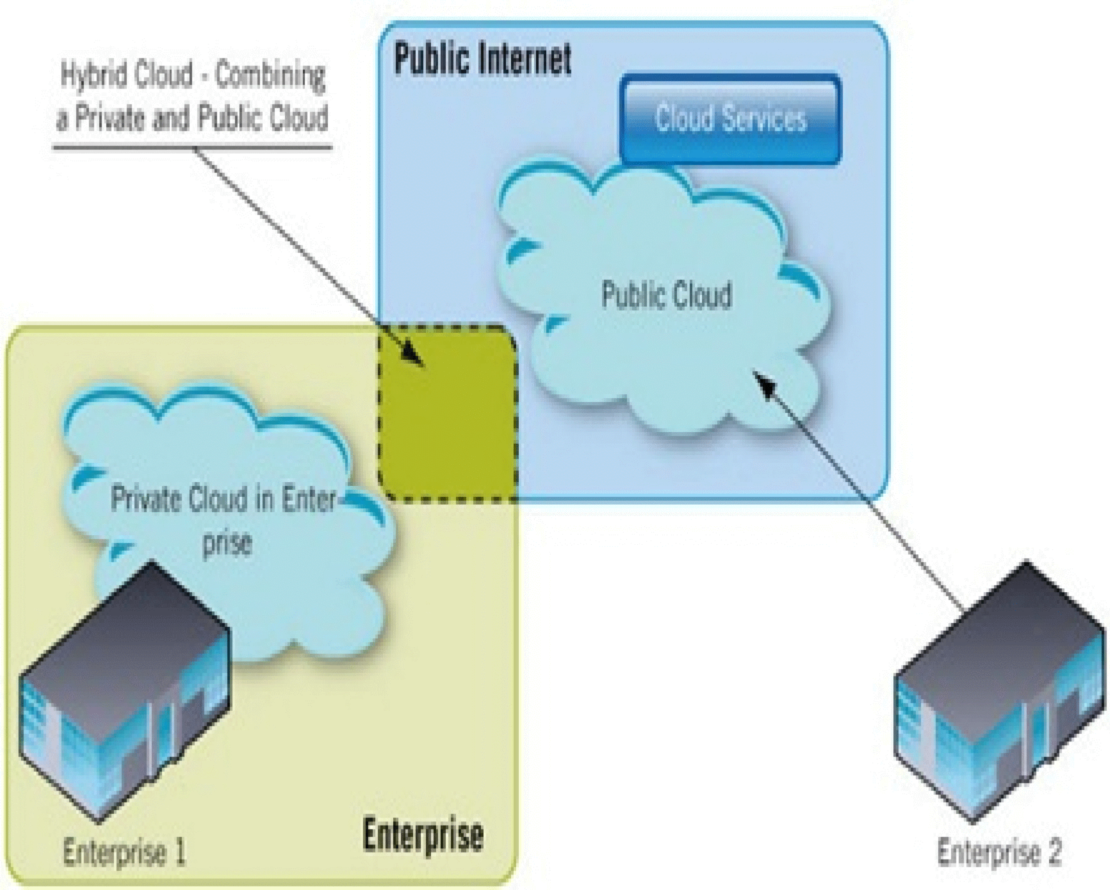

Figure 3: Public, Private, and Hybrid Cloud Deployment Example

3. Major differences between Grids and Clouds

In the following we summarize the major differences betweenGrids and Clouds [3].

Businessmodels. While in Grid business models areusually based on bilateral agreements between academicinstitutions, provision of resource in Clouds requiresmore differentiated business models as discussed next.Currently, we observe several types of business modelsranging from resource providers who only providecomputing resources (e.g., Amazon, Tsunamic Technologies),over SaaS providers who sell their ownresources together with their own software services (e.g.,GoogleApps, Salesforce.com) to companies that attemptto run a mixed approach, i.e., they allow users to createtheir own services but at the same time offer their ownservices (Sun N1 Grid, Microsoft Azure).

Resource management. Resource management representsanother major difference between Grids and Clouds.While Grids rely on batch systems, utilization of virtualizationtechnologies represents the resource managementsolution for the Clouds.

Resource provision models. As already discussed in previoussections Grid resource provisioning models arebased on virtual organisations where the relationships areestablished offline. In Clouds usage of SLAs, compliance,and trust management is essential.

Resource availability. In Grids resource sharing relies onthe best effort manner, sometimes resources are not availableand sometimes there are plenty of resources whichare idle. Clouds rely on massive elasticity in Clouds. Challengingissues in Clouds are to find the balance betweenwasting resources due to the virtualization overhead andstandby modes of devices on the one hand, and pooling ofresources to facilitate efficient consumption of resourcesand reducing energy consumption on the other.

4. Similaritiesand differences of Grid and Cloud Computing

Cloud computing and grid 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. Cloud and grid computing provide service-level agreements (SLAs) for guaranteed uptime availability of, say, 99 percent. If the service slides below the level of the guaranteed uptime service, the consumer will get service credit for receiving data late.

The Amazon S3 provides a Web services interface for the storage and retrieval of data in the cloud. Setting a maximum limits the number of objects you can store in S3. You can store an object as small as 1 byte and as large as 5 GB or even several terabytes. S3 uses the concept of buckets as containers for each storage location of your objects. The data is stored securely using the same data storage infrastructure that Amazon uses for its e-commerce Web sites.

While the storage computing in the grid is well suited for data-intensive storage, it is not economically suited for storing objects as small as 1 byte. In a data grid, the amounts of distributed data must be large for maximum benefit.

A computational grid focuses on computationally intensive operations. Amazon Web Services in cloud computing offers two types of instances: standard and high-CPU.

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