Distributed System:

System with multiple components located on different machines that communicate and coordinate actions in order to appear as a single coherent system to the end user.

features

- No shared memory
- Message based communication
- Each host runs its own local OS
- Heterogeneity

Centralised System.

- One component with Non-autonomous parts.
- Components shared by users all the time
- All resources ~~distribute~~ accessible.
- Software runs in a single process.
- Single point of control and failure.

Q. Differentiate b/w centralised and distributed systems.

Distributed System Characteristics (SEAM)

- Presents a single system image.
  - → hide internal organization.
  - → provide uniform interface.
- Easily expandable.
- Continuous availabilty.
  failures in one component can be covered by other
- Supported by Middle ware.

Advantages of Distributed System.

1. Speed - can implement parallel processing (where goal is to achieve maximum speed on single problem) at very high speeds.
2. Inherent distribution - Suitable for inherently distributed applications like, banking, airline, reservation.
3. Reliability - There is no single point of control which implies there is no single point of failure.
4. Incremental Growth - Allows for easy scalability by allowing gradual expansion as the need arises.

Disadvantages of Distributed System.

1. Software for distributed systems are difficult to develop.
2. Control is distribution.
3. There may be network related issues like saturation and lossy transmission.
4. As resources are easily accessible security is at stake.
5. Faults are hard to detect.
6. Administration issues.

Cluster Computing
Group of linked

Cloud Computing Cluster computing
group of linked computers, working together closely to achieve a single task.
- components are usually connected through a fast area Network.

advantage
- Improved performance & availability
- cost effective

Architecture
1. Nodes (master + computing)
2. Network.
3. OS.
4. Cluster middleware: permits compute clustering program to be portable to a wide variety of clusters.

When a large problem or set of data is given to a cluster, the master computer first runs a program that breaks the problem into small discrete pieces. and sends a piece to each node to compute. As nodes finish their tasks, the master computer continually sends more pieces to them until the entire problem has been computed.

Types of cluster computing

a) High availability and failover clusters (HA):
- nodes are built to uninterrupted availability of services and resources by the use of implicit redundancy of the system.
- If a node fails, applications or services may be available in another node.
- used to cluster database of critical missions, mail, file.

b) Load balancing (LB)
- distributes incoming traffic or requests from nodes that run the same programs between machines that make up the cluster.
- if a node fails, the requests are redistributed among the nodes available.
- used for web servers

c) HA & LB combination
- increased availability and scalability of services and resources
- used in web, email, news or ftp servers

Advantages -
- increased speed - better performance
- optimized resources utilization
- can execute large applications.

Disadvantages
- Complex programming models
- difficult for debugging & development

GRID COMPUTING

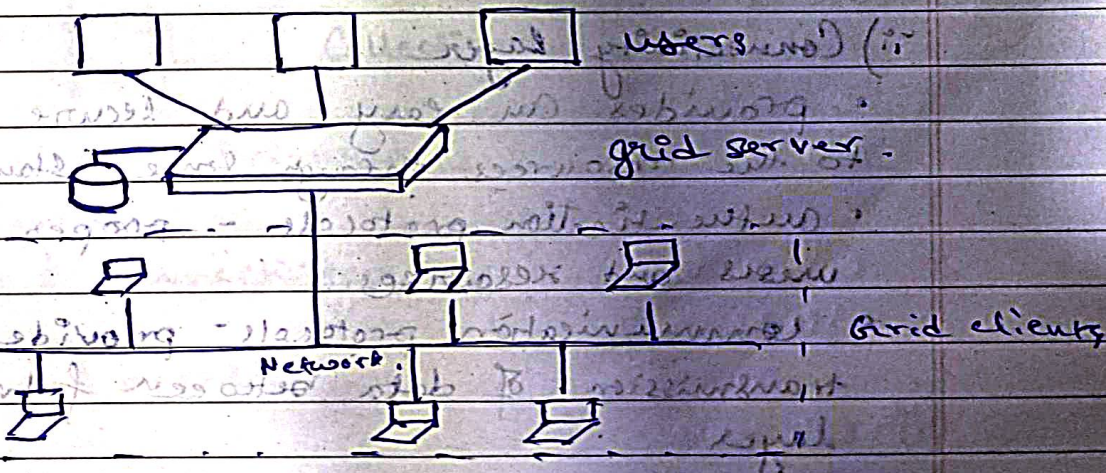
It is a coordinated resource sharing and problem solving in multi institutional virtual organizations.

- Grid computing uses middleware to coordinate distinct IT resources over the network allowing them to function and work as a virtual whole.
- provides remote access to IT distributed and aggregating processing power.
- provides a series of distributed computing resources via LAN and WAN to the terminal users application as if the is using a virtual supercomp

How Grid computing works?

Grid computing system requires

1. Grid server that handles administrative duties for the system
2. Network of computers running special grid computing network software.
3. Collection of computer software called middleware



Grid middleware

It is a software/networking protocol used for controlling the network and its resources.

It is responsible for administering that network.

The control nodes are merely executors.

It authorizes any process that is being executed on the network. It ensures no unwanted task is being executed on the network.

Layers of Grid Computing

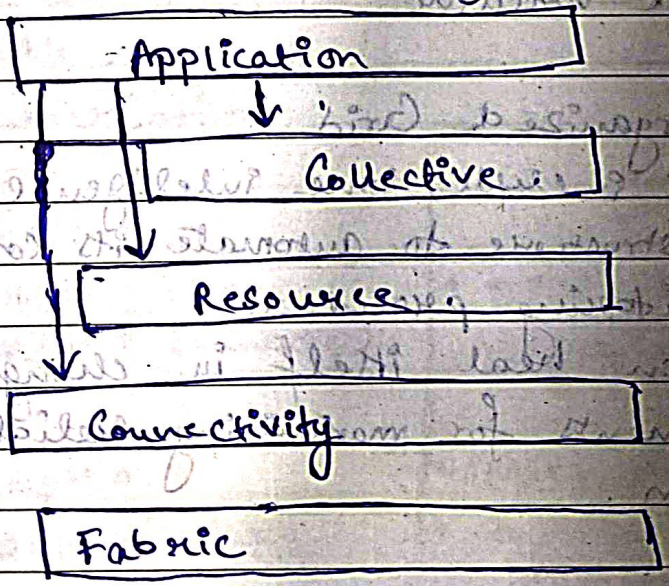
i) Fabric layer
- it comprises distributed and shareable resources such as storage devices, computing devices, high bandwidth networks and scientific instruments
- these resources are accessible from anywhere in the internet

ii) Connectivity layer
- provides an easy and secure access to resources to the resources through some standardised protocols
- authentication protocols - proper verification of users and resources.
- communication protocols - provide mechanism for transmission of data between fabric and resource layers

iii) Resource layer
- It specifies the protocols necessary to operate on the shared resources.
- It is built upon connectivity layer.
- defines APIs and SDK to secure the initiation, accounting, negotiation, controlling and monitoring of resources

iv) Collective layer
- used for common functionalities utilities
- provides services like brokering, monitoring, scheduling discovery, replication, coallocation, etc.
- Collaboration among shared resources are done in this layer.

v) Application layer
- offers communication interfaces to the users and administrators for interacting with the grid.



Based on functionality Grid Systems can be of 5 types.

i) Compute intensive Grid.
- offers powerful CPU resources.
- other characteristics are trivial.
- aims to provide aggregated CPU cycles of several resources for fulfilling computational need of a particular application.

ii) Data Intensive Grid.
- offer large storage space for data discovery, management and processing.

iii) Utility Grid.
- pools dynamically available resources to match the requirements of the application enabling the grid to provide services that cannot be provided by a single machine.

iv) Self Organized Grid.
- these include some intelligence embedded into its infrastructure to automate its control, organization and monitoring procedures.
- it can heal itself in changing and uncertain environments for maximizing reliability and resource utilisation.

v) Real time Grid.
- support real time application such as disaster management, healthcare, elearning, etc.
- can deal with real time interaction b/w user and apps

Grid Computing examples (Read Slide 35-36)

Mobile Computing

Mobile computing is a technology that allows transmission of data, voice and video via a computer or any other wireless enabled device without having to be connected to a fixed physical link.

Cloud Computing

It refers to manipulating, configuring and accessing the applications online. It offers online data storage, infrastructure and applications.

- hides complexity and details of underlying infrastructure from users and applications by providing simple GUI or API.
- provides on demand services
- easily scalable
- pay for subscriptions

Cluster	Cloud
• Smaller scanning area	• more wide scale and geographically distributed
• group of computers connected by LAN	
• tightly coupled	• loosely coupled.
• machines have similar hardware	• machines may have very different hardware configs.
• load is distributed among all nodes in cluster	• resources are allocated as per request. Whole data center is not occupied by one job

Deployment Models.

These define the type of access to the cloud.

1. public cloud: allows systems and services to be easily available to general public. Less secure.
2. Private Cloud: allows systems and services to be accessible within an organization. Increased security.
3. Community Cloud: allows systems and services to be accessible by group of organizations
4. Hybrid cloud: Mix of private and public cloud. Critical activities performed using private cloud while non-critical activities using public cloud

Service Models

1. Infrastructure as a service (IAAS) provide access to fundamental resources such as physical machine, virtual machine, virtual storage, etc.
2. Platform as a Service (PaaS) provides runtime environment for apps, deployment & deployment tools.
3. Software as a Service (SaaS) allows to use software applications as a service