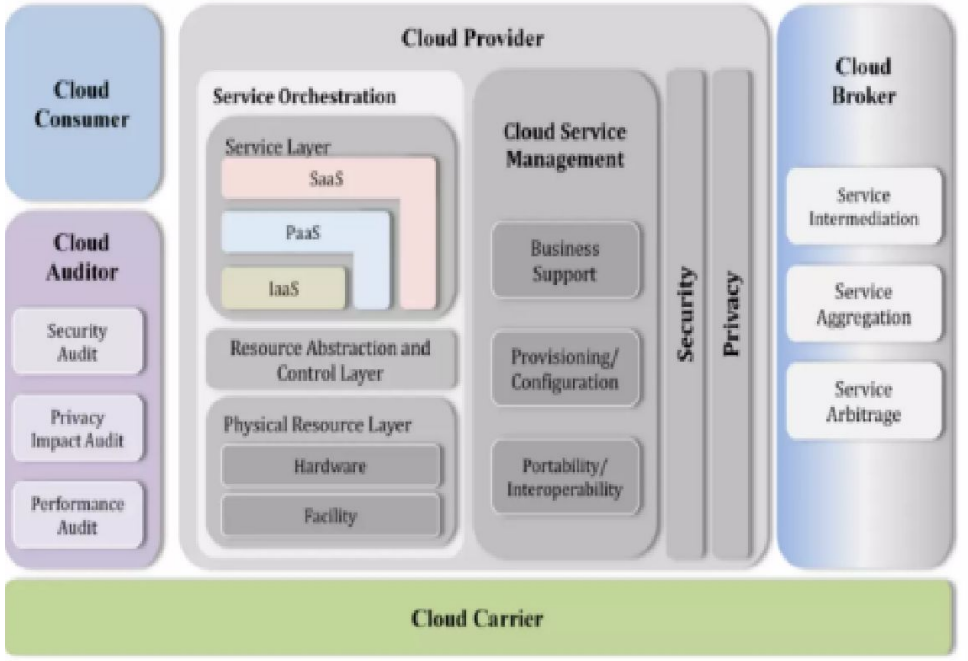
Cloud Reference Model and cloud service provider

Cloud Conceptual Reference Model

- Cloud High-level architecture
- Five major actors with their roles, responsibilities, activities and functions in cloud computing.
- Understanding of the requirements, uses, characteristics and standards of cloud computing.
    1. Cloud Consumer
    2. Cloud Provider
    3. Cloud Broker
    4. Cloud Auditor
    5. Cloud Carrier



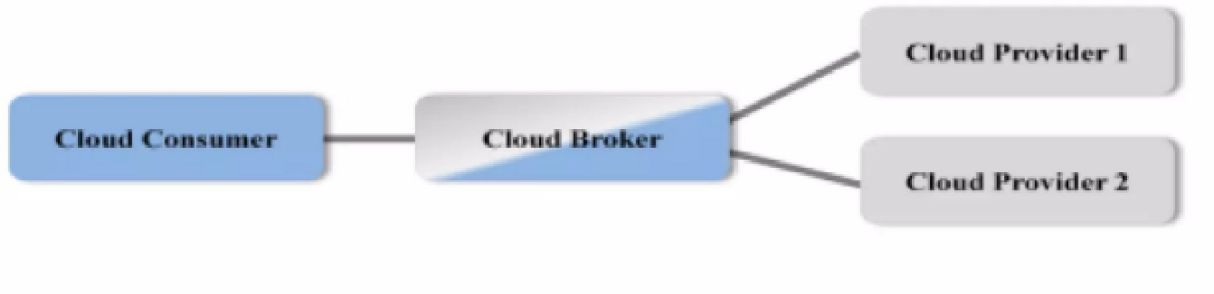
NIST Cloud Computing Reference Architecture

Actors in Cloud Computing

- Cloud Consumer A person or organization that maintains a business relationship with, and uses service from, Cloud Providers.
- Cloud Provider A person, organization, or entity responsible for making a service available to interested parties.
- Cloud Auditor A party that can conduct independent assessment of cloud services, information system operations, performance and security of the cloud implementation.
- Cloud Broker An entity that manages the use, performance and delivery of cloud services, and negotiates relationships between Cloud Providers and Cloud Consumers.
- Cloud Carrier An intermediary that provides connectivity and transport of cloud services from Cloud Providers to Cloud Consumers.

Scenarios in Cloud: 1

1. Cloud consumer interacts with the cloud broker instead of contacting a cloud provider directly.
2. The cloud broker may create a new service (mash up) by combining multiple services or by enhancing an existing service.
3. Actual cloud providers are invisible to the cloud consumer.



NIST Cloud Computing Reference Architecture

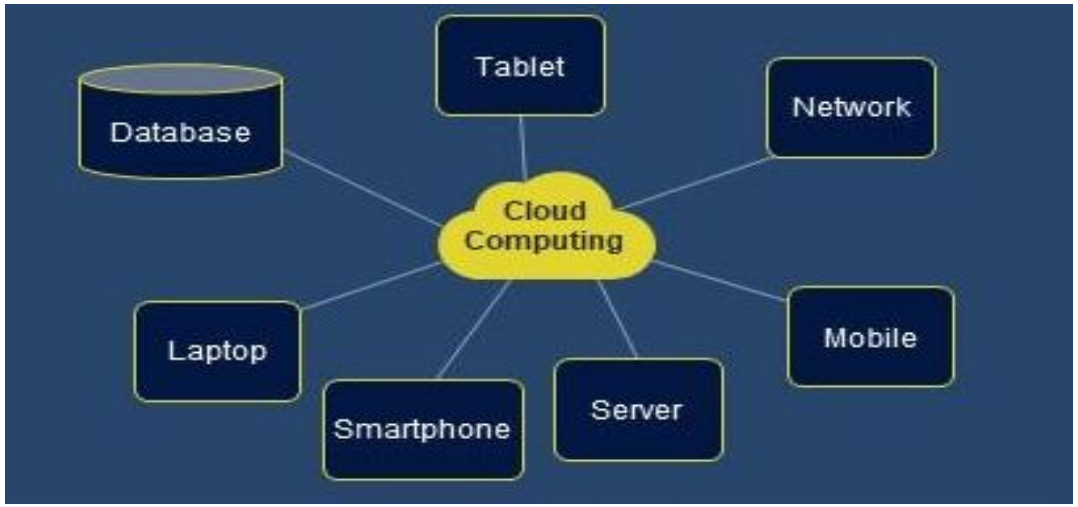
Scenarios in Cloud: 2

1. Cloud carriers provide the connectivity and transport of cloud services from cloud providers to cloud consumers.
2. Cloud provider participates in and arranges for two unique service level agreements (SLAs), one with a cloud carrier (e.g. SLA2) and one with a cloud consumer (e.g. SLA1).
3. A cloud provider may request cloud carrier to provide dedicated and encrypted connections to ensure the cloud services (SLA's).

NIST Cloud Computing Reference Architecture

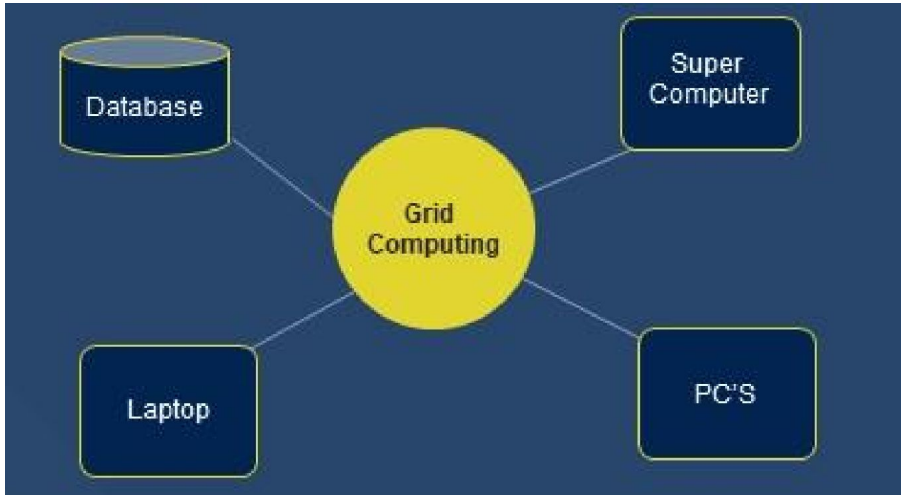
Cloud computing

- Cloud computing uses a **client-server** architecture to deliver computing resources such as servers, storage, databases, and software over the cloud (Internet) with pay-as-you-go pricing.
- Cloud computing becomes a very popular option for organizations by providing various advantages, including cost-saving, increased productivity, efficiency, performance, data back-ups, disaster recovery, and security.



Grid Computing

Grid computing is also called as "**distributed computing**." It links multiple computing resources (PC's, workstations, servers, and storage elements) together and provides a mechanism to access them.



Cluster

- **A cluster is a network topology containing two or more computers connected to each other.** Furthermore, a local network connects the computers or nodes on the cluster. Generally, we place all the nodes in the same location in a cluster. Additionally, it follows centralized architecture.
- The cluster can work with any operating system or architecture. Additionally, **the nodes on the cluster can be synchronous or asynchronous.** Synchronous nodes share data at the same time. Asynchronous nodes send data out at different times.
- The nodes in a cluster can be both synchronous and asynchronous, but it depends on the type of cluster. Clusters differ from clouds as clusters contain two or more computer systems connected to the cluster head node, acting like a single system. On the other hand, a cloud includes servers, storage, and databases ready to use over the Internet:

Cloud Vs Grid Vs Cluster

Cloud	Grid	Cluster
Consolidation of resources	Segregation of resources	Aggregation of resources
Single system made up of many systems	Collection of systems that act together like a single system	Group of nodes that are connected to each other
Works with different hardware and OS	Works with different hardware and OS	All the connected systems should have same OS and hardware
Follows centralized architecture	Follows distributed architecture	Follows centralized architecture
Suffers from a single point of failure	All the nodes work independently, hence no single point of failure	Suffers from a single point of failure
The owners have less control over the systems on the cloud	The owners have full control and management over the grid's systems	Have no owners, and each node works independently
Job execution is self-managed	Scalability of execution allows for the transfer of a job's execution to an available processor	The scheduling of jobs affects execution. Jobs, therefore, wait until their designated runtime
Used in Dropbox, Gmail	Used in simulations, automations	Used in web servers, search engines

Cloud Service Provider

Cloud Service providers (CSP) offers various services such as Software as a Service, Platform as a service, Infrastructure as a service, network services, business applications, mobile applications, and infrastructure in the cloud. The cloud service providers host these services in a data center, and users can access these services through cloud provider companies using an Internet connection.

There are the following Cloud Service Providers Companies –

- Amazon Web Services (AWS)
- Microsoft Azure
- Google Cloud Platform
- IBM Cloud Services
- VMware Cloud
- Oracle cloud
- Red Hat
- Alibaba Cloud

Amazon Web Services (AWS)

AWS (Amazon Web Services) is a **secure cloud service platform** provided by **Amazon**. It offers various services such as database storage, computing power, content delivery, Relational Database, Simple Email, Simple Queue, and other functionality to increase the organization's growth.

Features of AWS
AWS provides various powerful features for building scalable, cost-effective, enterprise applications. Some important features of AWS is given below-

- AWS is scalable because it has an ability to scale the computing resources up or down according to the organization's demand.
- AWS is cost-effective as it works on a pay-as-you-go pricing model.
- It provides various flexible storage options.
- It offers various security services such as infrastructure security, data encryption, monitoring & logging, identity & access control, penetration testing, and DDoS attacks.
- It can efficiently manage and secure Windows workloads.

Microsoft Azure

It is a worldwide cloud platform which is used for building, deploying, and managing services. It supports multiple programming languages such as Java, Nodejs, C, and C#. The advantage of using Microsoft Azure is that it allows us to a wide variety of services without arranging and purchasing additional hardware components.

Microsoft Azure provides several computing services, including servers, storage, databases, software, networking, and analytics over the Internet.

Microsoft Azure

Microsoft Azure is also known as **Windows Azure**. It supports various operating systems, databases, programming languages, frameworks that allow IT professionals to easily build, deploy, and manage applications through a worldwide network. It also allows users to create different groups for related utilities.

Features of Microsoft Azure

- Microsoft Azure provides **scalable**, **flexible**, and **cost-effective**
- It allows developers to quickly manage applications and websites.
- It managed each resource individually.
- Its IaaS infrastructure allows us to launch a general-purpose virtual machine in different platforms such as Windows and Linux.
- It offers a **Content Delivery System (CDS)** for delivering the Images, videos, audios, and applications.

Google Cloud Platform (GCP)

Google Cloud Platform (GCP) is introduced by **Google** in 2011. It allows us to use Google's products such as **Google search engine, Gmail, YouTube**, etc. Most of the companies use this platform to easily build, move, and deploy applications on the cloud. It allows us to access these applications using a high-speed internet connection. The advantage of GCP is that it supports various databases such as **SQL, MYSQL, Oracle, Sam**, and **more**.

Google Cloud Platform (GCP) provides various cloud computing services, including computing, data analytics, data storage, and machine learning.

Google Cloud Platform

Google cloud platform is a product of **Google**. It consists of a set of physical devices, such as computers, hard disk drives, and virtual machines. It also helps organizations to simplify the migration process.
Features of Google Cloud Platform

- Google cloud includes various **big data services** such as Google BigQuery, Google CloudDataproc, Google CloudDatalab, and Google Cloud Pub/Sub.
- It provides various services related to **networking**, including Google Virtual Private Cloud (VPC), Content Delivery Network, Google Cloud Load Balancing, Google Cloud Interconnect, and Google Cloud DNS.
- It offers various **scalable** and **high-performance**
- GCP provides various **serverless services** such as Messaging, Data Warehouse, Database, Compute, Storage, Data Processing, and Machine learning (ML)
- It provides a free cloud shell environment with Boost Mode.

IBM Cloud Services

IBM Cloud is an open-source, faster, and more reliable platform. It is built with a suite of advanced data and AI tools. It offers various services such as Infrastructure as a service, Software as a service, and platform as a service. You can access its services like compute power, cloud data & Analytics, cloud use cases, and storage networking using internet connection.
Features of IBM Cloud Services

- IBM cloud improves operational efficiency.
- Its speed and agility improve the customer's satisfaction.
- It offers Infrastructure as a Service (IaaS), Platform as a Service (PaaS), as well as Software as a Service (SaaS)
- It offers various cloud communications services to our IT environment.

VMware Cloud

VMware cloud is a Software-Defined Data Center (SSDC) unified platform for the Hybrid Cloud. It allows cloud providers to build agile, flexible, efficient, and robust cloud services.

Features of VMware Cloud

- VMware cloud works on the **pay-as-per-use** model and **monthly subscription**
- It provides better customer satisfaction by protecting the user's data.
- It can easily create a new VMware **Software-Defined Data Center (SDDC)** cluster on AWS cloud by utilizing a RESTful API.
- It provides flexible storage options. We can manage our application storage on a per-application basis.
- It provides a dedicated high-performance network for managing the application traffic and also supports multicast networking.
- It eliminates the time and cost complexity.

Oracle cloud

Features of Oracle cloud

- Oracle cloud provides various tools for build, integrate, monitor, and secure the applications.
- Its infrastructure uses various languages including, Java, Ruby, PHP, Node.js.
- It integrates with Docker, VMware, and other DevOps tools.
- Oracle database not only provides unparalleled integration between IaaS, PaaS, and SaaS, but also integrates with the on-premises platform to improve operational efficiency.
- It maximizes the value of IT investments.
- It offers customizable Virtual Cloud Networks, firewalls, and IP addresses to securely support private networks.

Red Hat

Features of Red Hat Red Hat

- Red Hat provides secure, certified, and updated container images via the Red Hat Container catalog.
- Red Hat cloud includes **OpenShift,** which is an app development platform that allows developers to **access**, **modernize**, and **deploy apps**
- It supports up to 16 virtual machines, each having up to 256GB of RAM.
- It offers better reliability, availability, and serviceability.
- It provides flexible storage capabilities, including very large SAN-based storage, better management of memory allocations, high availability of LVMs, and support for particularly roll-back.
- In the Desktop environment, it includes features like New on-screen keyboard, GNOME software, which allows us to install applications, update application, as well as extended device support.

Rackspace

Rackspace offers cloud computing services such as hosting web applications, Cloud Backup, Cloud Block Storage, Databases, and Cloud Servers. The main aim to designing Rackspace is to easily manage private and public cloud deployments. Its data centers operating in the USA, UK, Hong Kong, and Australia.

Features of Rackspace

- Rackspace provides various tools that help organizations to collaborate and communicate more efficiently.
- We can access files that are stored on the Rackspace cloud drive, anywhere, anytime using any device.
- It offers 6 globally data centers.
- It can manage both virtual servers and dedicated physical servers on the same network.
- It provides better performance at a lower cost.

Alibaba Cloud

Alibaba Cloud is used to develop data management and highly scalable cloud computing services. It offers various services, including Elastic Computing, Storage, Networking, Security, Database Services, Application Services, Media Services, Cloud Communication, and Internet of Things.

Features of Alibaba Cloud

- Alibaba cloud offers a suite of global cloud computing services for both international customers and Alibaba Group's e-commerce ecosystem.
- Its services are available on a pay-as-per-use basis.
- It globally deals with its 14 data centers.
- It offers scalable and reliable data storage.

Comparison between AWS, Azure, and Google Cloud Platform

Parameter	AWS	Azure	Google Cloud Platform
App Testing	It uses device farm	It uses DevTest labs	It uses Cloud Test labs.
API Management	Amazon API gateway	Azure API gateway	Cloud endpoints.
Kubernetes Management	EKS	Kubernetes service	Kubernetes engine
Git Repositories	AWS source repositories	Azure source repositories	Cloud source repositories.
Data warehouse	Redshift	SQL warehouse	Big Query
Object Storage	S3	Block Blobs and files	Google cloud storage.
Relational DB	RDS	Relational DBs	Google Cloud SQL
Block Storage	EBS	Page Blobs	Persistent disks
Marketplace	AWS	Azure	G suite
File Storage	EFS	Azure Files	ZFS and Avere
Media Services	Amazon Elastic transcoder	Azure media services	Cloud video intelligence API
Virtual network	VPC	VNet	Subnet
Pricing	Per hour	Per minute	Per minute
Maximum processors in VM	128	128	96
Maximum memory in VM (GiB)	3904	3800	1433
Catching	ElasticCache	RedisCache	CloudCDN
Load Balancing Configuration	Elastic Load Balancing	Load Balancer Application Gateway	Cloud Load Balancing
Global Content Delivery Networks	CloudFront	Content Delivery Network	Cloud Interconnect

Cloud Architecture vs Grid Architecture

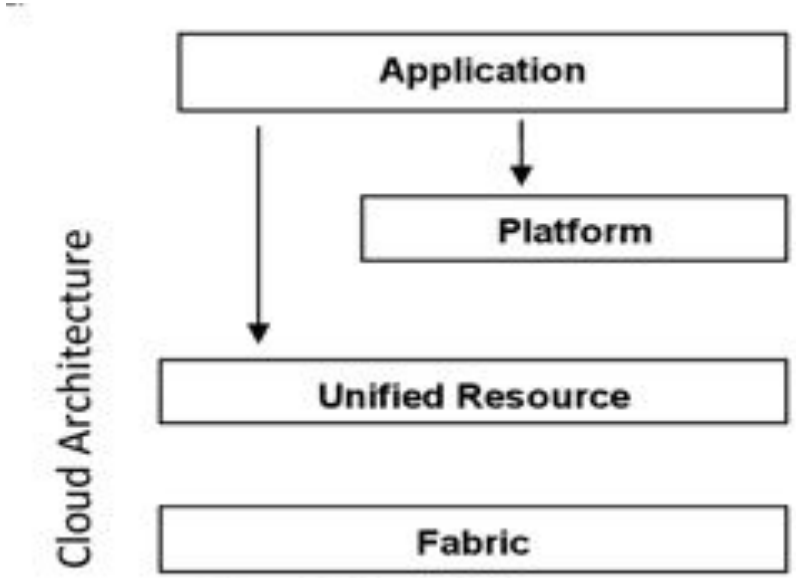


Figure 3: Cloud Architecture

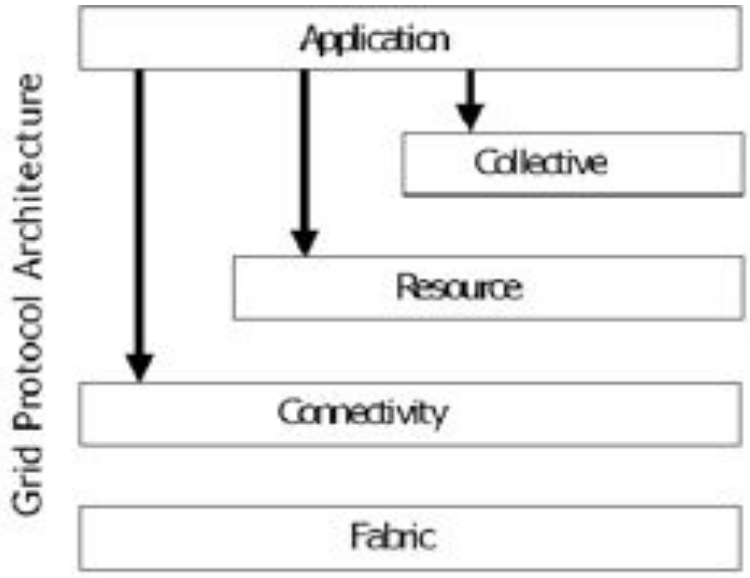


Figure 2: Grid Protocol Architecture

Architecture for Elasticity

Vertical Scale-Up

- Keep on adding resources to a unit to increase computation power.
- Process the job to single computation unit with high resources.

Horizontal Scale Out

- Keep on adding discrete resources for computation and make them behave as in converged unit.
- Splitting job on multiple discrete machines, combine the output.
- Distribute database.
- For HPC second option is better than first. Because Complexity and cost of first option is very high.