

# Cloud Computing

## Cloud Computing Model

## **Standard Cloud Model**

- Any technology needs a standard model for the convenience of understanding and globalization.
- During early days, several models were represented by different bodies from their respective viewpoints.
- The most appreciated and accepted model of cloud computing comes from U.S. National Institute of Standards and Technology (NIST).

## The NIST Model

- The model was proposed by Information Technology Laboratory of NIST in 2011.
- The definition states,

“Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model promotes availability and is composed of five essential characteristics, three service models, and four deployment models.”

## The NIST Model

- When unpacked, it can be observed that the definition says,
  - Cloud computing is a model and not a technology.
  - Cloud computing enables users' access to pools of computing resources via network.
  - The resources are shared among users and made available on-demand.
  - The prime benefit is the ease of use with very little management headache for users.

## The NIST Model

- The NIST model describes cloud from two perspective –
  - *Cloud modeling based on deployment* - It focuses on the access boundary and location of the cloud establishment.
  - *Cloud modeling based on service delivery* - describes the type of computing service that is offered to users.

## The NIST Model

- The NIST model also mentions five essential characteristics of cloud computing.
- A computing facility empowered by these five characteristics or attributes, can be referred as Cloud Computing.

# The NIST Model

- Essential Characteristic of Cloud Computing
  - 1. *On-demand self-service*
    - *On-demand* ability empowers users to consume the computing facility as much based on their current demand, at any moment.
    - Computing facility is delivered by third party service provider.
    - *Self-service* refers that computing facility can be arranged without any human intervention at service provider's end. Hence, system must have automated mechanism to manage things.

## The NIST Model

- Essential Characteristic of Cloud Computing

### 2. *Resource pooling*

- Computing requires resources like processor, memory, storage and network.
- Cloud vendors maintain pools of computing resources to support all users' computing need.
- Users can access and use these resources to satisfy their computing needs as and when required.

## The NIST Model

- Essential Characteristic of Cloud Computing

### 3. *Broad network access*

- The cloud service facility installed at the provider's end is remotely accessed by users through network.
- To serve this purpose, strong network infrastructure has to be in place.
- Broad network access facility makes cloud computing *ubiquitous* or accessible anywhere.

## The NIST Model

- Essential Characteristic of Cloud Computing

### 4. *Rapid elasticity*

- Cloud computing requires provisioning of adequate and frequently changing demand of resources for a large number of users.
- The computing environment must create an impression of limitless repository of resources .
- Rapid provisioning and release of resources is critical for building a low cost computing facility.

## The NIST Model

- Essential Characteristic of Cloud Computing
- 4. *Rapid elasticity*
  - Resources should be delivered to user immediately on demand.
  - Again when a user no more uses the resources, those have to be taken back immediately, to avoid wastage of valuable resources
    - .
  - Rapid elasticity refers to the ability of a system to grow and shrink swiftly, according to the requirement.

# The NIST Model

- Essential Characteristic of Cloud Computing

## 5. *Measured service*

- Measuring the usages of computing resources by a user is essential.
- This is done on known metric such as amount of processing power consumed, use of storage volume, network bandwidth used, number of network transactions etc.
- This usage of the pooled resources has to be calculated and stated (or billed) to every user/organization.

## The NIST Model

- Essential Characteristic of Cloud Computing

### 5. *Measured service*

- This way, users are no more charged for any idle resources or for resources they are not using.
- The metering of actual resource consumption dramatically reduces the cost of computing for users.

## The NIST Model

- Another Important Characteristic

### *Multi-tenancy*

- Single set of resources can have multiple tenants who are not linked with each other.
- Multi-tenancy allows the sharing of same resources by different subscribers without the subscribers being aware of it.
- Multi-tenancy is not called out as an essential cloud characteristic of cloud computing, but is often considered as such.

## The NIST Model

- **Another Important Characteristic**

### *Multi-tenancy*

- Single-tenancy increases usage cost.
- Multi-tenancy makes cloud computing economical.
- Multi-tenancy perfectly fits in public cloud environment, but does not apply in private deployments.

# The NIST Model

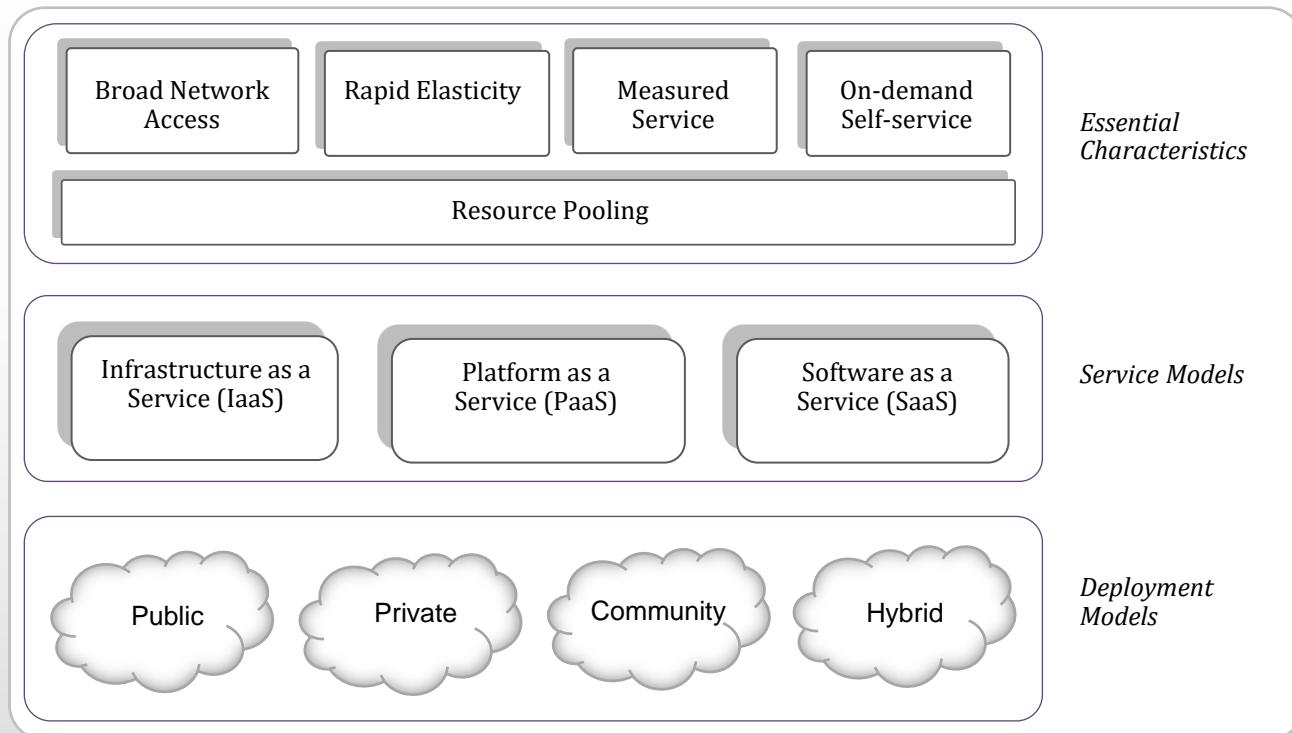
- Comparison of characteristics among cluster, grid and cloud computing models

|                        | Cluster | Grid | Cloud |
|------------------------|---------|------|-------|
| Resource Pooling       | Yes     | Yes  | Yes   |
| Broad Network Access   | Yes     | Yes  | Yes   |
| Measured Service       | No      | Yes  | Yes   |
| Rapid Elasticity       | No      | No   | Yes   |
| On-demand Self-service | No      | No   | Yes   |

## The NIST Model

- NIST Model consists of three components
  - Cloud service model
  - Cloud deployment model
  - Essential cloud attributes or characteristics

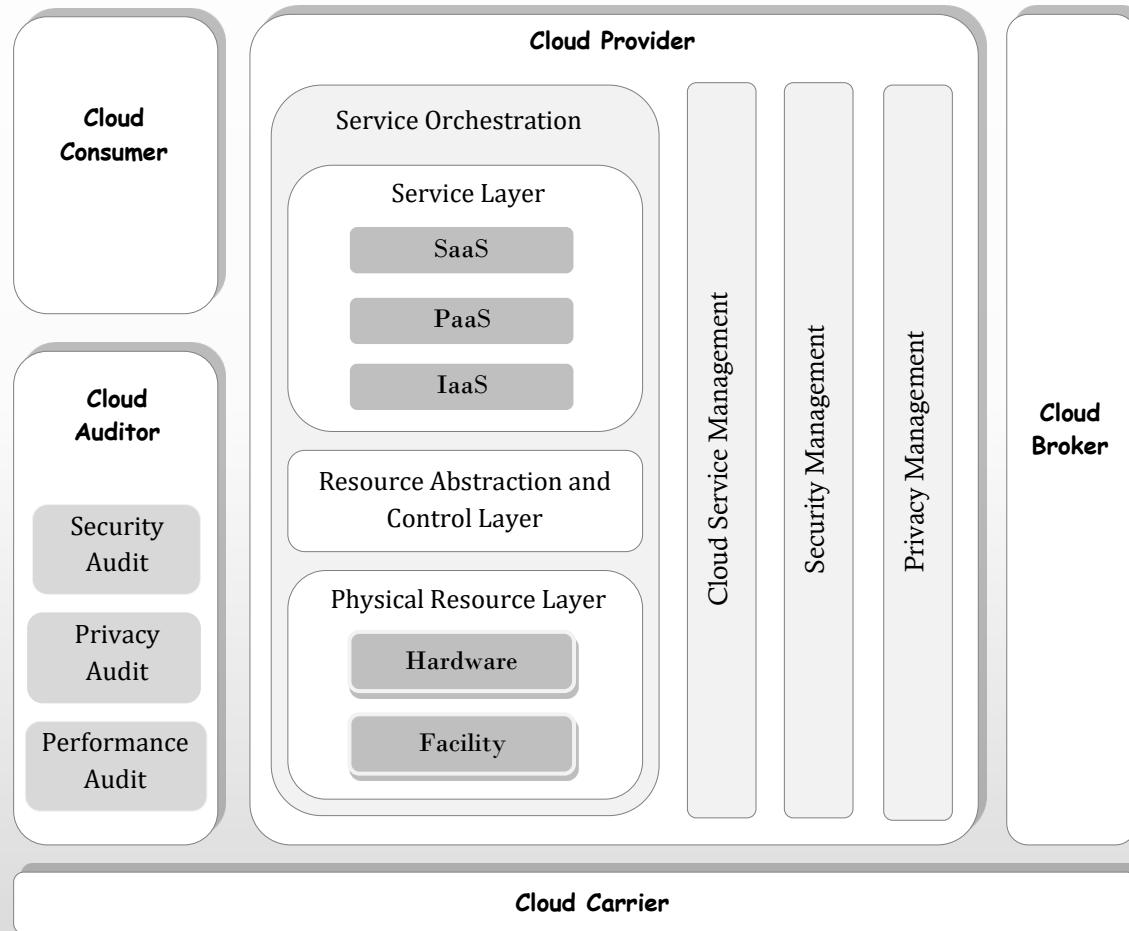
# The NIST Model



## NIST Cloud Reference Architecture

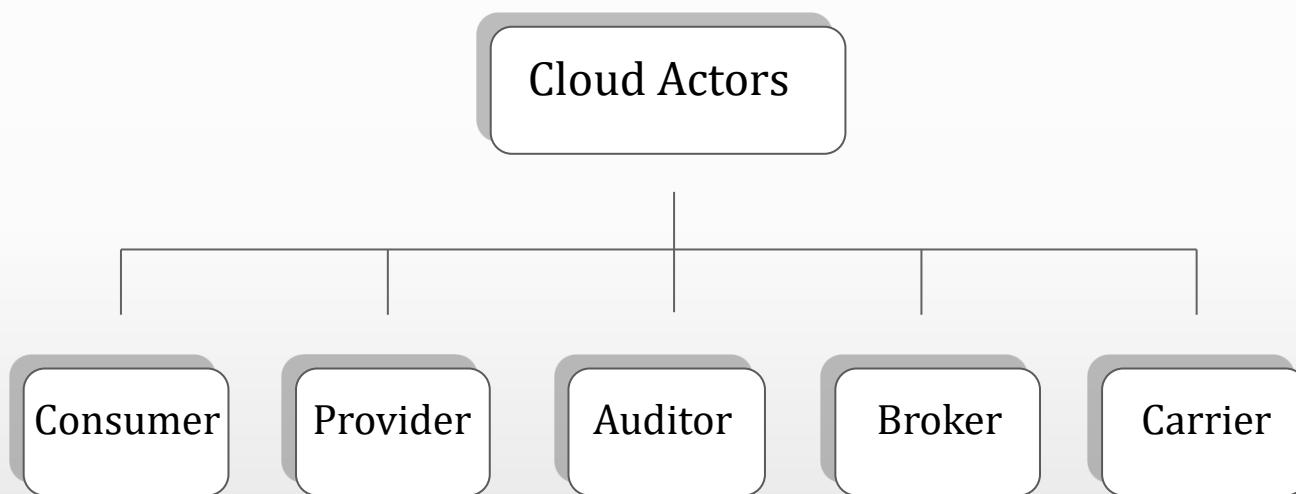
- ▶ NIST cloud reference architecture is a logical extension to the NIST cloud computing definition.
- ▶ The architecture focuses on “what” cloud services need to provide and not “how to” do that.
- ▶ It depicts a generic high-level architecture and represents an actor/role based model.

# NIST Cloud Reference Architecture



# NIST Cloud Reference Architecture

- The Actors



# NIST Cloud Reference Architecture

- **The Actors and Their Roles**

1. *Cloud Consumer*

- A cloud consumer represents a person or organization.
- They use the service from, a cloud provider.
- Cloud consumer is the principal stakeholder in cloud computing.

# NIST Cloud Reference Architecture

- The Actors and Their Roles

## 2. *Cloud Provider*

- It is the entity responsible for making service available to interested parties (consumers).
- Cloud Provider acquires and manages the computing infrastructure required for providing the services.

# NIST Cloud Reference Architecture

- **The Actors and Their Roles**

## **3. *Cloud Auditor***

- The cloud auditor is a party who can conduct independent assessment of cloud services and report it.
- They audit any violation in pre-agreed policies and regulations between provider and consumer.
- Audit happens on criterions like performance, security etc.

# NIST Cloud Reference Architecture

- The Actors and Their Roles

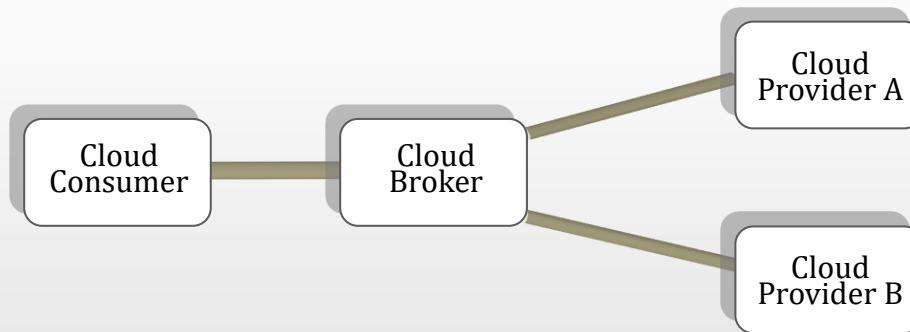
## 4. *Cloud Broker*

- There can be enormous numbers of services and service providers, that consumers may not be aware about.
- There may also be a need to integrate two different services from two different providers.
- Cloud broker makes these things easier for consumers.
- They negotiates relationships between cloud providers and cloud consumers.

# NIST Cloud Reference Architecture

- The Actors and Their Roles

## 4. *Cloud Broker*



Usage Scenario of Cloud Broker

# NIST Cloud Reference Architecture

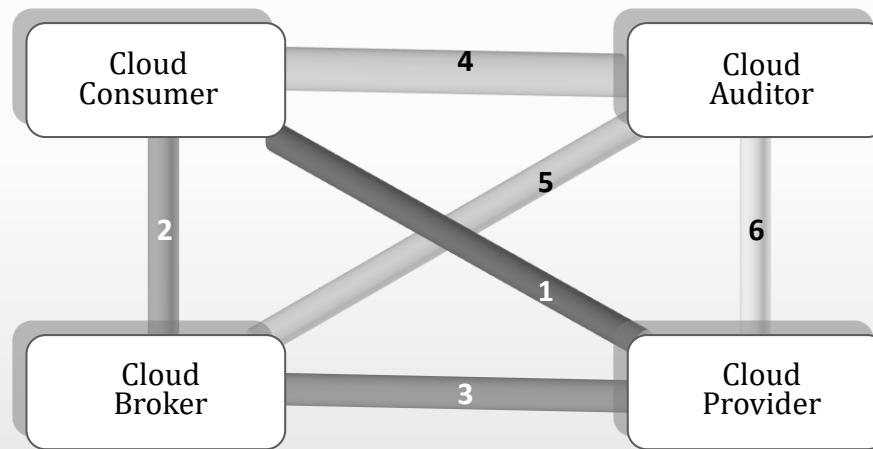
- **The Actors and Their Roles**

## 5. *Cloud Carrier*

- Cloud computing services are delivered from cloud provider to cloud consumer, either directly or via some cloud broker.
- Cloud carrier acts as an agent in this delivery.
- They are organizations who provide connectivity and transport facility of services through network.

# NIST Cloud Reference Architecture

- Interactions between the Actors in NIST model



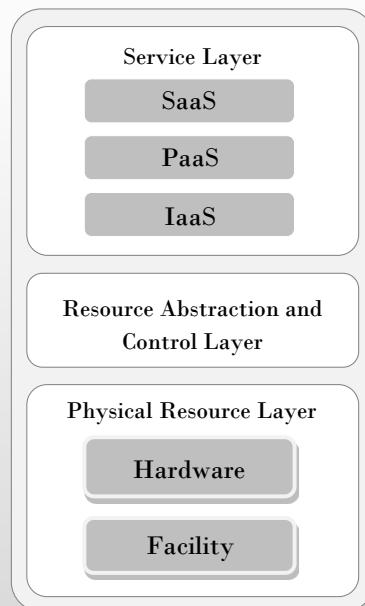
The numbers represent the order of interactions among actors.

# NIST Cloud Reference Architecture

- **Service Orchestration**
- Service orchestration is an important part for cloud provider.
- It is the composition of system components to support the cloud providers' activities.

# NIST Cloud Reference Architecture

- **Service Orchestration**
- Service orchestration has three layers in it.



# NIST Cloud Reference Architecture

- **Service Orchestration**
- The physical resource layer is the lowest layer in the stack that houses all the physical computing resources.
- The middle layer is the resource abstraction and control layer. At this layer the abstraction of physical resources are implemented (through software).
- At the top, there is the service layer, that provides computing services to users.

**Thank You**