Cluster, Grid, Cloud – Concepts

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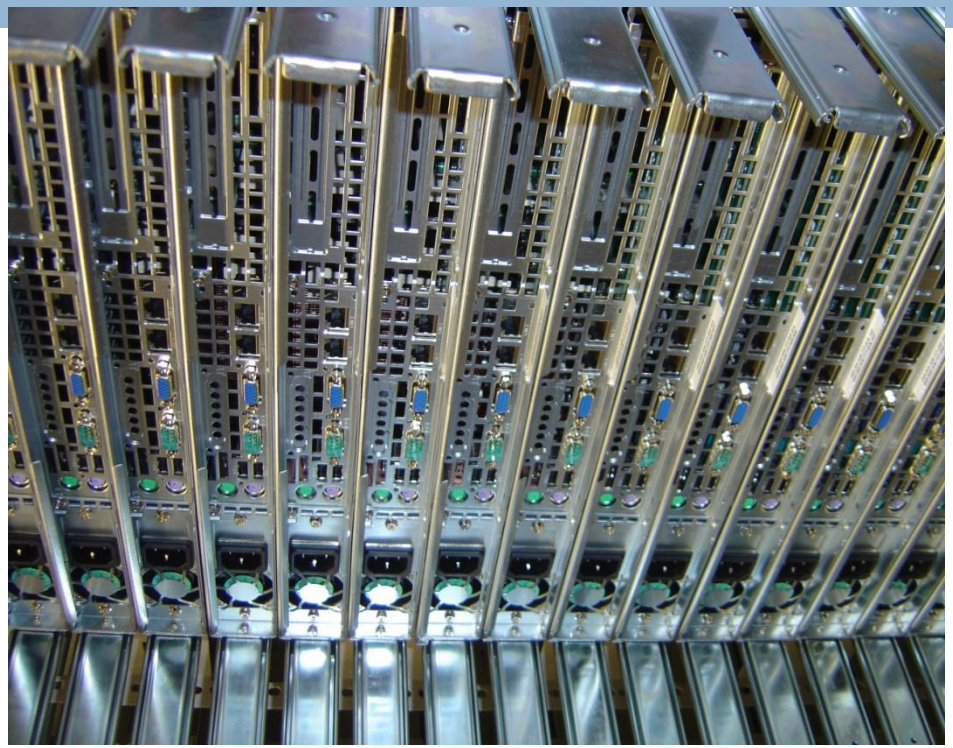
Cluster

- An Overview
- Need for a Cluster
- Cluster categorizations

What is a Cluster?

- A **computer cluster** is a group of linked computers, working together closely thus in many respects forming a single computer.
- The components of a cluster are connected to each other through fast local area networks



Need for a Cluster

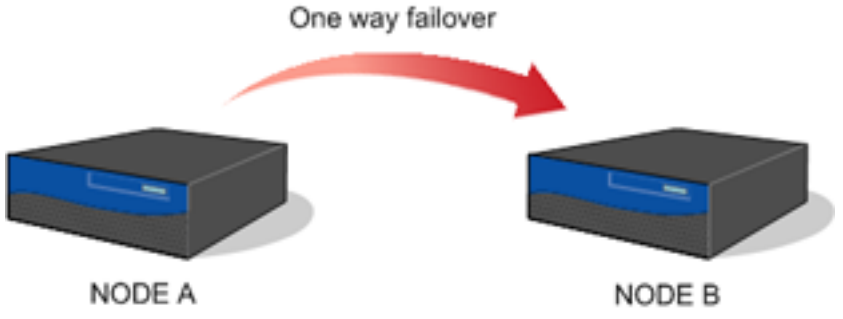
- Requirements for computing increasing fast.
  - More data to process.
  - More compute intensive algorithms available.
- Approaches to supply demand
  - Qualitative: Optimized algorithms, faster processors, more memory.
  - Quantitative: Cluster computing, grid computing, etc.

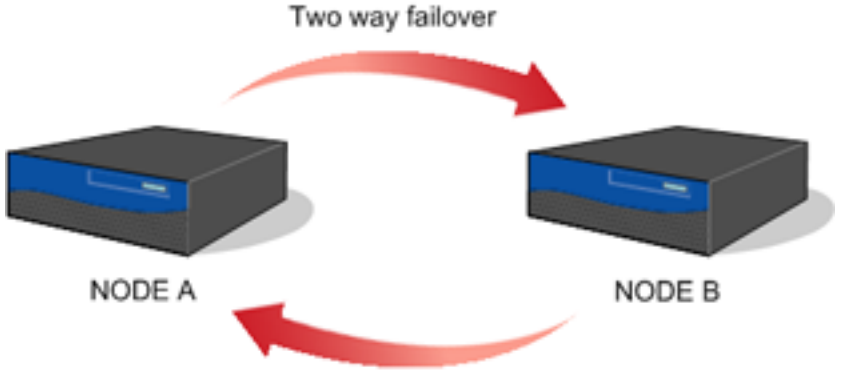
Cluster categorizations

- High Availability Cluster
- Load Balancing Cluster
- HPC Cluster

High Availability Clusters

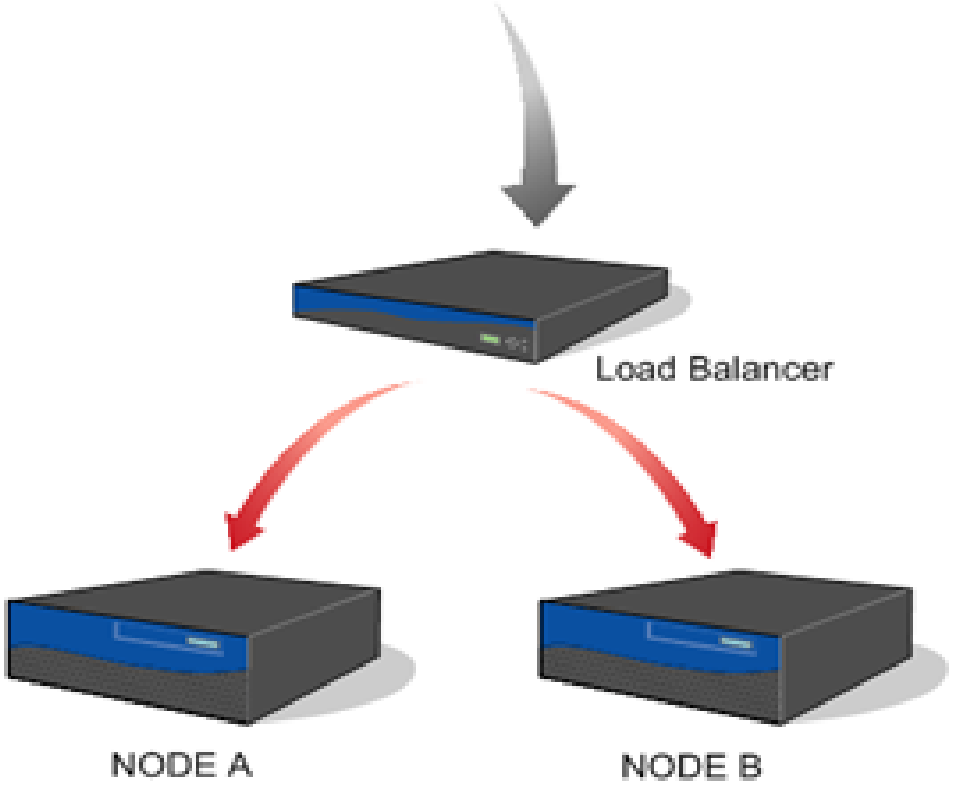
- Failover Clusters, mainly implemented to improve the availability of service that cluster provides
- They operates by having redundant nodes, upon failure the standby node take cares
- Types of High availability clusters: one way & two way
- Often used for critical databases, network file sharing and business applications





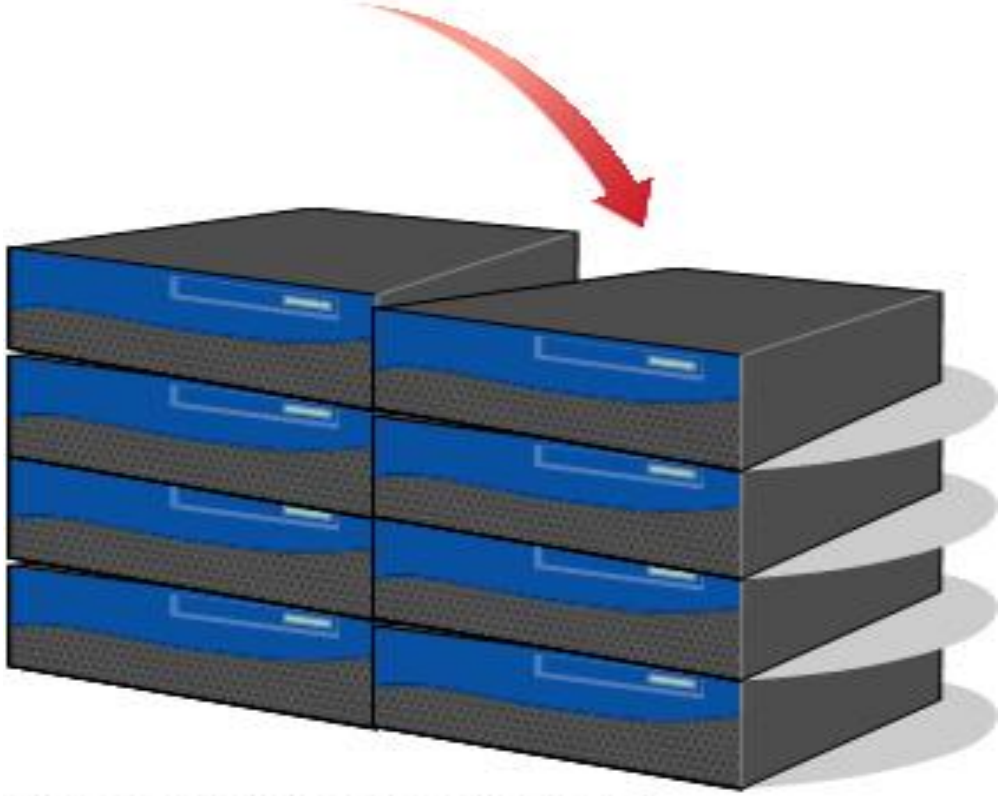
Load Balancing Clusters

- Multiple computers connected together to share computational workload
- Logically they are multiple computers but function as single virtual computer
- Request initiated from the user is distributed among all the nodes by one or more load balancer



HPC Clusters

- HPC clusters are mainly used to increases the performance by splitting the computational task into different nodes
- Mainly used in scientific computing
- Popular HPC cluster implementations are nodes running with linux os and free software's to implement the parallelism



All Node compute as one

Contd….

- The job running on the cluster nodes requires little or no inter nodes communication is called “Grid Computing”
- The local Scheduling software manages the cluster nodes load balancing
- Middleware such as MPI (Message Passing Interface) or PVM (Parallel Virtual Machine) permits compute clustering programs to be portable to a wide variety of clusters

Grid

- What is Grid?
- Why Grid?
- Grid Architecture
- Virtual Organization
- Grid Middleware's & It's Functionalities
- Grid Applications

What is Grid?

Definition: ***Grid computing*** *is a term referring to the combination of computer resources from multiple administrative domains to reach a common goal.*

- ✓ Coordinates resources that are not subject to centralized control
- ✓ Uses standard, open, general-purpose protocols and interfaces
- ✓ Delivers nontrivial qualities of service

Why Grid?

- Large-scale science and engineering are done through the interaction of people, heterogeneous computing resources, information systems, and instruments, all of which are geographically and organizationally dispersed.

- The overall motivation for "Grids" is to facilitate the routine interactions of these resources in order to support large-scale science and Engineering.

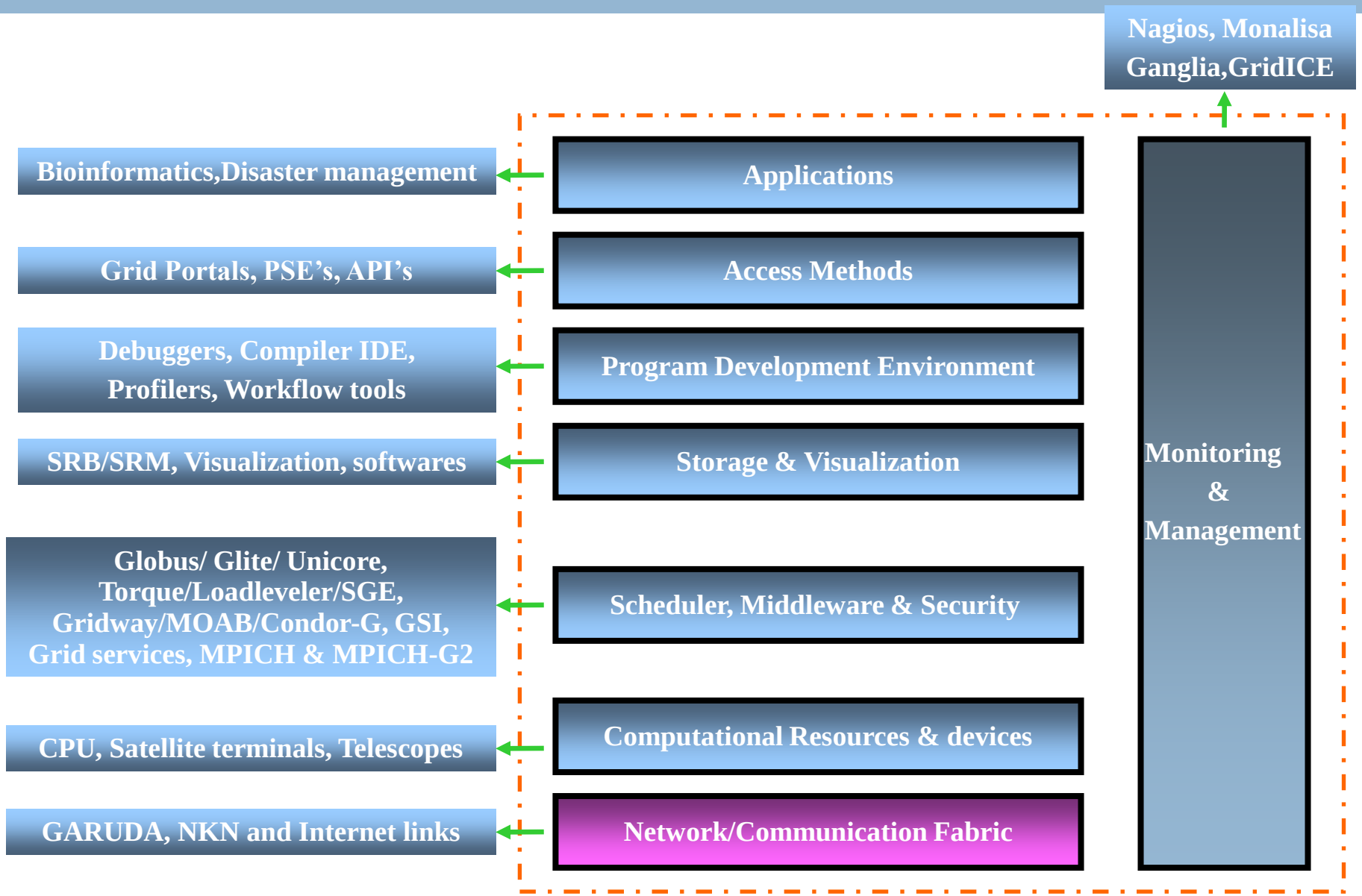
Virtual Organization

- **Virtual Organization** (VO) refers to a dynamic set of individual and/or institutions defined around a set of resource-sharing rules and conditions
- Multiple organizations that function as one unit through the use of their shared competencies and resources for the purpose of one or more identified goals

Example:

- LHC :1800 Physicists, 150 Institutes, 32 Countries
  100 PB of data by 2010; 50,000 CPUs

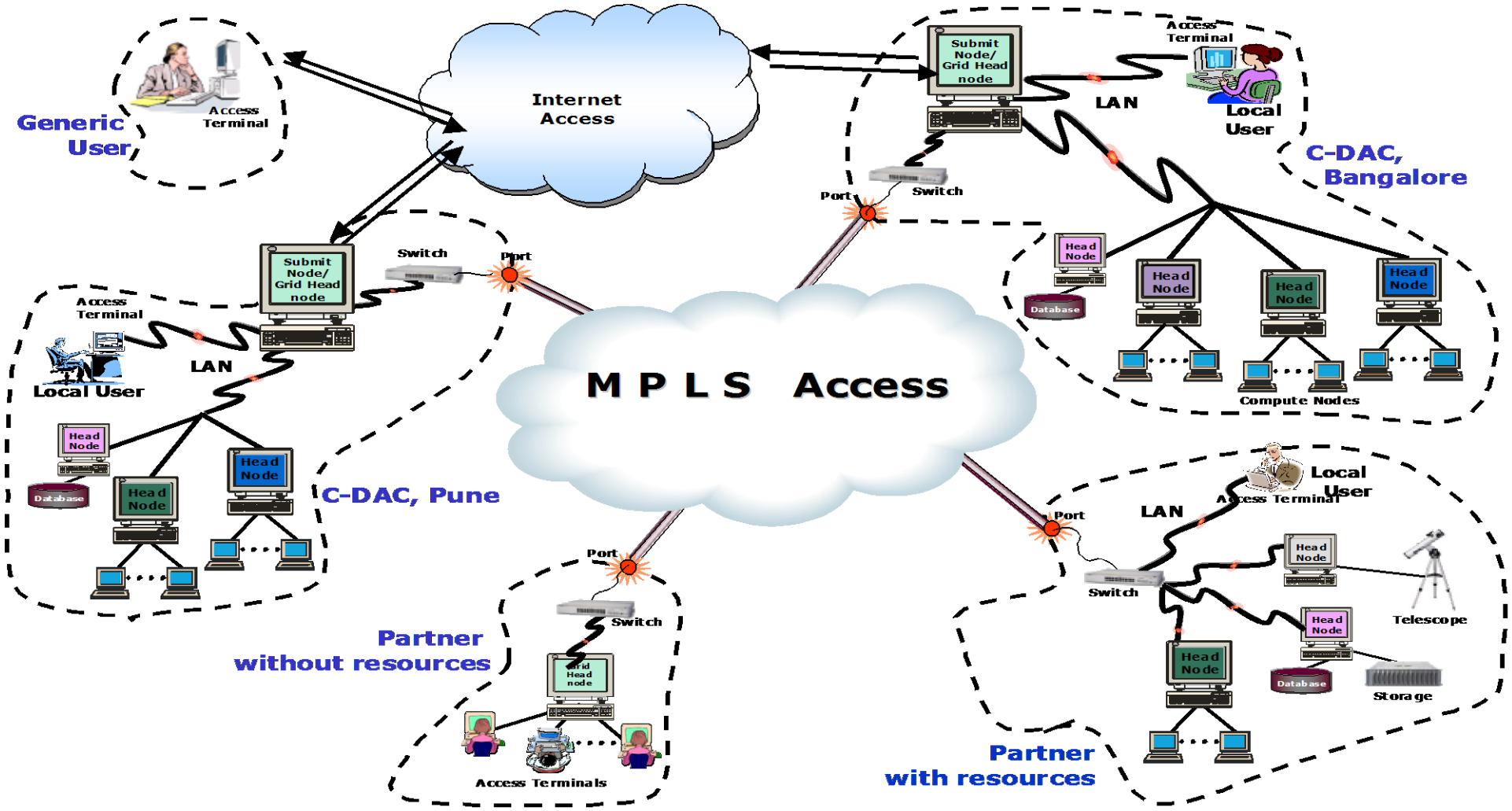
Components of Grid



Grid Architecture

Grid Architecture can be described as the layers of building blocks, where each layer has a specific function, to accomplish Grid Computing Infrastructure

Grid Architecture



Grid Middleware

- A mediator layer that provide a consistent and homogeneous access to resources managed locally with different syntax and access method
- It provide an uniform interface of the Grid to users and handle all the complexity generated due to heterogeneous systems.
- Middleware S/W is a layer between grid applications and low level functionality of grid

Popular Grid Middleware

- Globus Toolkit – Globus Alliance
- Glite-EGEE
- Gridbus-University of Melbourne
- Unicore (Uniform Interface to Computing Resources)-Institute for Advanced Simulation, Guelich, Germany
- OMII from the Open Middleware Infrastructure Institute

Middleware functionalities

- Security
- Job Management
- Data Management
- Information Management

Security

- Information Security
  - ✓ Secure communication
  - ✓ Authentication
  - ✓ Single sign on & Delegation
- Authorization
  - ✓ Resource Level
  - ✓ VO Level
- Infrastructure Level Security
  - ✓ Host Security

Job Management

- Support an open Job Description Language RSL, JDL, JSDL
- Submission, Status Query, Cancel & Destroy, Getting Output & Error
- Transferring input/output data from/to remote source/destination
- Support Serial/ Parallel Jobs (Heterogeneous & Homogeneous)
- Integration with all Local Resource Managers

Grid Middleware: Data Management

- Two Basic Categories of Data Management

  Data Movement

  - Secure
  - Robust
  - Efficient
  - Third party movement

  Data Replication

  - One or more copies or replicas
  - Survive loss
  - Easy availability
- Reduce access latency
- Performance for distributed applications

Grid Information Management

- System information is critical to operation of the grid and construction of applications
- How does an application determine what resources are available?
- What is the "state" of the computational grid?
- How can we optimize an application based on configuration of the underlying system?
- We need a general information infrastructure to answer these questions

Grid Information System

- Provides mechanism for discovery and monitoring of resources
- Designed to provide various characteristics of resource, computation, service and other entities.
- Provide access to static and dynamic information regarding system components
- Access to information is subject to authentication and authorization mechanisms.
- Information sources are distributed

Grid Applications

Types :

- ✓ Sequential Jobs for particular platform
- ✓ Concurrent Sequential Jobs for different platforms
- ✓ Homogeneous Parallel job for particular OS
- ✓ Heterogeneous Parallel Jobs

Grid Applications

- Bio Informatics applications
- High Energy Physics Applications
- Weather Modelling and Predicting Ocean Currents
- Disaster Management
- Aerodynamic Simulations

Advantages/ Disadvantages

Advantages

- ✓ Can solve larger, more complex problems in a shorter time
- ✓ Easier to collaborate with other organizations
- ✓ Make better use of existing hardware

Disadvantages

- ✓ Grid software and standards are still evolving
- ✓ Learning curve to get started
- ✓ Non-interactive job submission

Cloud Computing

- Cloud Overview
- What is New in Cloud?
- Cloud Architecture
- Cloud Types
- Cloud Services
- Cloud Virtualization
- Challenges

Cloud Overview

Definition:

"A large-scale distributed computing paradigm that is driven by economies of scale, in which a pool of abstracted, virtualized, dynamically-scalable, managed computing power, storage, platforms, and services are delivered on demand to external customers over the Internet."

Contd..

- Massively scalable
- Can be encapsulated as an abstract entity that delivers different levels of service
- Driven by economies of scale
- Services can be dynamically configured (via virtualization or other approaches) and delivered on demand
- increase in computing power and storage capacity (multi-cores etc)
- Exponentially growing data size
- Widespread adoption of Services Computing and Web 2.0 apps

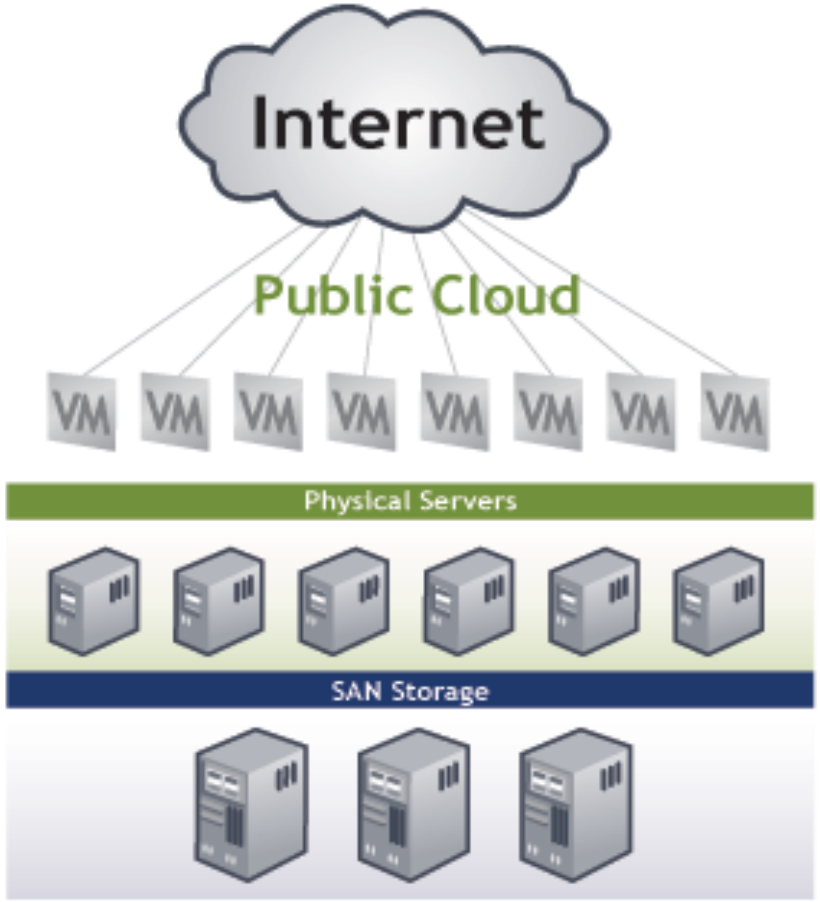
What is New in Cloud Computing?

- It is sold on demand – minute or a hour
- It is Elastic – can add or remove the resources at any time
- Fully Managed by the Cloud computing provider
- Infinite availability of resources

Cloud Computing Types

Public Clouds

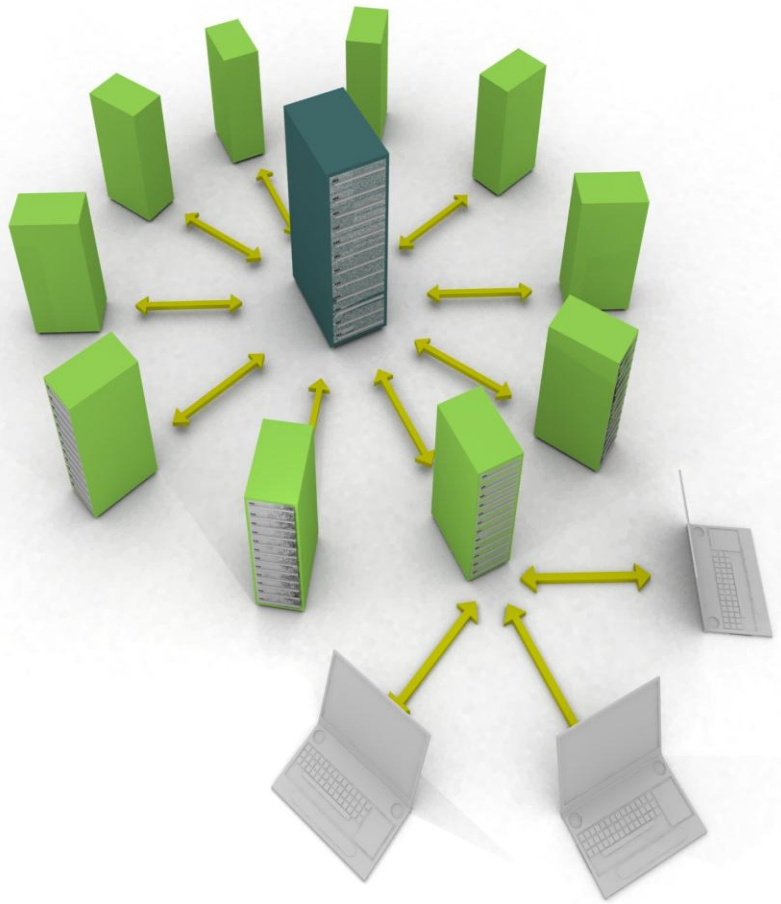
- Resources are dynamically provisioned on fine grained and self service basis over internet via web application & web pages to the public
- Standard computing model
- The services are dynamically scalable and often billable



Cloud Computing Types

Private Cloud

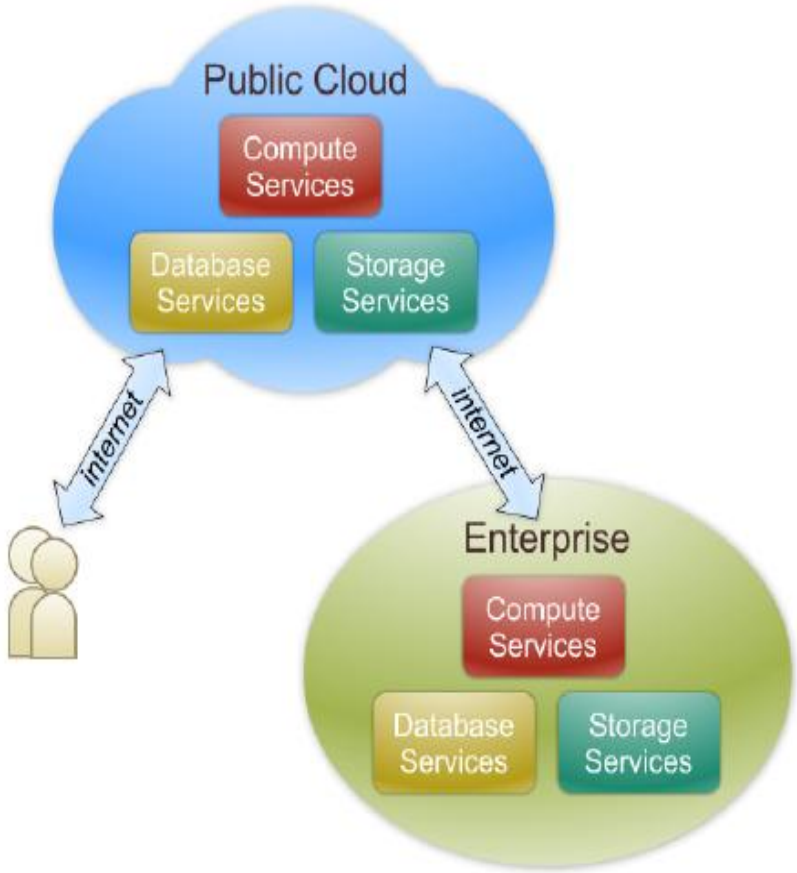
- Cloud computing implemented within corporate firewall
- Offers same features of public clouds
- Free from control over data, security issues and regulatory compliances



Cloud Computing Types

Hybrid Clouds

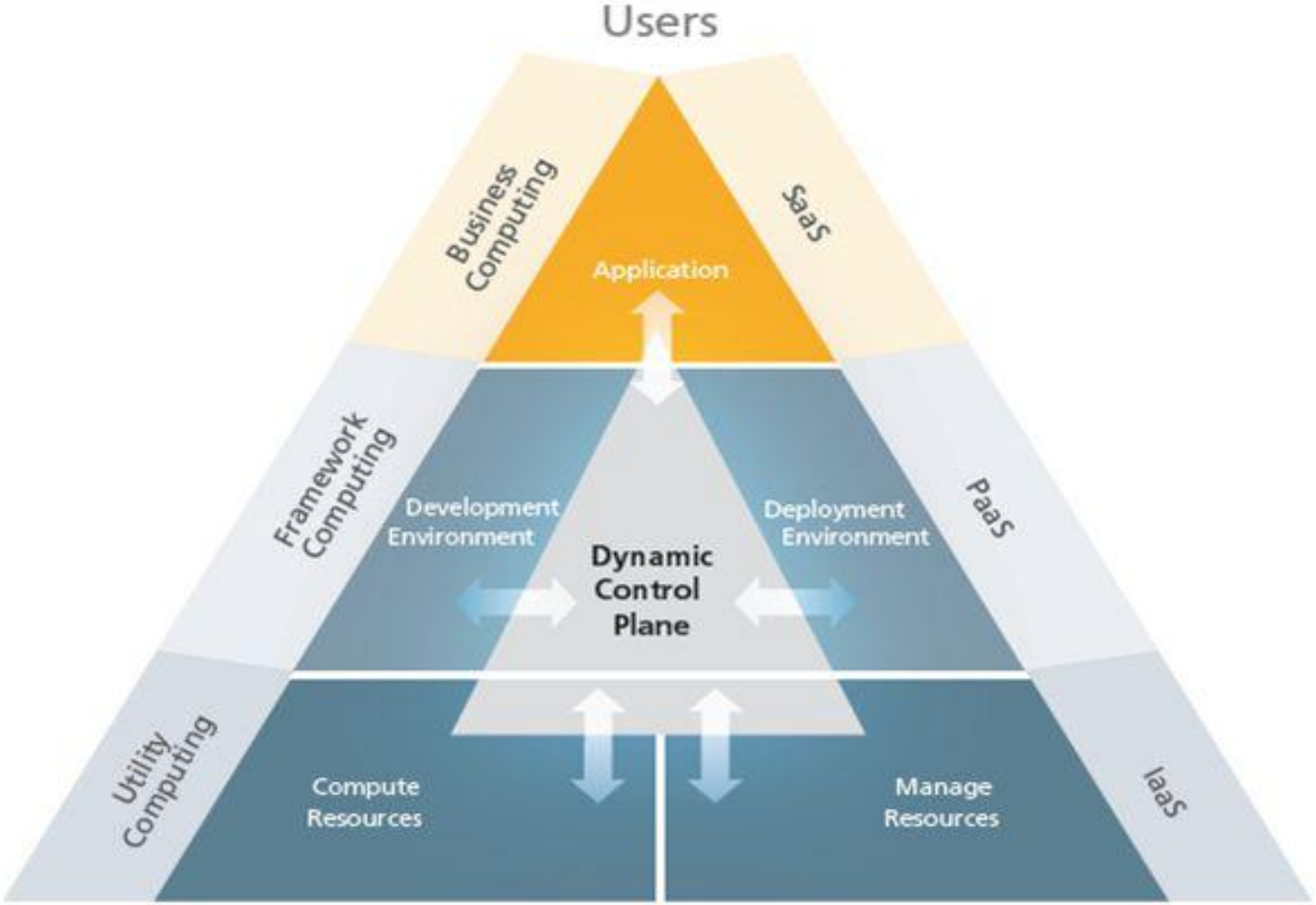
Organization provides and manages some resources in house – and other's are from public cloud.



Benefits:

- ✓ Organizations who are already having infrastructure
- ✓ Who want keep their sensitive data on their own control

General Cloud Architecture



Infrastructure as a Service

- **Infrastructure as a Service (IaaS):** hw, sw, equipments, can scale up and down dynamicallly (elastic). E.g.:
  - Amazon Elastic Compute Cloud (EC2) and Simple Storage Service (S3)
  - Eucalyptus: open source Cloud implementation compatible with EC2 (allows to set up local cloud infra prior to buying services)

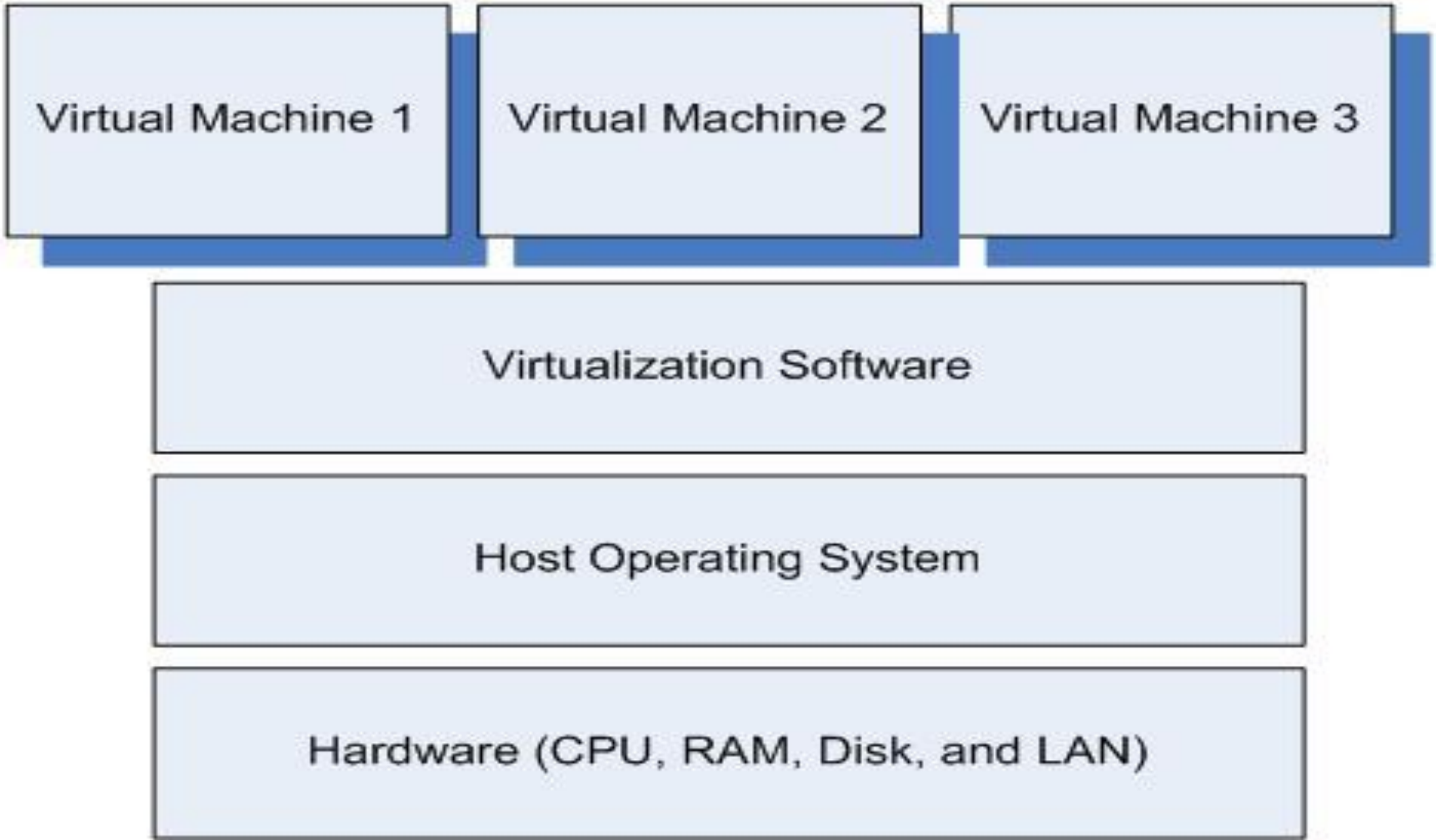
Platform as a Service

- **Platform as a Service (PaaS):** offers high level integrated environment to build, test, and deploy custom apps.
  - Restrictions on sw used to develop apps in exchange for built-in scalability. E.g.: Google App Engine

Software as a Service

- **Software as a Service (SaaS):** delivers special purpose software that is remotely accessible.
  E.g,: Google Maps, Live Mesh from Microsoft etc

Virtualization



Cloud Virtualization

- **Virtualization** is a virtualization of computers or OS
- Hides the physical characteristics of a computing platform
- Multi Tenancy – Multiple users can share the same physical resource
- Lower no of Physical Servers
- server consolidation – space utilization
- Multiple OS can run on single machine

Challenges

- Data Residency
  - ✓ Data Location
  - ✓ Data Segregation
- Security
- Interoperability between different cloud

Thank You

- Secure communication :
- GSI uses Public key cryptography – message is encrypted using public key . And decrypted using private key
- Authentication : user or service are authenticated using grid certificate
- Single sign on : reduces no of time sign in , done using proxy, done by certificate holder , it has time notation
- Authrization
- VO Level auth system : RP will have the rights , user gets credintial from authrization system , and send it to the RP to accquire resource

Similarities & Difference

Reduced Cost: The price of off-the-shelf consumer desktops has plummeted in recent years, and thi
The average desktop PC today is many times mor

2. **Processing Power :** The parallel processing power of a high-performance cluster c
This reduced price per unit of power enables enterp
Improved Network Technology: Driving the development of computer clust
along with a reduction in the
clusters are typically connected via a single virtual local area network (VLAN), and the network treats each computer as a separa

bility: Perhaps the greatest advantage of computer clusters is the scalability they offer. While mainframe computers have a fixed
5. Availability: When a mainframe computer fails, the entire system fails. However, if a node in a computer cluster fails, its