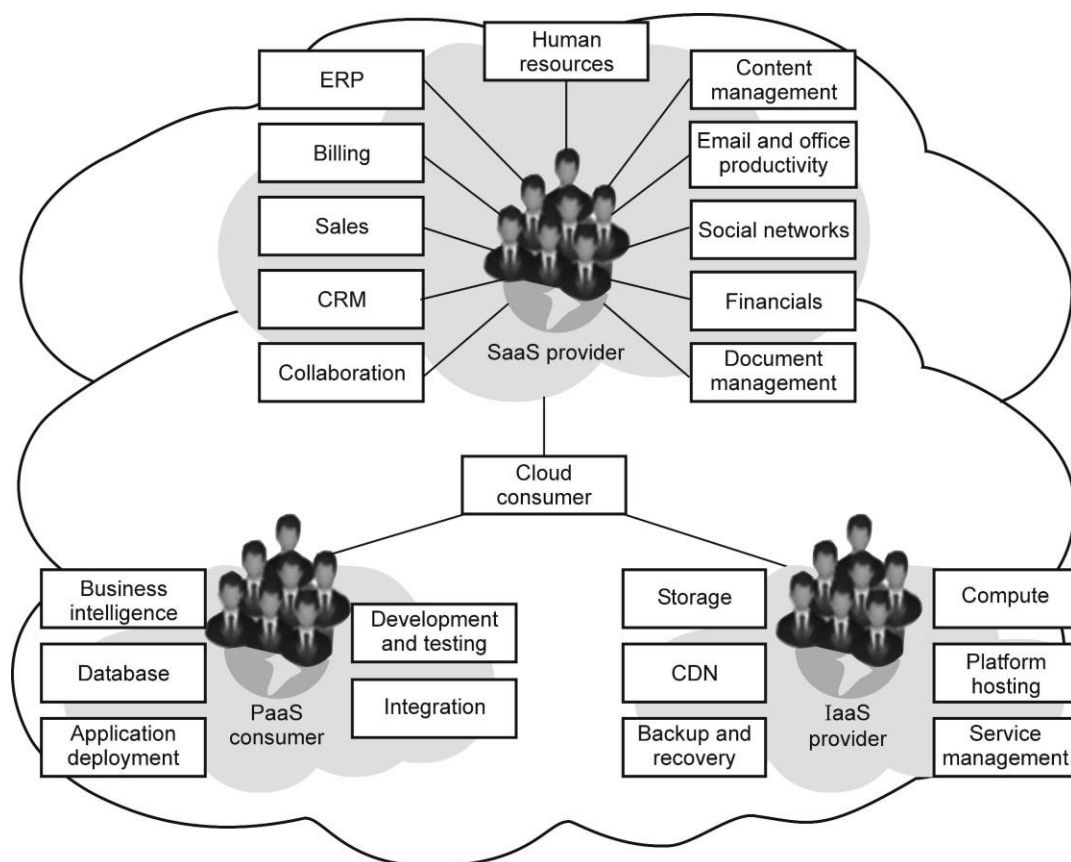


In all the given scenarios, the cloud consumer plays the most important role. Based on the service request, the activities of other players and usage scenarios can differ for other cloud consumers. Fig. 1.7 shows an example of available cloud services types.

In Fig. 1.7 note that SaaS applications are available over a network to all consumers. These consumers may be organisations with access to software applications, end users, app developers or administrators. Billing is based on the number of end users, the time of use, network bandwidth consumed and for the amount or volume of data stored.



Example of cloud services available to cloud consumers

PaaS consumers can utilize tools, execution resources, development IDEs made available by cloud providers. Using these resources, they can test, develop, manage, deploy and configure many applications that are hosted on a cloud. PaaS consumers are billed based on processing, database, storage, network resources consumed and for the duration of the platform used.

On the other hand, IaaS consumers can access virtual computers, network - attached storage, network components, processor resources and other computing resources that are deployed and run arbitrary software. IaaS consumers are billed based on the amount and duration of hardware resources consumed, number of IP addresses, volume of data stored, network bandwidth, and CPU hours used for a certain duration.

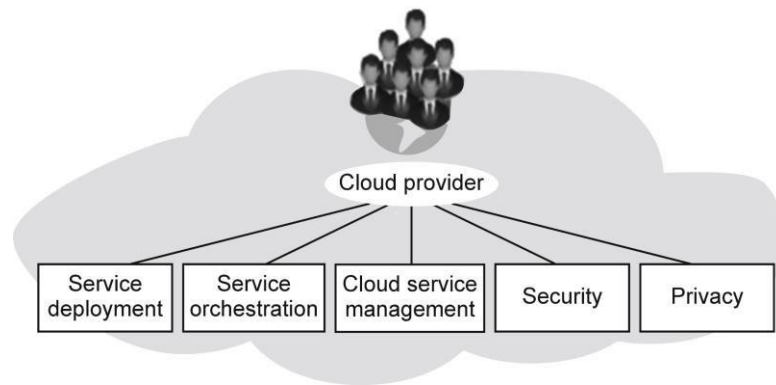
Cloud Provider

Cloud provider is an entity that offers cloud services to interested parties. A cloud provider manages the infrastructure needed for providing cloud services. The CSP also runs the software to provide services and organizes the service delivery to cloud consumers through networks.

SaaS providers then deploy, configure, maintain and update all operations of the software application on the cloud infrastructure, in order to ensure that services are provisioned and to fulfil cloud consumer service requests. SaaS providers assume most of the responsibilities associated with managing and controlling applications deployed on the infrastructure. On the other hand, SaaS consumers have no or limited administrative controls.

PaaS cloud providers manage the computing infrastructure and ensure that the platform runs the cloud software and implements databases, appropriate runtime software execution stack and other required middleware elements. They support development, deployment and the management of PaaS consumers by providing them with necessary tools such as IDEs, SDKs and others. PaaS providers have complete control of applications, settings of the hosting environment, but have lesser control over the infrastructure lying under the platform, network, servers, OS and storage.

Now, the IaaS CSP aggregates physical cloud resources such as networks, servers, storage and network hosting infrastructure. The provider operates the cloud software and makes all compute resources available to IaaS cloud consumer via a set of service interfaces, such as VMs and virtual network interfaces. The IaaS cloud provider will have control over the physical hardware and cloud software to enable provisioning and possible infrastructure services.



Major activities of a cloud provider

The major activities of a cloud provider include :

- **Service deployment:** Service deployment refers to provisioning private, public, hybrid and community cloud models.
- **Service orchestration:** Service orchestration implies the coordination, management of cloud infrastructure and arrangement to offer optimized capabilities of cloud services. The capabilities must be cost-effective in managing IT resources and must be determined by strategic business needs.
- **Cloud services management:** This activity involves all service-related functions needed to manage and operate the services requested or proposed by cloud consumers.
- **Security:** Security, which is a critical function in cloud computing, spans all layers in the reference architecture. Security must be enforced end-to-end. It has a wide range from physical to application security. CSPs must take care of security.
- **Privacy:** Privacy in cloud must be ensured at different levels, such as user privacy, data privacy, authorization and authentication and it must also have adequate assurance levels. Since clouds allow resources to be shared, privacy challenges are a big concern for consumers using clouds.

Cloud Auditor

The cloud auditor performs the task of independently evaluating cloud service controls to provide an honest opinion when requested. Cloud audits are done to validate standards conformance by reviewing the objective evidence. The auditor will examine services provided by the cloud provider for its security controls, privacy, performance, and so on.

Cloud Broker

The cloud broker collects service requests from cloud consumers and manages the use, performance, and delivery of cloud services. The cloud broker will also negotiate and manage the relationship between cloud providers and consumers. A cloud broker may provide services that fall into one of the following categories :

- **Service intermediation** : Here the cloud broker will improve some specific capabilities, and provide value added services to cloud consumers.
- **Service aggregation** : The cloud broker links and integrates different services into one or more new services.
- **Service Arbitrage** : This is similar to aggregation, except for the fact that services that are aggregated are not fixed. In service arbitrage, the broker has the liberty to choose services from different agencies.

Cloud Carrier

The cloud carrier tries to establish connectivity and transports cloud services between a cloud consumer and a cloud provider. Cloud carriers offer network access for consumers, by providing telecommunication links for accessing resources using other devices (laptops, computers, tablets, smartphones, etc.). Usually, a transport agent is an entity offering telecommunication carriers to a business organization to access resources. The cloud provider will set up SLAs with cloud carrier to ensure carrier transport is consistent with the level of SLA provided by the consumers. Cloud carriers provide secure and dedicated high - speed links with cloud providers and between different cloud Entities.

Actor	Definition
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 Carrier	An intermediary that provides connectivity and transport of cloud services from Cloud Providers to Cloud Consumers.

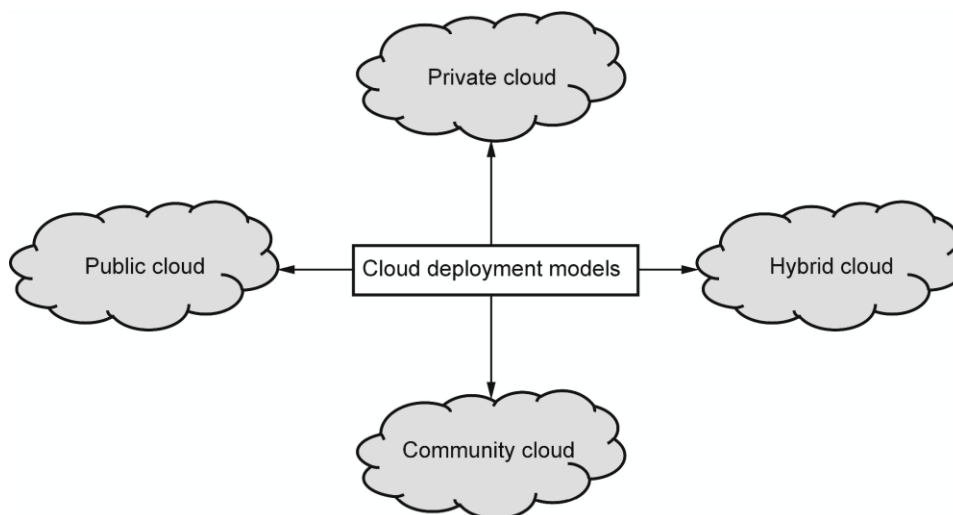
Cloud Auditor	A party that can conduct independent assessment of cloud services, information system operations, performance and security of the cloud implementation.
Cloud Broker	An entity that manages the use, performance and delivery of cloud services, and negotiates relationships between Cloud Providers and Cloud

Cloud Deployment Models

A cloud deployment models are defined according to where the computing infrastructure resides and who controls the infrastructure. The NIST have classified cloud deployment models into four categories namely,

- **Public cloud**
- **Private cloud**
- **Hybrid cloud**
- **Community cloud**

They describe the way in which users can access the cloud services. Each cloud deployment model fits different organizational needs, so it's important that you pick a model that will suit your organization's needs. The four deployment models are characterized based on the functionality and accessibility of cloud services. The four deployment models of cloud computing are shown in Fig. 1.9.



Four deployment models of cloud computing