a. Explain community cloud and list out the benefits.
b. Discuss about the economics of the cloud.

Community clouds

Community clouds are distributed systems created by integrating the services of different clouds to address the specific needs of an industry, a community, or a business sector. The National Institute of Standards and Technologies (NIST) characterize community clouds as follows:

The infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy, and compliance considerations). It may be managed by the organizations or a third party and may exist on premise or off premise.

Figure 3.6 provides a general view of the usage scenario of community clouds, together with reference architecture. The users of a specific community cloud fall into a well-identified community, sharing the same concerns or needs; they can be government bodies, industries, or even simple users, but all of them focus on the same issues for their interaction with the cloud. This is a different scenario than public clouds, which serve a multitude of users with different needs. Community clouds are also different from private clouds, where the services are generally delivered within the institution that owns the cloud.

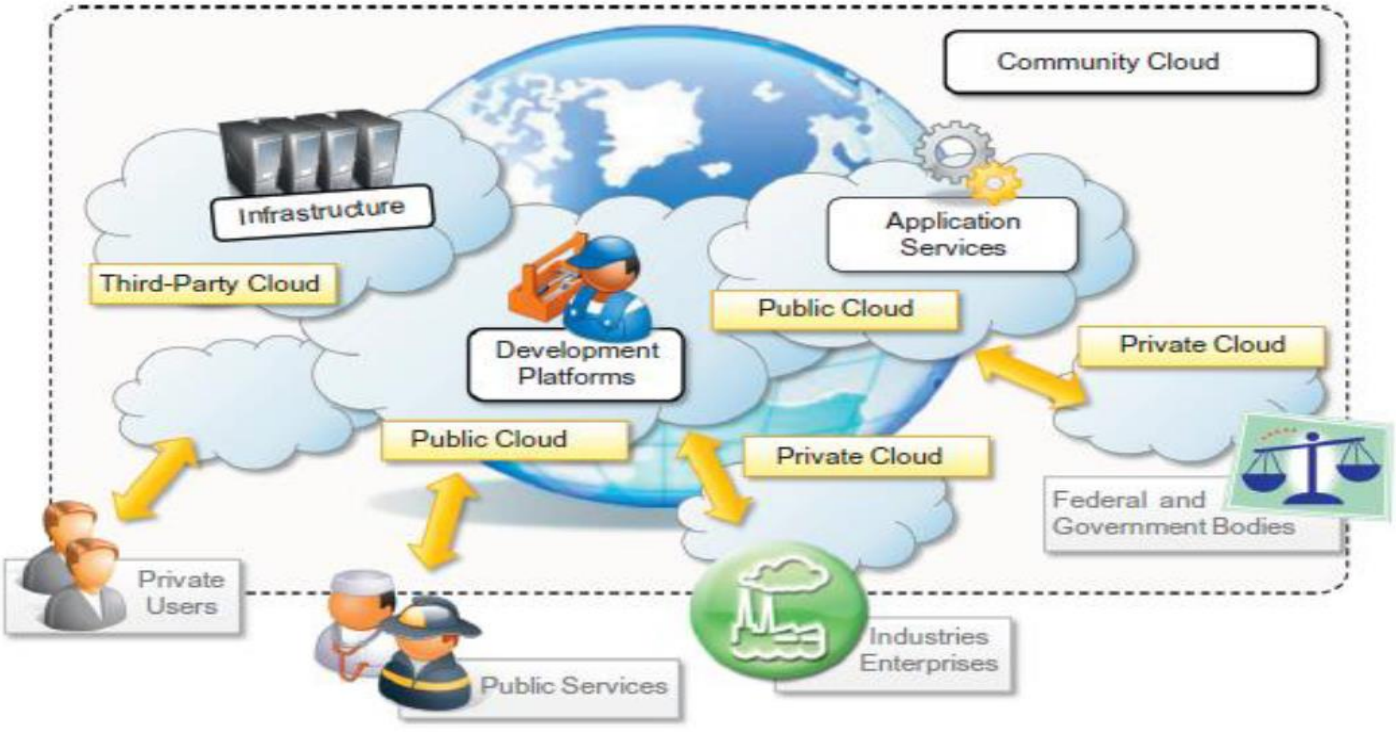

Figure 3.5 A Community Cloud

The benefits of these community clouds are the following:

- *Openness*. By removing the dependency on cloud vendors, community clouds are open systems in which fair competition between different solutions can happen.
- *Community*. Being based on a collective that provides resources and services, the infrastructure turns out to be more scalable because the system can grow simply by expanding its user base.
- *Graceful failures*. Since there is no single provider or vendor in control of the infrastructure, there is no single point of failure.
- *Convenience and control*. Within a community cloud there is no conflict between convenience and control because the cloud is shared and owned by the community, which makes all the decisions through a collective democratic process.
- *Environmental sustainability*. The community cloud is supposed to have a smaller carbon footprint because it harnesses underutilized resources. Moreover, these clouds tend to be more organic by growing and shrinking in a symbiotic relationship to support the demand of the community, which in turn sustains it.

Economics of the cloud:

The main drivers of cloud computing are economy of scale and simplicity of software delivery and its operation. In fact, the biggest benefit of this phenomenon is financial: the pay-as-you-go model offered by cloud providers. In particular, cloud computing allows:

1. Reducing the capital costs associated to the IT infrastructure
2. Eliminating the depreciation or lifetime costs associated with IT capital assets
3. Replacing software licensing with subscriptions
4. Cutting the maintenance and administrative costs of IT resources.

A capital cost is the cost occurred in purchasing an asset that is useful in the production of goods or the rendering of services. Capital costs are one-time expenses that are generally paid up front and that will contribute over the long term to generate profit.

IT resources constitute a capital cost for any kind of enterprise. It is good practice to try to keep capital costs low because they introduce expenses that will generate profit over time; more than that, since they are associated with material things they are subject to depreciation over time, which in the end reduces the profit of the enterprise because such costs are directly subtracted from the enterprise revenues.

One of the advantages introduced by the cloud computing model is that it shifts the capital costs previously allocated to the purchase of hardware and software into operational costs inducted by renting the infrastructure and paying subscriptions for the use of software. These costs can be better controlled according to the business needs and prosperity of the enterprise. Cloud

computing also introduces reductions in administrative and maintenance costs. That is, there is no or limited need for having administrative staff take care of the management of the cloud infrastructure.

In terms of the pricing models introduced by cloud computing, we can distinguish three different strategies that are adopted by the providers:

1. Tiered pricing. In this model, cloud services are offered in several tiers, each of which offers a fixed computing specification and SLA at a specific price per unit of time. This model is used by Amazon for pricing the EC2 service.

2. Per-unit pricing. This model is more suitable to cases where the principal source of revenue for the cloud provider is determined in terms of units of specific services, such as data transfer and memory allocation. In this scenario customers can configure their systems more efficiently according to the application needs. This model is used, for example, by GoGrid, which makes customers pay according to RAM/hour units for the servers deployed in the GoGrid cloud.

3. Subscription-based pricing. This is the model used mostly by SaaS providers in which users pay a periodic subscription fee for use of the software or the specific component services that are integrated in their applications.

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Classify & Explain the various types of clouds.

Clouds constitute the primary outcome of cloud computing. They are a type of parallel and distributed system harnessing physical and virtual computers presented as a unified computing resource.

A more useful classification is given according to the administrative domain of a cloud. It is then possible to differentiate four different types of cloud:

1. Public clouds. The cloud is open to the wider public.

2. Private clouds. The cloud is implemented within the private premises of an institution and generally made accessible to the members of the institution or a subset of them.

3. Hybrid or heterogeneous clouds. The cloud is a combination of the two previous solutions and most likely identifies a private cloud that has been augmented with resources or services hosted in a public cloud.

4. Community clouds. The cloud is characterized by a multi-administrative domain involving different deployment models (public, private, and hybrid), and it is specifically designed to address the needs of a specific industry.

Public clouds:

Public clouds are a realization of the canonical view of cloud computing in which the services offered are made available to anyone, from anywhere, and at any time through the Internet. From a structural point of view they are a distributed system, most likely composed of one or more datacenters connected together, on top of which the specific services offered by the cloud are implemented. Any customer can easily sign in with the cloud provider, enter her credential and billing details, and use the services offered.

Historically, public clouds were the first class of cloud that were implemented and offered. They offer solutions for minimizing IT infrastructure costs and serve as a viable option for handling peak loads on the local infrastructure.

A fundamental characteristic of public clouds is multitenancy. A public cloud is meant to serve a multitude of users, not a single customer. Any customer requires a virtual computing environment that is separated, and most likely isolated, from other users.

QoS management is a very important aspect of public clouds.

Hence, a significant portion of the software infrastructure is devoted to monitoring the cloud resources, to bill them according to the contract made with the user, and to keep a complete history of cloud usage for each customer.

A public cloud can offer any kind of service: infrastructure, platform, or applications. For example, Amazon EC2 is a public cloud that provides infrastructure as a service; Google AppEngine is a public cloud that provides an application development platform as a service; and SalesForce.com is a public cloud that provides software as a service.

Private clouds:

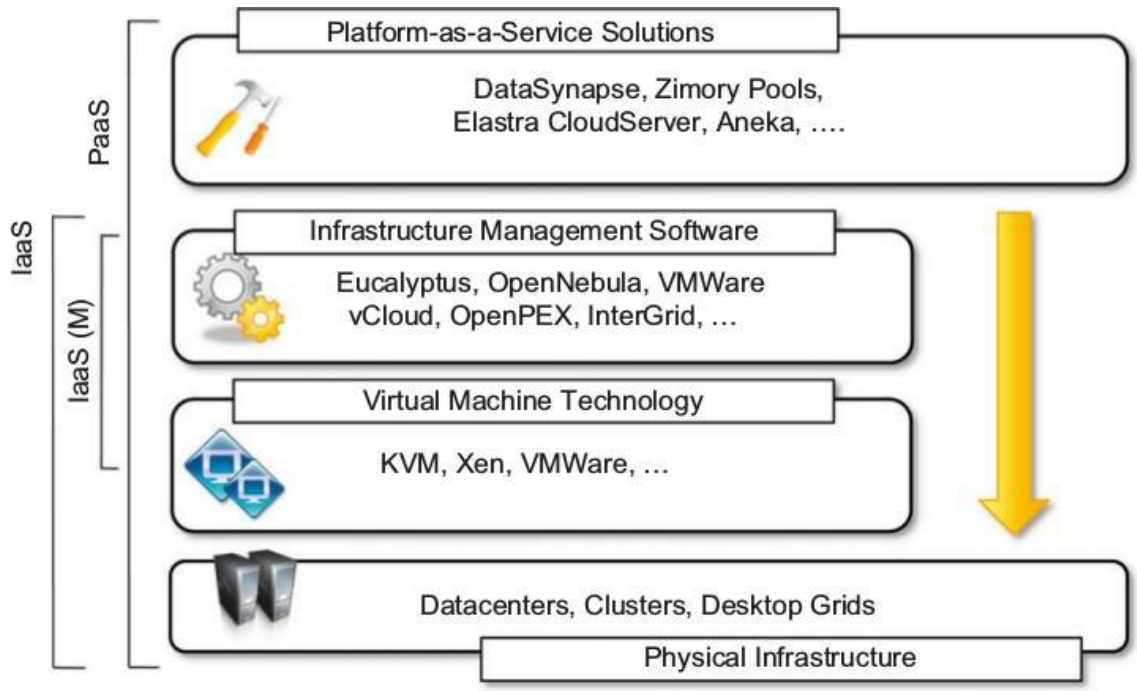

FIGURE 4.4

Private clouds hardware and software stack.

Private clouds are virtual distributed systems that rely on a private infrastructure and provide internal users with dynamic provisioning of computing resources. Instead of a pay-as-you-go model as in public clouds, there could be other schemes in place, taking into account the usage of the cloud and proportionally billing the different departments or sections of an enterprise. Private clouds have the advantage of keeping the core business operations in-house by relying on the existing IT infrastructure and reducing the burden of maintaining it once the cloud has been set up. In this scenario, security concerns are less critical, since sensitive information does not flow out of the private infrastructure. Moreover, existing IT resources can be better utilized because the private cloud can provide services to a different range of users. Another interesting opportunity that

comes with private clouds is the possibility of testing applications and systems at a comparatively lower price.

Key advantages of using a private cloud computing infrastructure:

1. Customer information protection. Despite assurances by the public cloud leaders about security, few provide satisfactory disclosure or have long enough histories with their cloud offerings to provide warranties about the specific level of security put in place on their systems. In-house security is easier to maintain and rely on.

2. Infrastructure ensuring SLAs. Quality of service implies specific operations such as appropriate clustering and failover, data replication, system monitoring and maintenance, and disaster recovery, and other uptime services can be commensurate to the application needs. Although public cloud vendors provide some of these features, not all of them are available as needed.

3. Compliance with standard procedures and operations. If organizations are subject to third- party compliance standards, specific procedures have to be put in place when deploying and executing applications. This could be not possible in the case of the virtual public infrastructure.

Data Synapse provides a flexible environment for building private clouds on top of datacenters. Elastra Cloud Server is a platform for easily configuring and deploying distributed application infrastructures on clouds.

Hybrid clouds:

Public clouds are large software and hardware infrastructures that have a capability that is huge enough to serve the needs of multiple users, but they suffer from security threats and administrative pitfalls.

One of the major drawbacks of private deployments is the inability to scale on demand and to efficiently address peak loads. In this case, it is important to leverage capabilities of public clouds as needed.

Hybrid clouds allow enterprises to exploit existing IT infrastructures, maintain sensitive information within the premises, and naturally grow and shrink by provisioning external resources and releasing them when they're no longer needed. Security concerns are then only limited to the public portion of the cloud that can be used to perform operations with less stringent constraints but that are still part of the system workload.

Figure 4.5 provides a general overview of a hybrid cloud: It is a heterogeneous distributed system resulting from a private cloud that integrates additional services or resources from one or more public clouds. For this reason they are also called heterogeneous clouds. As depicted in the diagram, dynamic provisioning is a fundamental component in this scenario. Hybrid clouds address scalability issues by leveraging external resources for exceeding capacity demand. These resources or services are temporarily leased for the time required and then released. This practice is also known as cloud bursting. Dynamic provisioning is most commonly implemented in PaaS solutions that support hybrid clouds.

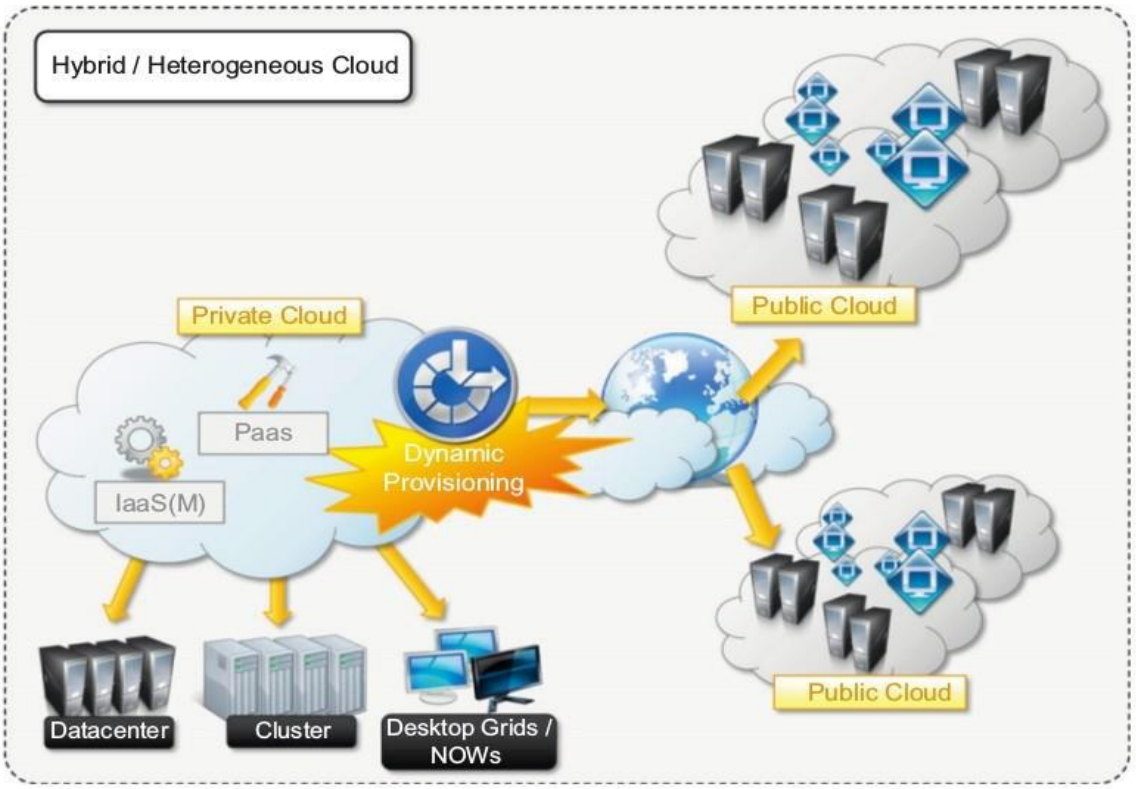

FIGURE 4.5

Hybrid/heterogeneous cloud overview.

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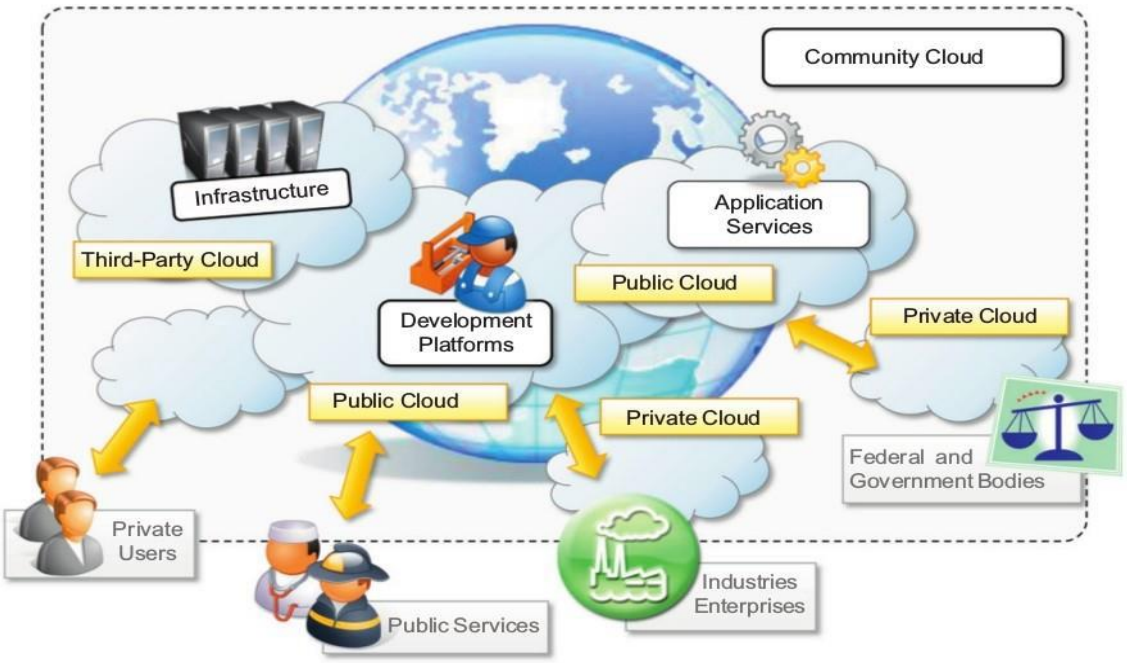

FIGURE 4.6

A community cloud.