

A Comparative Performance Analysis of Cloud, Cluster and Grid Computing over Network

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Abstract: An in-depth study of these computing environments (Cluster, Grid and Cloud computing), based on these findings the following data placement issues are identified: storage discovery, storage allocation, data replication, data consistency control, reliable file transfer, job-aware data placement optimization, data security and transactions. One of the major concerns is data security in cloud computing environment. Cloud computing is a flexible, cost effective and proven delivery platform for providing business or consumer IT services over the internet. Many computer resources such as hardware and software are collected into the resource pool which can be assessed by the users via the internet through web browsers or desktops or mobile devices. It is really not a new paradigm of computing; it is related to Grid & Cluster Computing. All these computing like Grid & Cluster have actually contributed in the development of cloud computing. In this paper, we are going to compare the performance of all the technologies which leads to the emergence of cloud computing [15].

Keywords: Cluster Computing, Grid Computing, Cloud Computing

I INTRODUCTION

We have experienced a tremendous change in computing from earlier times till now. Earlier, large computers are kept in large closed spaces and only the professional are allowed to operate them [1]. Later came the concept of grid computing which allows users to have computing on demand according to need [2]. After that we got such computing which makes resources provisioning and deprovisioning of computation, storage, data services to and from the user without user being not aware of the fact that from where he is getting the resources[4]. With the large scale use of internet all over the globe, everything can be delivered over internet using the concept of cloud computing as a utility like gas, water, and electricity etc[5].

The rest of the paper is organized as follows: Section II describes the Cloud computing including its advantages and disadvantages. Section III describes Cluster computing including its advantages and disadvantages. Section IV describes grid computing including its advantages and disadvantages. Section V represents the performance comparison between cloud, cluster and grid computing. In the last section conclusion is presented.

II CLOUD COMPUTING

Cloud computing is one of the most important current trends in the field of information and communications technology. It is a technology which uses the internet and central remote servers to maintain data and applications. Cloud computing allows consumers and businesses to use applications without installation and access their personal files at any remote computer with internet access. This technology allows for much more efficient computing by centralizing storage, memory, processing and bandwidth. Cloud computing services are used both by consumers as well as by organizations and companies.

“Cloud is a parallel and distributed computing system consisting of a collection of inter-connected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resources based on service level agreements (SLA) established through negotiation between the service provider and consumers”

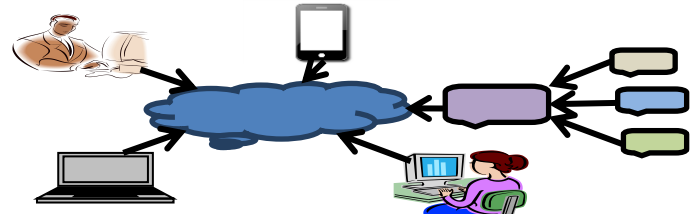


Fig.1.1 Cloud Computing Concept

Here Fig.1.1 shows that how users can connect to the cloud services provided by cloud service provider using any device over the internet. Cloud infrastructure includes scalable resources in storage, network and compute. It also contain virtualized infrastructure and provide these services to the users over the internet.

Cloud computing cuts the operational and capitol costs and allow the IT world to focus on strategic projects instead of keeping the data centre running. It provides the services on infrastructure level (IaaS), platform level (PaaS), and software level (SaaS). It provides many features such as speed, scalability of resources, parallel processing, technology independent, 24/7 availability of services, device and location dependent, provides best reliability and security etc. Clouds have five major features such as rapid elasticity, measured services, on-demand self service, resource pooling, and board network access as shown in Fig.1.2.

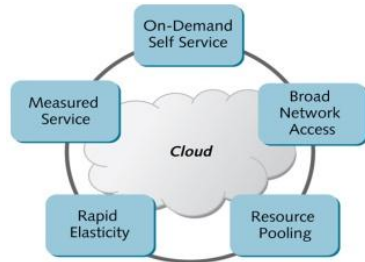


Figure 1.2 The essential characteristics of cloud computing

A Advantages of Cloud Computing

(1) Shared Resources: Cloud computing share resources to provide the services to multiple users at a time. So that it can easily provide the features like scale up and scale down the resources on demand.

(2) Pay-As-you-Use: Users just need to pay only for those resources which are used by them. They can demand for more resources if they required latter on and they can also release their resources after use.

(3) Secure Hardware Management: It is easy for cloud service provider to manage the hardware more efficiently because all computers run the same hardware. [7]

(4) Save CAPEX & OPEX of Users: New technologies are developing very rapidly. Organizations need to use new technologies to fulfill the requirements of their customers. But changing the technologies is very costly. With the help of cloud computing, users don't need to purchase the physical infrastructure and spend money on maintaining it. They can use any technology as per their requirement.

B. Disadvantages of Cloud Computing

(1) Less Reliability: Cloud computing is less reliable because it is used to share the resources with multiple users. So there is possibility to theft of the data of a user or data of any organization may mix with the data of another organization. A disgruntled employee could alter or destroy the data using his or her own access credentials. If cloud storage system is not reliable, no one wants to save the data on unreliable system [12].

(2) Internet: The main requirement for users to use the services of cloud computing is internet. Users required high speed of internet connection [16]. Unavailability of internet would cause unavailability of data on cloud.

(3) Non-Interoperability: If user stored data in one cloud then later on he/she can't move it to another cloud service provider because there is non-interoperability.

III CLUSTER COMPUTING

Cluster computing is a computing in which several nodes are made to run as a single entity [6]. The various nodes involved in cluster are normally connected to each other using some high end local area networks [7]. There are mainly two reasons of deploying a cluster instead of a single computer which are performance and fault tolerance. An application desires high computation in terms of response time, memory and throughput especially when we talk about real time applications. Cluster computing provides high computation by employing parallel programming, which is uses multiple processors simultaneously for a large number of or a single problems. Another reason is fault tolerance which is actually

the ability of a system to operate gracefully even in the presence of any fault. As the clusters are replicas of similar components, the fault in one component only affects the cluster's power but not its availability [8]. So users always have some components to work with even in the presence of faults.

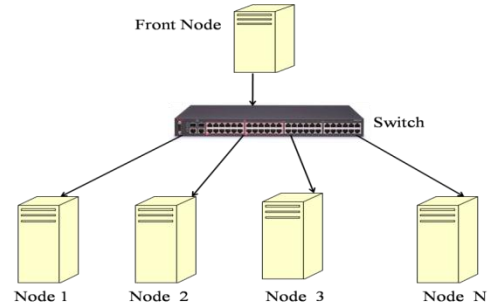


Fig.1.3. Concept of cluster computing

Here Fig.1.3. Shows the general concept of cluster computing according to which several nodes merge together and are presented as a single interface/node to the users.

A Advantages of Cluster Computing

(1) Manageability: It takes a lot of effort, cost and money to manage a large number of components. But, with cluster, large number of components is combined to work as a single entity. So, management becomes easy.

(2) Single System Image: Again with cluster, user just gets the feel that he is working with a single system but actually he is working with a large number of components. He need not worry about that components, he only needs to manage a single system image.

(3) High Availability: As all the components are replicas of each other, so if one component goes down because of any technical reason, then some other component can takes its place, and user can continue to work with the system[9].

B. Disadvantages of Cluster Computing

(1) Programmability Issues: This might be the case if the components are different in terms of software from each other, and then there may be issues when combining all the devices together as a single entity.

(2) Problem in Finding Fault: Because we are dealing with a single entity, so problem may arise when finding out fault that which of the components has some problem associated with it.

(3) Difficult to Handle by Layman: As cluster computing involves merging different or same components together with different programmability, so a non-professional person may find it difficult to manage [9].

IV GRID COMPUTING

Grid computing is the segregation of resources from multiple sites so as to solve a problem that can't be solved by using the processing of a single computer [7]. It employs use of multiple clusters that are loosely coupled, heterogeneous and are geographically dispersed [10]. Here individual user gets access to the resources (like processors, storage, data etc.) on demand with little or no knowledge of fact that where those resources are physically located. It is more commonly known

as a collection of servers that are bound together to attack a single problem[12]. Grid computing is concerned about sharing, collecting, hosting and providing services to various consumers[7].

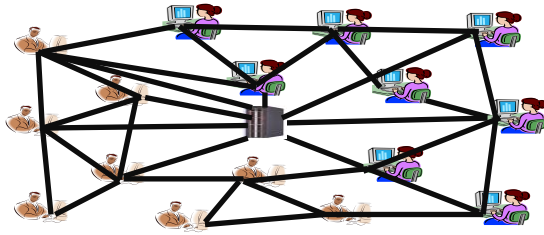


Fig.1.4 Concept of Grid Computing

Here Fig. 1.4 shows the general concept of grid computing which shows that various resources are segregated from across the world or geographically dispersed location towards a central location i.e. the grid system.

A Advantages of Grid Computing

- (1) Access to Additional Resources: In addition to CPU and other storage resources, a grid can also provide other resources as well[8].
- (2) Resource Balancing: A grid incorporates large number of systems into a single system image. For applications that are grid enabled, grid performs the resource balancing by scheduling grid jobs on machines that are showing low utilization.
- (3) Reliability: The systems in grid are cheap and geographically dispersed. If, for example, there is power or cooling failure at one site, then that will not affect the other site, thus high reliability will be there specially in case of real time systems[11].

B. Disadvantages of Grid Computing

- (1) Not Stable: Grid software and standards are not stable in comparison to other computing. Its standards are still evolving [13]
- (2) High Internet Connection Required: Collecting various resources from geographically dispersed sites require high internet connection which results in high monetary cost.
- (3) Different Administrator Domains: Sometimes political issues arise when sharing resources among different domains. Some additional tools are required for having proper syncing and managing among different environments like cfengine, opsware etc.

V. COMPARISON BETWEEN GRID, CLUSTER AND CLOUD COMPUTING

Table 1 shows the comparative performance analysis between cluster, grid, and cloud computing [15].

VI CONCLUSION

The variation between grid and cluster computing on the one hand and cloud computing on the other are attributable to the system dynamics. Resources in grid and cluster environments are normally pre-reserved, while cloud computing systems are dependent on the user needs. Service usage only tends to be accurately measured in grid and cloud computing systems,

whereas the cluster environment simply provides elementary functions. Cloud computing is a new technology of computer network, providing the web services at lower cost comparing to normal technique. It contributes to improve the services in other related technologies such as Grid Computing, Cluster Computing and Utility Computing. Presently, the security in clouds is less than the model in Grid environment. In this project I highlighted the characteristics, advantages, and disadvantages and compared the features of cluster computing, grid computing and cloud computing.

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Table 1

FEATURES	CLUSTER COMPUTING	GRID COMPUTING	CLOUD COMPUTING
Characteristics	Tightly coupled systems, Single system image, Centralized Job management & scheduling system	1: Loosely coupled (Decentralization) 2: Diversity and Dynamism 3: Distributed Job Management & scheduling	Dynamic computing infrastructure, IT service-centric approach, Self-service based usage model, Minimally or self-managed platform, Consumption-based billing
Physical Structure	In cluster computing, a bunch of similar/identical computers are hooked up locally (in the same physical location, directly connected with very high speed connections) to operate as a single computer	In grid computing, the computers do not have to be in the same physical location and can be operated independently. As far as other computers are concerned each computer on the grid is a distinct computer.	In cloud computing, the computers need not to be in the same physical location.
Hardware	The cluster computers all have the same hardware and OS.	The computers that are part of a grid can run different operating systems and have different hardware	The memory, storage device and network communication are managed by the operating system of the basic physical cloud units. Open source Software such as LINUX can support the basic physical unit management and virtualization computing.
Resources	The whole system (all nodes) behaves like a single system view and resources are managed by centralized resource manager.	Every node is autonomous i.e. it has its own resource manager and behaves like an independent entity	Every node acts as an independent entity
Application	1. Educational resources 2. Commercial sectors for industrial promotion 3. Medical research	1. Predictive Modeling and Simulations 2. Engineering Design and Automation 3. Energy Resources Exploration 4. Medical, Military and Basic Research 5. Visualization	1. Banking 2. Insurance 3. Weather Forecasting 4. Space Exploration 5. Software as a service 6. PaaS 7. Infrastructure- as -a-Service
Networking	Dedicated, high-end with low latency and high bandwidth Interconnection Network	Mostly Internet with high latency and low Bandwidth Interconnection Network	Dedicated, high-end with low latency and high Bandwidth Interconnection Network
Scalability	Size or scalability is 100s	Size or scalability is 1000s	Size or scalability is 100s to 1000s