



A Review of Computing Technologies: Distributed, Utility, Cluster, Grid and Cloud Computing

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Abstract: *Internet has been a driving force towards the various technologies that have been developed so far. As the use of high-speed broadband networks increases, a lot of changes have been observed in the field of computing. In computing, information and information services are managed. This paper discusses various types of computing technologies like distributed computing, cluster computing, utility computing, grid computing and cloud computing. All these technologies have actually contributed in the development of computing.*

Keywords: *Computing, distributed, utility, cluster, grid, cloud*

I. INTRODUCTION

Computing is the study of how computers and computer systems work and how they are constructed and programmed. Its primary aspects of theory, systems and applications are drawn from the disciplines of Technology, Design, Engineering, Mathematics, Physical Sciences and Social Sciences. The growing popularity of the Internet and the availability of powerful computers and high-speed networks as low-cost commodity components are changing the way we do computing. Through the 1990s to 2012 the internet changed the world of computing drastically. It started its journey with parallel computing after it advanced to distributed computing and further to grid computing. And in present scenario it creates a new world which is pronounced as a Cloud Computing. [1]

There are various types of computing technologies:

- 1) Distributed computing
- 2) Utility computing
- 3) Cluster computing
- 4) Grid computing
- 5) Cloud computing

II. DISTRIBUTED COMPUTING

It is a method of computer processing in which different parts of a program run simultaneously on two or more computers that are communicating with each other over a network. Distributed computing is a type of segmented or parallel computing, but the latter term is most commonly used to refer to processing in which different parts of a program run simultaneously on two or more processors that are part of the same computer. While both types of processing require that a program be segmented—divided into sections that can run simultaneously, distributed computing also requires that the division of the program take into account the different environments on which the different sections of the program will be running. For example, two computers are likely to have different file systems and different hardware components.

Distributed computing has been an essential component of scientific computing for decades. It consists of a set of processes that cooperate to achieve a common specific goal. It is widely recognized that Information and Communication Technologies (ICTs) have revolutionized the everyday practice. Social networks represent a stepping stone in the on-going process of using the Internet to enable the social manipulation of information and culture. Mostly social network sites are implemented on the concept of large distributed computing systems. These are running in centrally controlled data centers. [2]

Distributed computing faces many challenges:

A. Heterogeneity

It describes a system consisting of multiple distinct components. Heterogeneity applies to pretty much anything which is made up of many different items or objects. In many systems in order to overcome heterogeneity a software layer known as Middleware is often used to hide the differences amongst the components underlying layers.

B. Openness

It describes the property of each subsystem to be open for interaction with other systems. So once something has been published it cannot be taken back or reversed. Furthermore in open distributed systems there is often no central authority, as different systems may have their own intermediary.

C. Security

The issues surrounding security are those of confidentiality, integration and availability. To combat these issues encryption techniques such as those of cryptography can help but they are still not absolute. Denial of Service attacks can still occur, where a server or service is bombarded with false requests usually by botnets.

D. Scalability

A system is described scalable if as the system, number of resources, or users increase, the performance of the system is not lost and remains effective in accomplishing its goals. There are a number of important issues that arise as a result of increasing scalability, such as increase in cost and physical resources. It is also important to avoid performance bottlenecks by using caching and replication.

E. Fault Handling

Failures are inevitable in any system; some components may stop functioning while others continue running normally. So naturally we need a way to:

- 1) Detect Failures – Various mechanisms can be employed such as checksums.
- 2) Mask Failures – retransmit upon failure to receive acknowledgement
- 3) Recover from failures – if a server crashes roll back to previous state
- 4) Build Redundancy – Redundancy is the best way to deal with failures. It is achieved by replicating data so that if one sub system crashes another may still be able to provide the required information.

F. Concurrency

Concurrency issues arise when several clients attempt to request a shared resource at the same time. This is problematic as the outcome of any such data may depend on the execution order, and so synchronisation is required.

G. Transparency

A distributed system must be able to offer transparency to its users. As a user of a distributed system you do not care if we are using 20 or 100's of machines, so we hide this information, presenting the structure as a normal centralized system.

- 1) Access Transparency – where resources are accessed in a uniform manner regardless of location
- 2) Location Transparency – the physical location of a resource is hidden from the user
- 3) Failure Transparency – Always try and Hide failures from users.

III. UTILITY COMPUTING

Conventional Internet hosting services have the capability to quickly arrange for the rental of individual servers, for example to provision a bank of web servers to accommodate a sudden surge in traffic to a web site. Utility computing usually envisions some form of virtualization so that the amount of storage or computing power available is considerably larger than that of a single time-sharing computer. Multiple servers are used on the “back end” to make this possible. These might be a dedicated computer cluster specifically built for the purpose of being rented out, or even an under-utilized supercomputer.

Utility computing is one of the most popular IT service models, primarily because of the flexibility and economy it provides. This model is based on that used by conventional utilities such as telephone services, electricity and gas. The principle behind utility computing is simple. The consumer has access to a virtually unlimited supply of computing solutions over the Internet or a virtual private network, which can be sourced and used whenever it's required. The back-end infrastructure and computing resources management and delivery is governed by the provider.

Utility computing solutions can include virtual servers, virtual storage, virtual software, backup and most IT solutions. Cloud computing, grid computing and managed IT services are based on the concept of utility computing.

IV. CLUSTER COMPUTING

A computer cluster is a group of linked computers, working together closely so that in many respects they form a single computer. The components of a cluster are commonly, but not always, connected to each other through fast local area networks.

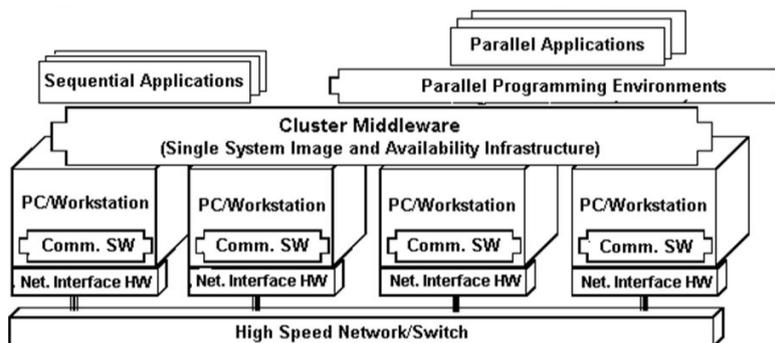


Fig. 1 A cluster computer architecture

Clusters are usually deployed to improve performance and/or availability over that provided by a single computer, while typically being much more cost-effective than single computers of comparable speed or availability. The components of a cluster are connected to each other through fast local area networks. To handle heavy workload with large datasets, clustered computer systems have demonstrated impressive results in the past. [2].

The architecture of the cluster computing environment is shown in the Fig. 1.
Clusters can be classified into three parts:

A. High Availability Clusters

High availability clusters (also known as HA clusters or failover clusters) are groups of computers that support server applications that can be reliably utilized with a minimum of down-time. They operate by harnessing redundant computers in groups or clusters that provide continued service when system components fail. Without clustering, if a server running a particular application crashes, the application will be unavailable until the crashed server is fixed.

HA clustering remedies this situation by detecting hardware/software faults, and immediately restarting the application on another system without requiring administrative intervention, a process known as failover. As part of this process, clustering software may configure the node before starting the application on it. For example, appropriate file systems may need to be imported and mounted, network hardware may have to be configured, and some supporting applications may need to be running as well.

B. Load Balancing Clusters

Load balancing is dividing the amount of work that a computer has to do between two or more computers so that more work gets done in the same amount of time and, in general, all users get served faster. Load balancing can be implemented with hardware, software, or a combination of both. Typically, load balancing is the main reason for computer server clustering. On the Internet, companies whose Web sites get a great deal of traffic usually use load balancing. For load balancing Web traffic, there are several approaches. For Web serving, one approach is to route each request in turn to a different server host address in a domain name system (DNS) table, round-robin fashion. Usually, if two servers are used to balance a work load, a third server is needed to determine which server to assign the work to. Since load balancing requires multiple servers, it is usually combined with failover and backup services. In some approaches, the servers are distributed over different geographic locations.

C. High Performance Cluster Computing

High Performance Cluster Computing (HPCC) stores and processes large quantities of data, processing billions of records per second using massive parallel processing technology. Large amounts of data across disparate data sources can be accessed, analyzed and manipulated in fractions of seconds. HPCC functions as both a processing and a distributed data storage environment, capable of analyzing terabytes of information.

V. GRID COMPUTING

Grid computing is a processor architecture that combines computer resources from various domains to reach a main objective. In grid computing, the computers on the network can work on a task together, thus functioning as a supercomputer.

Typically, a grid works on various tasks within a network, but it is also capable of working on specialized applications. It is designed to solve problems that are too big for a supercomputer while maintaining the flexibility to process numerous smaller problems. Computing grids deliver a multiuser infrastructure that accommodates the discontinuous demands of large information processing. A grid is connected by parallel nodes that form a computer cluster, which runs on an operating system, Linux or free software. The cluster can vary in size from a small work station to several networks. The technology is applied to a wide range of applications, such as mathematical, scientific or educational tasks through several computing resources. It is often used in structural analysis, Web services such as ATM banking, back-office infrastructures, and scientific or marketing research.

Grid computing is made up of applications used for computational computer problems that are connected in a parallel networking environment. It connects each PC and combines information to form one application that is computation-intensive. Grids have a variety of resources based on diverse software and hardware structures, computer languages, and frameworks, either in a network or by using open standards with specific guidelines to achieve a common goal.

Grid operations are generally classified into two categories:

A. Data Grid

A system that handles large distributed data sets used for data management and controlled user sharing. It creates virtual environments that support dispersed and organized research. The Southern California Earthquake Center is an example of a data grid; it uses a middle software system that creates a digital library, a dispersed file system and continuing archive.

B. CPU Scavenging Grids

A cycle-scavenging system that moves projects from one PC to another as needed. A familiar CPU scavenging grid is the search for extraterrestrial intelligence computation, which includes more than three million computers.

VI. CLOUD COMPUTING

Cloud computing is a type of computing that relies on sharing computing resources rather than having local servers or personal devices to handle applications. In cloud computing, the word cloud (also phrased as "the cloud") is used as a metaphor for "the Internet," so the phrase cloud computing means "a type of Internet-based computing," where different services — such as servers, storage and applications — are delivered to an organization's computers and devices through the Internet. Cloud computing is comparable to grid computing, a type of computing where unused processing cycles of all computers in a network are harnessed to solve problems too intensive for any stand-alone machine.

A. Types of cloud computing

Cloud computing is typically classified in two ways:

- 1) Location of the cloud computing
- 2) Type of services offered

B. Classification based on the location of the cloud

Cloud computing is typically classified in the following three ways:

- 1) **Public cloud:** In Public cloud the computing infrastructure is hosted by the cloud vendor. The customer has no visibility and control over where the computing infrastructure is hosted. The computing infrastructure is shared between any organizations.
- 2) **Private cloud:** The computing infrastructure is dedicated to a particular organization and not shared with other organizations. Some experts consider that private clouds are not real examples of cloud computing. Private clouds are more expensive and more secure when compared to public clouds. Private clouds are of two types: On-premise private clouds and externally hosted private clouds. Externally hosted private clouds are also exclusively used by one organization, but are hosted by a third party specializing in cloud infrastructure. Externally hosted private clouds are cheaper than On-premise private clouds.
- 3) **Hybrid cloud** Organizations may host critical applications on private clouds and applications with relatively less security concerns on the public cloud. The usage of both private and public clouds together is called hybrid cloud. A related term is Cloud Bursting. In Cloud bursting organization use their own computing infrastructure for normal usage, but access the cloud using services like Salesforce cloud computing for high/peak load requirements. This ensures that a sudden increase in computing requirement is handled gracefully.
- 4) **Community cloud** involves sharing of computing infrastructure in between organizations of the same community. For example all Government organizations within the state of California may share computing infrastructure on the cloud to manage data related to citizens residing in California.

C. Classification based upon service provided

Based upon the services offered, clouds are classified in the following ways:

- 1) **Infrastructure as a service (IaaS):** It involves offering hardware related services using the principles of cloud computing. These could include some kind of storage services (database or disk storage) or virtual servers. Leading vendors that provide Infrastructure as a service are Amazon EC2, Amazon S3, Rackspace Cloud Servers and Flexiscale.
- 2) **Platform as a Service (PaaS):** It involves offering a development platform on the cloud. Platforms provided by different vendors are typically not compatible. Typical players in PaaS are Google Application Engine, Microsofts Azure.
- 3) **Software as a service (SaaS):** It includes a complete software offering on the cloud. Users can access a software application hosted by the cloud vendor on pay-per-use basis. This is a well-established sector. The pioneer in this field has been Salesforce.coms offering in the online Customer Relationship Management (CRM) space. Other examples are online email providers like Googles gmail and Microsofts hotmail, Google docs and Microsofts online version of office called BPOS (Business Productivity Online Standard Suite).

VII. CONCLUSION

In this paper, various computing technologies like distributed computing, utility computing, cluster computing, grid computing and cloud computing has been discussed. Distributed computing is a type of parallel computing in which different parts of a program run simultaneously. Social networking sites are based on distributed computing.

Utility computing forms the basis of grid and cloud computing by using the concept of virtualization. Cluster computing on the other hand are deployed to handle heavy workload by linking a group of computers to make a single computer. Cloud computing is a new technology computing technique that improves the services of other computing technologies and is becoming more popular due to its lower cost services.

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