Amrita Vishwa Vidyapeetham
Amritapuri Campus
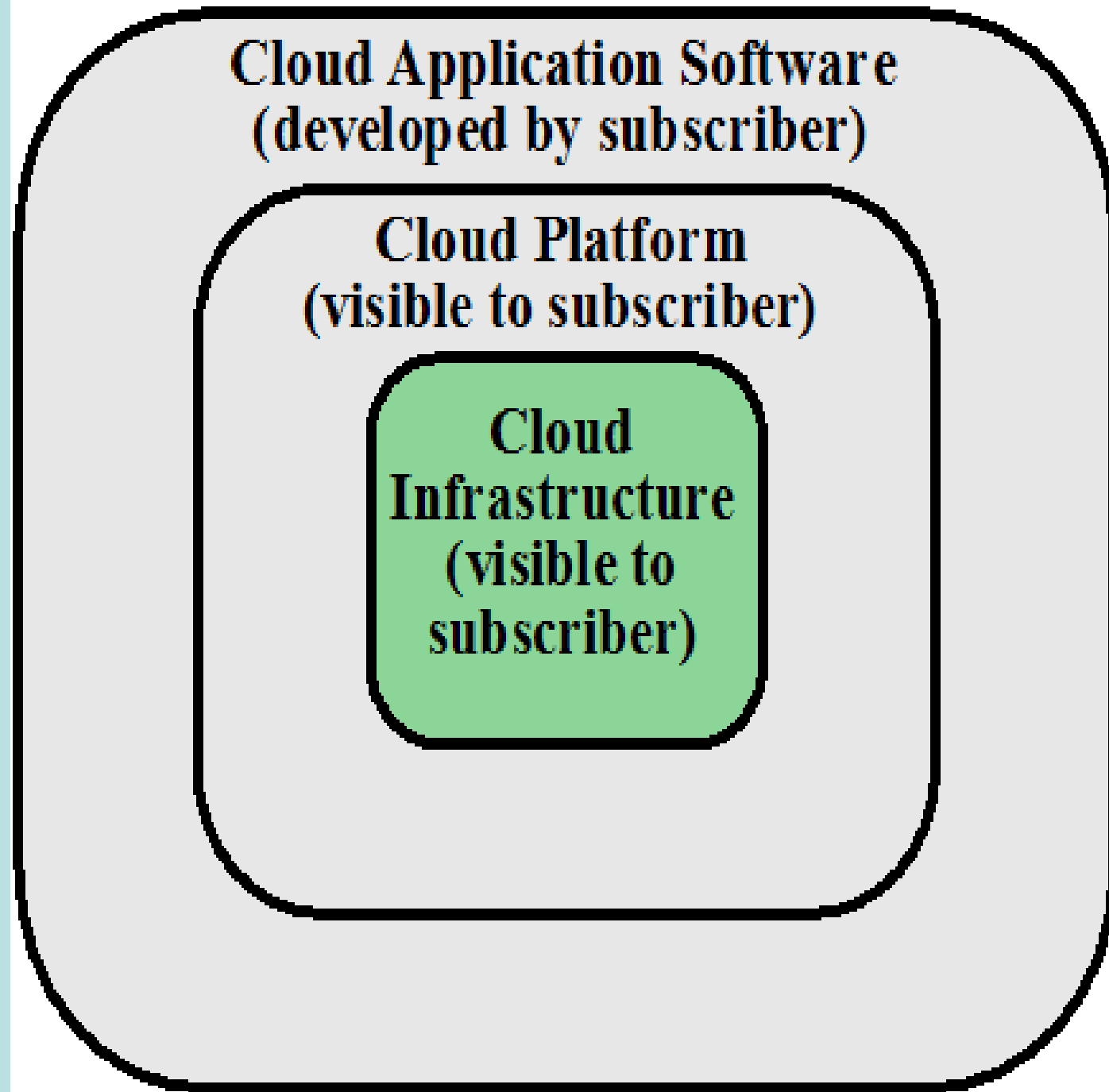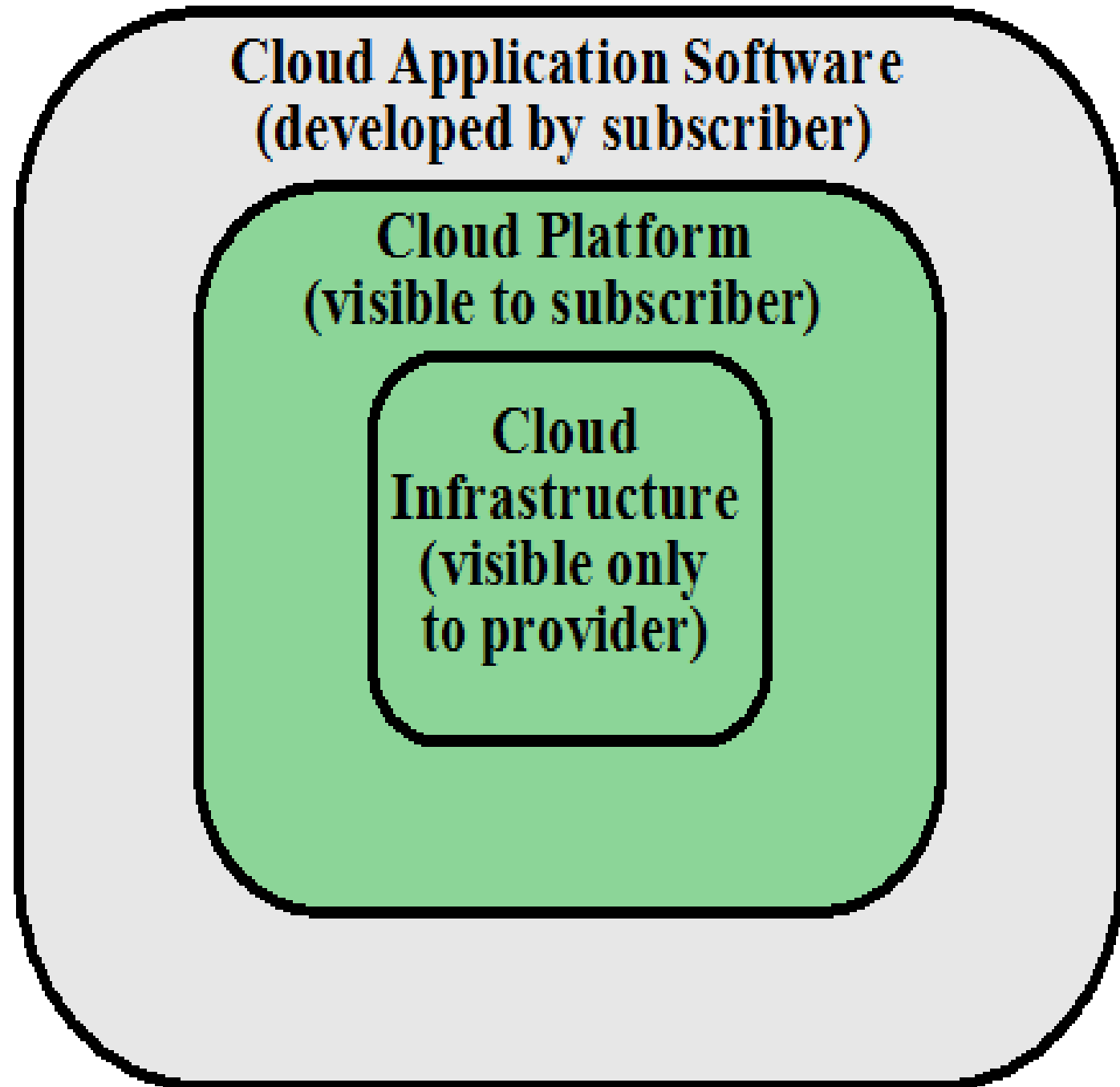
22AIE305: CLOUD COMPUTING

Service model: IaaS

- Provides clients access to the underlying cloud infrastructure
- VM and other abstracted hardware, OS, APIs
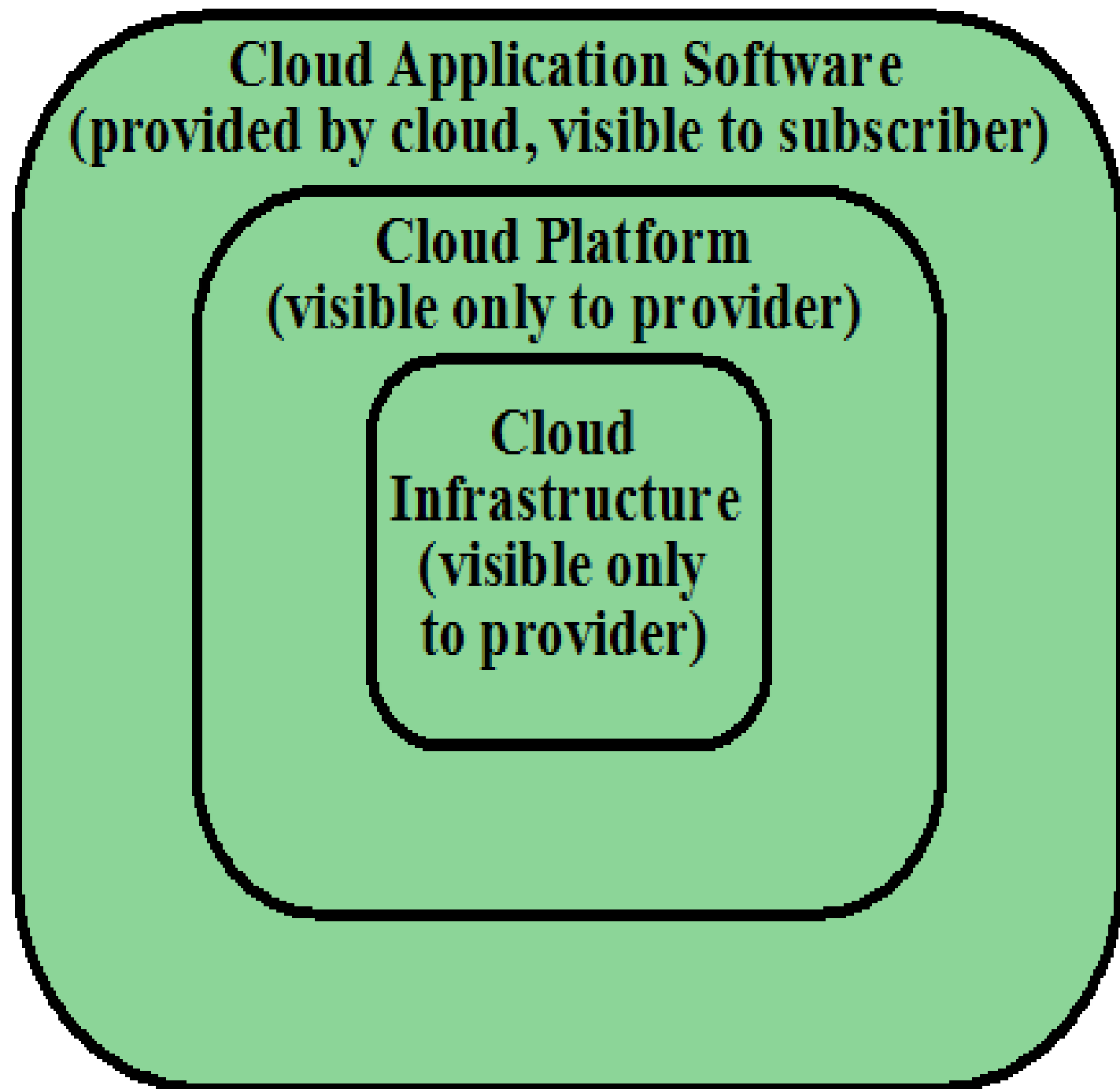- Amazon Elastic Computing (EC2) and Windows Azure

Cloud Application Software
(developed by subscriber)

Cloud Platform
(visible to subscriber)

Cloud Infrastructure
(visible to subscriber)

Service model: PaaS

- Provides service to customers in the form of a platform on which customer apps can run

- Clients deploy on the cloud

- PaaS provides useful building block/tools

Cloud Application Software
(developed by subscriber)

Cloud Platform
(visible to subscriber)

Cloud Infrastructure
(visible only to provider)

Service model: SaaS

- provides service to customers in the form of application software
- Clients need not have to install
- Clients can access applications via various platforms thru a simple interface (often a browser)

Cloud Application Software
(provided by cloud, visible to subscriber)

Cloud Platform
(visible only to provider)

Cloud Infrastructure
(visible only to provider)

Types of clouds

- **Public** Cloud - the infrastructure is made available to the general public or a large industry group and is owned by the organization selling cloud services.

- **Private** Cloud – the infrastructure is operated solely for an organization.

- **Community** Cloud - the infrastructure is shared by several organizations and supports a community that has shared concerns.

- **Hybrid** Cloud - Composition of two or more clouds (public, private, or community) as unique entities but bound by standardized technology that enables data and application portability.

Public clouds are owned and operated by a third-party cloud service provider, who deliver their computing resources like servers and storage over the Internet. With a public cloud, all hardware, software and other supporting infrastructure are owned and managed by the cloud provider. You access these services and manage your account using a web browser.

Public Cloud

These are available to the general public and data are created and stored on third-party servers. As server infrastructure belongs to service providers that manage them and administer pool resources, the need for user companies to buy and maintain their own hardware is eliminated.

Provider companies offer resources as a service on a free of charge or pay-per-use basis via the Internet connection. Users can scale them when required. Examples are Amazon Elastic Compute, Google AppEngine, IBM's Blue, Microsoft Azure, Salesforce Heroku and others.

Public cloud deployments provide both services and infrastructure shared by all customers. These services are provided on a pay-as-you-go basis. The cloud provider is responsible for the creation and upkeep of the instances. This type of deployment is ideal for small to mid-sized businesses that need to save money on resources but still need to collaborate on projects. In most cases, projects that are in public clouds are designed to be portable, so they can be moved to a private cloud, to be tested from production.

The types of services provided in a public cloud range from Infrastructure as a Service (storage and processing power) to Software as a Service (web applications). Examples of public cloud providers are Google Cloud Platform, Microsoft Azure Cloud, and Amazon Web Services.

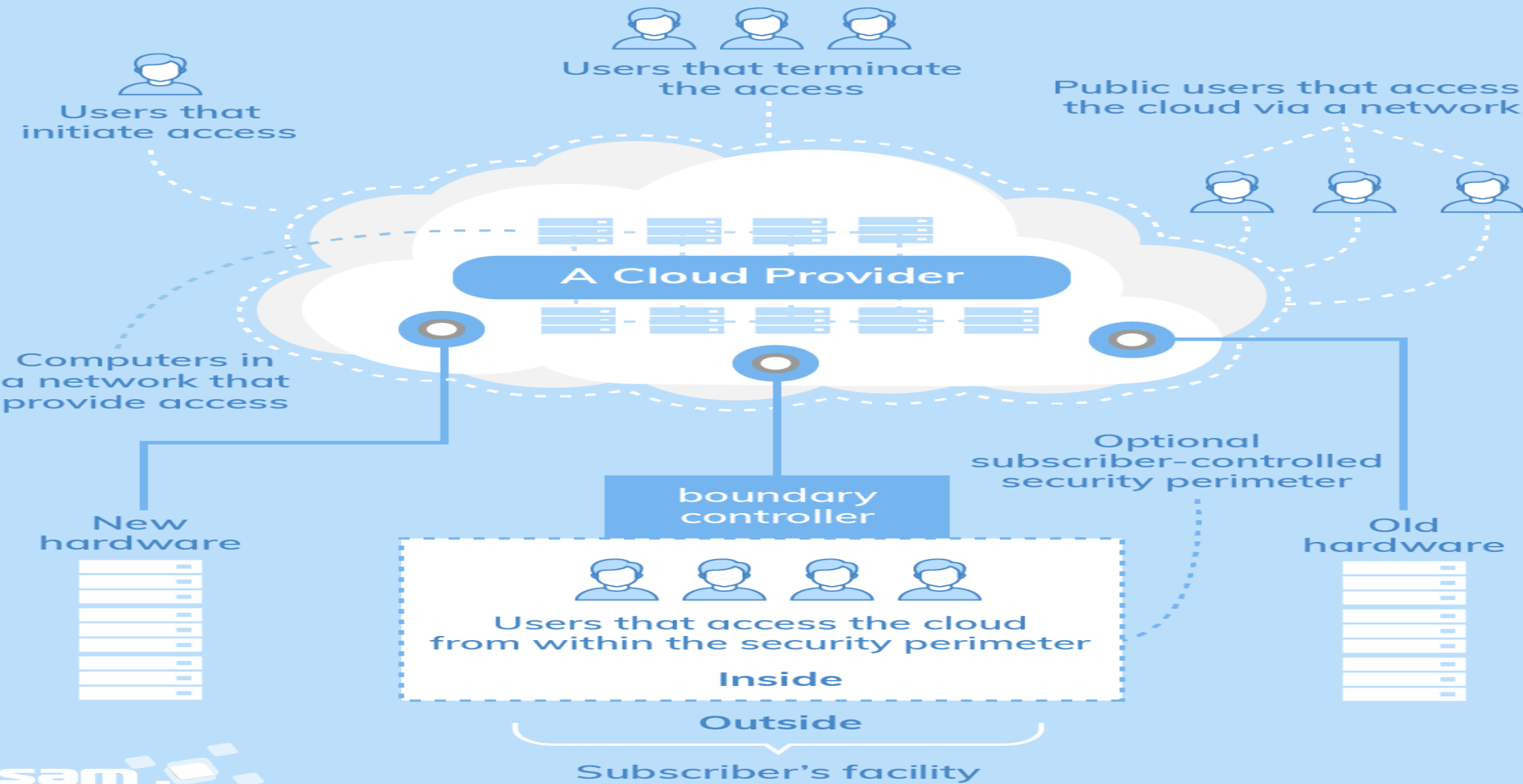# The pros and cons of a public Cloud

The pros of a public cloud are:

- Unsophisticated setup and use

- Easy access to data

- Flexibility to add and reduce capacity, Scalability

- Cost-effectiveness

- Continuous operation time

- 24/7 upkeep

- Eliminated need for software

The cons of a public model:

- Data security and privacy

- Compromised reliability

- The lack of individual approach

Public Cloud

Users that
initiate access

Users that terminate
the access

Public users that access
the cloud via a network

A Cloud Provider

Computers in
a network that
provide access

New
hardware

boundary
controller

Optional
subscriber-controlled
security perimeter

Old
hardware

Users that access the cloud
from within the security perimeter

Inside

Outside

Subscriber's facility

Private cloud

A private cloud refers to cloud computing resources used exclusively by a single business or organization.

A private cloud is one in which the services and infrastructure are maintained on a private network.

Private Cloud

- Only one specific company owns a private cloud, which is why it is also called internal or corporate. Because these data center architectures reside within the firewall, they provide enhanced security.

- Even though one organization runs its workloads on a private basis, a third party can also manage it, and the server can be hosted externally or on-premises of the user company.

Private Cloud

- Only a clearly defined scope of persons have access to the information kept in a private repository, preventing the general public from using it. In light of numerous breaches, a growing number of large corporations decided on a closed private type as it is less risky.

A private cloud deployment is used by a single business, and may be hosted externally or in some cases, located on-site. The deployment is behind a firewall, and no other organizations have access to the infrastructure. Private clouds are perfect for companies where industry regulation is strict. Users within the organization can still access the private cloud from anywhere with internet access. Though more expensive than public cloud deployments, private cloud instances offer more security and customization.

Pros: More security, more customization options, organizational users can access from anywhere.

Cons: Cloud provider does not manage instance, more information technology expertise required, remote access may require IP whitelisting.

In a private cloud, a single organization controls and maintains the underlying infrastructure to deliver the IT resources. Consider an organization with several departments, like finance and marketing, that need computing resources for their software applications. In a private cloud setup, the organization purchases server hardware, maintains it in a central data center, and delivers the resources to the different departments over a network. Individual teams may additionally invest in software infrastructure like operating systems or database software for their applications.
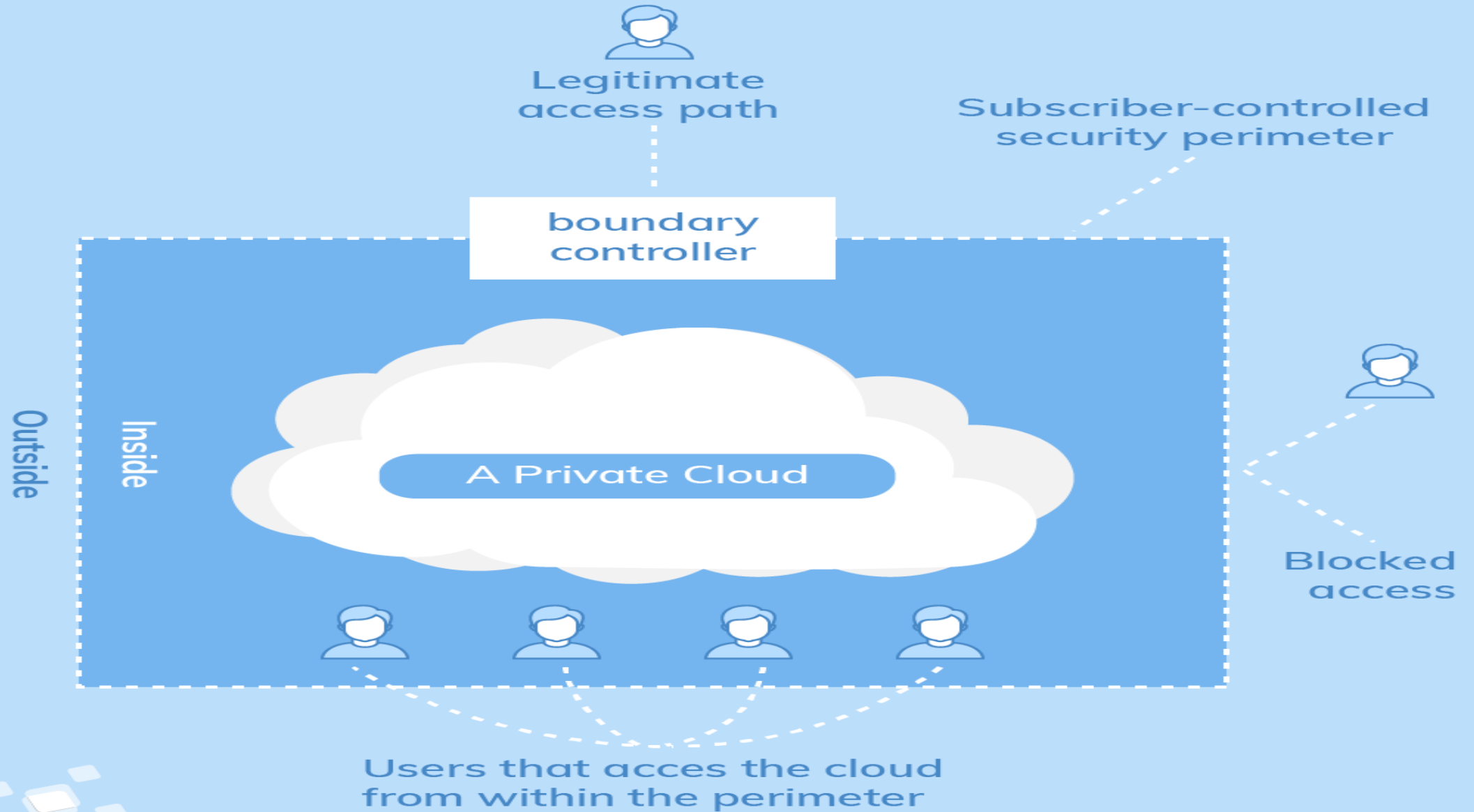
Advantages and Disadvantages

Advantages of a private model:

- Individual development

- Storage and network components are customizable

- High control over the corporate information

- High security, privacy and reliability

Disadvantage of the private cloud deployment model:

- Cost intensiveness, as it entails considerable expenses on hardware, software and staff training.

Private Cloud

Legitimate access path

Subscriber-controlled security perimeter

boundary controller

Outside

Inside

A Private Cloud

Blocked access

Users that acces the cloud from within the perimeter

sam solutions

Community Cloud

- Several organizations with similar background share the infrastructure and related resources. As the organizations have uniform security, privacy and performance requirements, this multi-tenant data center architecture helps companies achieve their business-specific objectives.

- That is why a community model is particularly suited for organizations that work on joint projects.

Advantages and Disadvantages

Advantages of a community computing

- Cost reduction

- Improved security, privacy and reliability

- Ease of data sharing and collaboration

Disadvantages of a community computing

- Higher cost than that of a public one

- Sharing of fixed storage and bandwidth capacity

- It is not widespread so far

The least commonly used deployment, community cloud instances are shared by multiple users or organizations, who share access to applications. In most respects, a community cloud is a private cloud that functions similarly to a public cloud deployment. Community clouds are utilized where users have common goals, are part of the same industry, and agree on compliance and security policies. These are used in government, finance, healthcare, and in some professional industries like open source.

Community clouds are managed privately, either on-site or remotely through a data center. Authorized users given access to segmented areas on the instance.
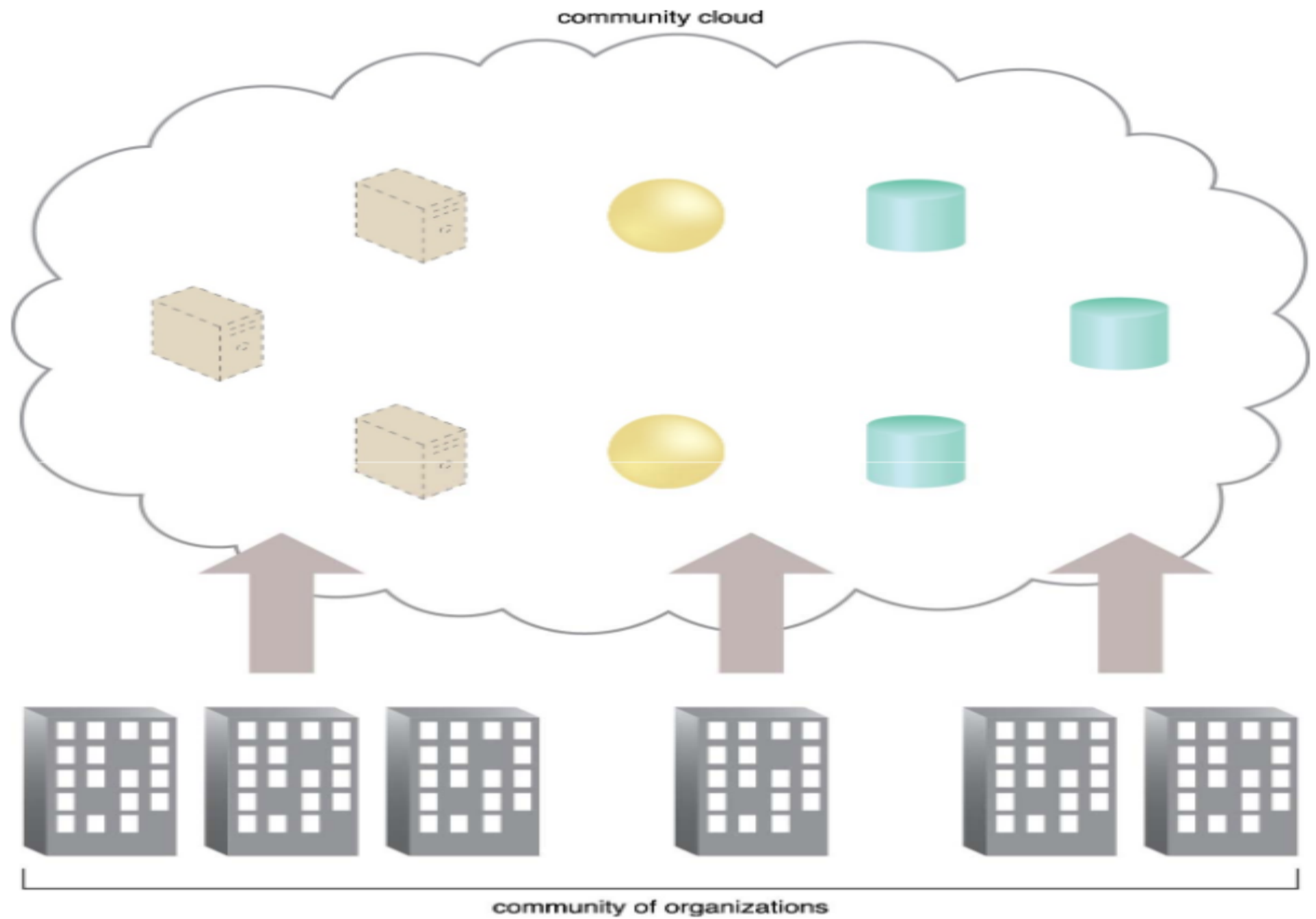
Pros: Collaborative decision making and teamwork, shared concerns and interests.

Cons: Bandwidth concerns, access approval takes time and resources, security concerns.

Community Cloud

community cloud

community of organizations
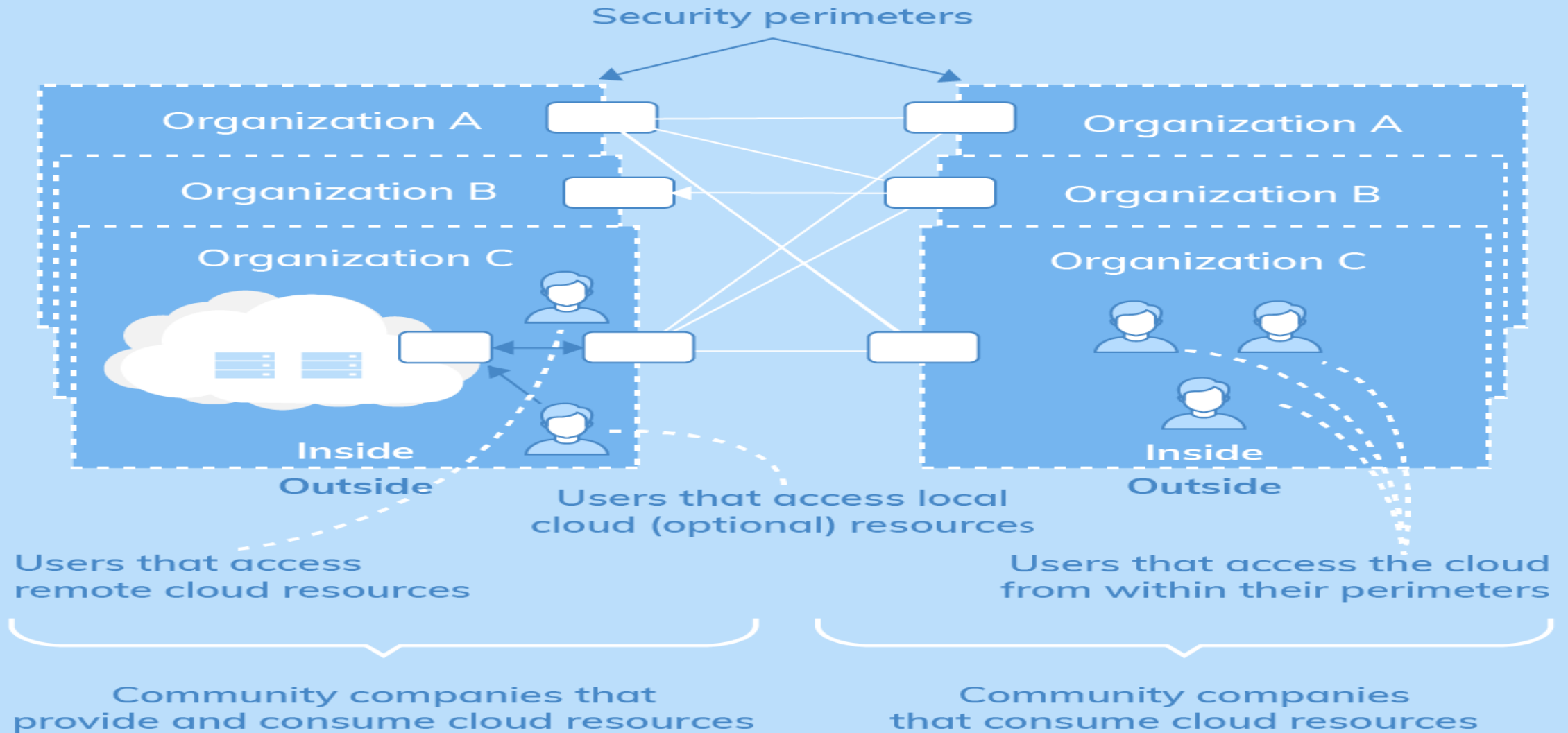
Hybrid cloud

Hybrid clouds combine public and private clouds, bound together by technology that allows data and applications to be shared and move between them.

A hybrid cloud gives your business greater flexibility, more deployment options and helps optimize our existing infrastructure, security and compliance.

Hybrid Cloud

- Encompasses the best features of the above-mentioned cloud computing deployment models, a public, private and community ones. It allows companies to mix and match the facets of all three types that best suit their requirements.

  As an example, a company can balance its load by locating mission-critical workloads on a secure private cloud and deploying less sensitive ones to a public one. It not only safeguards and controls strategically important assets but does so in the most cost- and resource-effective way possible for each specific case.

hybrid model benefits

This approach facilitates data and application portability.
The benefits of a hybrid model are:

- Improved security and privacy

- Enhanced scalability and flexibility

- Reasonable price

In a hybrid cloud system, data and applications move between the private cloud platform and public cloud services.
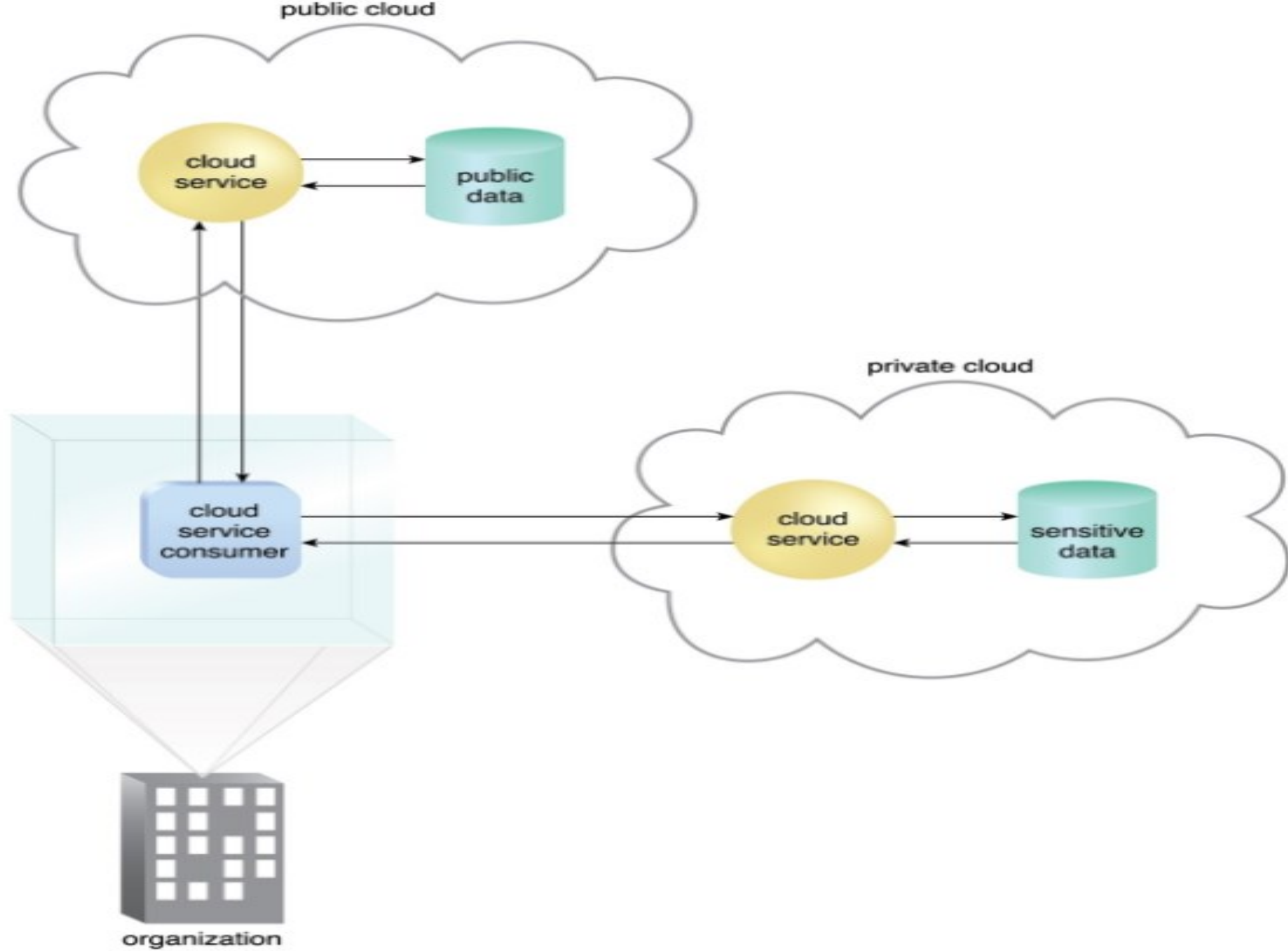
One type of hybrid cloud system utilizes cloudbursting. In this configuration, proprietary applications and programs run on the private cloud, but when usage is high, and the system is taxed for resources, it can expand to leverage the public cloud to provide additional resources and processing capacity.

Another common hybrid cloud configuration has internal programs and applications running on the private cloud, but external services run on public cloud services. The organization may need access to external tools like Microsoft 365 or Google Workspace for email, Dropbox or Google Drive for storage, or Adobe Creative Suite for image and video editing.
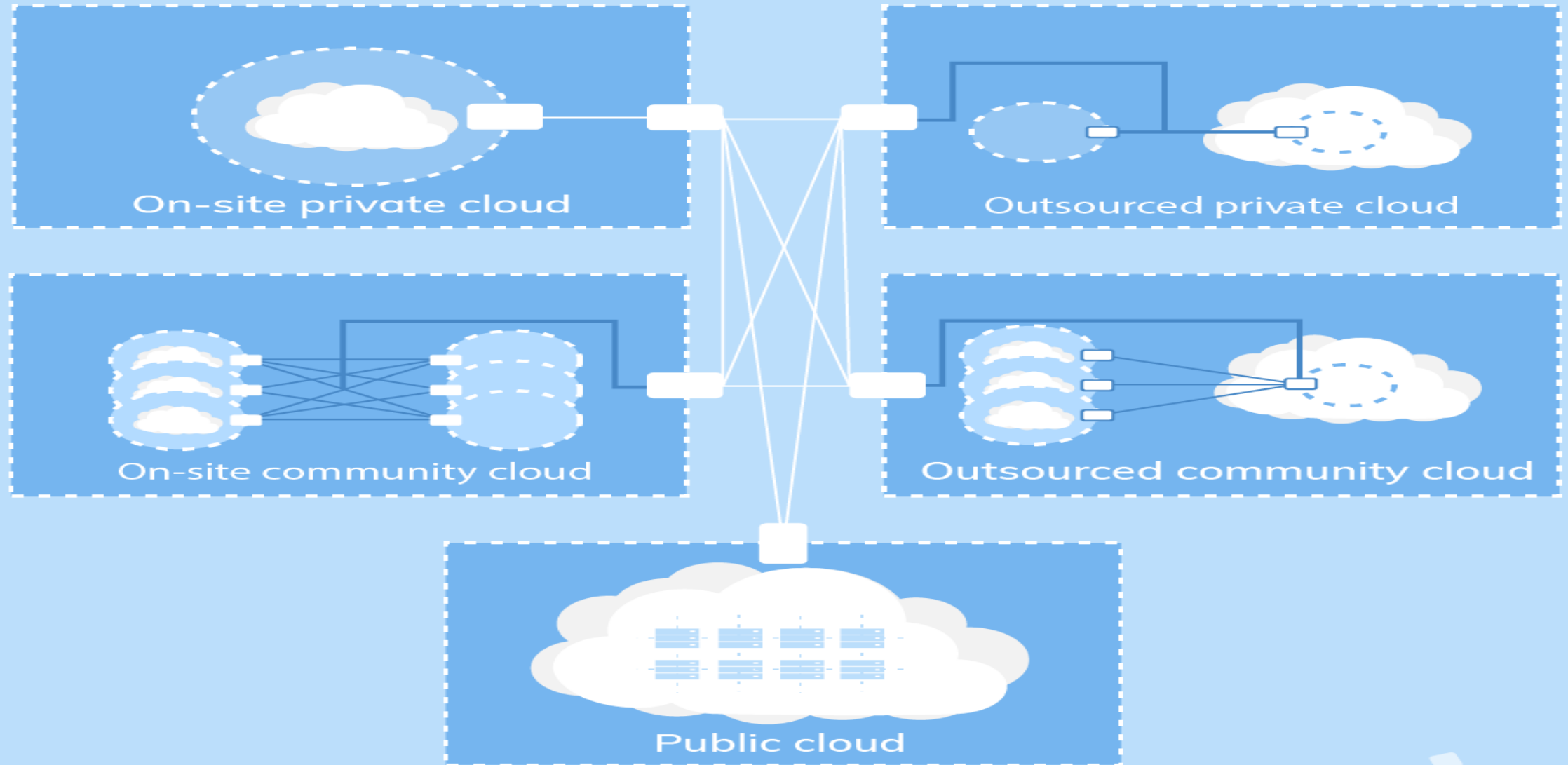
Pros: Scalable, cost effective, security for proprietary applications.

Cons: Sharing data smoothly require extra configuration and development.

public cloud

private cloud

cloud service

public data

cloud service consumer

cloud service

sensitive data

organization

Hybrid Cloud

On-site private cloud

Outsourced private cloud

On-site community cloud

Outsourced community cloud

Public cloud

sam solutions

Hybrid vs Community/Federated

Hybrid Cloud - composition of two or more Clouds (public, private, or community) as unique entities but bound by a standardised technology that enables data and application portability.

Community/Federated Cloud - the infrastructure is shared by several organizations and supports a community that has shared concerns.

The cloud

Public cloud
(external)

Private cloud
(internal)

Hybrid cloud
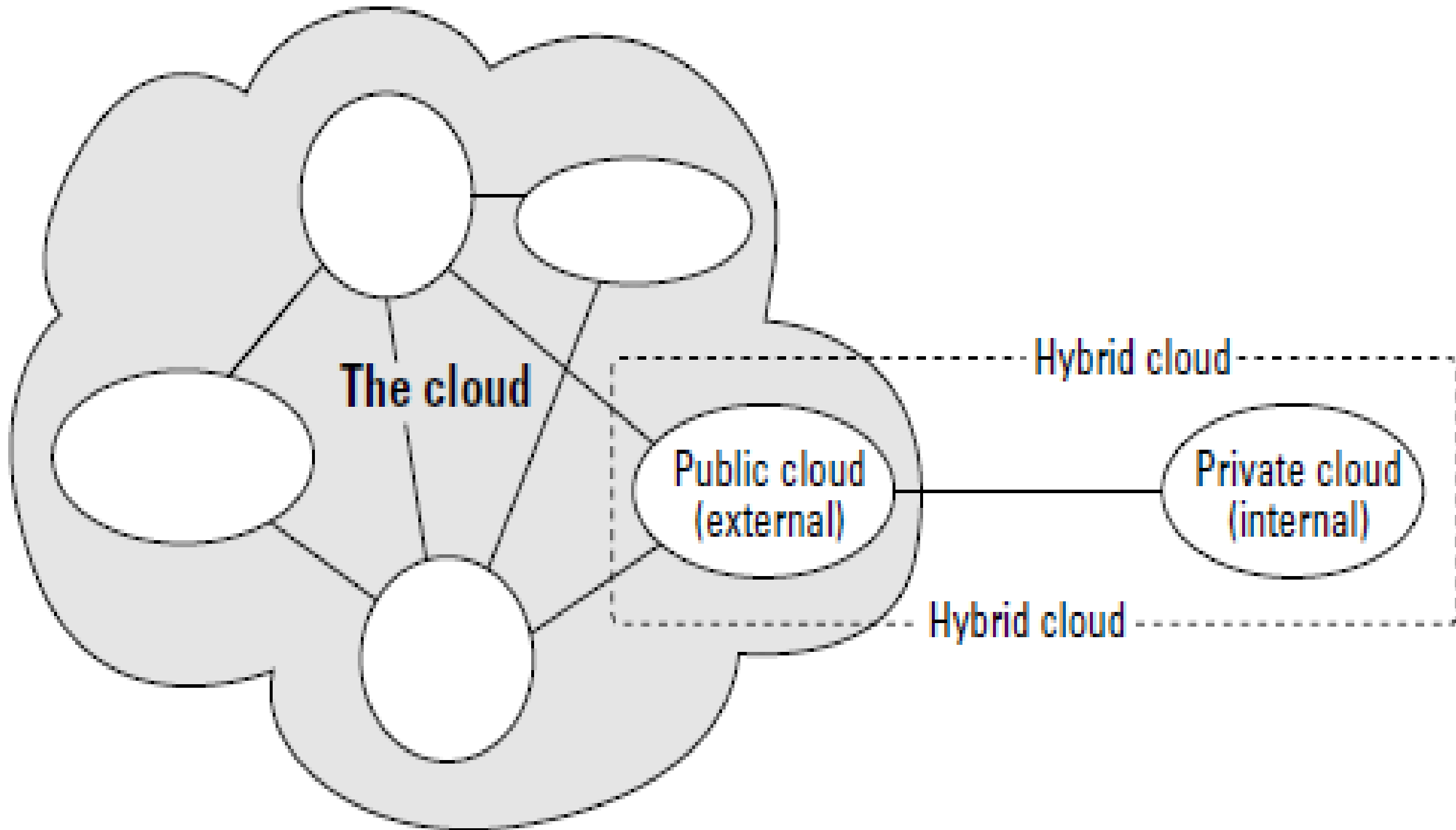
Hybrid cloud

The terms multicloud and hybrid cloud are often used synonymously but they are not the same.

Multicloud is focused on using multiple cloud computing services or platforms from different vendors. For example, an organization might use Amazon Web Services (AWS) for some of its applications and Microsoft Azure for others.

Hybrid cloud is focused on using both cloud services and on-premises infrastructure with cloud services. For example, an organization's hybrid cloud environment might involve running some applications in a public cloud like AWS, while others are run in a private cloud hosted on-premises.

Architecture: Multicloud spans multiple public cloud environments from different providers. The different public clouds are generally used for different tasks (e.g., one for program logic, another for databases, and a third for machine learning) and the distribution across clouds can vary on a per-application basis. Organizations choose a multicloud strategy to take advantage of the flexibility and features of various clouds.

Hybrid cloud includes two or more different types of cloud environments (on-premises, private cloud, and public cloud). In many architectures, the public cloud's role is to extend the functionality of the private cloud or on-premises environments. A hybrid cloud architecture is typically used by organizations that are migrating apps to the cloud or those who have too much technical debt (sub-optimal systems or code) to go 100% cloud native.

Security: A multicloud architecture distributes data across multiple public clouds, which improves security by reducing the risk of a single point of failure. When using different cloud providers, an organization can take advantage of each provider's security features. This approach does introduce a level of complexity, in that there must be management of the variety of security features across the multiple cloud environments. There may also be potential security risks associated with integrating different cloud platforms.

An additional layer of security for sensitive data and critical applications is provided by private cloud companies in a hybrid cloud architecture. This infrastructure gives the organization greater control over the security measures (e.g., access control, encryption, and data protection) implemented in the private cloud. However, the public cloud component can introduce security concerns—chiefly, the need to protect against data breaches, account hijacking, and other threats that could compromise the integrity and availability of the data.

Key features of Hybrid cloud

Workload portability is the ability to move and adapt data and applications between on-premises systems and the cloud, or from one cloud service provider to another. Portability is a key consideration when designing an application or service, and is often addressed through the adoption of open-source standards and APIs, which also facilitates interoperability and automation.

Data integration is the process of bringing together data from multiple different sources to gain greater visibility and to ensure a smooth transition to cloud computing. Historically, most organizations stored data in stand-alone silos or separate data stores. Having real-time telemetry and insights is especially important to the success of digital transformation strategies and to compete in an increasingly digital world.

Summary

- Public cloud: A cloud platform run by a service provider made available to many end-users (clients or customers)

- Private cloud: A cloud platform run solely for a single end-user, such as a bank or retailer

  - The technology can be much like public clouds, but the economics are different

- Most organizations will probably use some hybrid of both
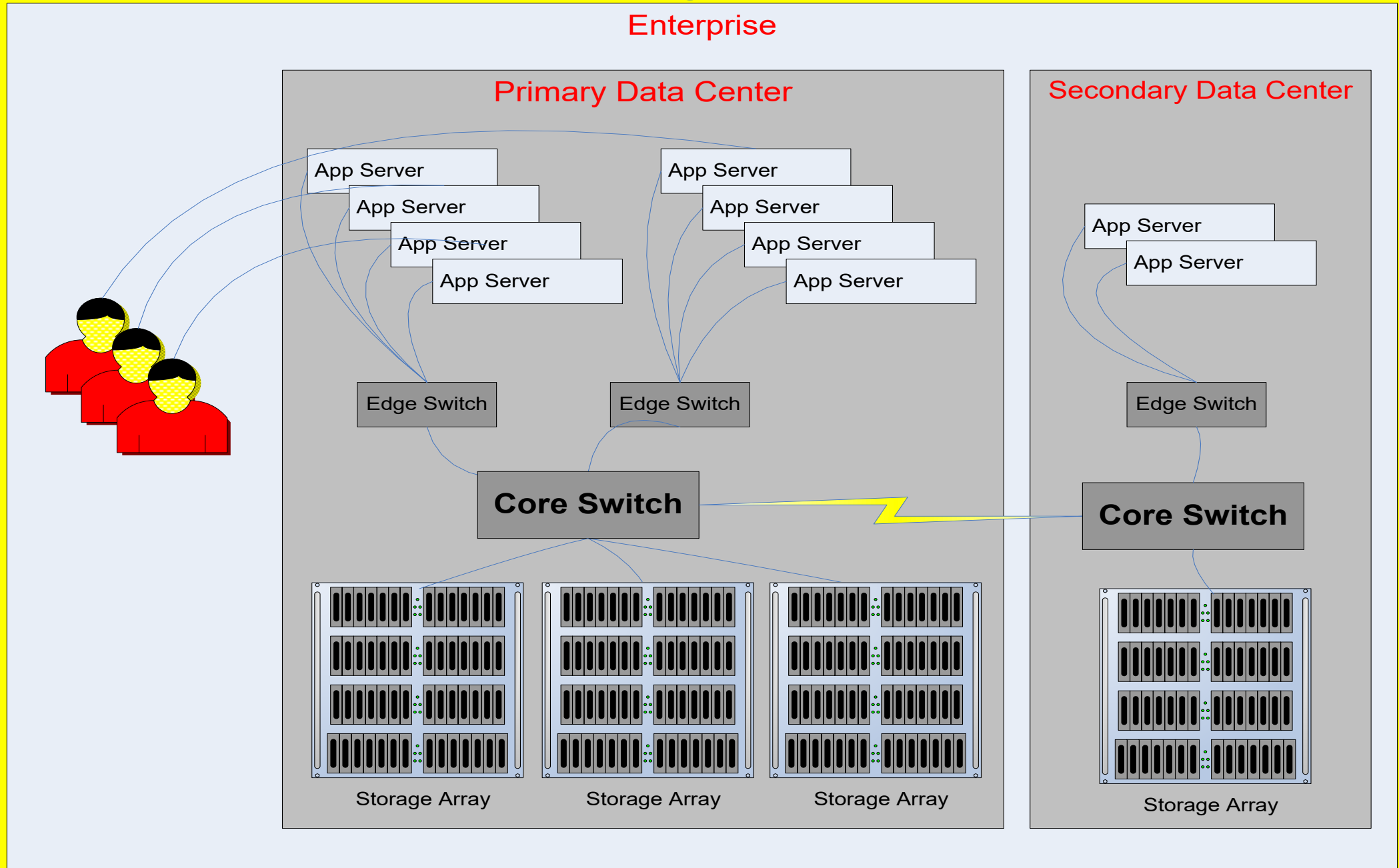
Some websites to create Cloud accounts

- https://portal.aws.amazon.com/billing/signup
- **To create virtual private console (VPC), subnets, and other VPC resources using the console**
- https://console.aws.amazon.com/vpc/
- **To create Google cloud service**
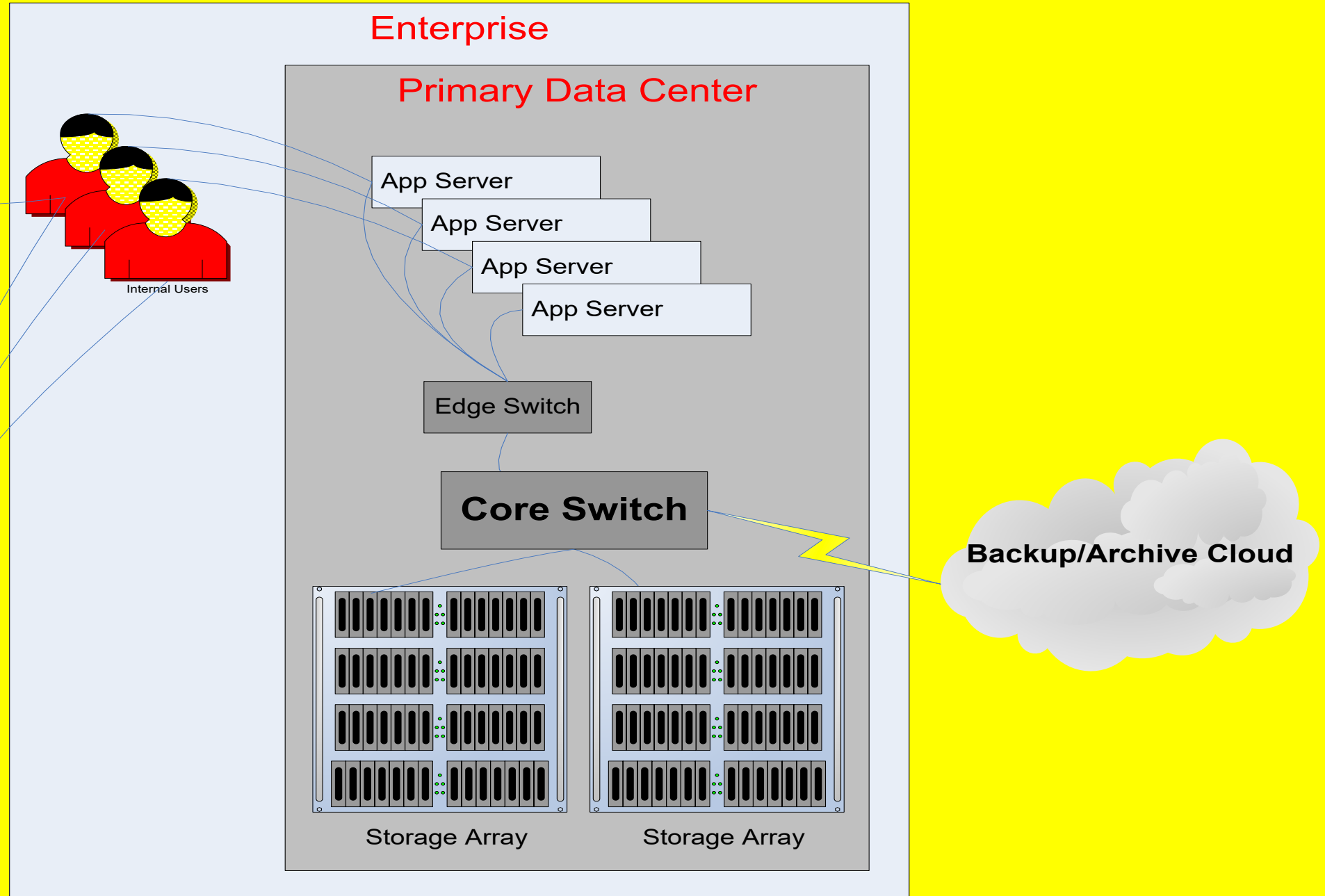- **https://cloud.google.com/compute/docs/instances/create-start-instance**

How cloud computing is successful

- It is in a better position to exploit recent advances in software, networking, storage, and processor technologies promoted by the same companies who provide Cloud services.

- Economical reasons: It is used for enterprise computing; its adoption by industrial organizations, financial institutions, government, and so on has a huge impact on the economy.

- Infrastructures Management reasons:

  - A single Cloud consists of a mostly homogeneous (now more heterogeneous) set of hardware and software resources.

  - The resources are in a single administrative domain (AD). Security, resource management, fault-tolerance, and quality of service are less challenging than in a heterogeneous environment with resources in multiple ADs.

Cloud Storage Infrastructure

Enterprise

Primary Data Center

File Storage/Services "In the Cloud"

App Server

App Server

App Server

App Server

Internal Users

Edge Switch

External Users

Core Switch

Backup/Archive Cloud
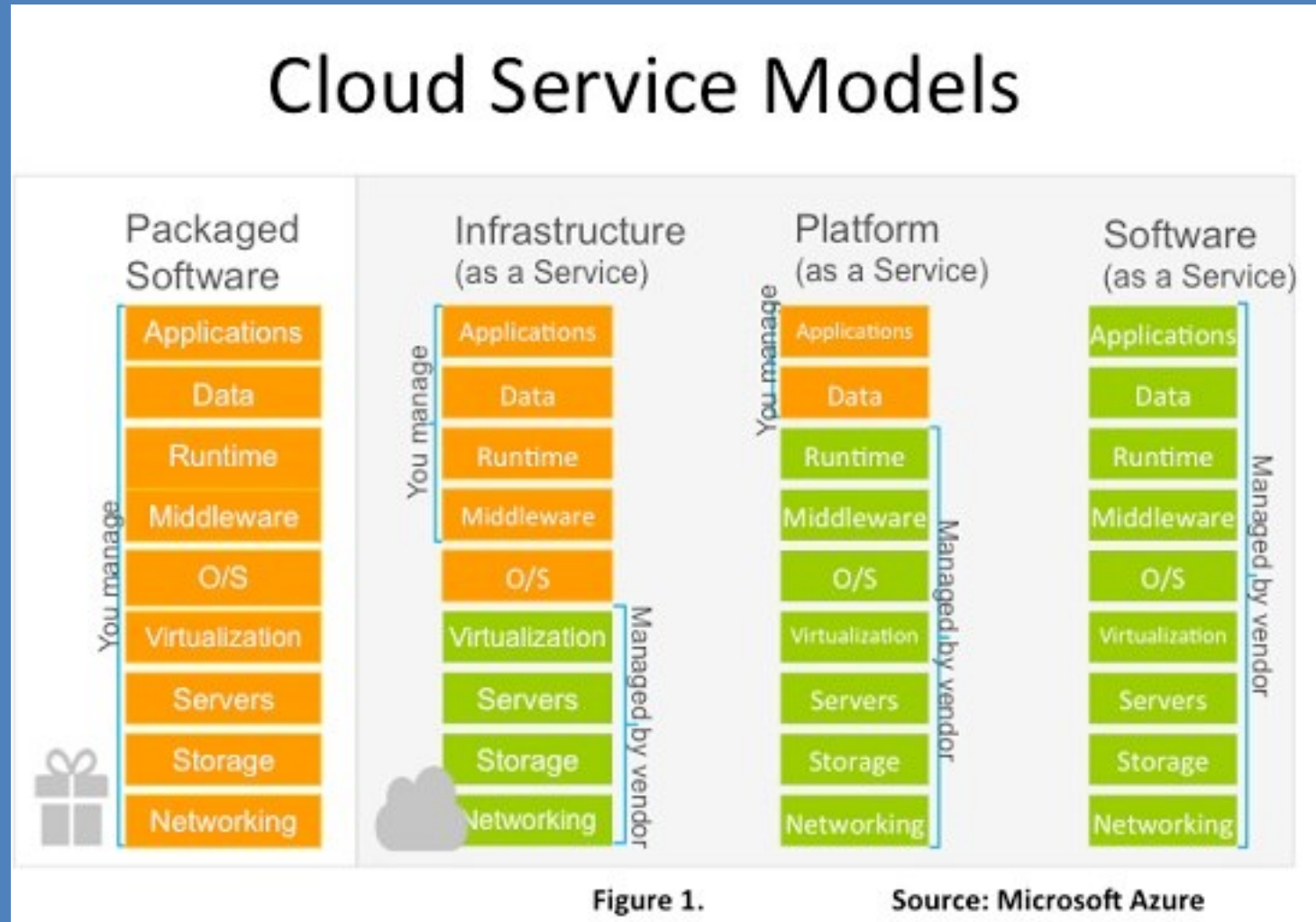
Application "In the Cloud"
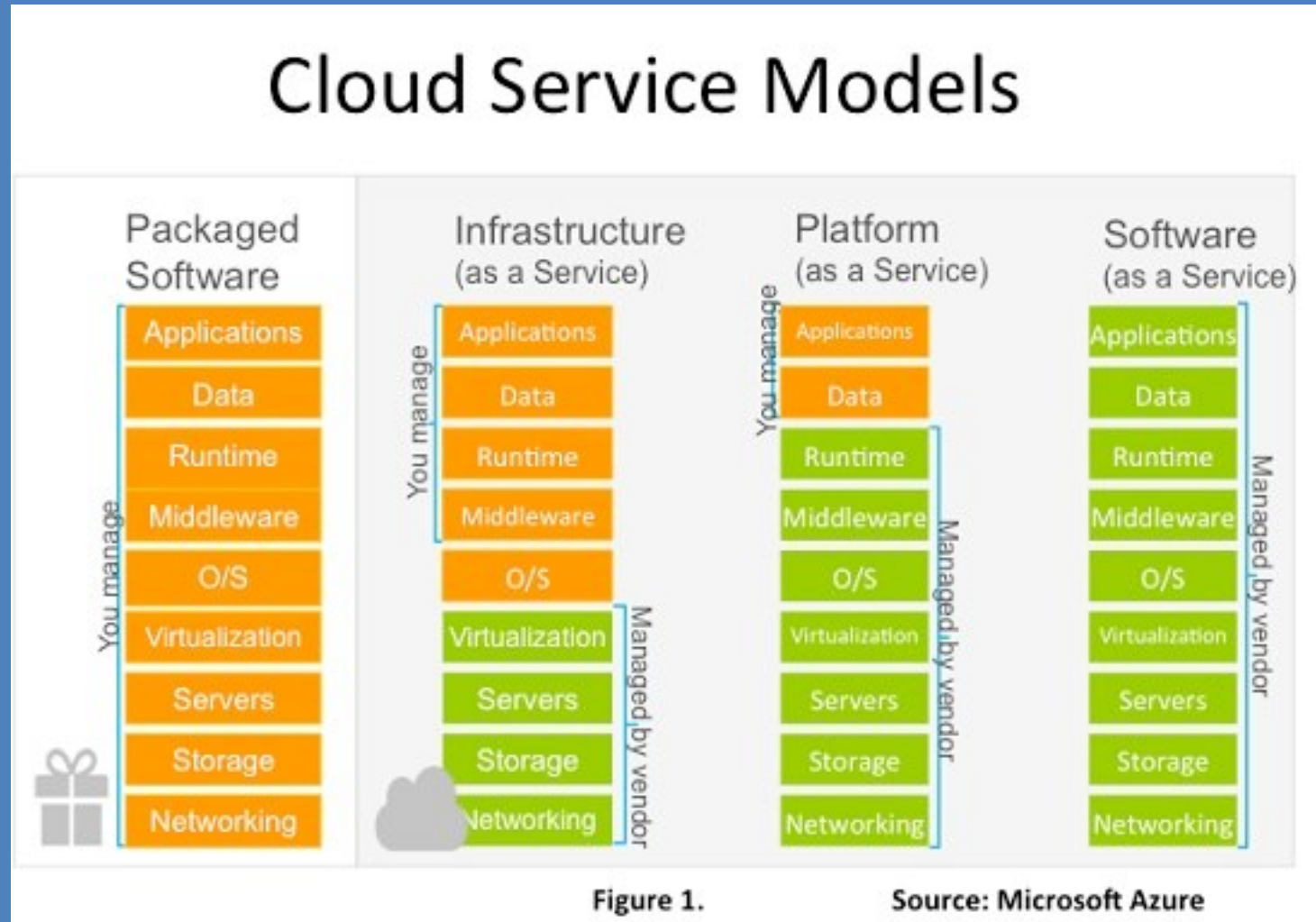
Storage Array

Storage Array

Popular Cloud-Platforms

- **Amazon Web Services (AWS)**: Best for **Public Cloud**
- **Microsoft Azure**: Best for **Developer Solutions**
- **Salesforce**: Best for **CRM Solutions**
- **VMWare**: Best for **Multi-Cloud Services**
- **Alibaba Cloud**: Best for **Elastic Computing**
- **Oracle Cloud**: Best for **Data Management**
- **Rackspace**: Best for **Cloud Optimization**
- **Digital Ocean**: Best for **Web Applications**
- **ServiceNow**: Best for **Enterprise Automation**
- **NetApp**: Best for **Data Intelligence**
- **Google Cloud**: Best for **Cloud Computing**
- **CloudSigma**: Best for **Cloud Hosting**
- **IBM Cloud**: Best for **Integrated Cloud Experience**
- **Cisco Cloud Solutions**: Best for **Hybrid Cloud Strategy**
- **RedHat Hybrid Cloud**: Best for **Edge Architecture**
- **Tencent Cloud** Best for **Cheap development**
- **Manjrasoft Aneka** (http://www.manjrasoft.com/manjrasoft_downloads.html)

The Three delivery models of Cloud Computing

Figure 1.   Source: Microsoft Azure

The Three delivery models of Cloud Computing

Cloud Service Models

Figure 1.   Source: Microsoft Azure

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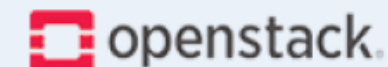
On-premises	IaaS	PaaS	SaaS
Applications	Applications	Applications	Applications
Data	Data	Data	Data
Runtime	Runtime	Runtime	Runtime
Middleware	Middleware	Middleware	Middleware
OS	OS	OS	OS
Virtualization	Virtualization	Virtualization	Virtualization
Servers	Servers	Servers	Servers
Storage	Storage	Storage	Storage
Networking	Networking	Networking	Networking
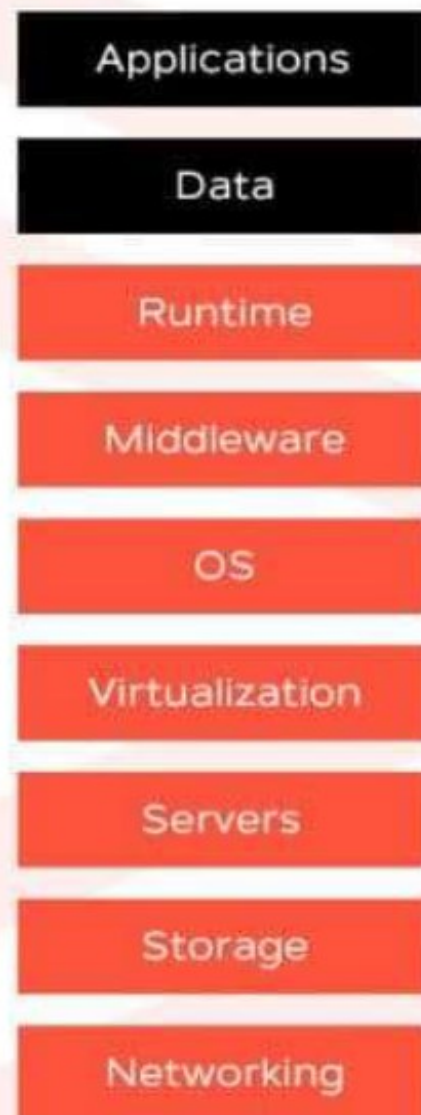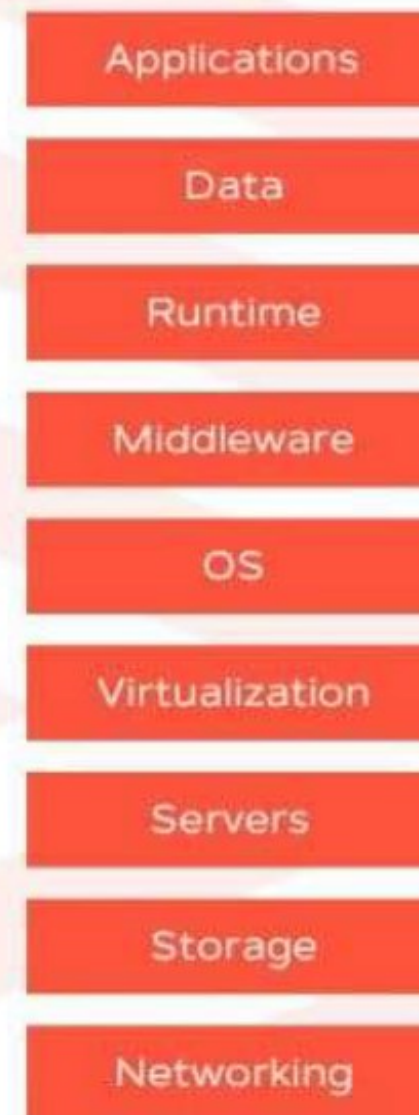
Managed by your team
Managed by a provider

Stackscale