고려대학교
KOREA UNIVERSITY

KU-The Future

Cloud computing – Chapter 4

Heonchang Yu

Distributed and Cloud Computing Lab.

Roles and Boundaries

- Cloud Provider – the organization that provides cloud-based IT resources
- Cloud Consumer – the organization that has a formal contract or arrangement with a cloud provider to use IT resources
- Cloud Service Owner – the organization that legally owns a cloud service (figure 4.2 & 4.3)

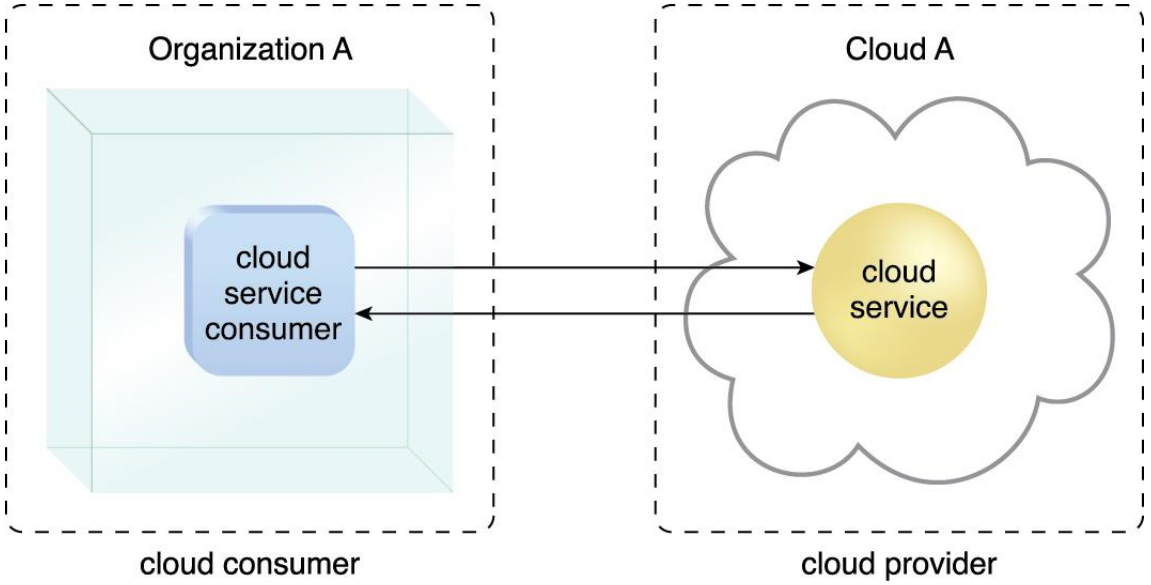

Figure 4.1 A cloud consumer (Organization A) interacts with a cloud service from a cloud provider(that owns Cloud A). Within Organization A, the cloud service consumer is being used to access the cloud service.

Roles and Boundaries

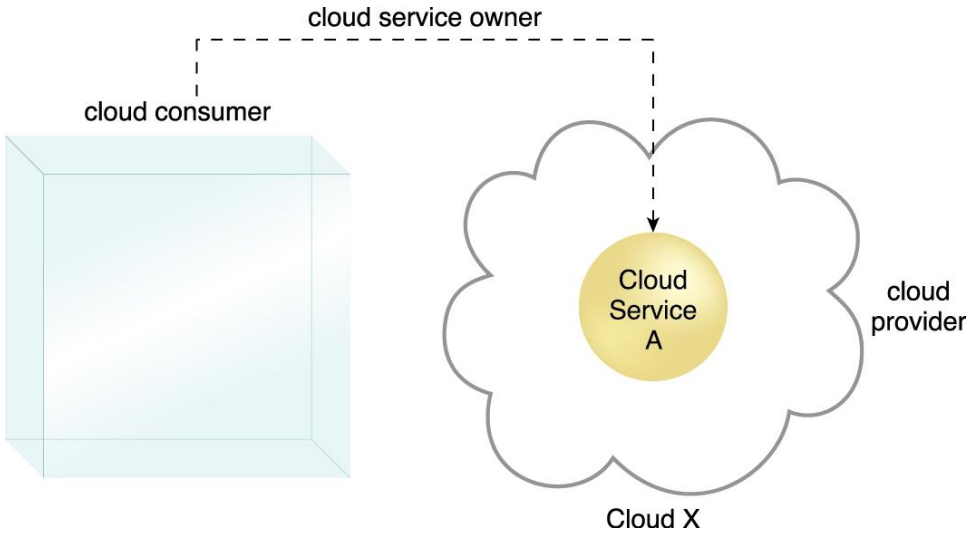

Figure 4.2 A cloud consumer can be a cloud service owner when it deploys its own service in a cloud.

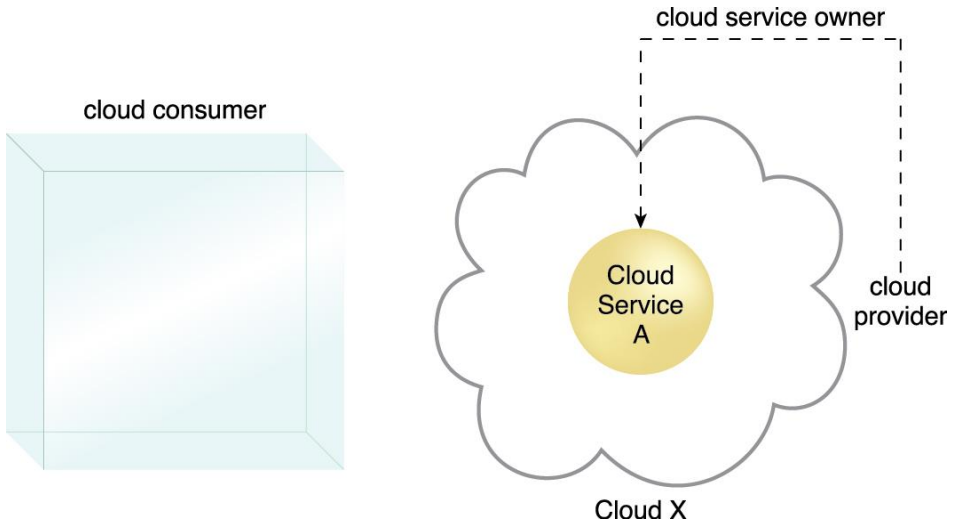

Figure 4.3 A cloud provider becomes a cloud service owner if it deploys its own cloud service, typically for other cloud consumer to use.

Roles and Boundaries

- Cloud Resource Administrator
  - ✓ The person or organization responsible for administering a cloud-based IT resource (including cloud services)
  - ✓ Can be the cloud consumer or cloud provider of the cloud within which the cloud service resides
  - ✓ Is not referred to as a "cloud service administrator"
    - ❖ May be responsible for administering cloud-based IT resources that don't exist as cloud services

Roles and Boundaries

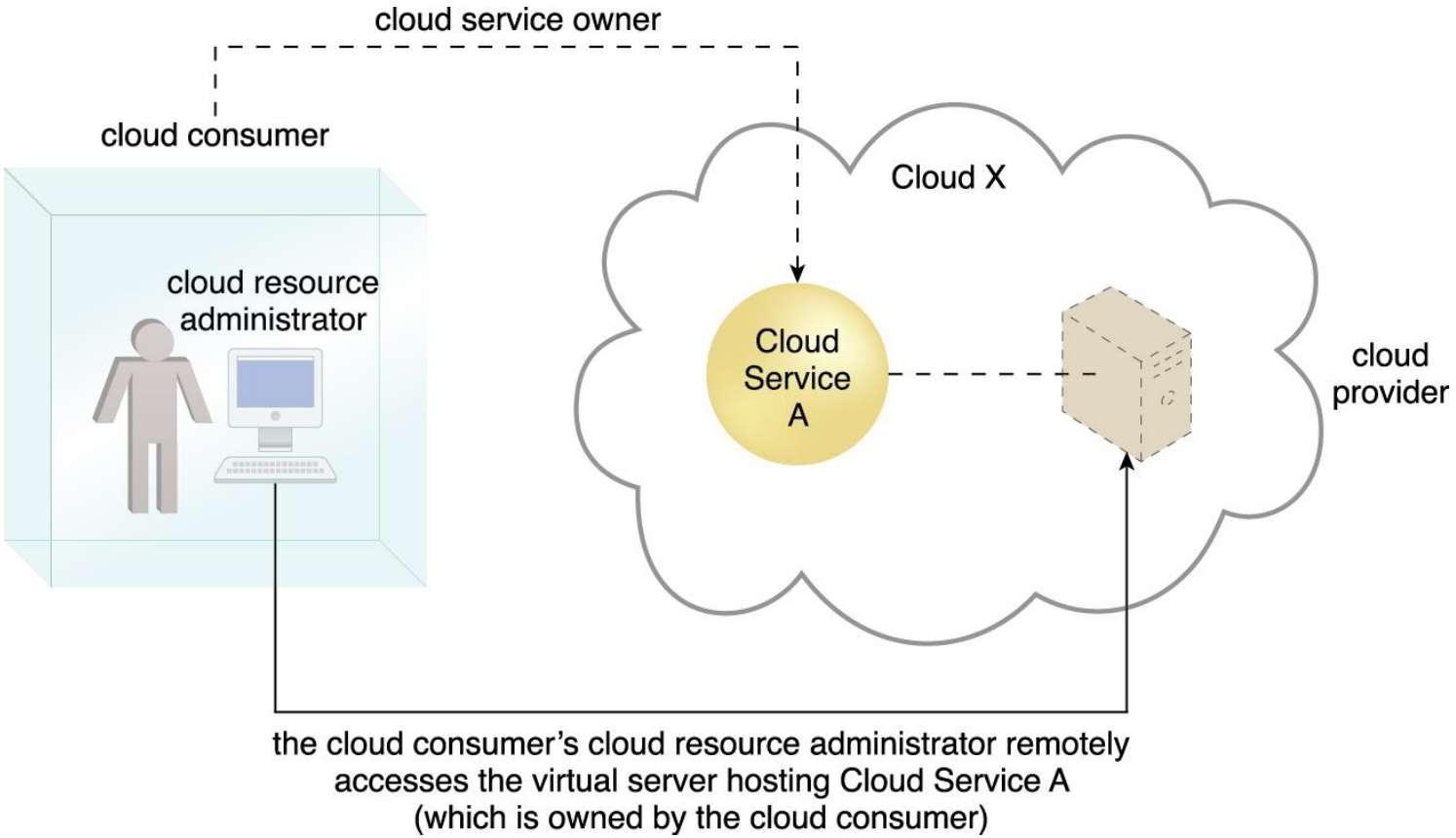

Figure 4.4 A cloud resource administrator can be with a cloud consumer organization and administer remotely accessible IT resource that belong to the cloud consumer.

Roles and Boundaries

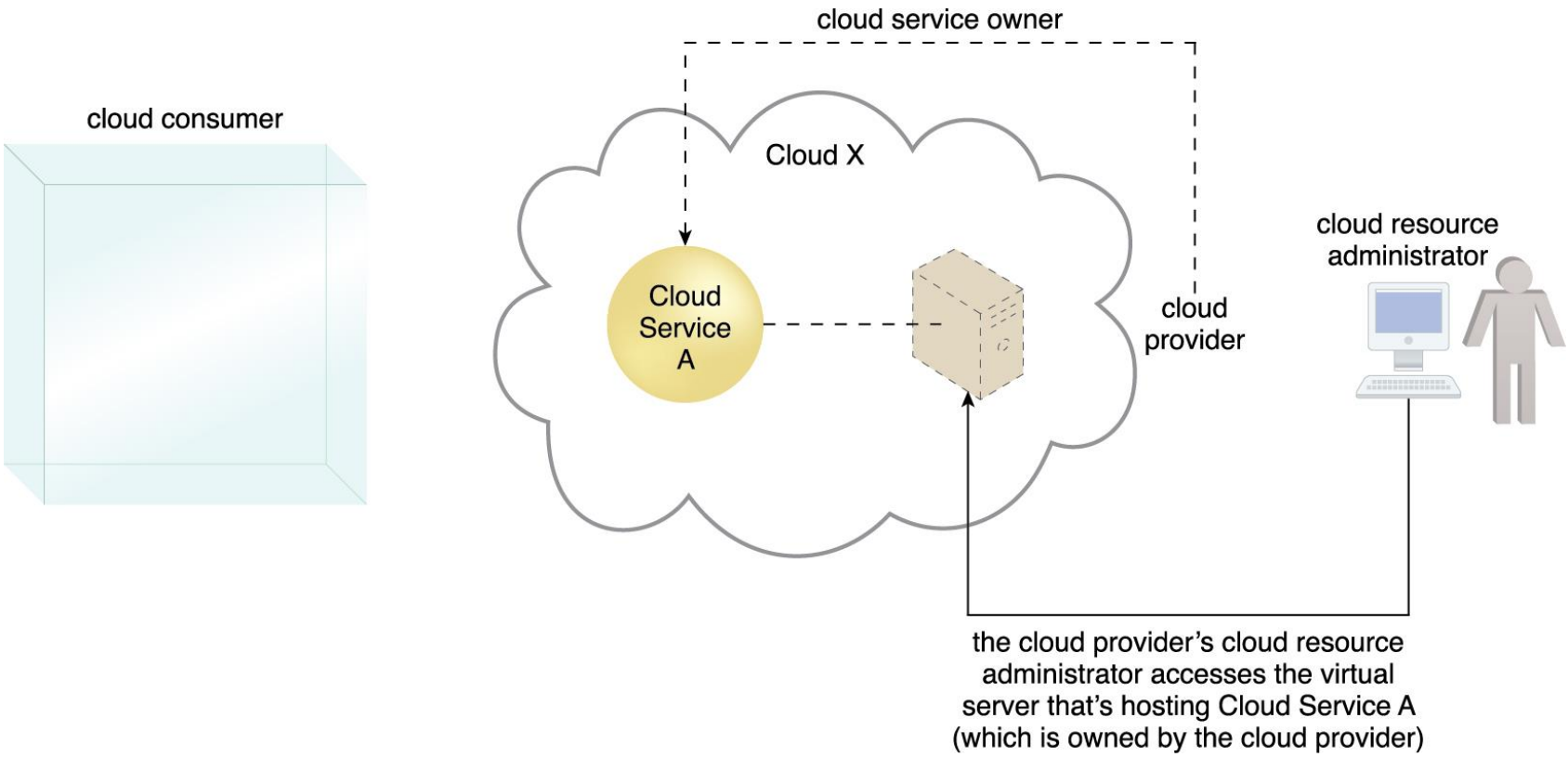

Figure 4.5 A cloud resource administrator can be with a cloud provider organization for which it can administer the cloud provider's internally and externally available IT resources

Roles and Boundaries

- Cloud Auditor
  - ✓ To provide an unbiased assessment of a cloud environment to help strengthen the trust relationship between cloud consumers and cloud providers
- Cloud Broker
  - ✓ The responsibility of managing and negotiating the usage of cloud services between cloud consumers and cloud providers
- Cloud Carrier
  - ✓ Responsible for providing the wire-level connectivity between cloud consumers and cloud providers

Roles and Boundaries

- Organizational Boundary
  - ✓ The physical perimeter that surrounds a set of IT resources that are owned and governed by an organization

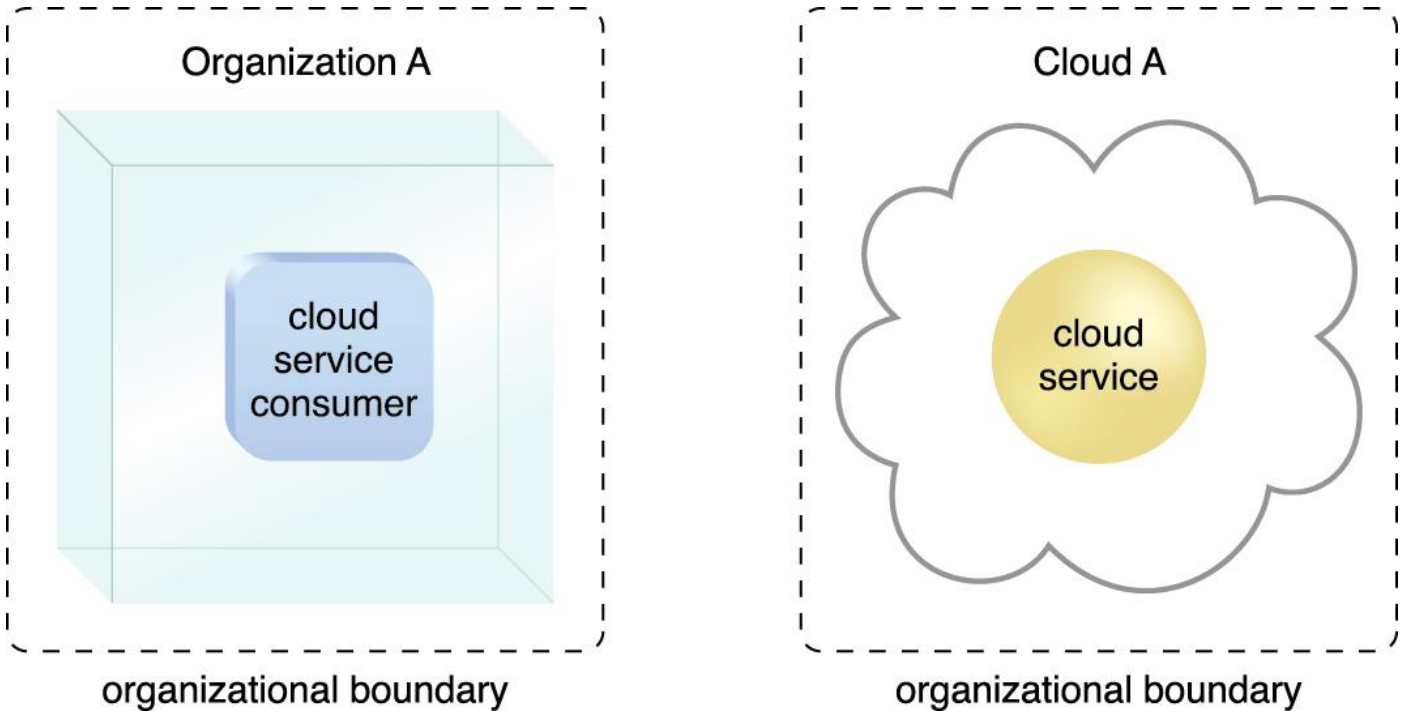

Figure 4.6 Organizational boundaries of a cloud consumer (left), and a cloud provider (right), represented by a broken line notation.

Roles and Boundaries

- Trust Boundary
  - ✓ A logical perimeter that typically spans beyond physical boundaries to represent the extent to which IT resources are trusted

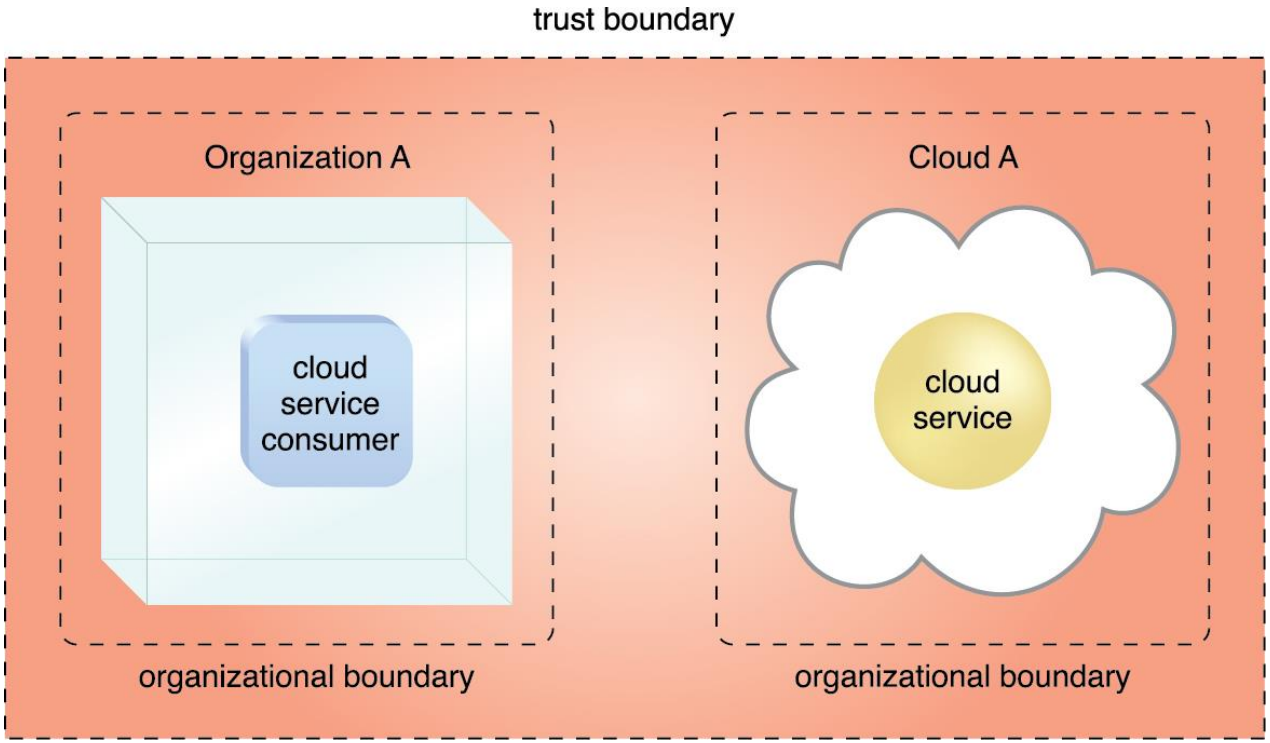

Figure 4.7 An extended trust boundary encompasses the organizational boundaries of the cloud provider and the cloud consumer

Cloud Characteristics

- On-Demand Usage
  - ✓ A cloud consumer can unilaterally access cloud-based IT resources giving the cloud consumer the freedom to self-provision these IT resources.
- Ubiquitous Access
  - ✓ Represents the ability for a cloud service to be widely accessible
- Multitenancy (and Resource Pooling)
  - ✓ The characteristic of a software program that enables an instance of the program to serve different consumers (tenants) whereby each is isolated from the other, is referred to as multitenancy.
  - ✓ Resource pooling allows cloud providers to pool large-scale IT resources to serve multiple cloud consumers.
  - ✓ Resource pooling is commonly achieved through multitenancy technology.

Cloud Characteristics

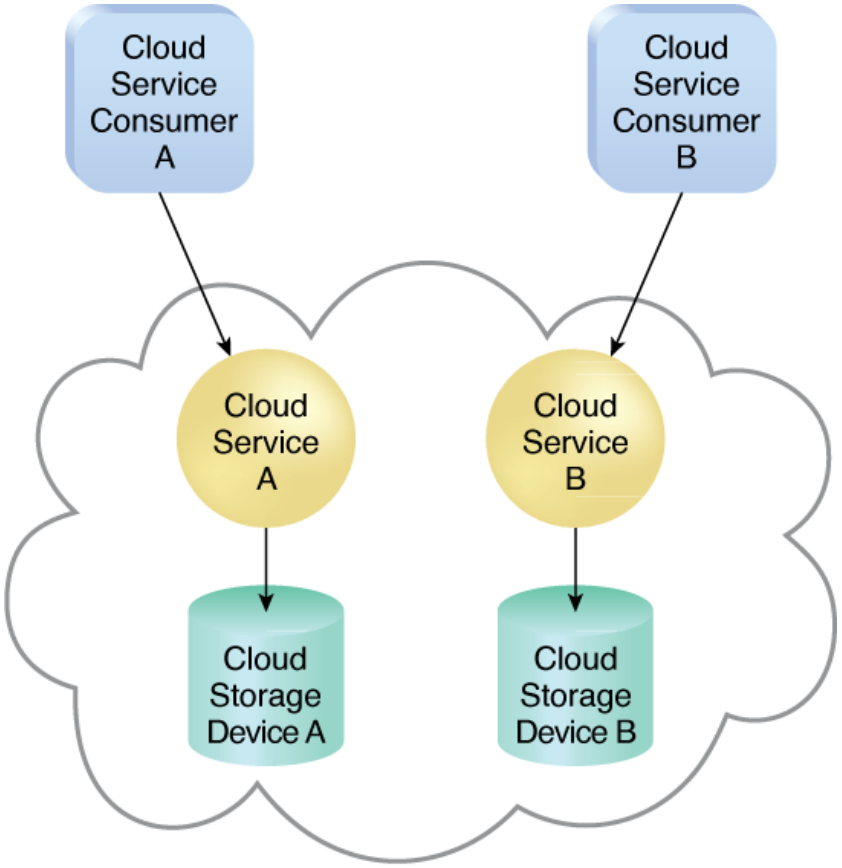

Figure 4.8 In a single-tenant environment, each cloud consumer has a separate IT resource instance

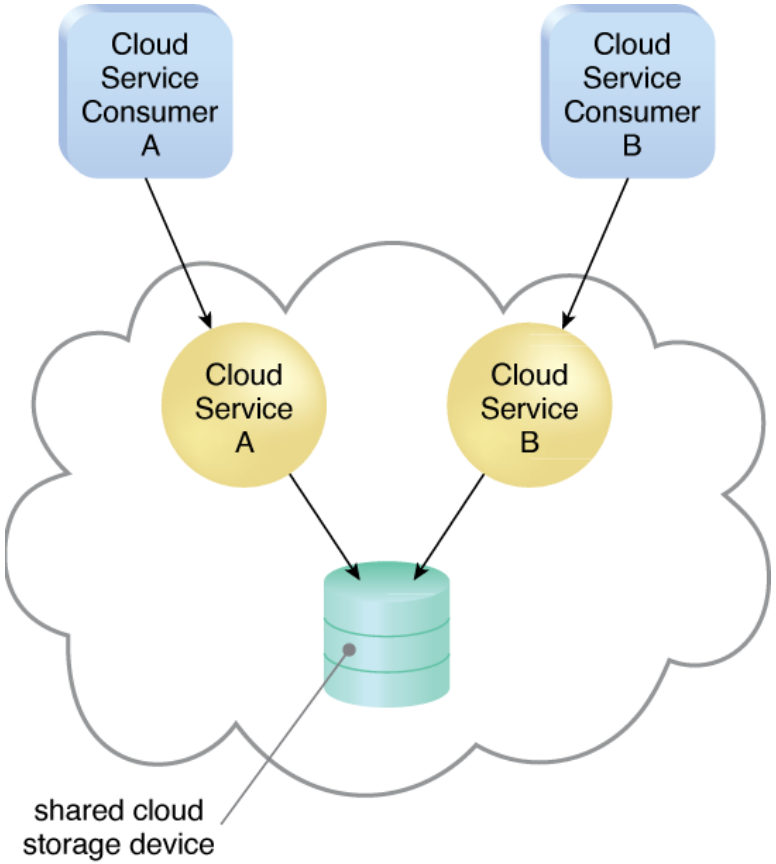

Figure 4.9 In a multitenant environment, a single instance of an IT resource, such as a cloud storage device, serves multiple consumers

Cloud Characteristics

- Elasticity
  - ✓ The automated ability of a cloud to transparently scale IT resources, as required in response to runtime conditions or as pre-determined by the cloud consumer or cloud provider
- Measured Usage
  - ✓ The ability of a cloud platform to keep track of the usage of its IT resources, primarily by cloud consumers
  - ✓ The cloud provider can charge a cloud consumer only for the IT resources actually used and/or for the timeframe during which access to the IT resources was granted
- Resiliency
  - ✓ A form of failover that distributes redundant implementations of IT resources across physical locations
  - ✓ Cloud consumers can increase both the reliability and availability of their applications by leveraging the resiliency of cloud-based IT resources.

Cloud Characteristics

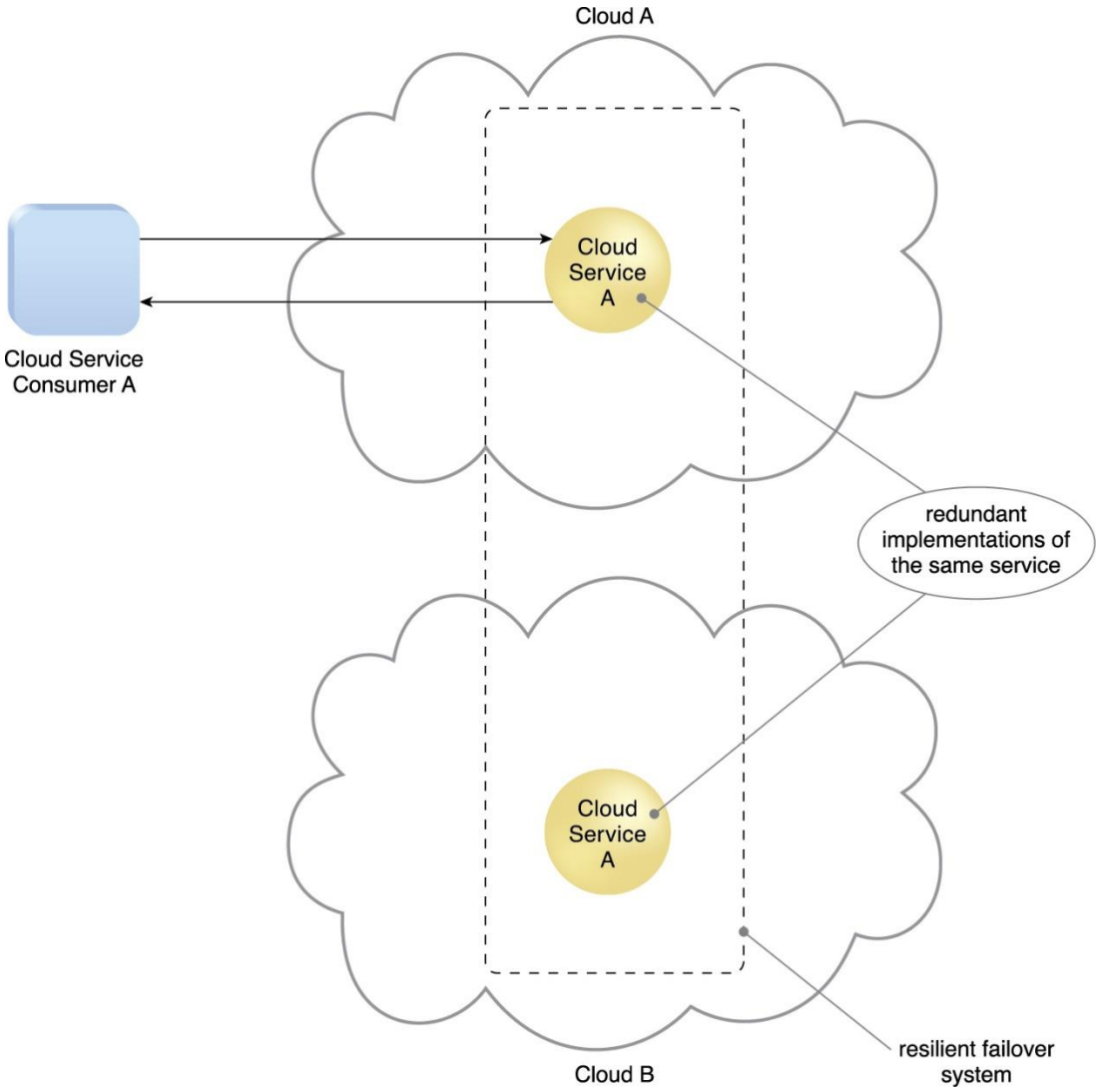

Figure 4.10 A resilient system in which Cloud B hosts a redundant implementation of Cloud Service A to provide failover in case Cloud Service A on Cloud A becomes unavailable

Cloud Delivery Models

- Cloud service delivery models
  - ✓ Infrastructure-as-a-Service (IaaS)
  - ✓ Platform-as-a-Service (PaaS)
  - ✓ Software-as-a-Service (SaaS)
- Many specialized variations of the three base cloud delivery models
  - ✓ Storage-as-a-Service
  - ✓ Database-as-a-Service
  - ✓ Security-as-a-Service
  - ✓ Communication-as-a-Service
  - ✓ Integration-as-a-Service
  - ✓ Testing-as-a-Service
  - ✓ Process-as-a-Service

Cloud Delivery Models

- Infrastructure-as-a-Service (IaaS)
  - ✓ A self-contained IT environment comprised of infrastructure-centric IT resources that can be accessed and managed via cloud service-based interfaces and tools
  - ✓ Is to provide cloud consumers with a high level of control and responsibility over its configuration and utilization
  - ✓ A central and primary IT resource within a typical IaaS environment is the virtual server
  - ✓ Virtual servers are leased by specifying server hardware requirements, such as processor capacity, memory, and local storage space.

Cloud Delivery Models

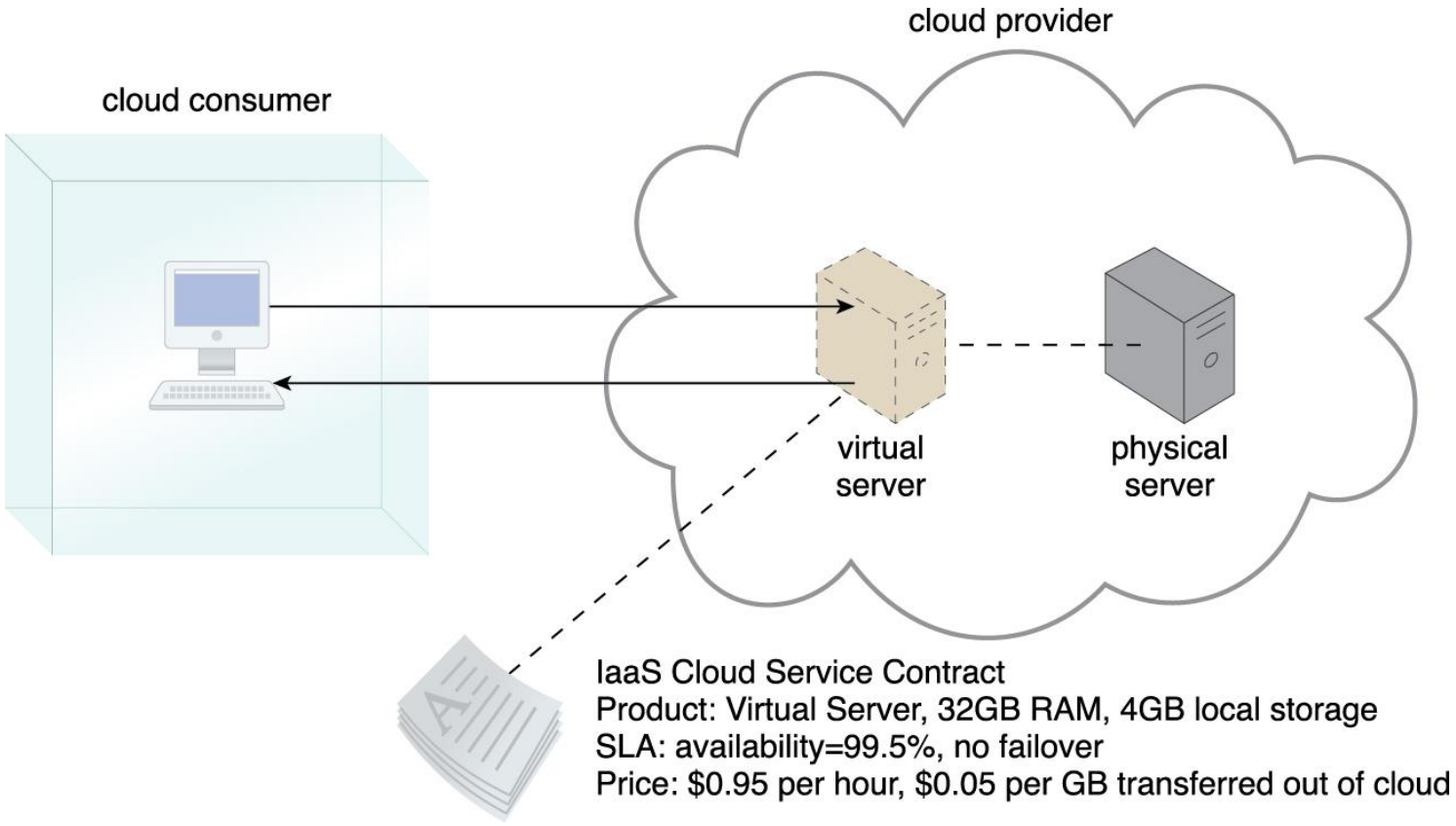

Figure 4.11 A cloud consumer is using a virtual server within an IaaS environment. Cloud consumers are provided with a range of contractual guarantees by the cloud provider, pertaining to characteristics such as capacity, performance, and availability

Cloud Delivery Models

- Platform-as-a-Service (PaaS)
  - ✓ A pre-defined "ready-to-use" environment typically comprised of already deployed and configured IT resources
  - ✓ The usage of a ready-made environment that establishes a set of pre-packaged products and tools
  - ✓ Common reasons a cloud consumer would use and invest in a PaaS environment include:
    - ❖ The cloud consumer wants to extend on-premise environments into the cloud for scalability and economic purposes.
    - ❖ The cloud consumer uses the ready-made environment to entirely substitute an on-premise environment.
    - ❖ The cloud consumer wants to become a cloud provider and deploys its own cloud services to be made available to other external cloud consumers.

Cloud Delivery Models

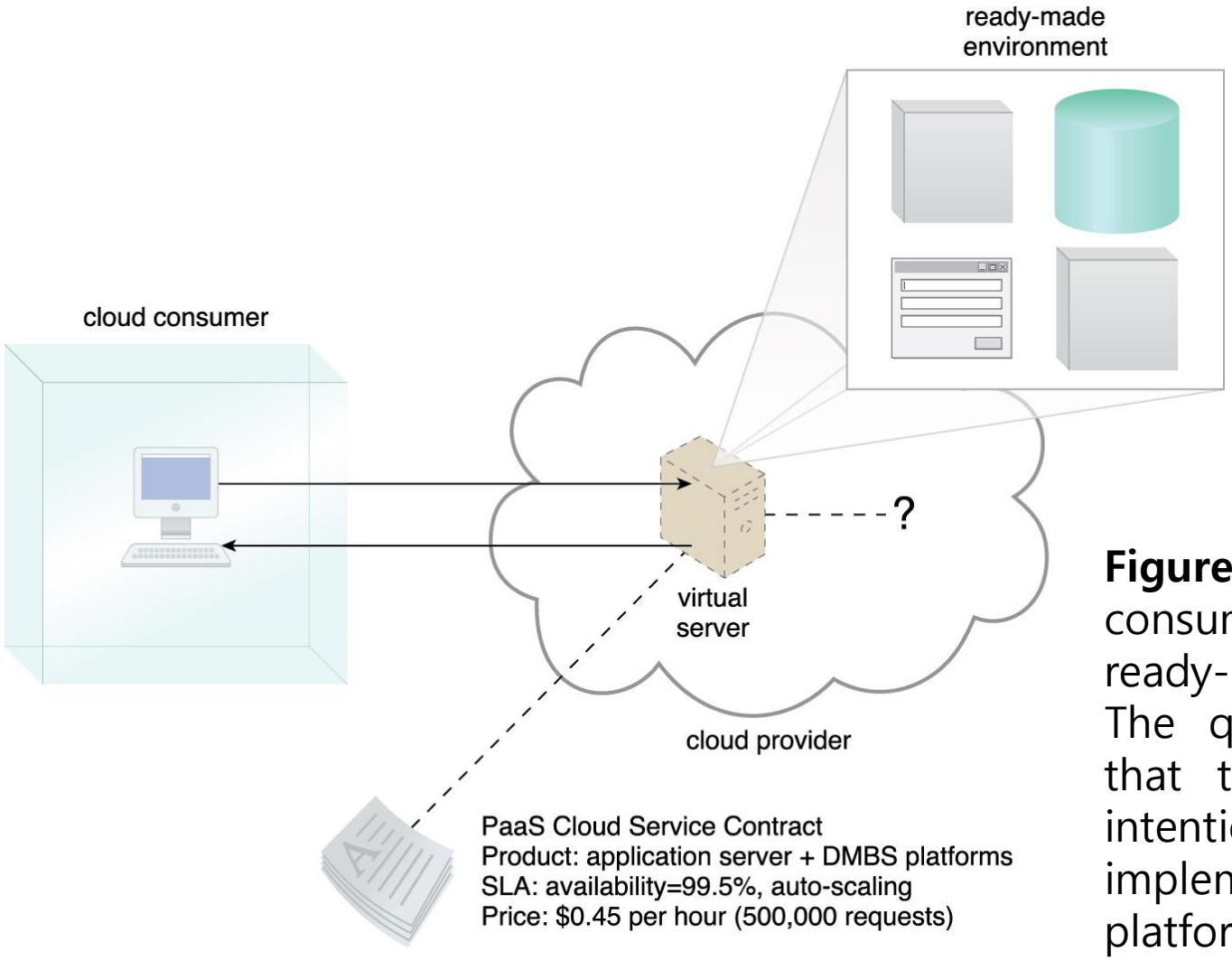

Figure 4.12 A cloud consumer is accessing a ready-made PaaS environment. The question mark indicates that the cloud consumer is intentionally shielded from the implementation details of the platform

Cloud Delivery Models

- Software-as-a-Service (SaaS)
  - ✓ A software program positioned as a shared cloud service and made available as a "product" or generic utility
  - ✓ An organization acting as a cloud consumer while using and working with a PaaS environment can build a cloud service that it decides to deploy in that same environment as a SaaS offering.

Cloud Delivery Models

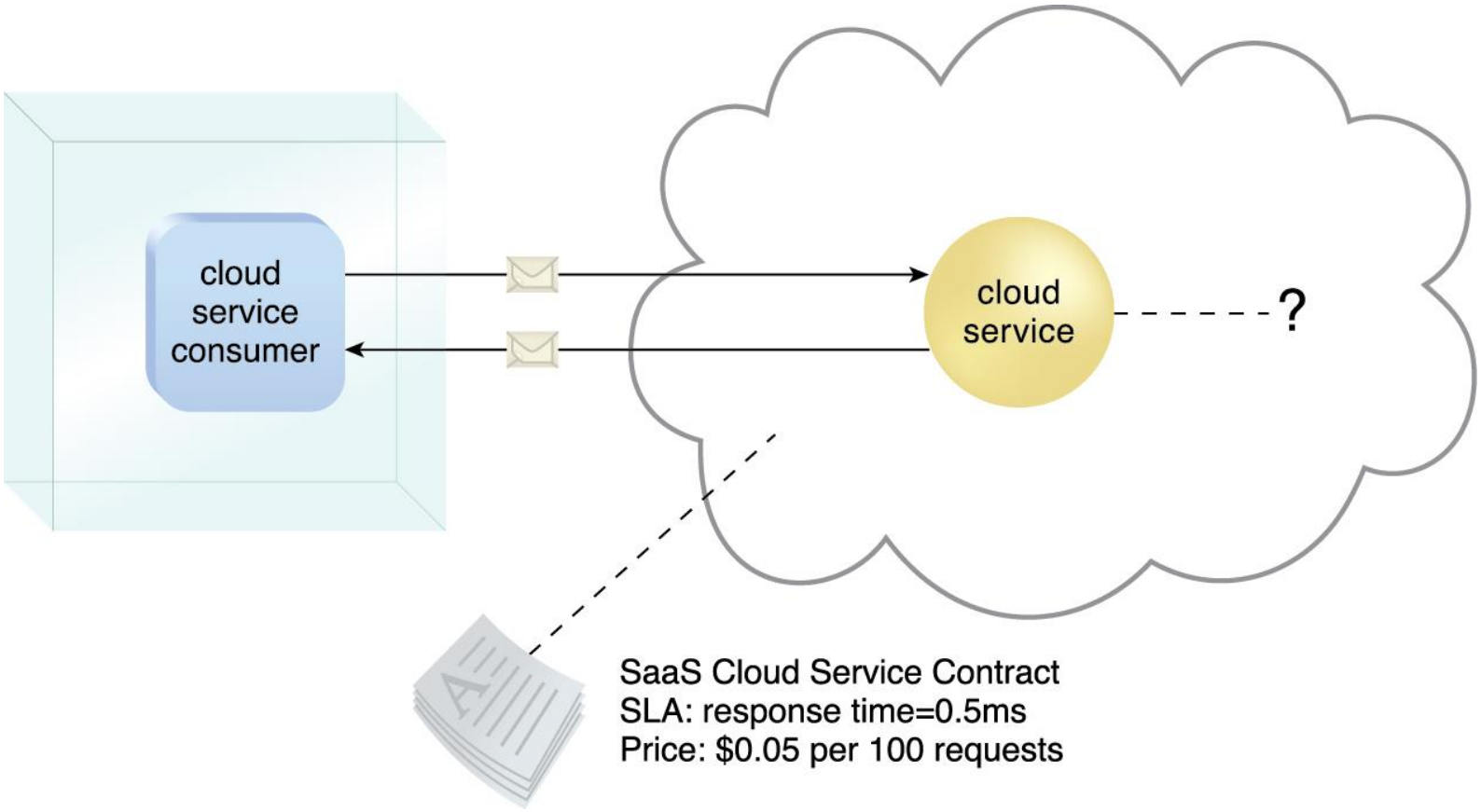

Figure 4.13 The cloud service consumer is given access the cloud service contract, but not to any underlying IT resources or implementation details

Comparing Cloud Delivery Models

Table 4.1 A comparison of typical cloud delivery model control levels

Cloud Delivery Model	Typical Level of Control Granted to Cloud Consumer	Typical Functionality Made Available to Cloud Consumer
SaaS	usage and usage-related configuration	access to front-end user-interface
PaaS	limited administrative	moderate level of administrative control over IT resources relevant to cloud consumer's usage of platform
IaaS	full administrative	full access to virtualized infrastructure-related IT resources and possibly, to underlying physical IT resources

Comparing Cloud Delivery Models

Table 4.2 Typical activities carried out by cloud consumers and cloud providers in relation to the cloud delivery models

Cloud Delivery Model	Common Cloud Consumer Activities	Common Cloud Provider Activities
SaaS	uses and configures cloud service	implements, manages, and maintains cloud service monitors usage by cloud consumers
PaaS	develops, tests, deploys, and manages cloud services and cloud-based solutions	pre-configures platform and provisions underlying infrastructure, middleware, and other needed IT resources, as necessary monitors usage by cloud consumers
IaaS	sets up and configures bare infrastructure, and installs, manage, and monitors any needed Software	provisions and manages the physical processing, storage, networking, and hosting required monitors usage by cloud consumers

Combining Cloud Delivery Models

- IaaS + PaaS
  - ✓ A PaaS environment will be built upon an underlying infrastructure comparable to the physical and virtual servers and other IT resources provided in an IaaS environment.
  - ✓ A cloud provider would not normally need to provision an IaaS environment from its own cloud in order to make a PaaS environment available to cloud consumers.
    - ❖ May be influenced by economics
    - ❖ Maybe because the first cloud provider is close to exceeding its existing capacity by serving other cloud consumers
    - ❖ A legal requirement for data to be physically stored in a specific region

Combining Cloud Delivery Models

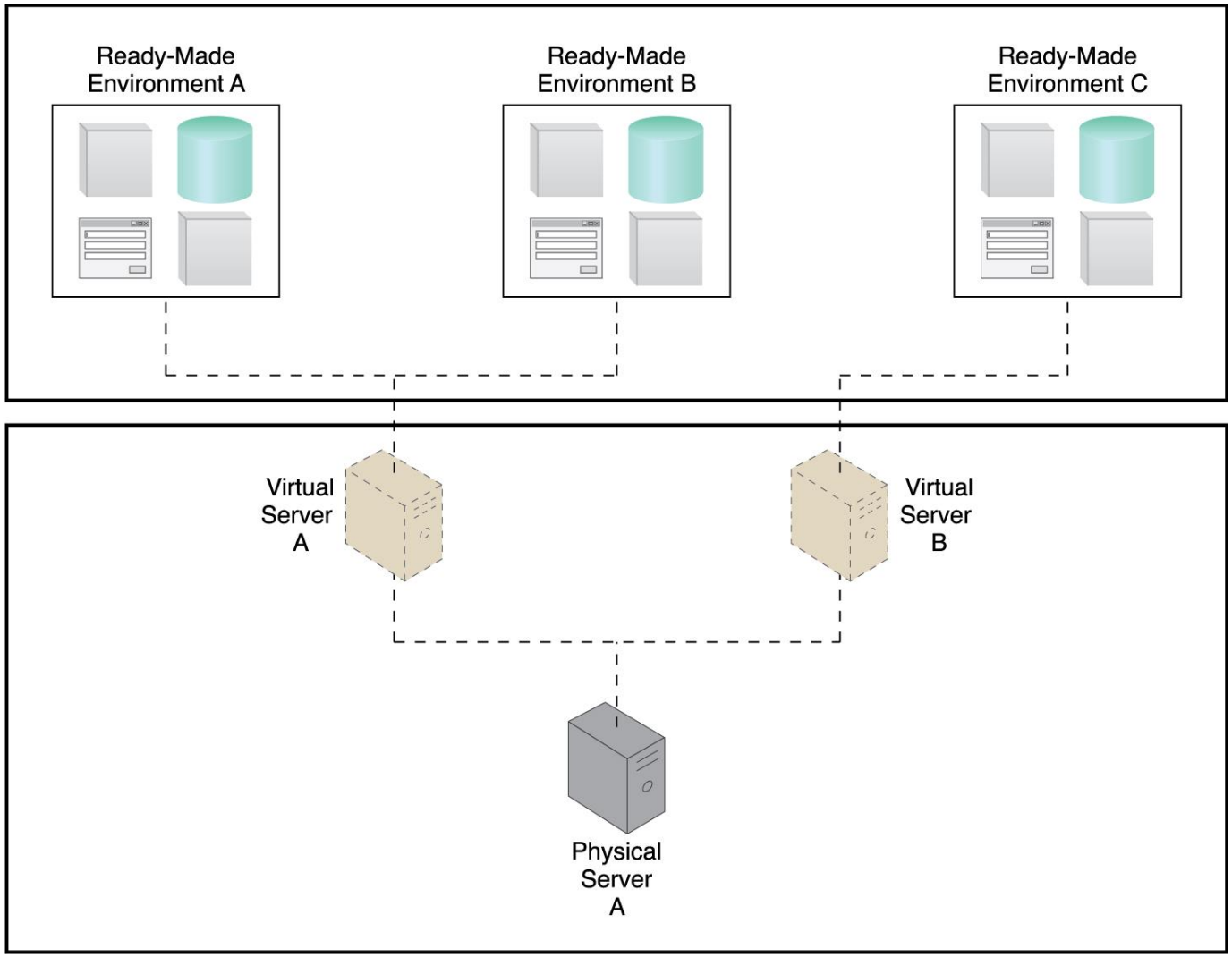

Figure 4.14 A PaaS environment based on the IT resources provided by an underlying IaaS environment

Combining Cloud Delivery Models

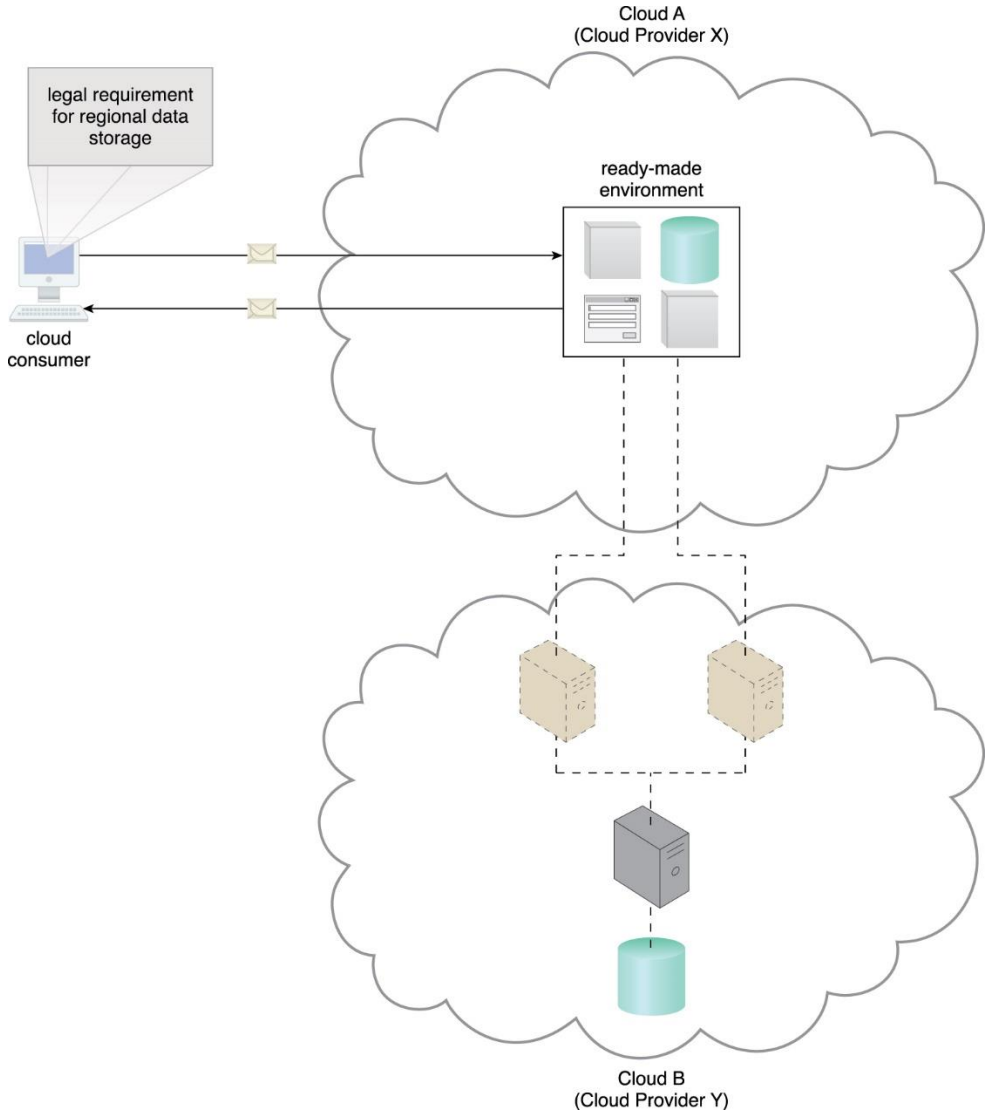

Figure 4.15 An example of a contract between Cloud Providers X and Y, in which services offered by Cloud Provider X are physically hosted on virtual servers belonging to Cloud Provider Y. Sensitive data that is legally required to stay in a specific region is physically kept in Cloud B, which is physically located in that region

Combining Cloud Delivery Models

- IaaS + PaaS + SaaS
  - ✓ All three cloud delivery models can be combined to establish layers of IT resources that build upon each other.
  - ✓ The ready-made environment provided by the PaaS environment can be used by the cloud consumer organization to develop and deploy its own SaaS cloud services that it can then make available as commercial products.

Combining Cloud Delivery Models

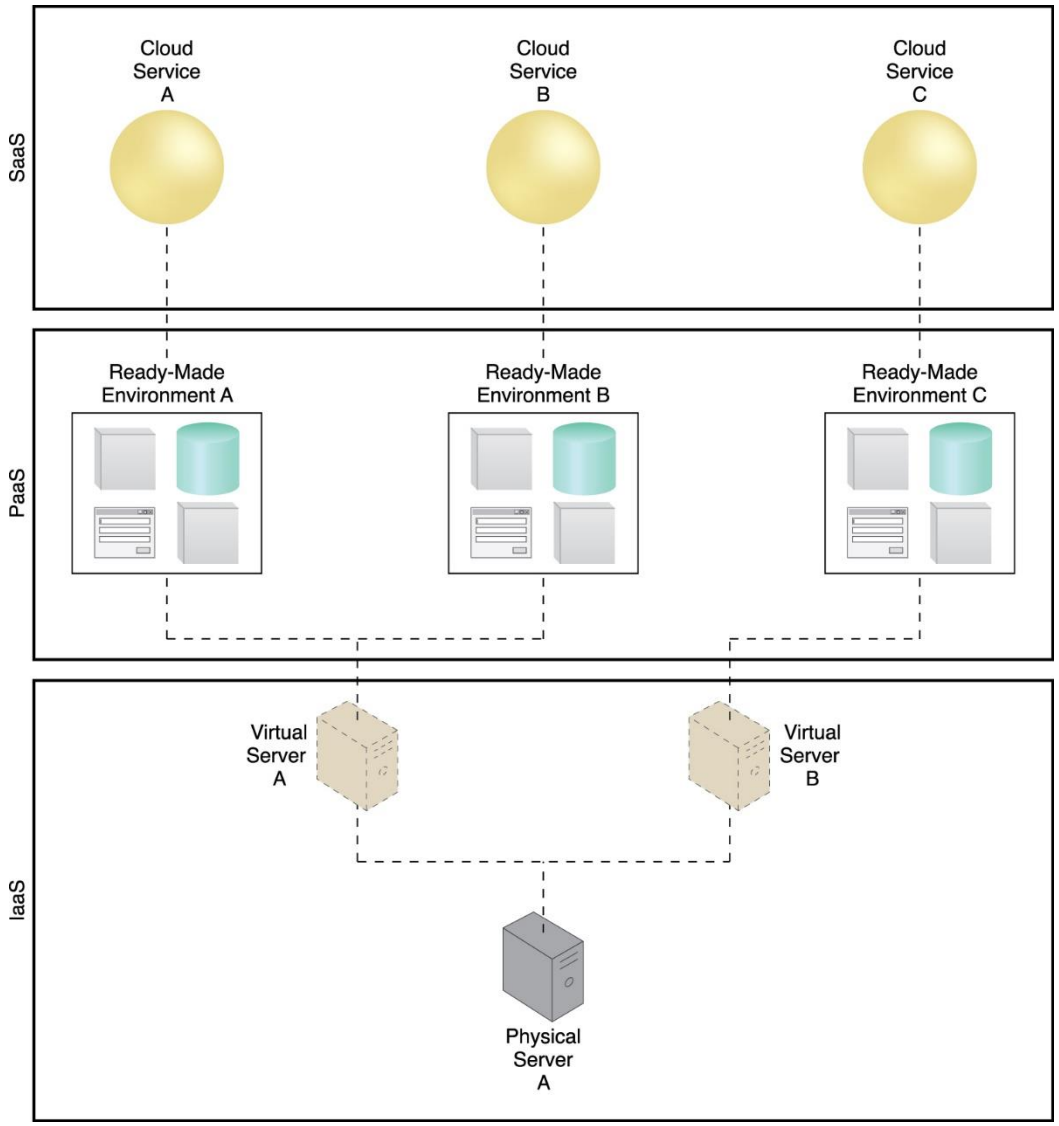

Figure 4.16 A simple layered view of an architecture comprised of IaaS and PaaS environments hosting three SaaS cloud service implementations

Cloud Deployment Models

- Public Clouds
  - ✓ A publicly accessible cloud environment owned by a third-party cloud provider
  - ✓ The cloud provider is responsible for the creation and on-going maintenance of the public cloud and its IT resources
- Community Clouds
  - ✓ Is similar to a public cloud except that its access is limited to a specific community of cloud consumers
  - ✓ The community cloud may be jointly owned by the community members or by a third-party cloud provider that provisions a public cloud with limited access

Cloud Deployment Models

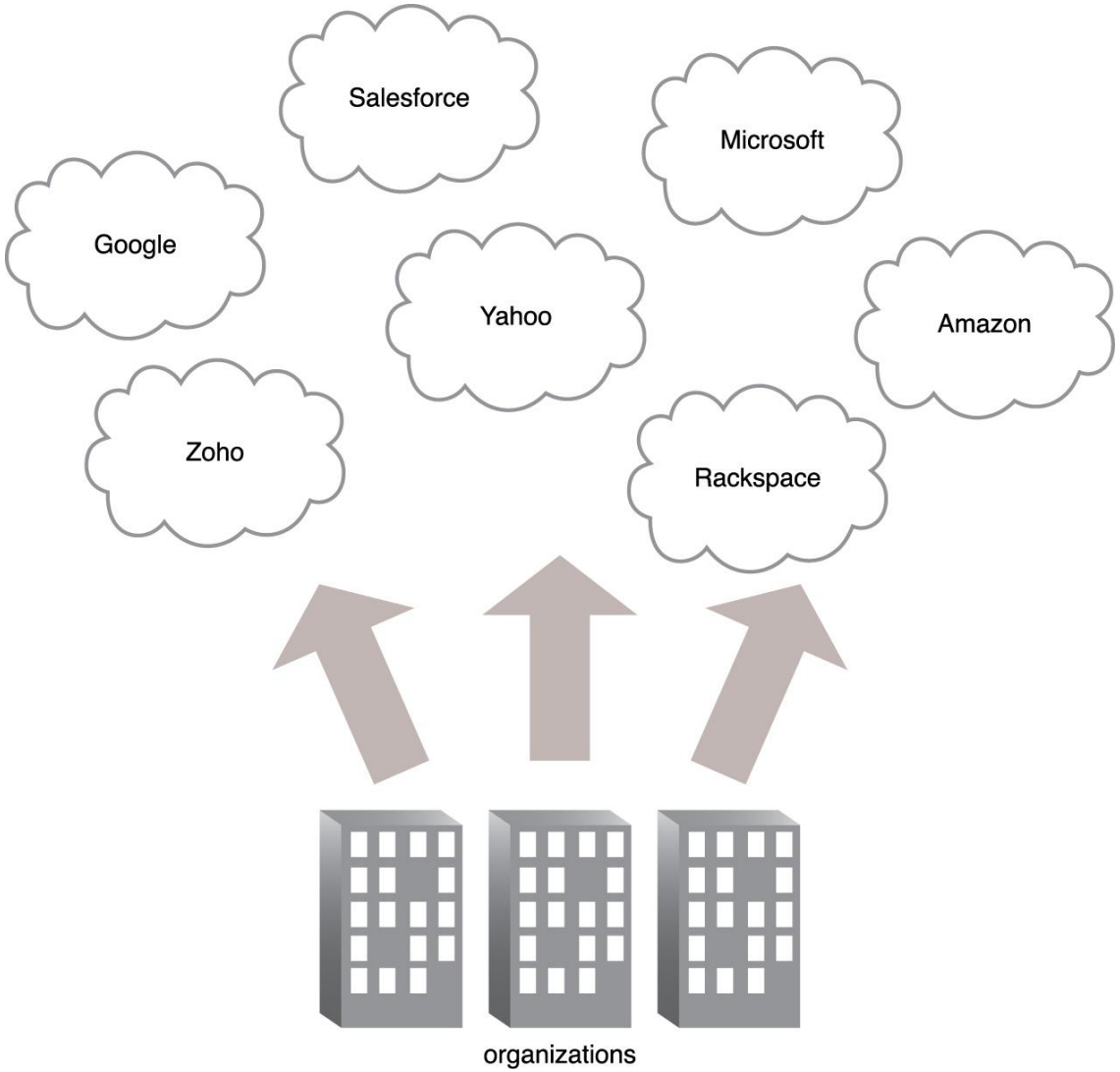

Figure 4.17 Organizations act as cloud consumers when accessing cloud services and IT resources made available by different cloud providers

Cloud Deployment Models

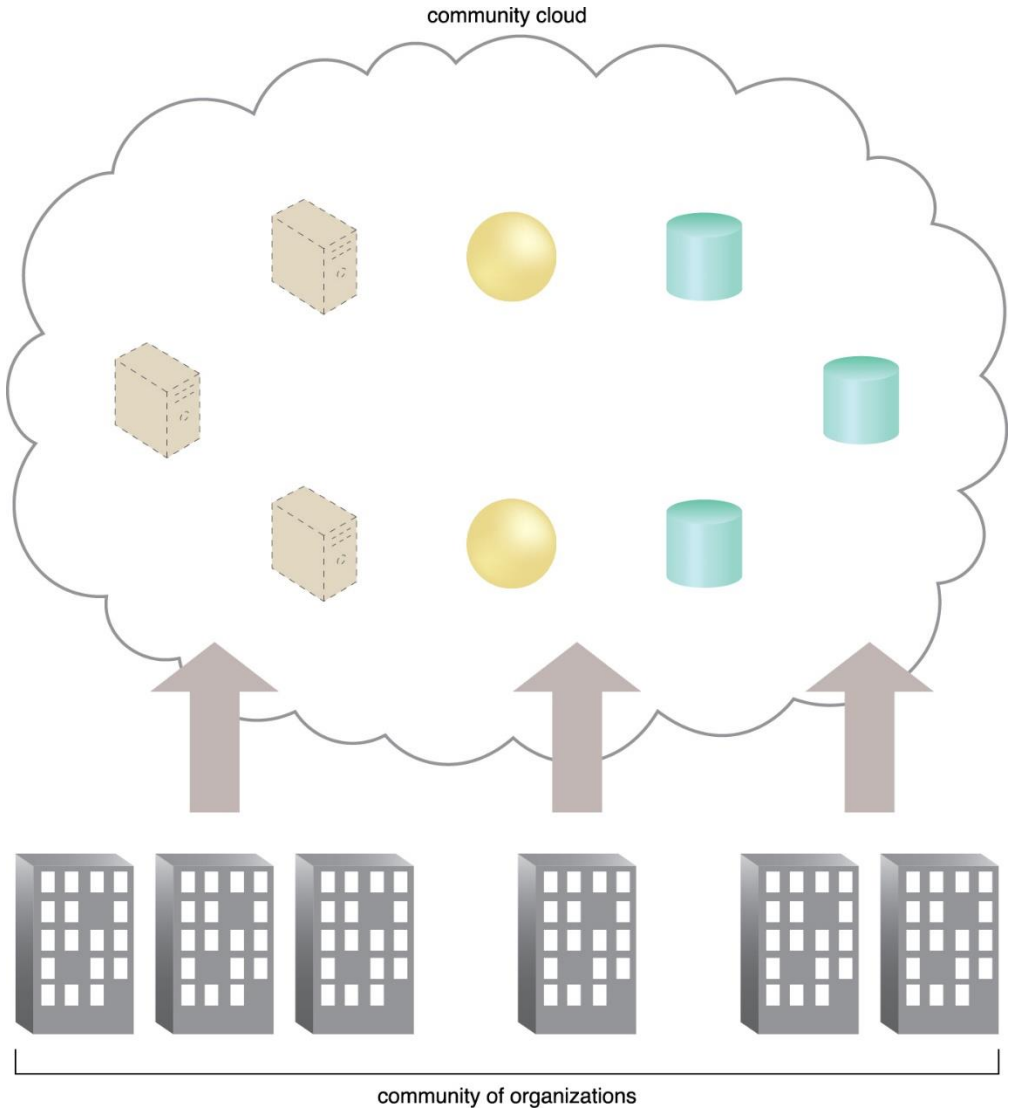

Figure 4.18 An example of a "community" of organizations accessing IT resources from a community cloud

Cloud Deployment Models

- Private Clouds
  - ✓ Is owned by a single organization
  - ✓ The use of a private cloud can change how organizational and trust boundaries are defined and applied.
  - ✓ The same organization is technically both the cloud consumer and cloud provider.
    - ❖ a separate organizational department typically assumes the responsibility for provisioning the cloud
    - ❖ departments requiring access to the private cloud assume the cloud consumer role
- Hybrid Clouds
  - ✓ A cloud environment comprised of two or more different cloud deployment models
  - ✓ Hybrid deployment architectures can be complex and challenging to create and maintain due to the potential disparity in cloud environments and the fact that management responsibilities are typically split between the private cloud provider organization and the public cloud provider.

Cloud Deployment Models

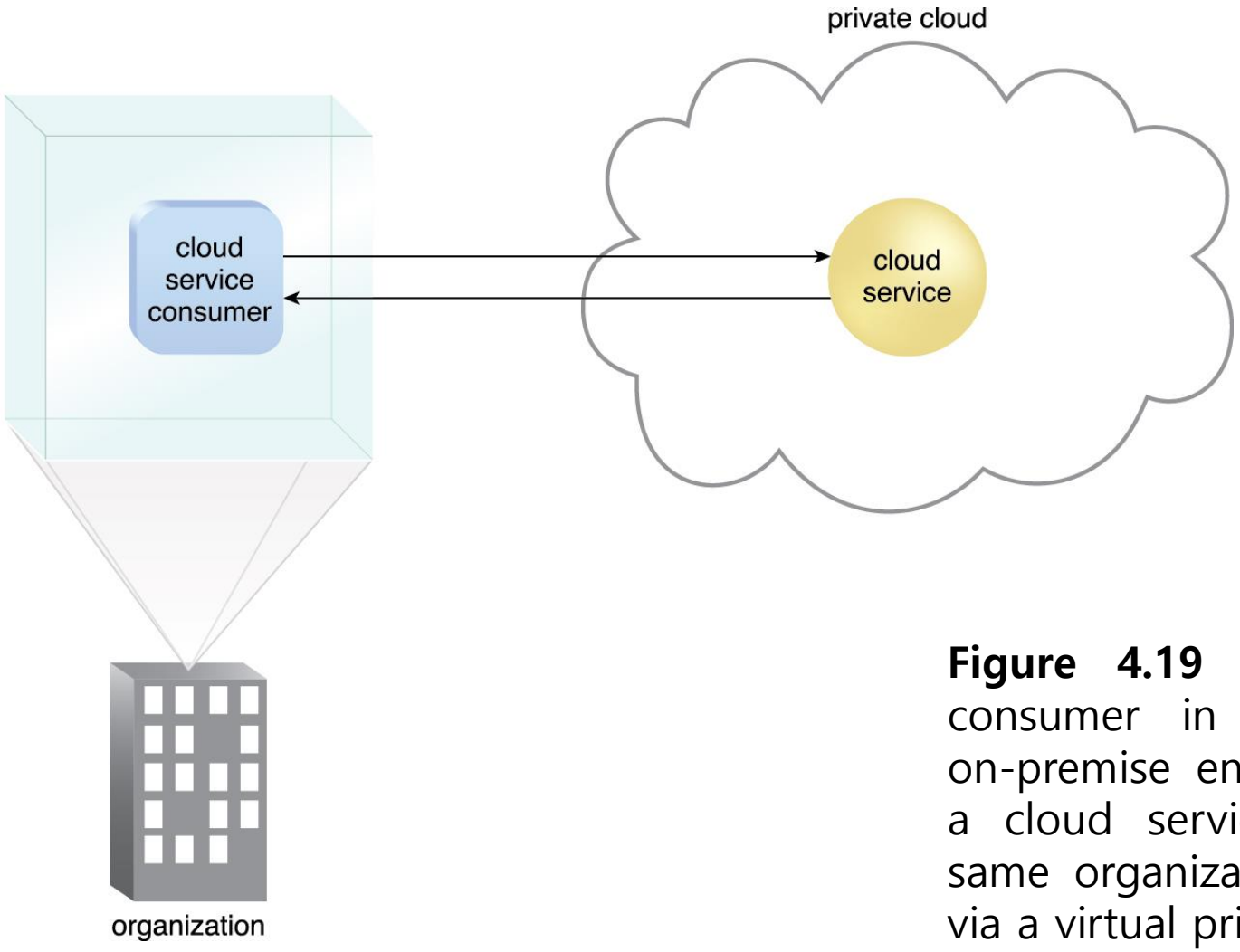

Figure 4.19 A cloud service consumer in the organization's on-premise environment accesses a cloud service hosted on the same organization's private cloud via a virtual private network

Cloud Deployment Models

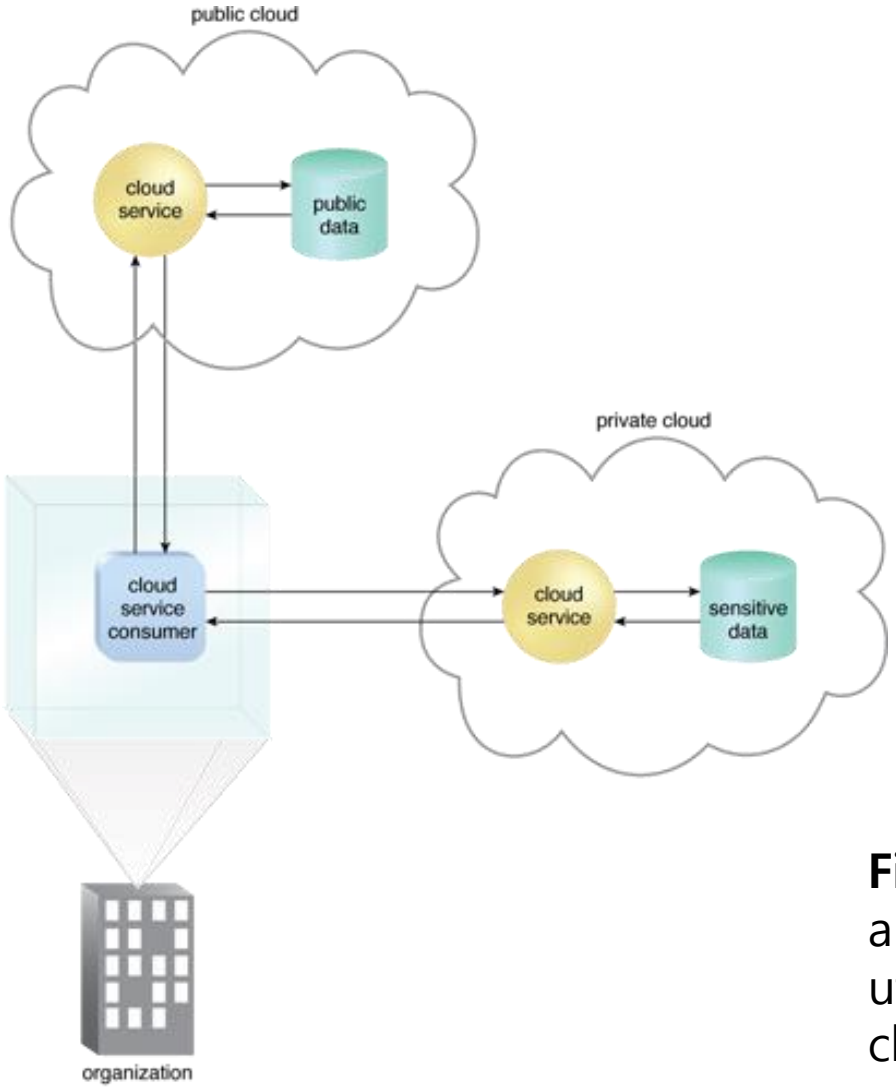

Figure 4.20 An organization using a hybrid cloud architecture that utilizes both a private and public cloud