

Cluster, Grid, Cloud – Concepts

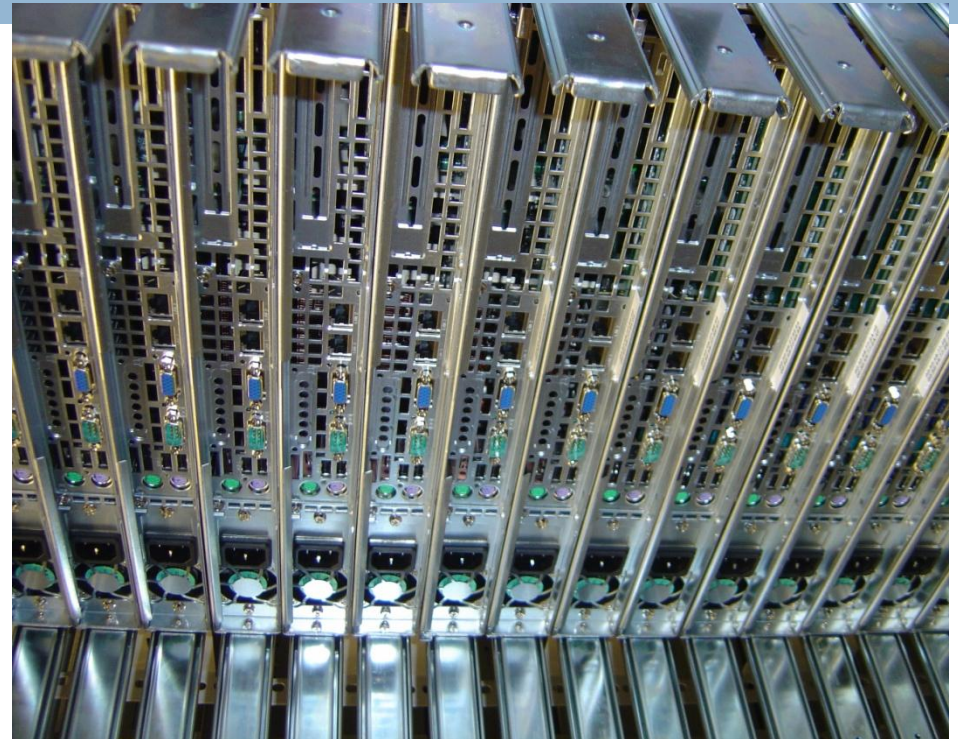
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- ❖ **Section 1: Cluster**
- ❖ **Section 2: Grid**
- ❖ **Section 3: Cloud**

- ❖ **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

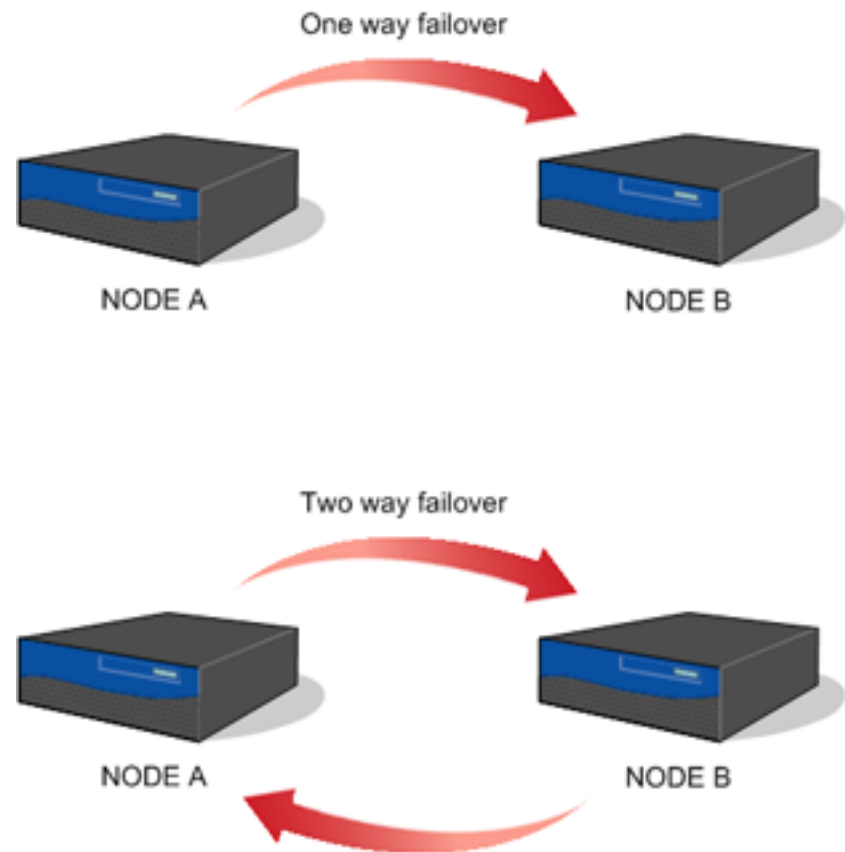


- ✓ Requirements for computing increasing fast.
 - ✓ More data to process.
 - ✓ More compute intensive algorithms available.
- ✓ Approaches to supply demand
 - ✓ **Qualitative:** Optimized algorithms, faster processors, more memory.
 - ✓ **Quantitative:** Cluster computing, grid computing, etc.

- ✓ High Availability Cluster
- ✓ Load Balancing Cluster
- ✓ HPC Cluster

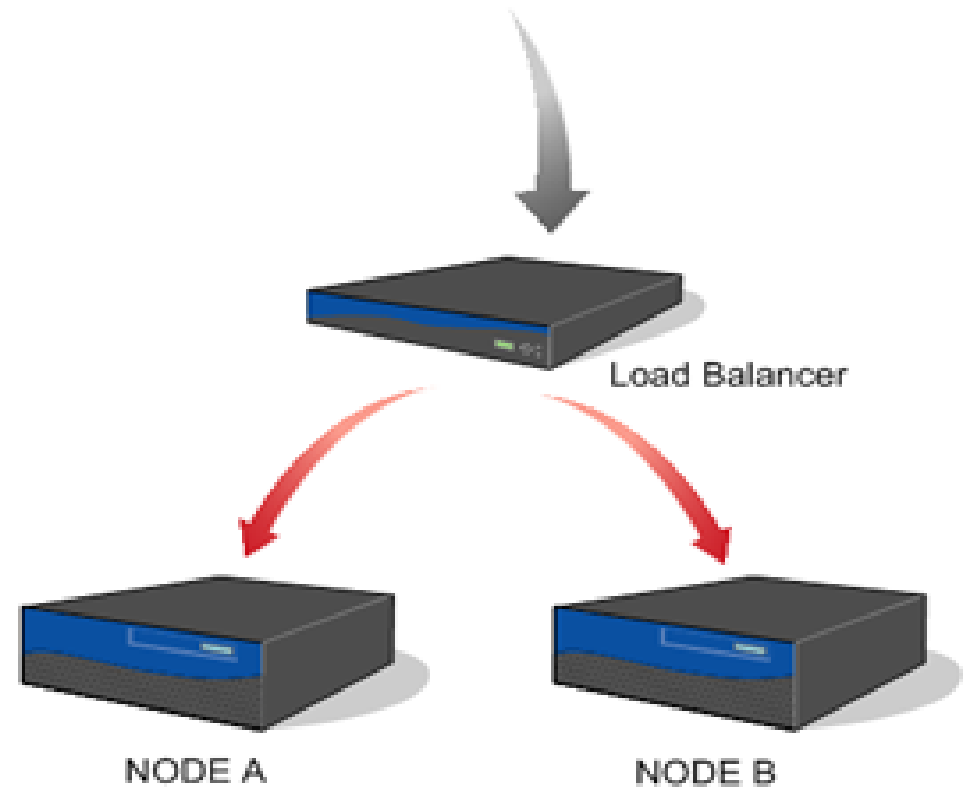
High Availability Clusters

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

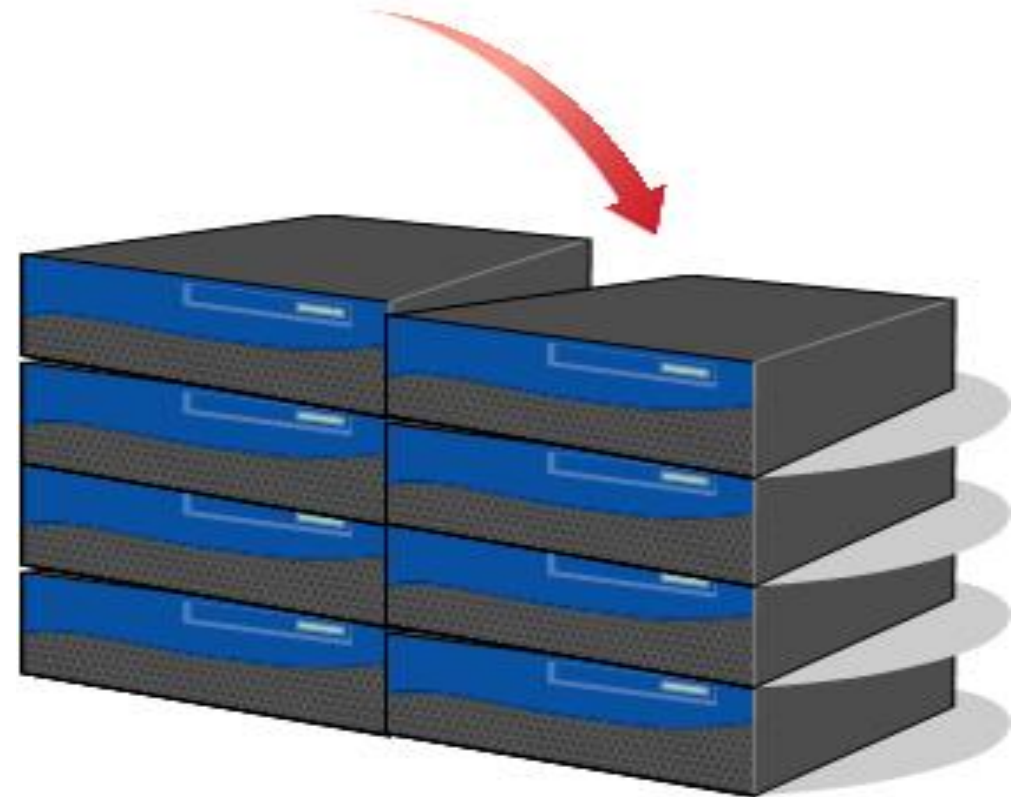


Load Balancing Clusters

- ✓ 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 are mainly used to increase 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

- ✓ 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

- ❖ **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.

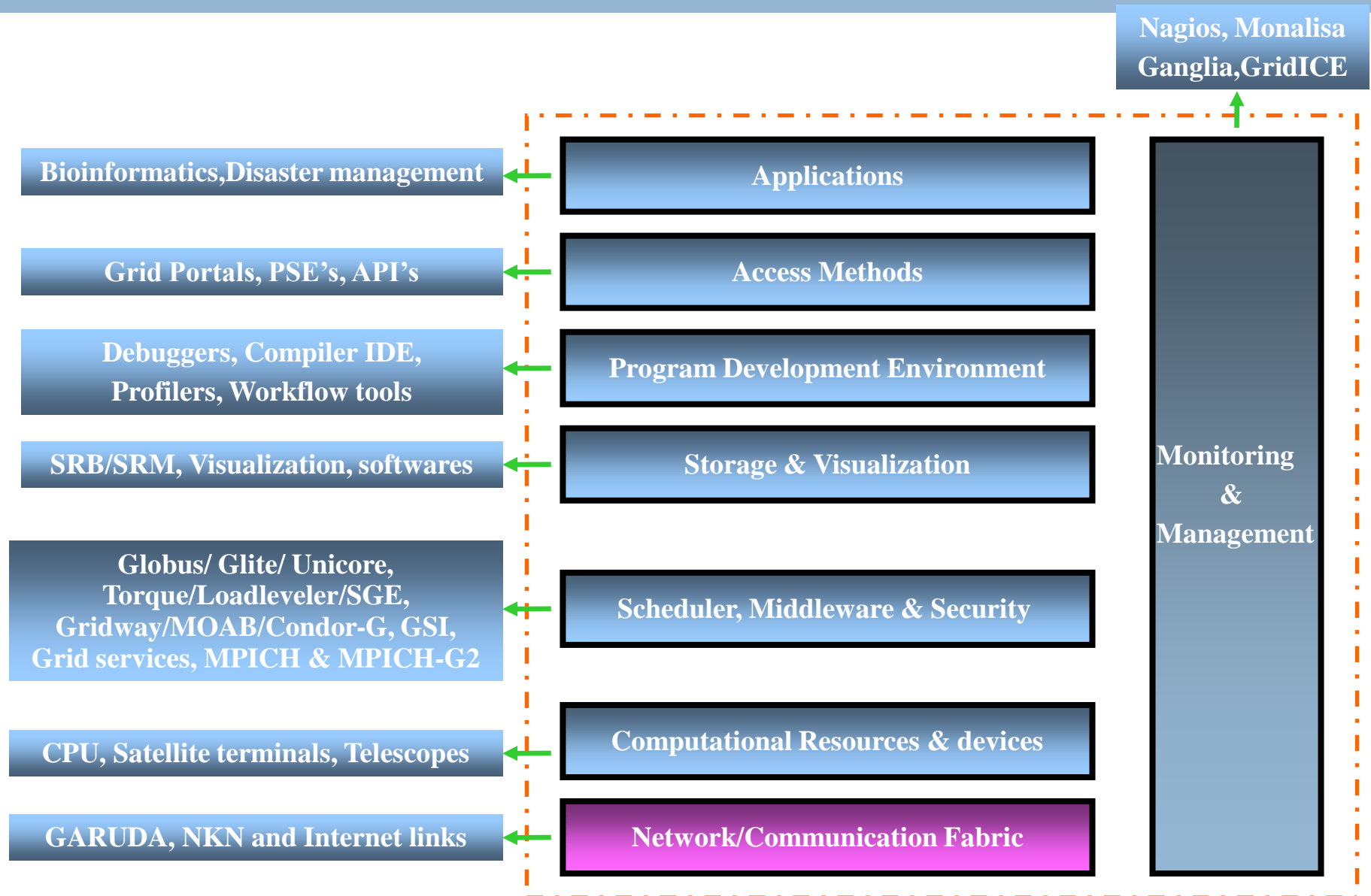
- ❖ **Virtual Organization (VO)** refers to a dynamic set of individual and/or institutions defined around a set of resource-sharing rules and conditions
- ❖ Multiple organizations that function as one unit through the use of their shared competencies and resources for the purpose of one or more identified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

Example:

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

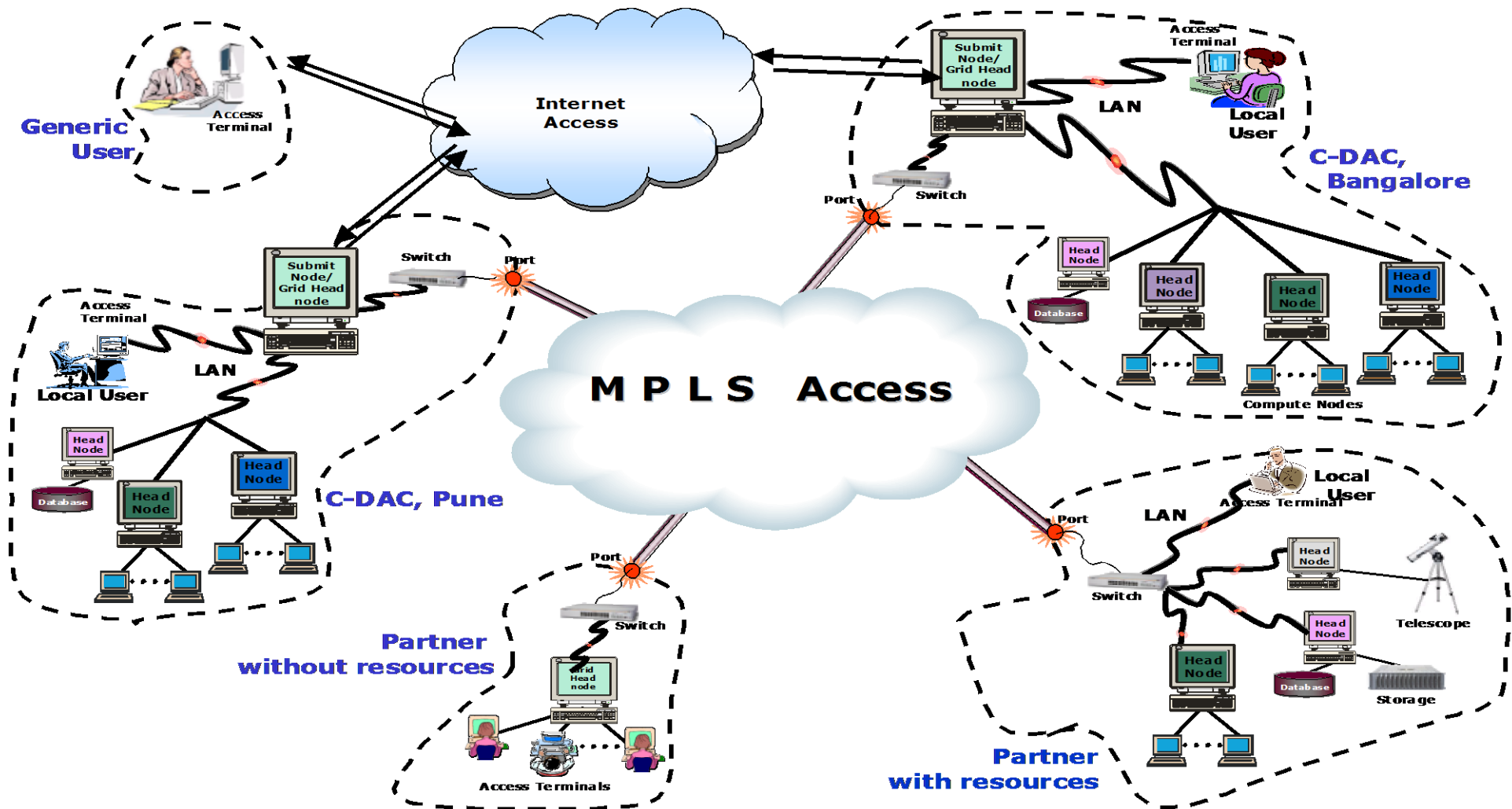


Components of Grid



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

Grid Architecture



- ❖ 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

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

- ❖ Security
- ❖ Job Management
- ❖ Data Management
- ❖ Information Management

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



- ❖ 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

➤ 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

- ❖ 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

- ❖ 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

Types :

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

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

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

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.”

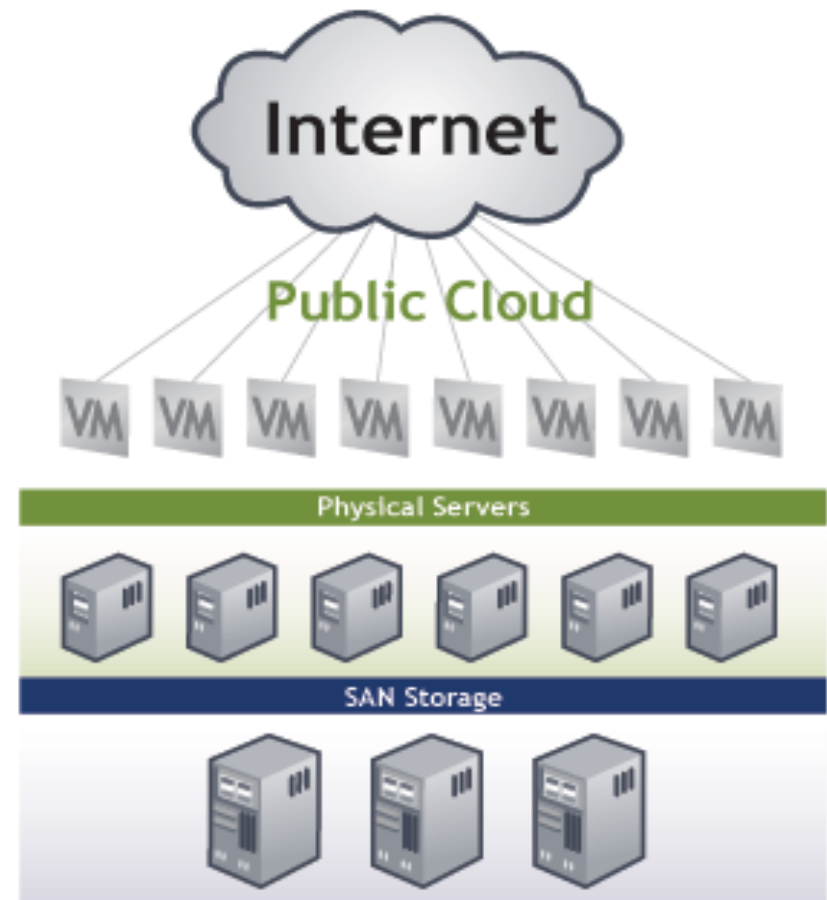
- Massively scalable
- Can be encapsulated as an abstract entity that delivers different levels of service
- Driven by economies of scale
- Services can be dynamically configured (via virtualization or other approaches) and delivered on demand
- increase in computing power and storage capacity (multi-cores 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

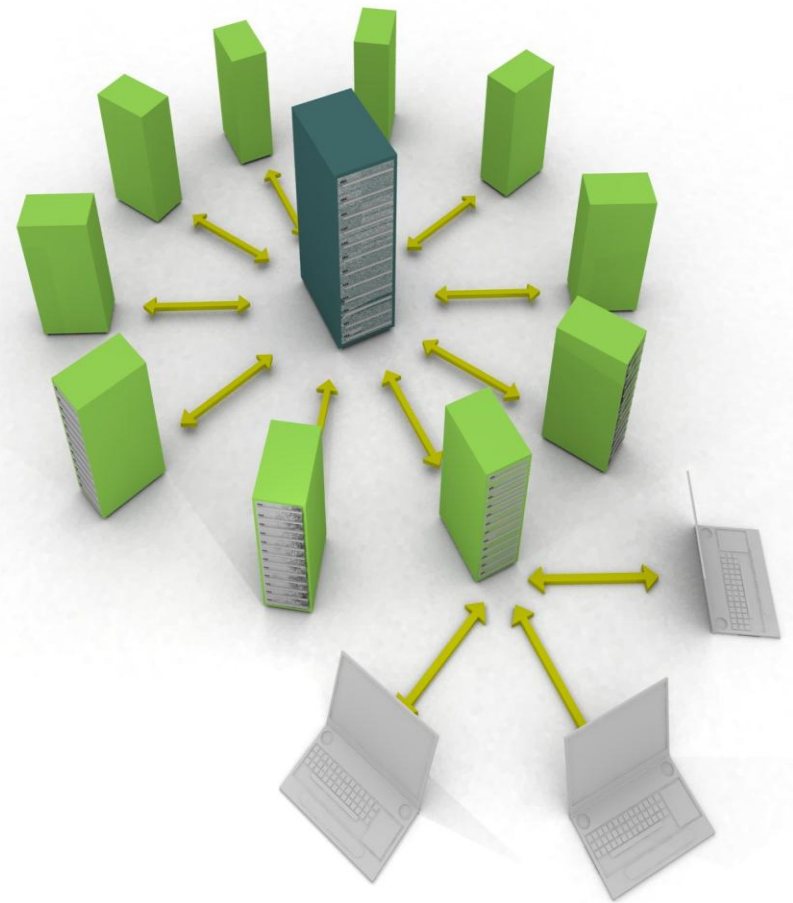
Public Clouds

- 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



Private Cloud

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

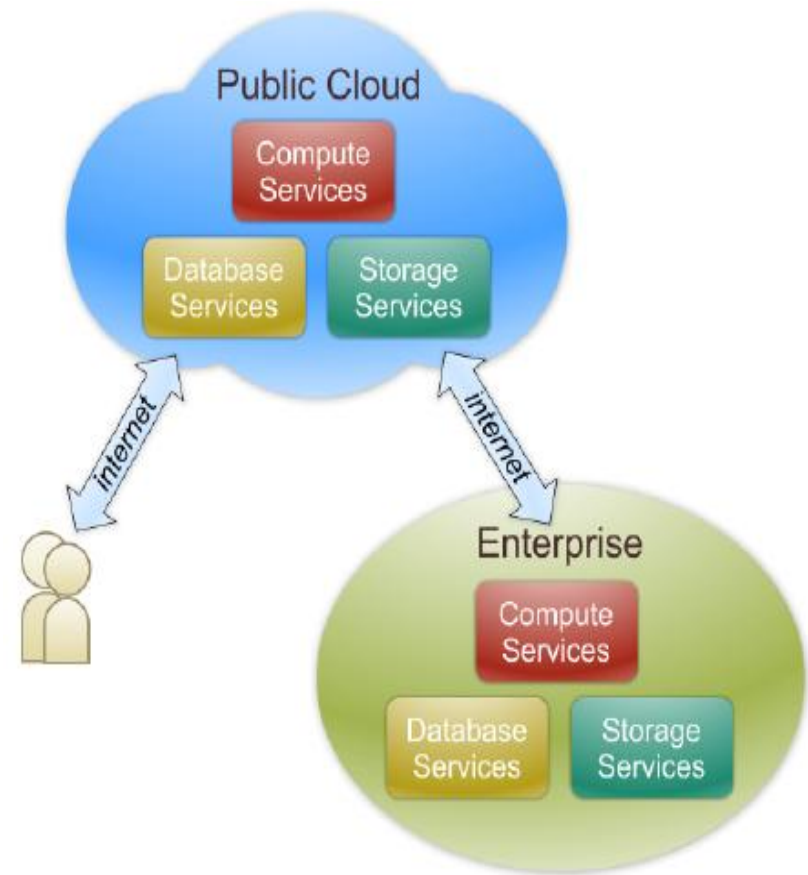


Hybrid Clouds

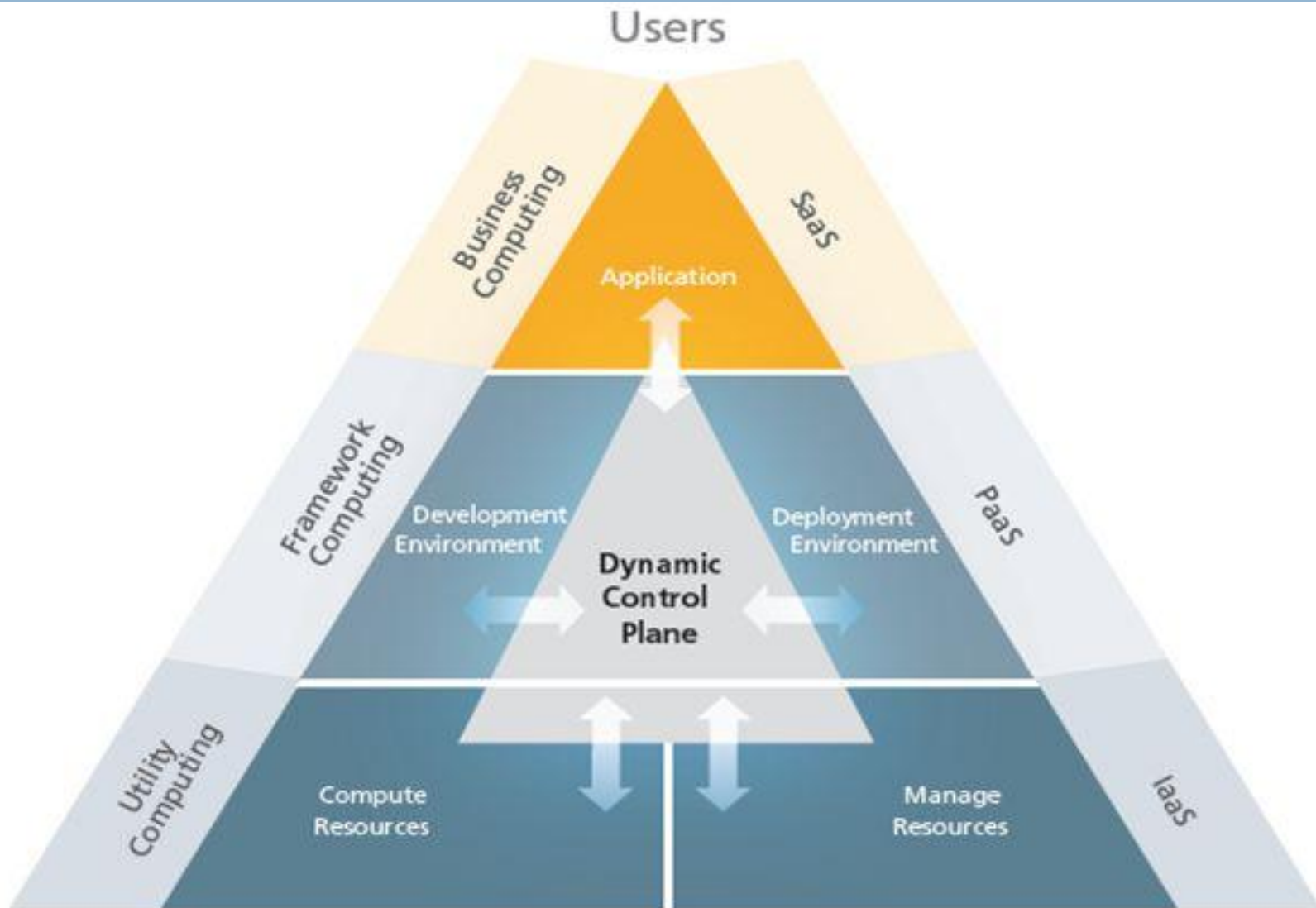
Organization provides and manages some resources in house – and other's are from public cloud.

Benefits:

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



General Cloud Architecture



- ✓ **Infrastructure as a Service (IaaS):** hw, sw, equipments, can scale up and down dynamically (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 (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 (SaaS):** delivers special purpose software that is remotely accessible.
E.g.,: Google Maps, Live Mesh from Microsoft etc



Virtualization

Virtual Machine 1

Virtual Machine 2

Virtual Machine 3

Virtualization Software

Host Operating System

Hardware (CPU, RAM, Disk, and LAN)

- ✓ **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

- ❖ 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 acquire resource



Similarities & Difference

Reduced Cost: The price of off-the-shelf consumer desktops has plummeted in recent years, and this trend is expected to continue. The average desktop PC today is many times more powerful than it was just a few years ago.

2. **Processing Power :** The parallel processing power of a high-performance cluster computer has increased significantly. This reduced price per unit of power enables enterprises to build larger clusters.

Improved Network Technology: Driving the development of computer clusters is the rapid advancement of network technology, along with a reduction in the cost of networking. Clusters are typically connected via a single virtual local area network (VLAN), and the network treats each computer as a separate node.

Availability: Perhaps the greatest advantage of computer clusters is the scalability they offer. While mainframe computers have a fixed capacity, clusters can be expanded or contracted as needed.

5. **Availability:** When a mainframe computer fails, the entire system fails. However, if a node in a computer cluster fails, its workload can be redistributed to other nodes, ensuring continued operation.