UNIT - 2

CLOUD COMPUTING

Motivation for Cloud Computing

Cloud computing is needed in getting the services of **computing resources.** Thus, one can say as a one-line answer to the need for cloud computing that it **eliminates a large computing investment** without compromising the use of computing at the user level at an operational cost. Cloud computing is **very economical** and **saves a lot of money**. A blind benefit of this computing is that even if we lose our laptop or due to some crisis our personal computer—and the desktop system—gets damaged, still **our data and files will stay safe and secured** as these are not in our local machine (but remotely located at the provider's place—machine)

The Need for Cloud Computing

The main reasons for the need and use of cloud computing are **convenience and reliability.** The cloud also makes it much easier to share a file with friends, making it possible to **collaborate over the web.**

NIST Definition of Cloud Computing

The formal definition of cloud computing comes from the **National Institute of Standards and Technology (NIST)**: “Cloud computing is a model for enabling **ubiquitous, 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.

Cloud Computing Is a Service

The simplest thing that any computer does is allow us to **store and retrieve information**.

For Example:

1. First, **Flickr** allows us to **easily access our images** no matter where we are or what type of device we are using. While we might upload the photos of our vacation from our home computer, later, we can easily access them from our laptop at the office.
2. Second, Flickr lets us **share the images.** There is no need to burn them to a CD or save them on a flash drive. We can just send someone our Flickr address to share these photos or images.
3. Third, Flickr provides **data security.** By uploading the images to Flickr, we are providing ourselves with data security **by creating a backup on the web.** And, while it is always best to keep a local copy— either on a computer, a CD, or a flash drive—the truth is that we are far more likely to lose the images that we store locally than Flickr is of losing our images.

Cloud Computing Is a Platform

The World Wide Web (WWW) can be considered as the operating system for all our Internet-based applications. However, one has to understand that we will always need a **local operating system in our computer to access web based applications.** The basic meaning of the term platform is that it is the support on which applications run or give results to the users.

For example,

Microsoft Windows is a platform. But, a platform does not have to be an operating system. Java is a platform even though it is not an operating system. Through cloud computing, the **web is becoming a platform**. With trends (applications) such as Office 2.0, more and more applications that were originally available on desktop computers are now being converted into web–cloud applications. Word processors like Buzzword and office suites like Google Docs are now available in the cloud as their desktop counterparts. All these kinds of trends in providing applications via the cloud are turning **cloud computing into a platform or to act as a platform**

Principles of Cloud computing

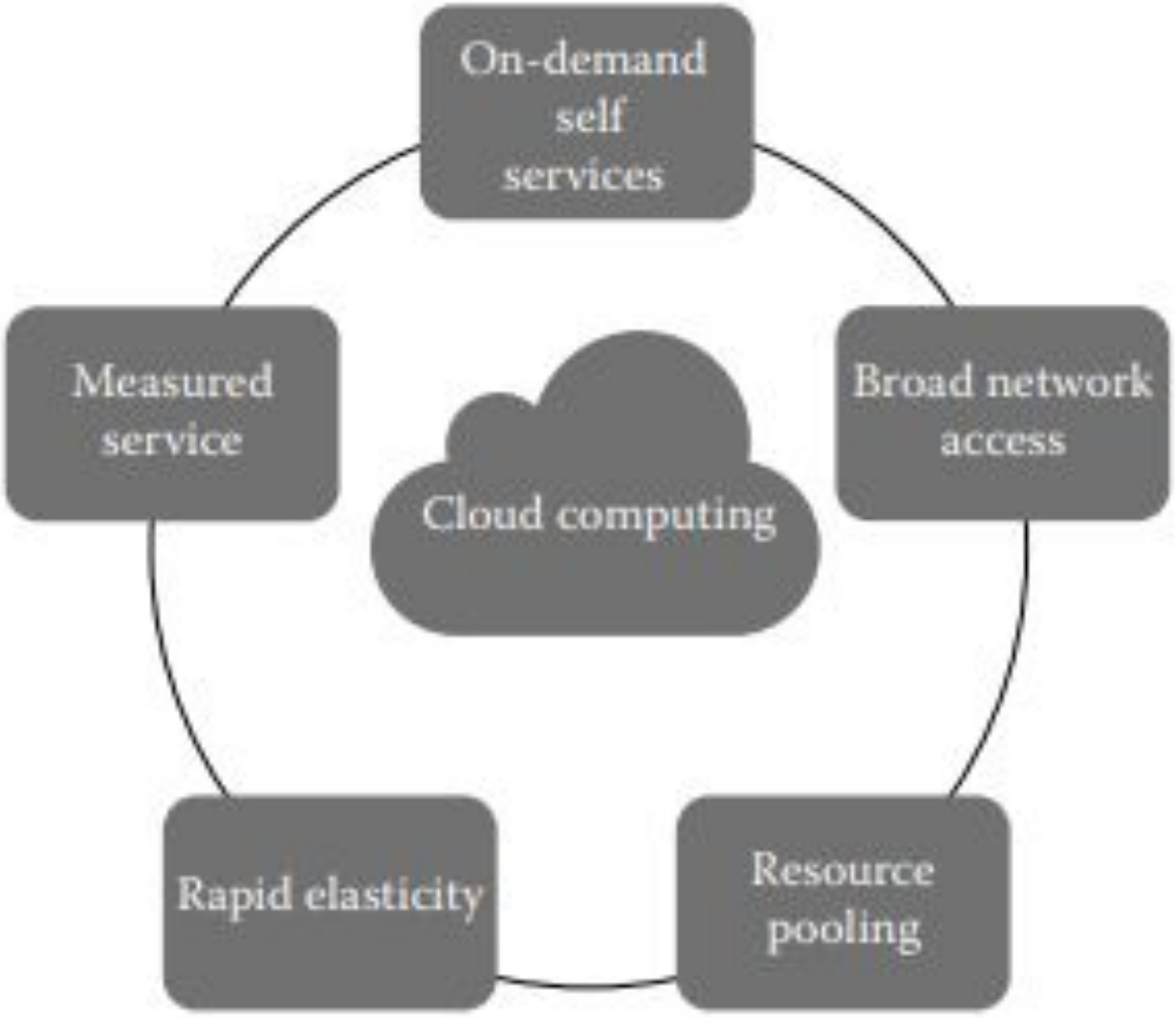
Principles put forth by NIST describe

a) the **five essential characteristic** features that promote cloud computing,

b) the **four deployment models** that are used to narrate the cloud computing opportunities for customers while looking at architectural models, and

c) the three important and **basic service** offering models of cloud computing.

Five Essential Characteristics

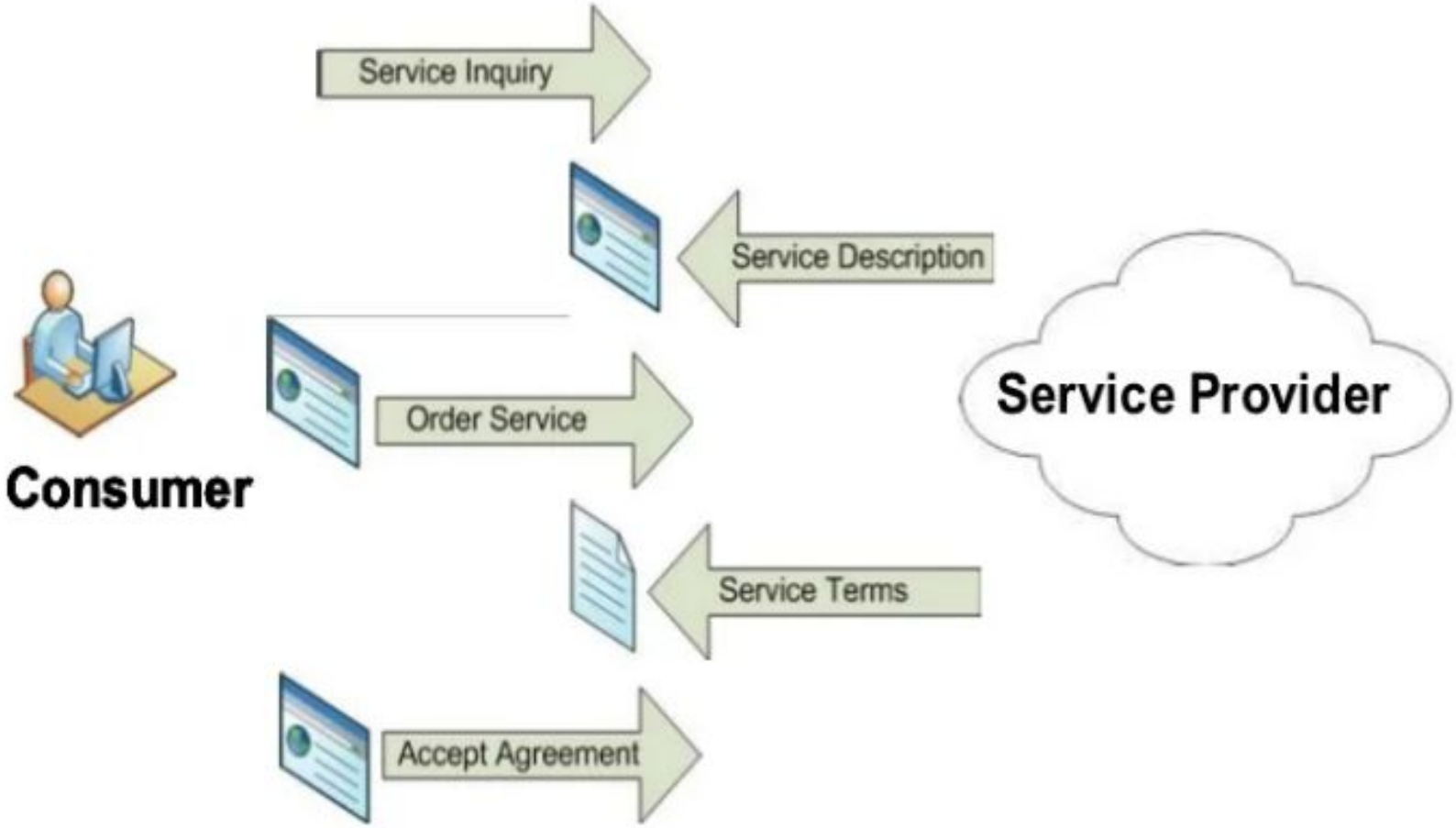


Five Essential Characteristics

- **On-demand self-service:** A consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed **automatically without requiring human interaction** with each service's provider.
- **Broad network access:** Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, laptops, and personal digital assistants [PDAs]).

Five Essential Characteristics

Essential Characteristics:
On-demand Self Service

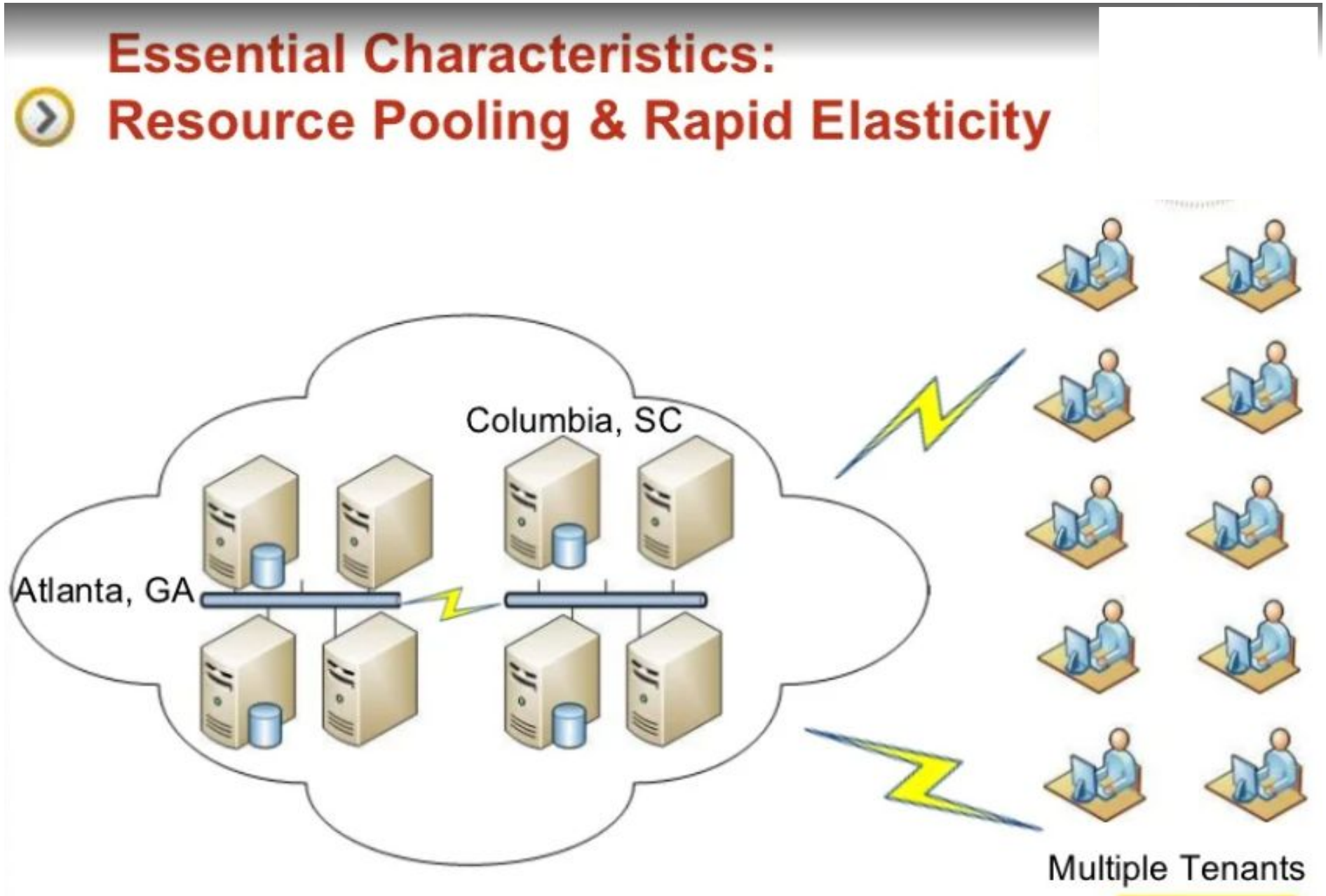


Five Essential Characteristics

Elastic resource pooling: The provider's computing r**esources are pooled** to serve **multiple consumers** using a multitenant model, with different physical and virtual resources **dynamically assigned and reassigned according to consumer demand**. There is a sense of location independence in that the customer generally has **no control or knowledge** over the exact location of the provided resources but may be able to specify the location at a higher level of abstraction (e.g., country, state, or data center). **Examples of resources include storage, processing, memory, and network bandwidth**.

Rapid elasticity: Capabilities can be rapidly and elastically provisioned, in some cases automatically, to quickly scale out and rapidly released to quickly scale in. To the consumer, the capabilities available for provisioning often appear to be **unlimited and can be purchased in any quantity at any time.**

Five Essential Characteristics



Five Essential Characteristics

Measured service: Cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts). **Resource usage can be monitored, controlled, and reported** providing **transparency for both the provider and consumer** of the utilized service.

Four Cloud Deployment Models

Private cloud: The cloud infrastructure is provisioned for exclusive use by a single organization comprising multiple consumers (e.g., business units). It may be **owned, managed, and operated by the organization**, a third party, or some combination of them, and it may exist on or off premises.

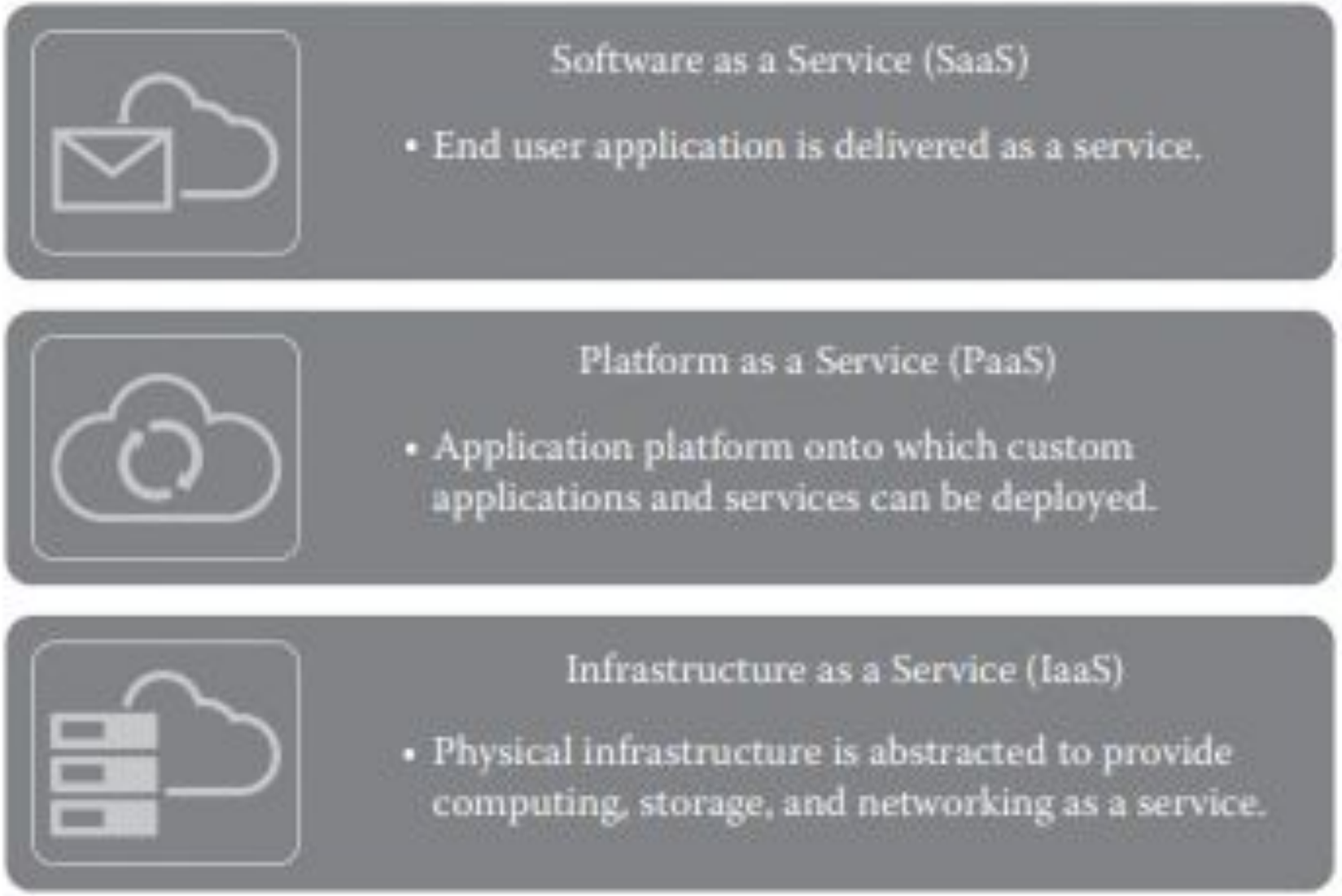
Public cloud: The cloud infrastructure is provisioned for open use by the general public. It may be **owned, managed, and operated by a business, academic, or government organization**, or some combination of them. It exists on the premises of the cloud provider.

Community cloud: The cloud 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.

Four Cloud Deployment Models

Hybrid cloud: The cloud infrastructure is a **composition of two or more distinct cloud** infrastructures (private, community, or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load balancing between clouds

Three Service Offering Models



Cloud Ecosystem

Cloud ecosystem is a term used to **describe the complete environment** or system of interdependent components or entities that work together to enable and support the cloud services.

To be more precise, the cloud computing's ecosystem is a **complex environment** that includes the description of every term or entity along with their interaction; the **complex entities include the traditional elements of cloud computing such as software (SaaS), hardware (PaaS and/or IaaS),** other infrastructure (e.g., network, storage), and also stakeholders like consultants, integrators, partners, third parties, and anything in their environments that has a bearing on the other components of the cloud.

Cloud Ecosystem

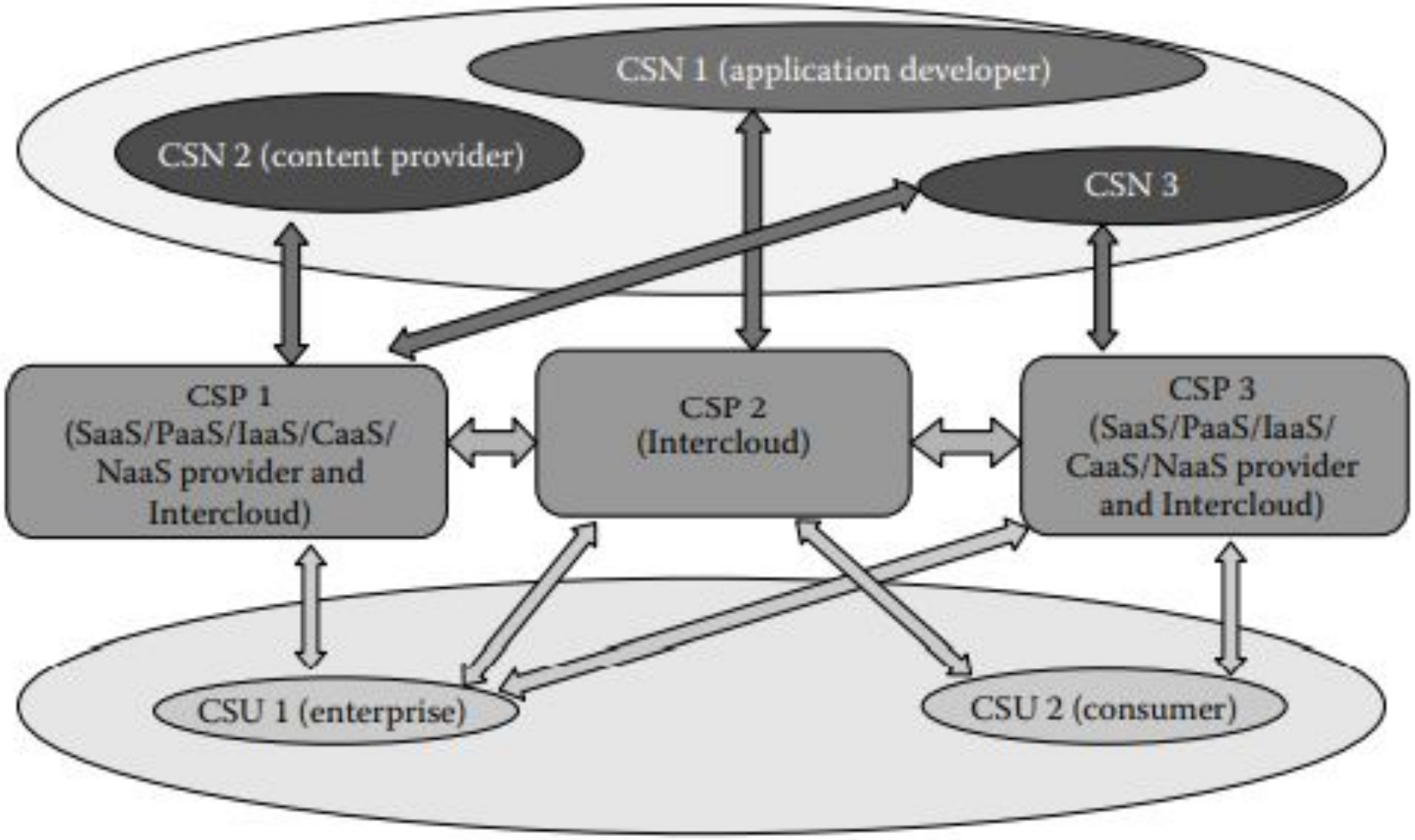


FIGURE 2.4
Actors with some of their possible roles in a cloud ecosystem.

Requirements for Cloud Services

1. **Multitenancy:**

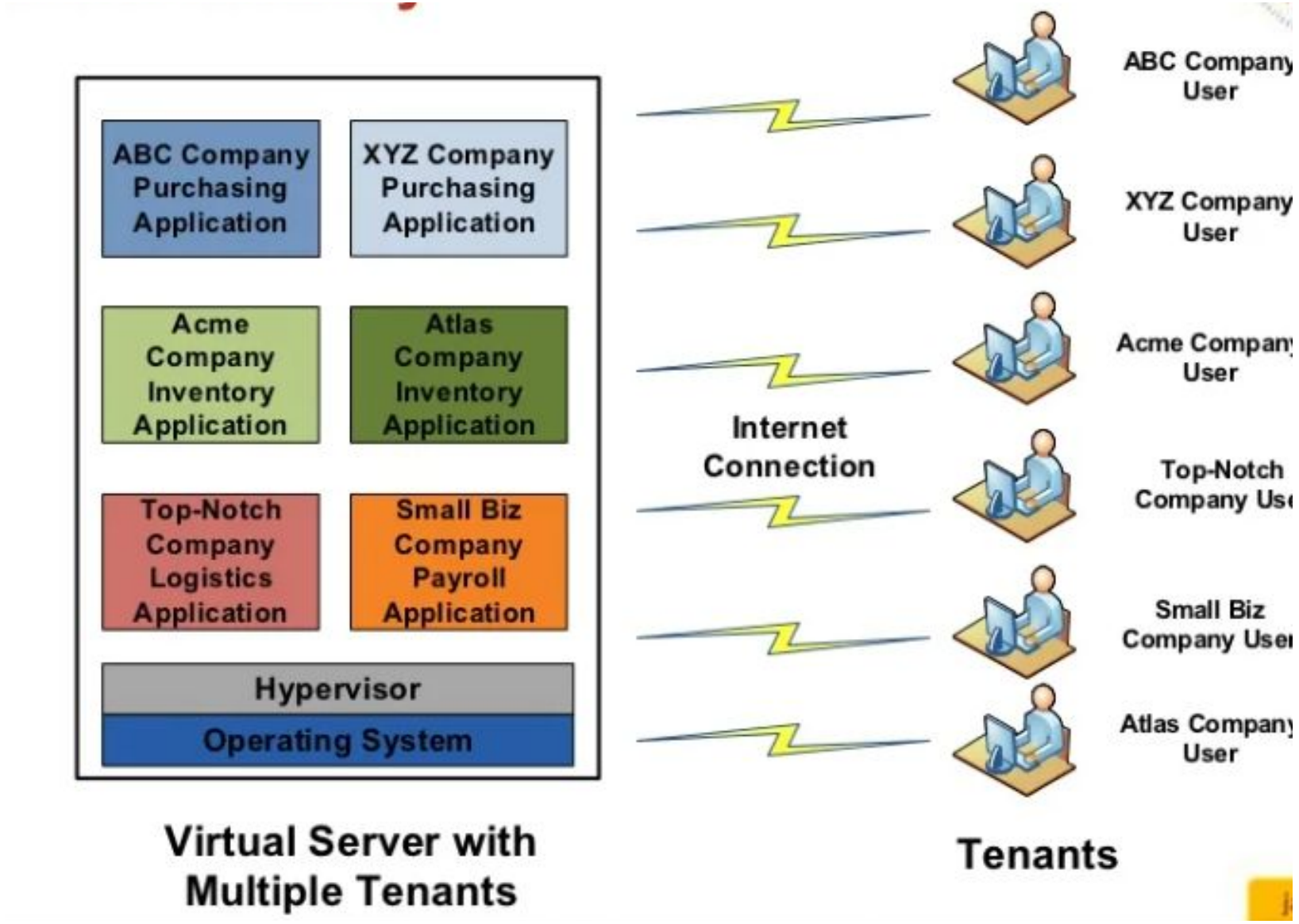
Multitenancy is an essential characteristic of cloud systems aiming to **provide isolation of the different users of the cloud system** (tenants) while maximizing resource sharing. It is expected that multitenancy be supported at various levels of a cloud infrastructure.

As an example, at the application level, multitenancy is a feature that allows a single instance of an application (say, database system) and leverages the economy of scale to satisfy several users at the same time.

2. Service life cycle management:

Cloud services are **paid as per usage** and can be **started and ended** at any time. Therefore, it is required that a cloud service support **automatic service provisioning.** In addition, **metering and charging or billing settlement** needs to be provided for services that are **dynamically created, modified, and then released** in virtual environments.

Requirements for Cloud Services



Requirements for Cloud Services

3. Security: The security of each individual service **needs to be protected in the multitenant cloud environment**; the users (tenants) also support the needed secured services, meaning that a cloud provides strict control for tenants' service access to different resources to avoid the abuse of cloud resources and to facilitate the management of CSUs by CSPs

4.Responsiveness: The cloud ecosystem is expected to in order to help the customers use the services faithfully. **enable early detection, diagnosis, and fixing of service-related problems**

5. Intelligent service deployment: It is expected that the cloud enables efficient use of resources in service deployment, that is, **maximizing the number of deployed services** while minimizing the usage of resources and still respecting the SLAs. For example, the specific application characteristics (e.g., central processing unit [CPU]-intensive, input/output [IO]-intensive) that can be provided by developers or via application monitoring may help CSPs in making efficient use of resources.

Requirements for Cloud Services

6. Portability: It is expected that a cloud service supports the portability of its features over various underlying resources and that CSPs should be able to accommodate cloud workload portability (e.g., **VM portability**) with limited service disruption.

7. Interoperability: It is expected to have available **well-documented and well-tested specifications** that allow **heterogeneous systems** in cloud environments to work together.

8. Regulatory aspects: All applicable regulations shall be respected, including **privacy protection.**

9. Environmental sustainability: A key characteristic of cloud computing is the capability to access, through a **broad network** and thin clients, **on-demand shared pools** of configurable resources that can be rapidly provisioned and released. Cloud computing can then be considered in its essence as an ICT energy consumption consolidation model, supporting mainstream technologies aiming to optimize **energy consumption** (e.g., in data centers) and application performance. Examples of such technologies include **virtualization and multitenancy.**

Requirements for Cloud Services

10. Service reliability, service availability, and quality assurance: CSUs demand for their services end-to-end quality of service (QoS) assurance, **high levels of reliability**, and continued availability to their CSPs.

11. Service access: A cloud infrastructure is expected to provide CSUs with access to cloud services **from any user device**. It is expected that CSUs have a consistent experience when accessing cloud services.

12. Flexibility: It is expected that the cloud service be capable of supporting **multiple cloud deployment models** and cloud service categories.

13. Accounting and charging: It is expected that a cloud service be capable to support **various accounting and charging models and policies**.

14. Massive data processing: It is expected that a cloud supports mechanisms for massive data processing (e.g., **extracting, transforming, and loading data**).

Cloud Application

A cloud application is an application program that functions or executes in the cloud; the application can exhibit some characteristics of a **pure desktop application** and some characteristics of a **pure web-based application**

Benefits and Drawbacks

1. Achieve economies of scale: We can increase the volume output or productivity with fewer systems and thereby **reduce the cost** per unit of a project or product.
2. Reduce spending on technology infrastructure: It is easy to access data and information with minimal upfront spending in a **pay-as-you-go approach**, in the sense that the usage and payment are similar to an electricity meter reading in the house, which is based on demand.
3. Globalize the workforce: People **worldwide can access the cloud** with Internet connection.
4. Streamline business processes: It is possible to get **more work done in less time with less resource**.
5. Reduce capital costs: There is **no need to spend huge money** on hardware, software, or licensing fees.

Benefits and Drawbacks

6. Pervasive accessibility: Data and applications can be **accessed anytime, anywhere**, using any smart computing device, making our life so much easier.
7. Monitor projects more effectively: It is possible to confine **within budgetary allocations** and can be ahead of completion cycle times.
8. **Less personnel training is needed:** It takes fewer people to do more work on a cloud, with a minimal learning curve on hardware and software issues.
9. **Minimize maintenance and licensing software:** As there is no too much of on-premise computing resources, maintenance becomes simple and updates and renewals of software systems rely on the cloud vendor or provider.
0. **Improved flexibility:** It is possible to make fast changes in our work environment without serious issues at stake

Drawbacks to cloud computing

The main point in this context is that if we **lose our Internet connection,** we have lost the link to the cloud and thereby to the data and applications. There is also a concern about security as our entire working with data and applications depend on other's (cloud vendor or providers) computing power. Also, while cloud computing supports scalability (i.e., quickly scaling up and down computing resources depending on the need), it does not permit the control on these resources as these are not owned by the user or customer. Depending on the cloud vendor or provider, customers may face restrictions on the availability of applications, operating systems, and infrastructure options.

Drawbacks to cloud computing

And, sometimes, all development platforms may not be available in the cloud due to the fact that the cloud vendor may not aware of such solutions. A major barrier to cloud computing is the interoperability of applications, which is the ability of two or more applications that are required to support a business need to work together by sharing data and other business-related resources. Normally, this does not happen in the cloud as these applications may not be available with a single cloud vendor and two different vendors having these applications do not cooperate with each other.