# EMPOWERING HIGH PERFORMANCE COMPUTING OVER CLOUD, CLUSTER & GRID COMPUTING IN NETWORK"

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**Abstract**

*With the noteworthy growth in computing and networking technologies over the last decade, there is an increasingly possibility that computing will be key area in information and communication technologies over network. To enhance the efficiency of any job, the system would require high computing environment for data fetching and processing along with low cost and flexibilities for client. There is major inclination of small scale organization for their own manipulation and investigation of data which leads to decrease the cost of the production and improve services and many more, if it performed at the side of organization. However such small scale organizations would not in the condition to give the high and computing intensive environment for their own data analysis. In this condition, cloud, cluster and grid plays a vital role to provide collective computer processing infrastructure and resources for their operations to compute adequately huge amount of operations consequently. High performance computing plays a vital role over the network performance through cloud, cluster and grid computing. In order to achieve a high performance network, we need to scrutinize and explore the various characteristic of Cloud, Grid and cluster computing. In this paper, intensive analysis of architecture and behaviour of all these three type of computing which lead to suggest the development area of high performance computing that enhance the network efficiently of the end user and services. Author is confident through this paper that Cloud, Grid and cluster computing play a key to empower HPC over network.*

***Key Words:*** *Cluster Computing, High Performance Computing, Cloud Computing, Grid Computing, network.*

## 1. INTRODUCTION

Due to fast development and advancement of communication over network, processing and data storage technologies have become rapid decreases in cost and much more significant as compared to prior. These changes give a way to some new computing model which is glowing known as cloud computing. To understand the cloud computing concept, it may highly recommend narrating the two major extensively used architectures: Cluster Computing and Grid computing.

In network, Cloud is distributed and parallel system which comprises of a wide network of interrelated host which are dynamically allocate with one or more computing resources like computing power and memory. Basically the behaviour of cloud to be seems the mixer of grids and clusters. On the other hand, Grid is just similar like cloud but it allow the selection and sharing of independent distributed resources dynamically at run time keep in in the view of potential, availability, performance, cost and end users service requirements[1]. While, cluster is a also similar to the cloud structure that comprises of a bunch of interrelated individual workstation which are working together to give an image of single integrated computing resource.

Hence, in the way , we can say that Cloud Computing acquire features of both grids and clusters along with its own special capabilities like dynamically composed services, virtualization, application services and storage. Therefore clouds assure to provide required services without indication to the infrastructure on which they are hosted.

The paper basically focuses on the various factors that would provide high performance computing environment in distributed systems. High performance computing is closely defined as the

expansion and employ of the fastest and most powerful computing systems i.e., prospective computing. It combines technological, economic and political features of the computing enterprise. The major findings and recommendations to empower HPC over cloud, grid and cluster have been summarized in the later sections of the paper.

## I. CLOUD COMPUTING

In current Scenario, Cloud computing is one of the most emerging present inclination in the field of information and communications technology. Through this concept, user use the internet to maintain the data and application kept on remote system or servers. Cloud computing permits customers and businesses to use applications without installation in their own system. It also gives a way to access their personal files from remote system at any remote computer with internet facility. The key importance of cloud computing technology is allows to provide much more efficient computing by providing centralizing storage, bandwidth, memory and processing power. Cloud computing services are widely used by organizations, companies and consumers to get their required services. 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.

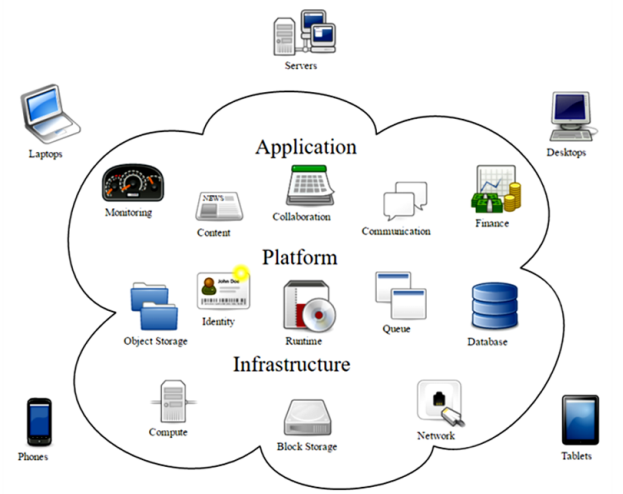


**Fig. 1 : Layout of Cloud Structure [1]**

In the given above Figure 1 which shows that how users may associate and connect to the cloud to acquiring the various services offered by the various service provider across the globe through any machine over internet. Scalable storage resources, computing power and high speed network are core part of infrastructure in cloud concept [4]. It also provides an environment for virtualized infrastructure to make available such required services to end users over internet.

Broadly, Cloud computing concept is divided into three major sections like application, connectivity, and storage. Each section supplies a different function and offers different service or individuals and businesses across the globe.

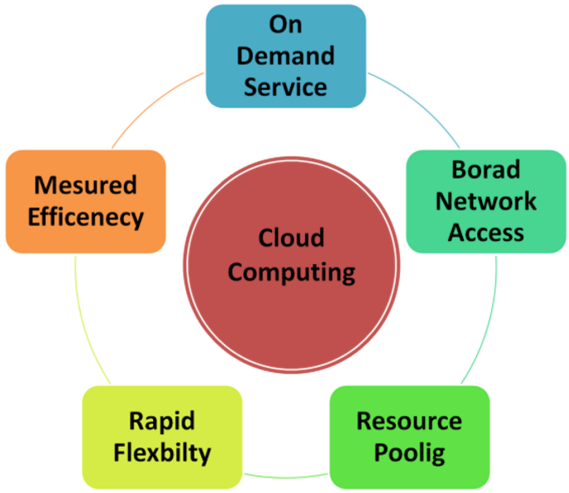


**Fig 2: The Broad features of Cloud Computing**

Some major necessary features of cloud computing are justified and briefly highlighted as below[6];

- On demand self services: Such host services like application, chat, email, server service and network may be provided and exchange with each service provider without the required of human interaction.
- Broad network access: Cloud services are available anywhere, anytime through standard Internet-enabled devices.
- Rapid Flexibility: It allows cloud to enlarge and reduce allocated resources rapidly and economically to meet the desired requirements. But in some cases , resources allocation might be done automatically.
- Calculated (Measured) Efficiency: this is one

of the key features where usages of Cloud computing resource may be calculated, controlled and manage to provide transparency to contributor and consumer of the utilized services. So that such services may charges as per the usage metrics like pay as per consumption. Its mean more utilization of services, lead to more payment of such services.

## I. CLUSTER COMPUTING

When a number of node are comprised together to run as a single entity, known as cluster of node and perform the computation with the help of such node in cluster know as cluster computing. The varieties of nodes implicated in clusters are usually connected to each other by using some fast local area networks. Performance and fault tolerance are mainly two causes of arranging a cluster instead of a single computer. In the real time application case, application needs high computation in terms of memory, response time and throughput. Cluster Computing is the best to provide high computation by employing parallel programming concept where many processors simultaneously execute more number of sub job of a single problem[5]. The second cause is fault tolerance which is really the capability of a system to operate gracefully even in the presence of bug or fault. In the clusters, nodes are the replicas of similar components and the fault in one component may only affects the cluster's power but not its availability. Therefore users always have some mechanism to do some work, even in the presence of fault.

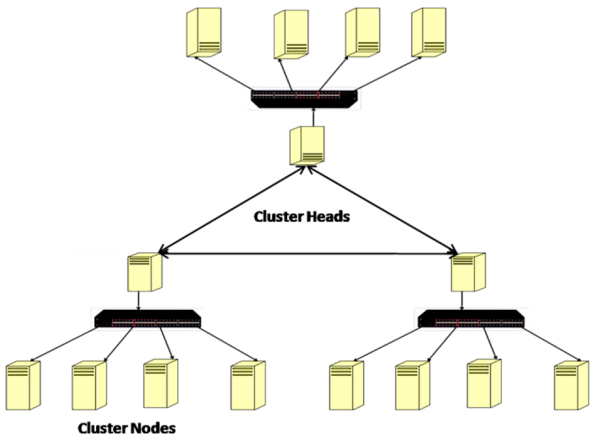


**Figure 3 : Layout of Various Nodes in Cluster Computing**

In the above figure 3, it illustrates the broad concept of cluster computing where the many individual many nodes combine together to give a single image of interface/node to the user. The key advantages of cloud computing are well justified and presented below, which are as;

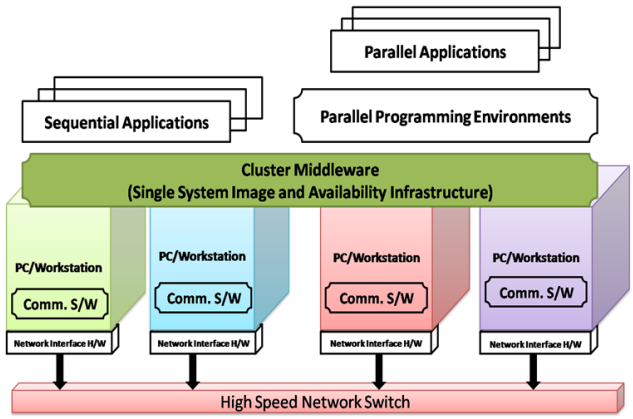


**Fig. 4: Broad Sketch of Nodes in Cluster Architecture**

- Manageability: To manage a large number of independent components required huge efforts in the terms of cost and time but with cluster concept. It would be very effective and easy to manage a large numbers of components by combining their work as single entity. Hence cluster node management becomes very easy.
- Single System Image: Yet again with cluster, users always get the sense that they are working with a individual system but in the reality, they are working with a large number of node. So users do not need to worry about separate node, but must be have a strong mechanism to manage all nodes in a single system image.
- High Availability: In cluster, all nodes are copy of each other's nodes. If any node goes down due any cause then the other nodes of cluster may take its task and carry on with the work of system.

## IV. GRID COMPUTING

The assembly of computer resources from distributed locations to achieve a common target of service, called grid computing. The grid may be thought of a loosely coupled (a large scale of distributed system) with multiple location workloads that involve a large number of computing

resources. Grid computing is different from conventional high performance computing systems like cluster and cloud computing. In High performance computing system, system has the tendency of compute intensive feature where the computer concentrates the throughput of computation. But in the grid computing, each node have their own set of work to perform a different task or application. Grid computers are an open source technology which tends to be more heterogeneous and physically distributed (thus not physically coupled) than cluster computers. Although a single grid can be dedicated to a particular application, commonly a grid is used for a variety of purposes where users can shared computing power and storage capacity form your host system. Grids are basically comprised with general-purpose grid middleware, grid tools, grid fabric and software libraries as shown in figure 6.[2]

The size of grid have a considerable amount to form of distributed computing where super virtual computer is composed of numerous networked loosely coupled computers working collectively to execute huge tasks. For some important applications, grid or distributed computing may seen as a particular type of parallel computing system. Such complete computers with committed CPUs, power supplies, storage network interfaces etc. connected to a network of private, public or the Internet through conventional network interface card like as Ethernet card. This is in contrast with the traditional concept of a supercomputer which has many processors that are closely connected by a local high-speed communication bus.

Grid computing is allocated the distributed resources of many computers to a single problem in a network. Grid computing may play significant role when hen scientific or technical problem requires a huge number of computer processing power or access to large amounts of data toward any particular task[3]. One of the key features of grid system is the capability to make available the high-level quality of service essential for user satisfaction or experience. Thus, QoS justification must be incorporated as a fundamental characteristic of any grid system as calculated by the existing resource pool. These resources pool include performance monitoring, response time, security, memory utilization measurements, monitoring, resource scalability, availability, autonomic features, fault detection mechanisms and network communication services. At this point, individual users have right to access available resources such as processors, memory, application, data and other component on the requirement basis in real time manner without knowing any detail of physically location of such resources.

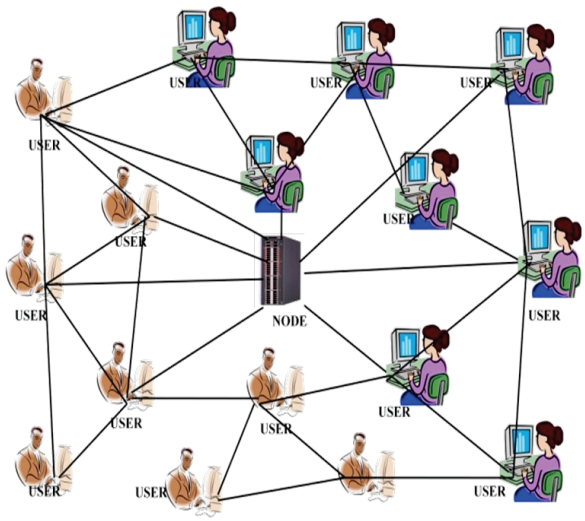


**Figure 5. User Node in Grid Computing Concept**

The well-known five big facts of Grid Computing are define below which play key role to provide an environment for high performance computing are usability of resource, secure access, resource sharing, low importance of distance and open standards of application.

There are many other popular features and properties that are considerably essential by a grid to provide facility to users with a computing atmosphere by providing the support of following key particulars. They are as given as:

- **Heterogeneity:** The grid comprised with various types of resources which are different in feature and type. Such resource may cover a large geological distance via a variety of domains.
- **Scalability:** The architectural component of grid should design in such way, as shown in figure XX which may be capable to handle a

huge large number of nodes without the degradation in while computing any task.

- **Adaptability or Fault Tolerant:** the resource controller or manager of grid must be able to manages the fault or bug during computation like computational aborts, software faults, no hardware response etc which are high in nature.
- **Security:** The security of grid is one of the prime concerns where participating user and nodes must protected with high secured tool to avoid any attack, or any malicious manipulations.

## V. MAJOR COMPONENTS OF GRID ARCHITECTURE

As shown in the figure 6 the Computational architecture of grids is shown which has designed in such a way that provides the services to various distributed nodes or users with changing features and needs. Due to this, all grid architecture may not have a uniform single architecture because of verity of service nature. However, gernally, we can identify basic services which will make available to almost all the grids. But these different girds will adopt their own way for the availability of such services. Such explanation of grid architecture does not provide a absolute details of all the required protocols and offer services however it recognize the needs for general class of basic components of grid.

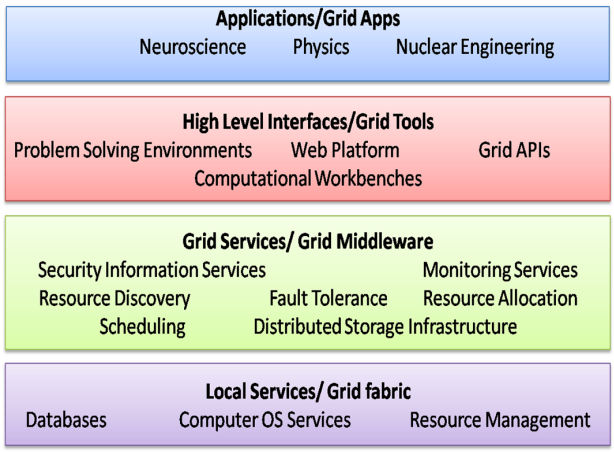


**Figure 6. Grid Components Architecture**

## I. SCOPES IN HIGH PERFORMANCE COMPUTING

Form the last few decades, the computing field emerge as one of the fast growing field of computing and technological revolution. Despite this, the long term evolution of performance seems to be stagnant. Massively Parallel Processor (MPP) systems are being accepted for engineering as well as for new commercial applications. At the onset of 1990s, Massively Parallel Processor systems entered into the market claiming vector multiprocessors as pushovers[10].

As per the Top 500 list of supercomputing computer which make available a more reliable information on high performance computers [9], in June 1993 declared that 156 MPP systems were employed already. Based on the present Top500 data and statement that the current speed of performance enchantment would remain continue in future on a fast pace. We can imagine and do some experiential conduct and analyze such values with the intention of various imitative and development programs to enhance the power of computing and communications. Presently some initiative to provide the performance to Petaflops to exaflops computing power. Considering that in 2005, no small system made it to get the place in the Top500 ranking of supercomputer. First PetaFlop/s were available around 2009 and rapid changes were adopted in technology used in high performance computing devices and concept. To gain the high level computing power in system which may be have the following characteristic as shown the in below figure 7.


**Figure 7: Various parameter of High performance computing**

**VII. COMPARISON BETWEEN GRID, CLUSTER AND CLOUD COMPUTING:** The details comparative analysis of cloud, cluster and grid computing has been examine on the various parameters, which is highlighted below[7][8][11];

| S. NO. | Fact points | Cloud | Cluster | Grid |
|---|---|---|---|---|
| 1. | **Network Type** | Public Internet/ Ethernet Based | Private IP or Proprietary Based | Private Ethernate Based |
| 2. | **Size** | Small to Large | Small to Mediaum | Large |
| 3. | **Initial Cost Capital** | Low | Very High | High |
| 4. | **Security** | Low | Low nut typically High | High |
| 5. | **System type** | Bunch of VMs | Supercomputer | Fast Workstations |
| 6. | **Characteristics** | Distributed computing infrastructure Self-service, model, IT enable service approach, usage model, self manage platform, use based reporting or billing | 1:Tightly coupled systems<br>2: Single system image<br>3: Centralized Job management & scheduling system | 1: Loosely coupled (Decentralization)<br>2: Diversity and Dynamism<br>3: Distributed Job Management & scheduling |
| 7. | **Resources** | Every node acts as an independent entity | 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 |
| 8. | **Scalability** | Scalability node size varies from 100s to 1000s | Scalability node size is around 100s | Scalability node size is around 1000s |
| 9. | **Application** | 1.Banking<br>2.Insurance<br>3.Weather Forecasting | Educational resources<br>2.Commercial sectors for industrial promotion | 1.Predictive Modeling and Simulations |

## VIII. OUTLOOK SCENRIO OF DISTRIBUTED COMPUTING IN HPC:

Due to extensive requirement of power and speed for data centre is always prime requirement which leads to an added cost where one should not expect to increase the efficiency more than a required limit. Allocation of data centres in various places and use of nearest data centers is an always superior and a far more optimal choice in the term of data latency. It has been predicted that storage and computing on personal computers will be forgotten and transferred into distributed clouds. Therefore, architecture and evaluation of data centers should be performed for future of computing through suitable prediction. According to review and evaluation performed in the field of high performance computing, distributed computing through grid, cloud and cluster still has a shortage in performance assessment and required special measures for such work. It is better to consider delay and implement criteria in the estimate parameter of service level conformity. Because such agreements are mainly important for the developer /users who can present more precise evaluation in future by specifying type of users requests or specifying and distinguishing all users. High performance embedded computing (HPEC) systems are amongst the most challenging systems in the world to build[12]. The primary sources of these difficulties are the large number of constraints on an HPEC implementation:

- **Performance:** latency and throughput.
- **Efficiency:** processing, bandwidth, and memory.
- **Form Factor:** size, weight, and power.
- **Software Cost:** code size and portability.

Thus in future, we hope to achieve high performance distributed system by combining best features of grid, cluster and cloud computing as well as reconfigurable computing[11][13]. Besides the afore mentioned requirements, the emergence of Jungle Computing has given a boost to the field of Distributed Computing. It uses a system which is distributed, is highly diverse and provides computing at very high speeds. But the fact that it is highly non-uniform is viewed as a hindrance if not handled properly. There is an urgent need for easy and efficient Jungle Computing in scientific practice, by exploring a set of state-of-the-art application domains. Thus, the need of an hour is a system which not only combines the features of grid, cloud and cluster computing but goes beyond it to incorporate efficient jungle computing, thus providing an easier and faster system.

## 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[14].

We discussed origin of cluster, grid and cloud computing and studied their architecture, characteristic features and discussed their current applications and fields of implementation. Further we had an overview on trends of computing and glimpse of green sustainable computing as well as reconfigurable computing which allowed us to create intent of developing a high performance distributed system which would meet the aim of green sustainable computing and would combine best features of all the available computing models, especially the most popular ones as per trends in computing [13]. In the nutshell, we conclude that by extrapolating trends in high performance computing we draw the conclusions that parallel computing is the core mechanism by which computer performance can cope up with the predictions of Moore‟s law in the face of increasing influence of performance and the architecture of HPC will

continue to develop at quick rates. Thus, it would be increasingly important to find paths to motivate scalable parallel programming without compromising with transportability. Such a challenge could be defeated by evolution of software systems and algorithms that support portability besides relaxing burden of program design and implementation. Table 1 enable us to compare and achieve this high performance distributed system using grid, cluster and cloud computing.

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