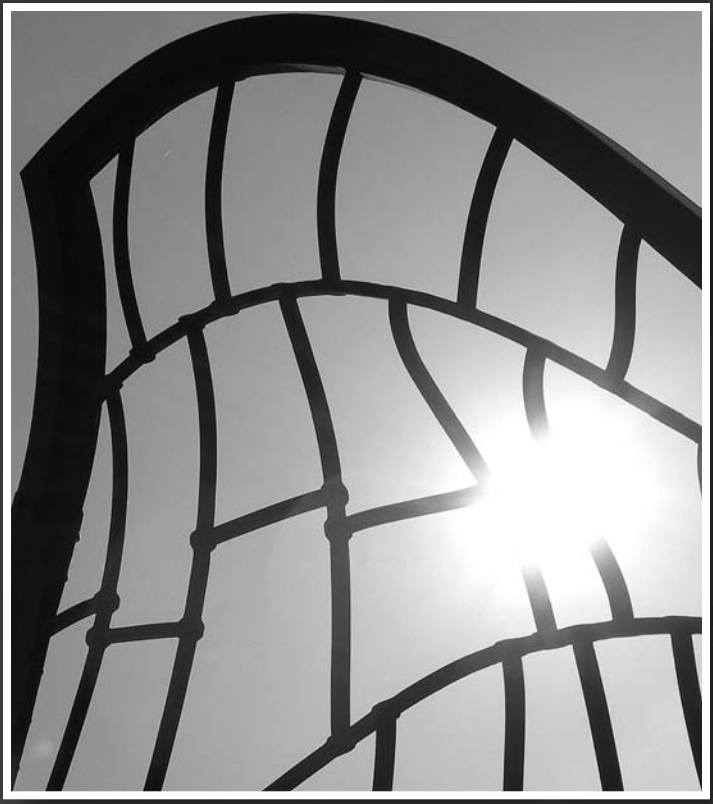


Chapter 4

Fundamental Concepts and Models

4.1 Roles and Boundaries

4.2 Cloud Characteristics

4.3 Cloud Delivery Models

4.4 Cloud Deployment Models

The upcoming sections cover introductory topic areas pertaining to the fundamental models used to categorize and define clouds and their most common service offerings, along with definitions of organizational roles and the specific set of characteristics that collectively distinguish a cloud.

4.1 Roles and Boundaries

Organizations and humans can assume different types of pre-defined roles depending on how they relate to and/or interact with a cloud and its hosted IT resources. Each of the upcoming roles participates in and carries out responsibilities in relation to cloud-based activity. The following sections define these roles and identify their main interactions.

Cloud Provider

The organization that provides cloud-based IT resources is the *cloud provider*. When assuming the role of cloud provider, an organization is responsible for making cloud services available to cloud consumers, as per agreed upon SLA guarantees. The cloud provider is further tasked with any required management and administrative duties to ensure the on-going operation of the overall cloud infrastructure.

Cloud providers normally own the IT resources that are made available for lease by cloud consumers; however, some cloud providers also "resell" IT resources leased from other cloud providers.

Cloud Consumer

A *cloud consumer* is an organization (or a human) that has a formal contract or arrangement with a cloud provider to use IT resources made available by the cloud provider. Specifically, the cloud consumer uses a cloud service consumer to access a cloud service (Figure 4.1).

The figures in this book do not always explicitly label symbols as "cloud consumers." Instead, it is generally implied that organizations or humans shown remotely accessing cloud-based IT resources are considered cloud consumers.

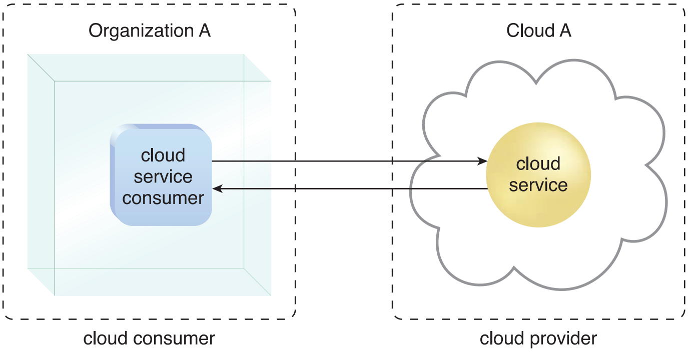


Figure 4.1
A cloud consumer (Organization A) interacts with a cloud service from a cloud provider (that owns Cloud A). Within Organization A, the cloud service consumer is being used to access the cloud service.

NOTE

When depicting interaction scenarios between cloud-based IT resources and consumer organizations, there are no strict rules as to how the terms “cloud service consumer” and “cloud consumer” are used in this book. The former is usually used to label software programs or applications that programmatically interface with a cloud service’s technical contract or API. The latter term is more broad in that it can be used to label an organization, an individual accessing a user-interface, or a software program that assumes the role of cloud consumer when interacting with a cloud, a cloud-based IT resource, or a cloud provider. The broad applicability of the “cloud consumer” term is intentional as it allows it to be used in figures that explore different types of consumer-provider relationships within different technical and business contexts.

Cloud Service Owner

The person or organization that legally owns a cloud service is called a *cloud service owner*. The cloud service owner can be the cloud consumer, or the cloud provider that owns the cloud within which the cloud service resides.

For example, either the cloud consumer of Cloud X or the cloud provider of Cloud X could own Cloud Service A (Figures 4.2 and 4.3).

Note that a cloud consumer that owns a cloud service hosted by a third-party cloud does not necessarily need to be the user (or consumer) of the cloud service. Several cloud consumer organizations develop and deploy cloud services in clouds owned by other parties for the purpose of making the cloud services available to the general public.

The reason a cloud service owner is not called a cloud resource owner is because the cloud service owner role only applies to cloud services (which, as explained in Chapter 3, are externally accessible IT resources that reside in a cloud).

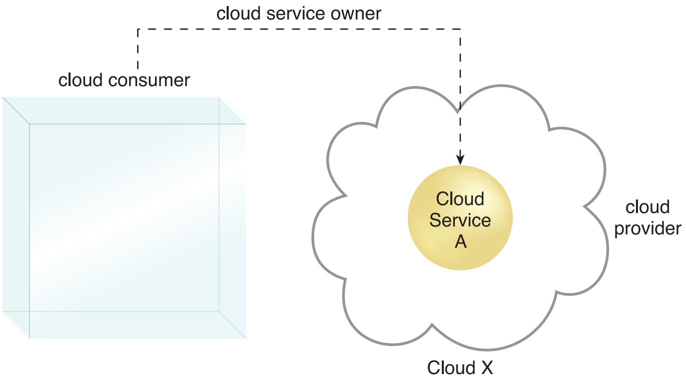


Figure 4.2
A cloud consumer can be a cloud service owner when it deploys its own service in a cloud.

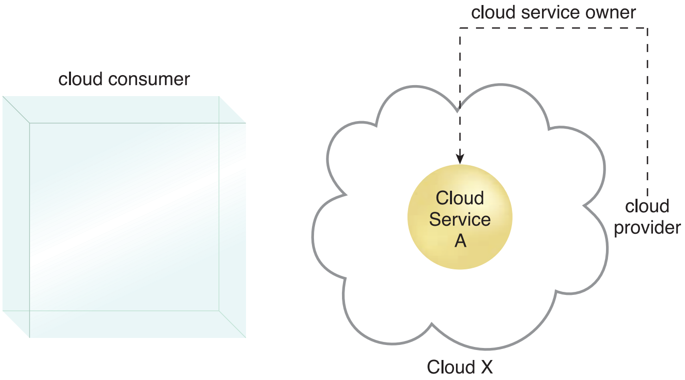


Figure 4.3
A cloud provider becomes a cloud service owner if it deploys its own cloud service, typically for other cloud consumers to use.

Cloud Resource Administrator

A *cloud resource administrator* is the person or organization responsible for administering a cloud-based IT resource (including cloud services). The cloud resource administrator can be (or belong to) the cloud consumer or cloud provider of the cloud within which the cloud service resides. Alternatively, it can be (or belong to) a third-party organization contracted to administer the cloud-based IT resource.

For example, a cloud service owner can contract a cloud resource administrator to administer a cloud service (Figures 4.4 and 4.5).

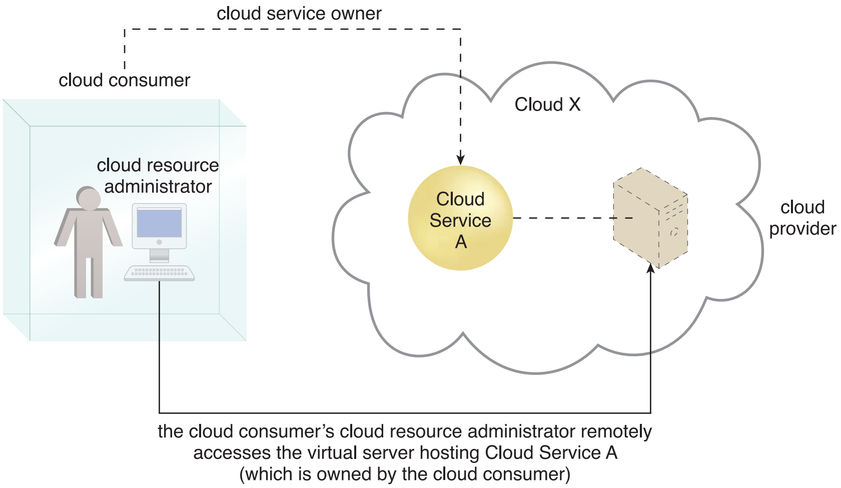

cloud service owner
cloud consumer
cloud resource administrator
Cloud X
Cloud Service A
cloud provider
the cloud consumer's cloud resource administrator remotely accesses the virtual server hosting Cloud Service A (which is owned by the cloud consumer)

Figure 4.4

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

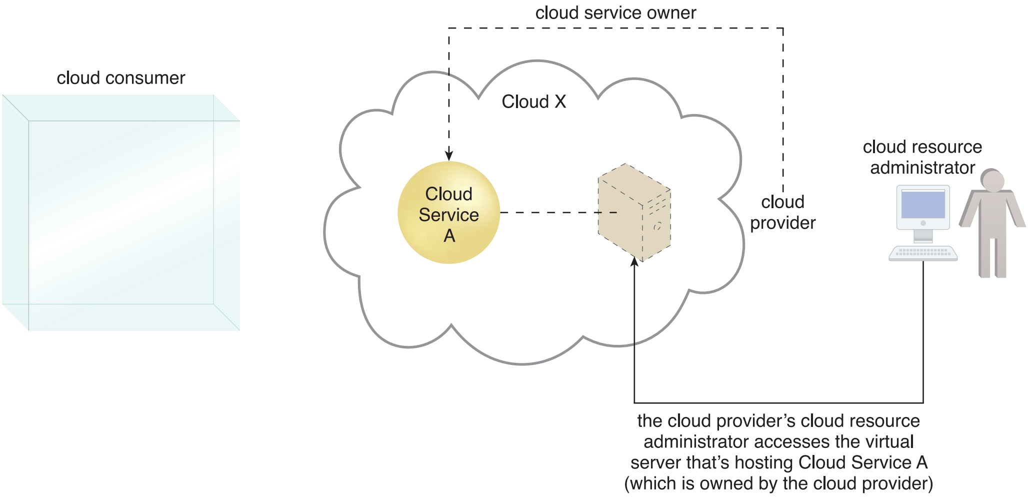

cloud service owner
cloud consumer
Cloud X
Cloud Service A
cloud provider
cloud resource administrator
the cloud provider's cloud resource administrator accesses the virtual server that's hosting Cloud Service A (which is owned by the cloud provider)

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.

The reason a cloud resource administrator is not referred to as a “cloud service administrator” is because this role may be responsible for administering cloud-based IT resources that don’t exist as cloud services. For example, if the cloud resource administrator belongs to (or is contracted by) the cloud provider, IT resources not made remotely accessible may be administered by this role (and these types of IT resources are not classified as cloud services).

Additional Roles

The NIST Cloud Computing Reference Architecture defines the following supplementary roles:

- *Cloud Auditor* – A third-party (often accredited) that conducts independent assessments of cloud environments assumes the role of the *cloud auditor*. The typical responsibilities associated with this role include the evaluation of security controls, privacy impacts, and performance. The main purpose of the cloud auditor role is to provide an unbiased assessment (and possible endorsement) of a cloud environment to help strengthen the trust relationship between cloud consumers and cloud providers.
- *Cloud Broker* – This role is assumed by a party that assumes the responsibility of managing and negotiating the usage of cloud services between cloud consumers and cloud providers. Mediation services provided by *cloud brokers* include service intermediation, aggregation, and arbitrage.
- *Cloud Carrier* – The party responsible for providing the wire-level connectivity between cloud consumers and cloud providers assumes the role of the *cloud carrier*. This role is often assumed by network and telecommunication providers.

While each is legitimate, most architectural scenarios covered in this book do not include these roles.

Organizational Boundary

An *organizational boundary* represents the physical perimeter that surrounds a set of IT resources that are owned and governed by an organization. The organizational boundary does not represent the boundary of an actual organization, only an organizational set of IT assets and IT resources. Similarly, clouds have an organizational boundary (Figure 4.6).

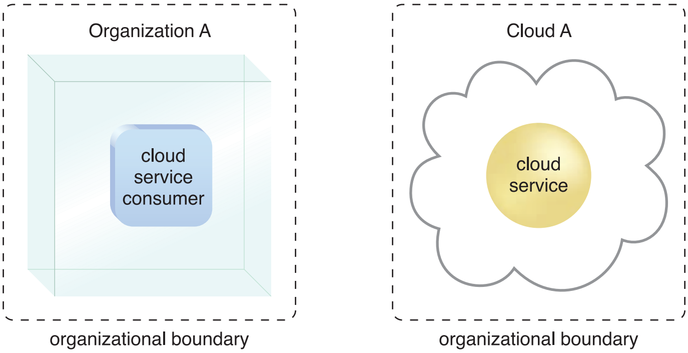


Figure 4.6
Organizational boundaries of a cloud consumer (left), and a cloud provider (right), represented by a broken line notation.

Trust Boundary

When an organization assumes the role of cloud consumer to access cloud-based IT resources, it needs to extend its trust beyond the physical boundary of the organization to include parts of the cloud environment.

A *trust boundary* is a logical perimeter that typically spans beyond physical boundaries to represent the extent to which IT resources are trusted (Figure 4.7). When analyzing cloud environments, the trust boundary is most frequently associated with the trust issued by the organization acting as the cloud consumer.

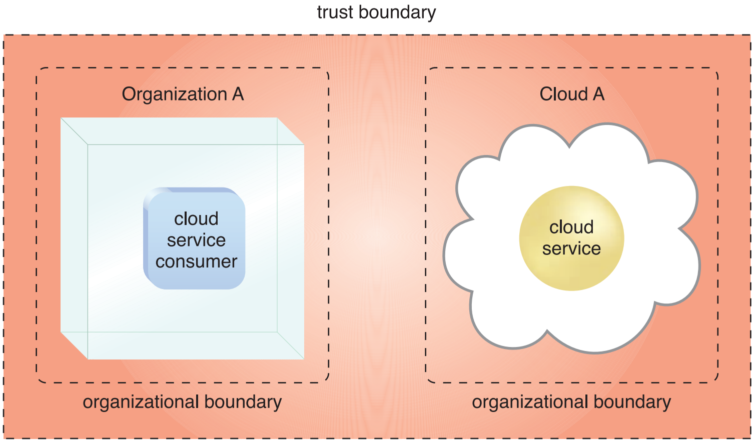


Figure 4.7
An extended trust boundary encompasses the organizational boundaries of the cloud provider and the cloud consumer.

NOTE

Another type of boundary relevant to cloud environments is the logical network perimeter. This type of boundary is classified as a cloud computing mechanism and is covered in Chapter 7.

SUMMARY OF KEY POINTS

- Common roles associated with cloud-based interaction and relationships include the cloud provider, cloud consumer, cloud service owner, and cloud resource administrator.
- An organizational boundary represents the physical scope of IT resources owned and governed by an organization. A trust boundary is the logical perimeter that encompasses the IT resources trusted by an organization.

4.2 Cloud Characteristics

An IT environment requires a specific set of characteristics to enable the remote provisioning of scalable and measured IT resources in an effective manner. These characteristics need to exist to a meaningful extent for the IT environment to be considered an effective cloud.

The following six specific characteristics are common to the majority of cloud environments:

- on-demand usage
- ubiquitous access
- multitenancy (and resource pooling)
- elasticity
- measured usage
- resiliency

Cloud providers and cloud consumers can assess these characteristics individually and collectively to measure the value offering of a given cloud platform. Although cloud-based services and IT resources will inherit and exhibit individual characteristics to varying extents, usually the greater the degree to which they are supported and utilized, the greater the resulting value proposition.

NOTE

The NIST definition of cloud computing defines only five characteristics; resiliency is excluded. Resiliency has emerged as an aspect of significant importance and its common level of support constitutes its necessary inclusion as a common cloud characteristic.

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. Once configured, usage of the self-provisioned IT resources can be automated, requiring no further human involvement by the cloud consumer or cloud provider. This results in an *on-demand usage* environment. Also known as "on-demand self-service usage," this characteristic enables the service-based and usage-driven features found in mainstream clouds.

Ubiquitous Access

Ubiquitous access represents the ability for a cloud service to be widely accessible. Establishing ubiquitous access for a cloud service can require support for a range of devices, transport protocols, interfaces, and security technologies. To enable this level of access generally requires that the cloud service architecture be tailored to the particular needs of different cloud service consumers.

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*. A cloud provider pools its IT resources to serve multiple cloud service consumers by using multitenancy models that frequently rely on the use of virtualization technologies. Through the use of multitenancy technology, IT resources can be dynamically assigned and reassigned, according to cloud service consumer demands.

Resource pooling allows cloud providers to pool large-scale IT resources to serve multiple cloud consumers. Different physical and virtual IT resources are dynamically assigned and reassigned according to cloud consumer demand, typically followed by execution through statistical multiplexing. Resource pooling is commonly achieved through multitenancy technology, and therefore encompassed by this multitenancy characteristic. See the *Resource Pooling Architecture* section in Chapter 11 for a more detailed explanation.

Figures 4.8 and 4.9 illustrate the difference between single-tenant and multitenant environments.

Figure 4.8

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

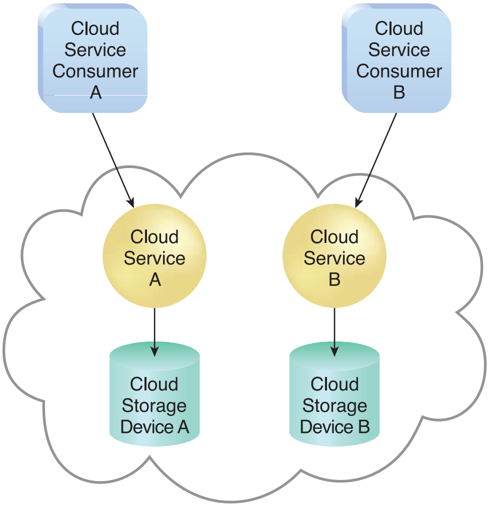
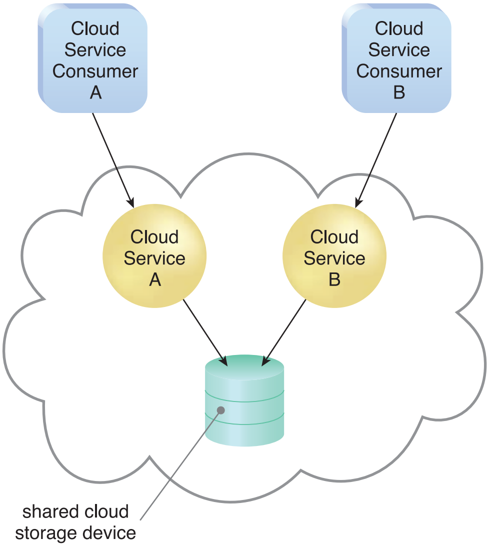


Figure 4.9

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



As illustrated in Figure 4.9, multitenancy allows several cloud consumers to use the same IT resource or its instance while each remains unaware that it may be used by others.

Elasticity

Elasticity is 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. Elasticity is often considered a core justification for the adoption of cloud computing, primarily due to the fact that it is closely associated with the Reduced Investment and Proportional Costs benefit. Cloud providers with vast IT resources can offer the greatest range of elasticity.

Measured Usage

The *measured usage* characteristic represents the ability of a cloud platform to keep track of the usage of its IT resources, primarily by cloud consumers. Based on what is measured, 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. In this context, measured usage is closely related to the on-demand characteristic.

Measured usage is not limited to tracking statistics for billing purposes. It also encompasses the general monitoring of IT resources and related usage reporting (for both cloud provider and cloud consumers). Therefore, measured usage is also relevant to clouds that do not charge for usage (which may be applicable to the private cloud deployment model described in the upcoming *Cloud Deployment Models* section).

Resiliency

Resilient computing is a form of failover that distributes redundant implementations of IT resources across physical locations. IT resources can be pre-configured so that if one becomes deficient, processing is automatically handed over to another redundant implementation. Within cloud computing, the characteristic of *resiliency* can refer to redundant IT resources within the same cloud (but in different physical locations) or across multiple clouds. Cloud consumers can increase both the reliability and availability of their applications by leveraging the resiliency of cloud-based IT resources (Figure 4.10).

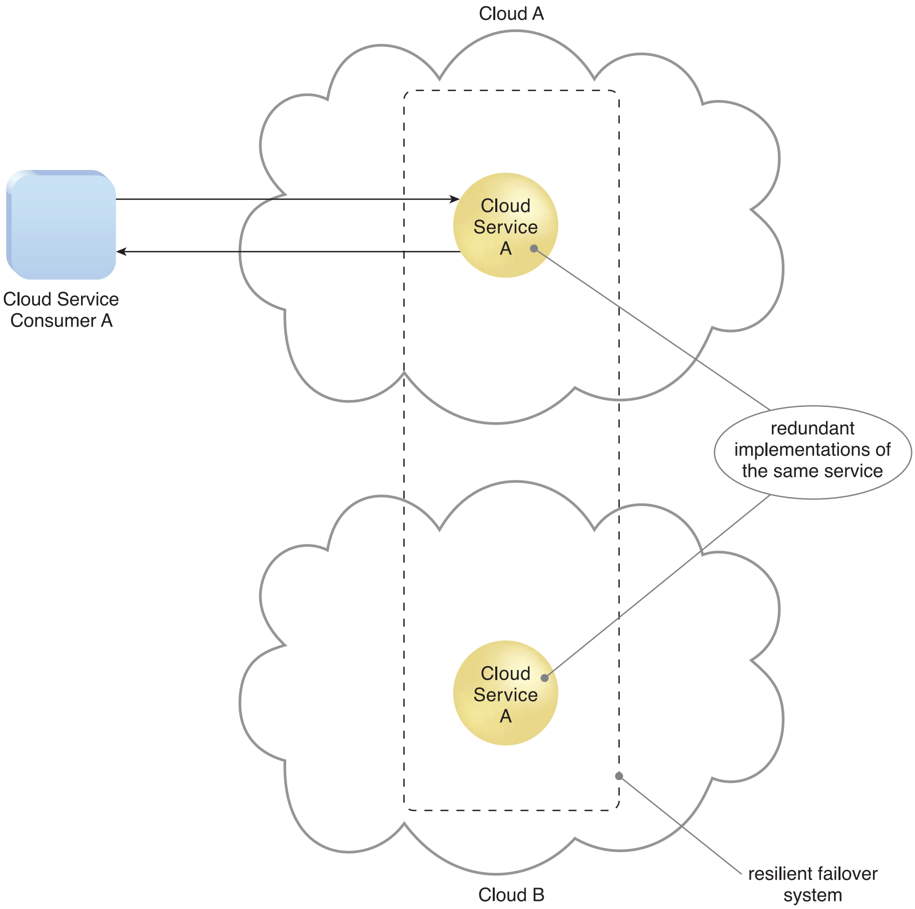

Cloud A
Cloud Service A
Cloud Service Consumer A
redundant implementations of the same service
Cloud Service A
resilient failover system
Cloud B

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.

SUMMARY OF KEY POINTS

- On-demand usage is the ability of a cloud consumer to self-provision and use necessary cloud-based services without requiring cloud provider interaction. This characteristic is related to measured usage, which represents the ability of a cloud to measure the usage of its IT resources.
- Ubiquitous access allows cloud-based services to be accessed by diverse cloud service consumers, while multitenancy is the ability of a single instance of an IT resource to transparently serve multiple cloud consumers simultaneously.
- The elasticity characteristic represents the ability of a cloud to transparently and automatically scale IT resources out or in. Resiliency pertains to a cloud's inherent failover features.

4.3 Cloud Delivery Models

A *cloud delivery model* represents a specific, pre-packaged combination of IT resources offered by a cloud provider. Three common cloud delivery models have become widely established and formalized:

- Infrastructure-as-a-Service (IaaS)
- Platform-as-a-Service (PaaS)
- Software-as-a-Service (SaaS)

These three models are interrelated in how the scope of one can encompass that of another, as explored in the *Combining Cloud Delivery Models* section later in this chapter.

NOTE

Many specialized variations of the three base cloud delivery models have emerged, each comprised of a distinct combination of IT resources. Some examples include:

- 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

Note also that a cloud delivery model can be referred to as a cloud service delivery model because each model is classified as a different type of cloud service offering.

Infrastructure-as-a-Service (IaaS)

The IaaS delivery model represents a self-contained IT environment comprised of infrastructure-centric IT resources that can be accessed and managed via cloud service-based interfaces and tools. This environment can include hardware, network, connectivity, operating systems, and other "raw" IT resources. In contrast to traditional hosting or outsourcing environments, with IaaS, IT resources are typically virtualized and packaged into bundles that simplify up-front runtime scaling and customization of the infrastructure.

The general purpose of an IaaS environment is to provide cloud consumers with a high level of control and responsibility over its configuration and utilization. The IT resources provided by IaaS are generally not pre-configured, placing the administrative responsibility directly upon the cloud consumer. This model is therefore used by cloud consumers that require a high level of control over the cloud-based environment they intend to create.

Sometimes cloud providers will contract IaaS offerings from other cloud providers in order to scale their own cloud environments. The types and brands of the IT resources provided by IaaS products offered by different cloud providers can vary. IT resources available through IaaS environments are generally offered as freshly initialized virtual instances. 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, as shown in Figure 4.11.

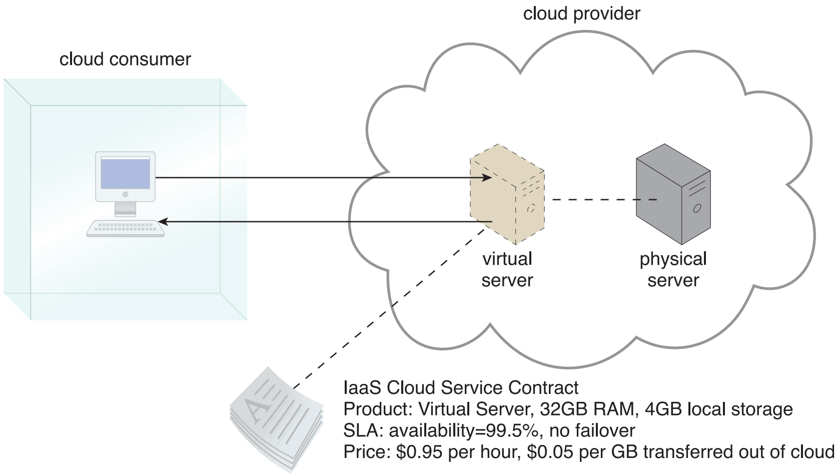

cloud provider
cloud consumer
virtual server
physical server
IaaS Cloud Service Contract
Product: Virtual Server, 32GB RAM, 4GB local storage
SLA: availability=99.5%, no failover
Price: $0.95 per hour, $0.05 per GB transferred out of cloud

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.

Platform-as-a-Service (PaaS)

The PaaS delivery model represents a pre-defined "ready-to-use" environment typically comprised of already deployed and configured IT resources. Specifically, PaaS relies on (and is primarily defined by) the usage of a ready-made environment that establishes a set of pre-packaged products and tools used to support the entire delivery lifecycle of custom applications.

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.

By working within a ready-made platform, the cloud consumer is spared the administrative burden of setting up and maintaining the bare infrastructure IT resources provided via the IaaS model. Conversely, the cloud consumer is granted a lower level of control over the underlying IT resources that host and provision the platform (Figure 4.12).

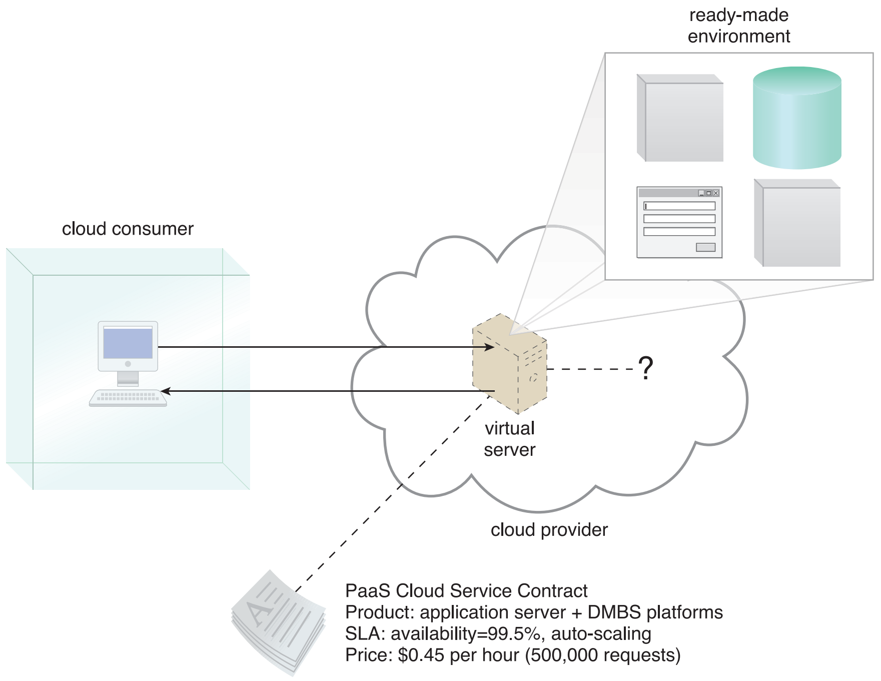

ready-made
environment
cloud consumer
?
virtual
server
cloud provider
PaaS Cloud Service Contract
Product: application server + DMBS platforms
SLA: availability=99.5%, auto-scaling
Price: $0.45 per hour (500,000 requests)

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.

PaaS products are available with different development stacks. For example, Google App Engine offers a Java and Python-based environment.

The ready-made environment is further described as a cloud computing mechanism in Chapter 7.

Software-as-a-Service (SaaS)

A software program positioned as a shared cloud service and made available as a "product" or generic utility represents the typical profile of a SaaS offering. The SaaS delivery model is typically used to make a reusable cloud service widely available (often commercially) to a range of cloud consumers. An entire marketplace exists around SaaS products that can be leased and used for different purposes and via different terms (Figure 4.13).

A cloud consumer is generally granted very limited administrative control over a SaaS implementation. It is most often provisioned by the cloud provider, but it can be legally owned by whichever entity assumes the cloud service owner role. For example, 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. The same organization then effectively assumes the cloud provider role as the SaaS-based cloud service is made available to other organizations that act as cloud consumers when using that cloud service.

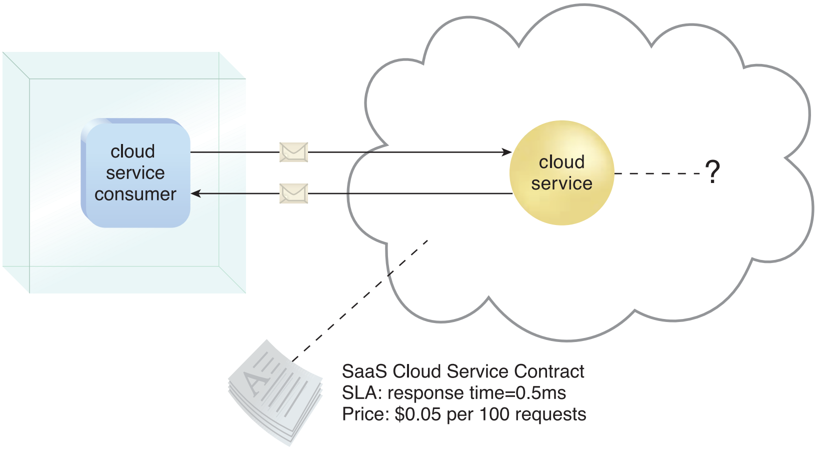


Figure 4.13

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

Provided in this section are three tables that compare different aspects of cloud delivery model usage and implementation. Table 4.1 contrasts control levels and Table 4.2 compares typical responsibilities and usage.

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

Table 4.1
A comparison of typical cloud delivery model control levels.

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, manages, and monitors any needed software	provisions and manages the physical processing, storage, networking, and hosting required monitors usage by cloud consumers

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

Combining Cloud Delivery Models

The three base cloud delivery models comprise a natural provisioning hierarchy, allowing for opportunities for the combined application of the models to be explored. The upcoming sections briefly highlight considerations pertaining to two common combinations.

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. Figure 4.14 shows how these two models can conceptually be combined into a simple layered architecture.

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. So how would the architectural view provided by Figure 4.15 be useful or applicable? Let's say that the cloud provider offering the PaaS environment chose to lease an IaaS environment from a *different* cloud provider.

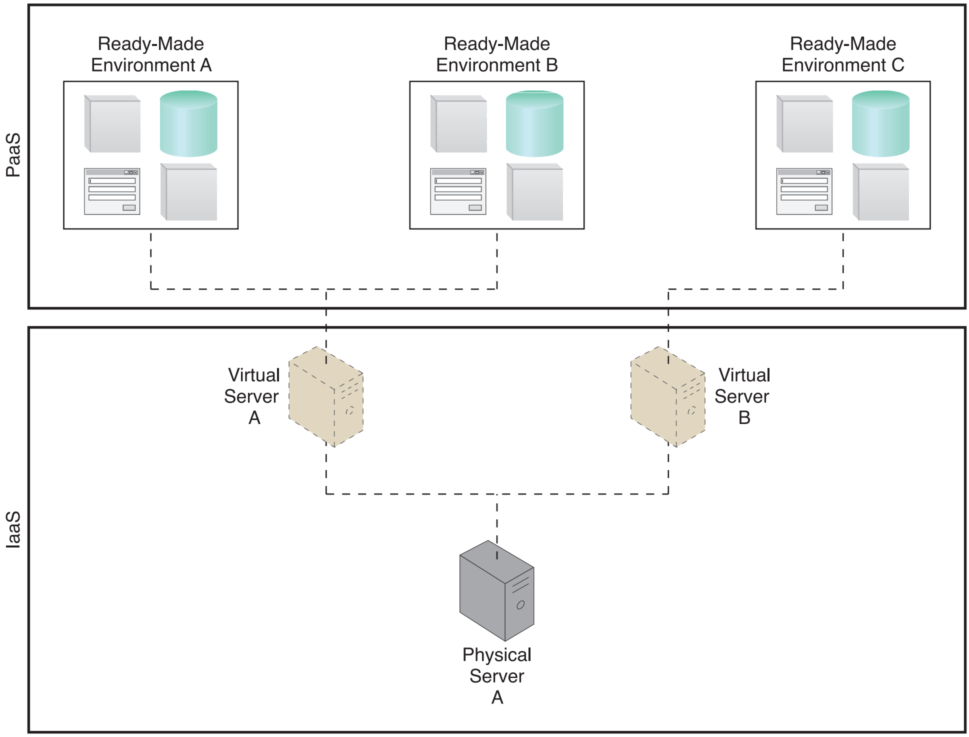


Figure 4.14

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

The motivation for such an arrangement may be influenced by economics or maybe because the first cloud provider is close to exceeding its existing capacity by serving other cloud consumers. Or, perhaps a particular cloud consumer imposes a legal requirement for data to be physically stored in a specific region (different from where the first cloud provider's cloud resides), as illustrated in Figure 4.15.

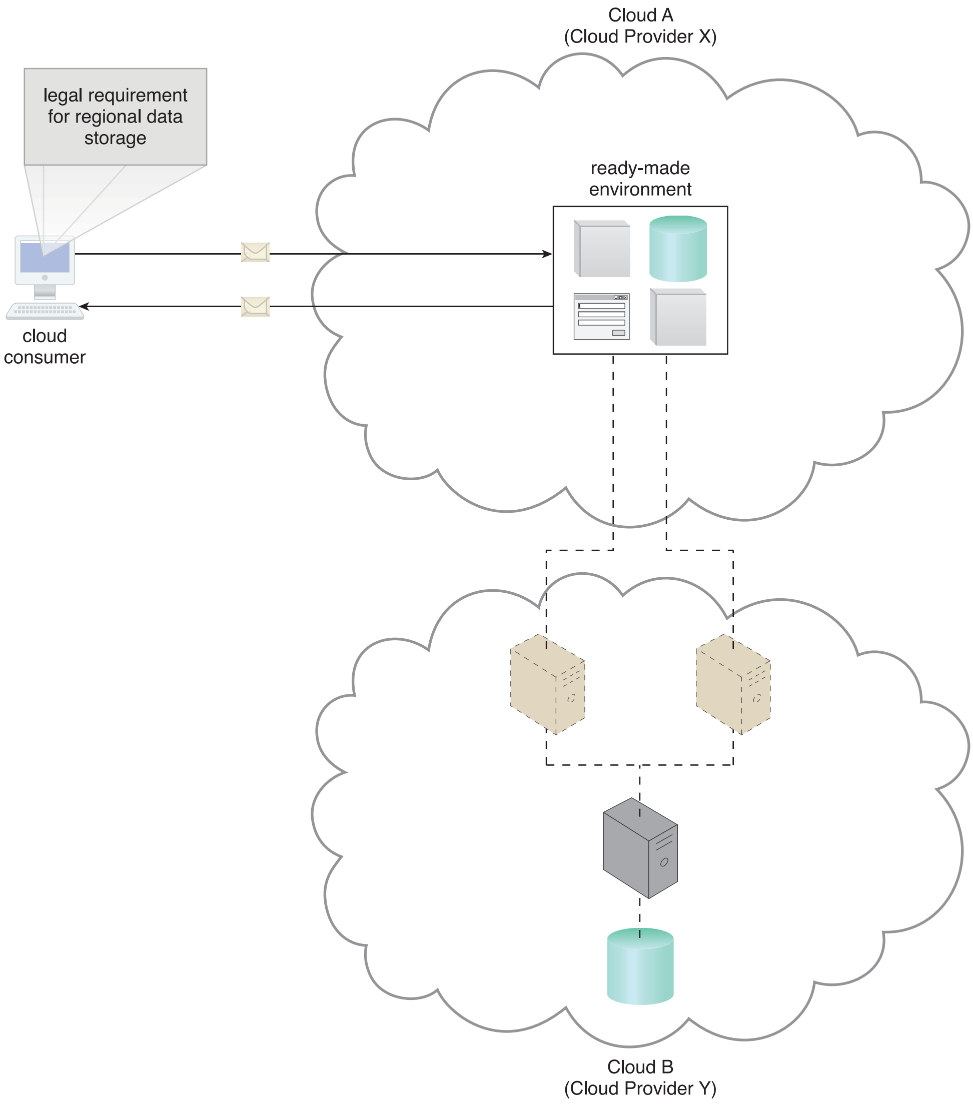


Figure 4.15

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.

IaaS + PaaS + SaaS

All three cloud delivery models can be combined to establish layers of IT resources that build upon each other. For example, by adding on to the preceding layered architecture shown in Figure 4.15, 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 (Figure 4.16).

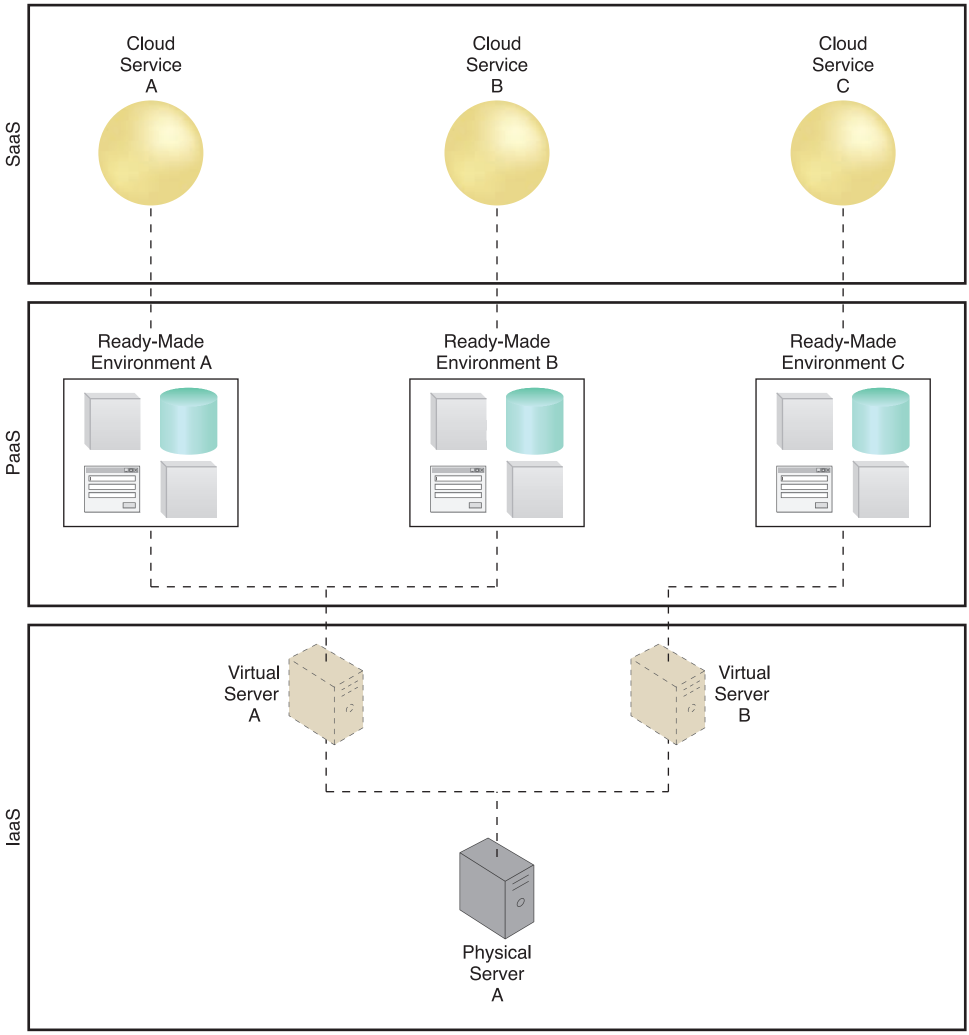


Figure 4.16

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

SUMMARY OF KEY POINTS

- The IaaS cloud delivery model offers cloud consumers a high level of administrative control over "raw" infrastructure-based IT resources.
- The PaaS cloud delivery model enables a cloud provider to offer a pre-configured environment that cloud consumers can use to build and deploy cloud services and solutions, albeit with decreased administrative control.
- SaaS is a cloud delivery model for shared cloud services that can be positioned as commercialized products hosted by clouds.
- Different combinations of IaaS, PaaS, and SaaS are possible, depending on how cloud consumers and cloud providers choose to leverage the natural hierarchy established by these base cloud delivery models.

4.4 Cloud Deployment Models

A cloud deployment model represents a specific type of cloud environment, primarily distinguished by ownership, size, and access.

There are four common cloud deployment models:

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

The following sections describe each.

Public Clouds

A *public cloud* is a publicly accessible cloud environment owned by a third-party cloud provider. The IT resources on public clouds are usually provisioned via the previously described cloud delivery models and are generally offered to cloud consumers at a cost or are commercialized via other avenues (such as advertisement).

The cloud provider is responsible for the creation and on-going maintenance of the public cloud and its IT resources. Many of the scenarios and architectures explored in upcoming chapters involve public clouds and the relationship between the providers and consumers of IT resources via public clouds.

Figure 4.17 shows a partial view of the public cloud landscape, highlighting some of the primary vendors in the marketplace.

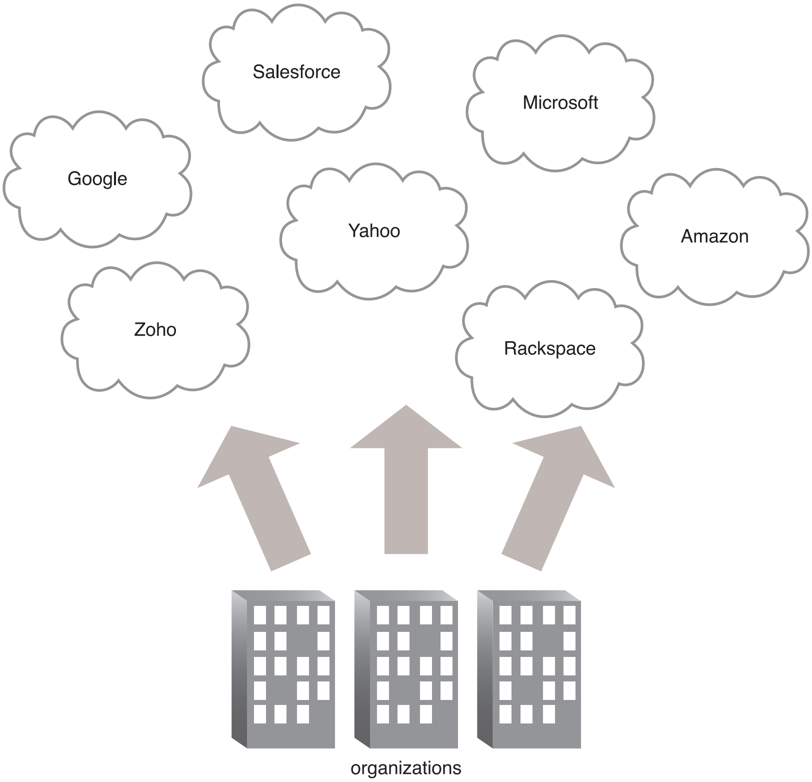


Figure 4.17
Organizations act as cloud consumers when accessing cloud services and IT resources made available by different cloud providers.

Community Clouds

A community cloud 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. The member cloud consumers of the community typically share the responsibility for defining and evolving the community cloud (Figure 4.18).

Membership in the community does not necessarily guarantee access to or control of all the cloud's IT resources. Parties outside the community are generally not granted access unless allowed by the community.

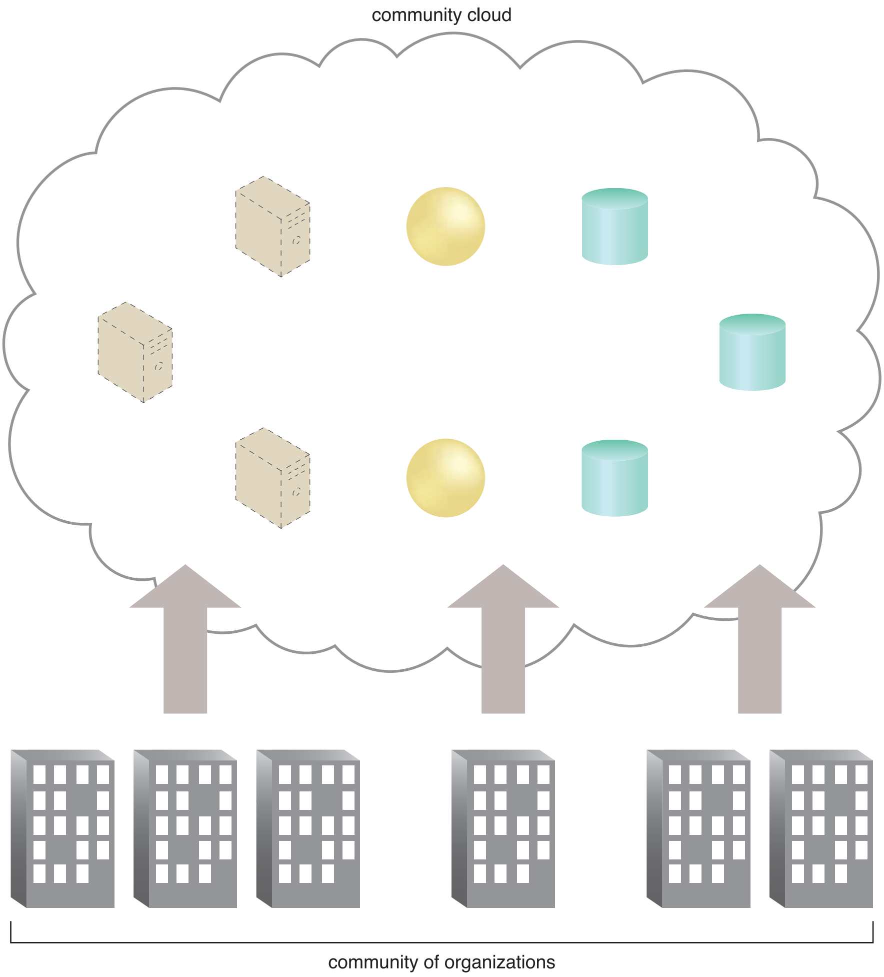


Figure 4.18
An example of a "community" of organizations accessing IT resources from a community cloud.

Private Clouds

A private cloud is owned by a single organization. Private clouds enable an organization to use cloud computing technology as a means of centralizing access to IT resources by different parts, locations, or departments of the organization. When a private cloud exists as a controlled environment, the problems described in the *Risks and Challenges* section from Chapter 3 do not tend to apply.

The use of a private cloud can change how organizational and trust boundaries are defined and applied. The actual administration of a private cloud environment may be carried out by internal or outsourced staff.

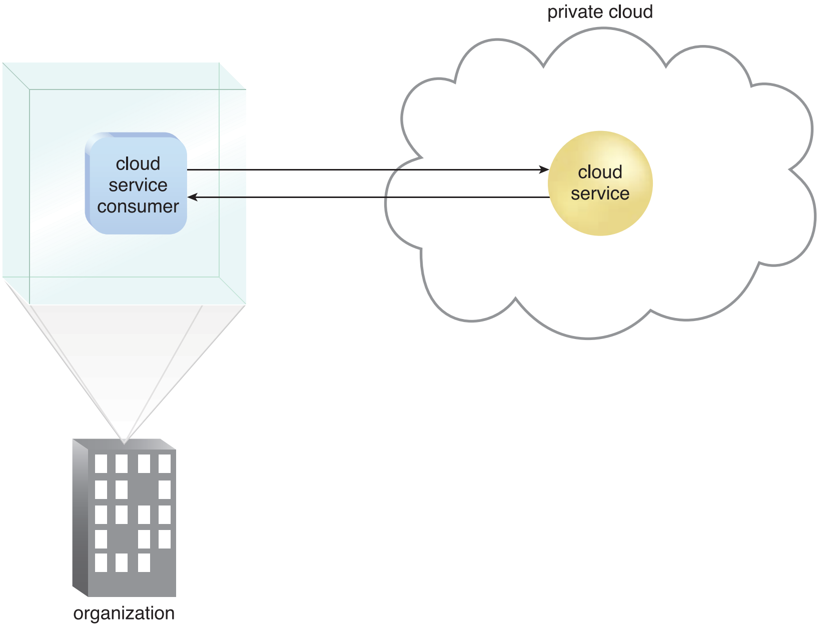


Figure 4.19

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.

With a private cloud, the same organization is technically both the cloud consumer and cloud provider (Figure 4.19). In order to differentiate these roles:

- a separate organizational department typically assumes the responsibility for provisioning the cloud (and therefore assumes the cloud provider role)
- departments requiring access to the private cloud assume the cloud consumer role

It is important to use the terms "on-premise" and "cloud-based" correctly within the context of a private cloud. Even though the private cloud may physically reside on the organization's premises, IT resources it hosts are still considered "cloud-based" as long as they are made remotely accessible to cloud consumers. IT resources hosted outside of the private cloud by the departments acting as cloud consumers are therefore considered "on-premise" in relation to the private cloud-based IT resources.

Hybrid Clouds

A hybrid cloud is a cloud environment comprised of two or more different cloud deployment models. For example, a cloud consumer may choose to deploy cloud services processing sensitive data to a private cloud and other, less sensitive cloud services to a public cloud. The result of this combination is a hybrid deployment model (Figure 4.20).

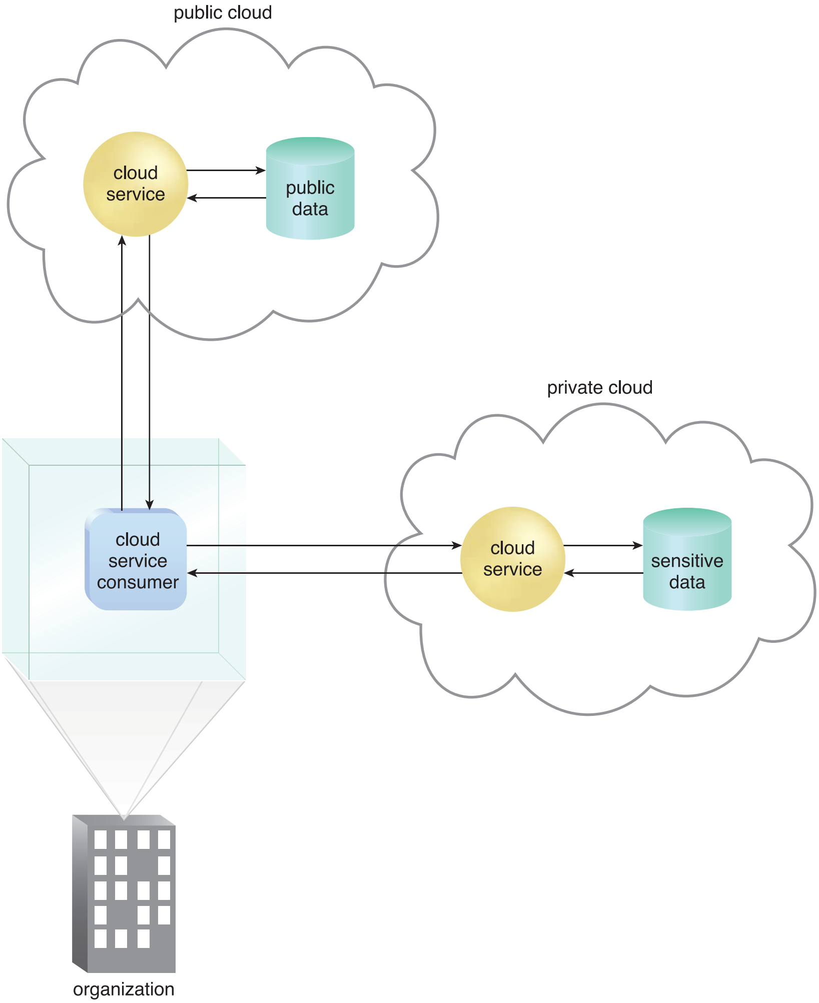


Figure 4.20

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

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.

Other Cloud Deployment Models

Additional variations of the four base cloud deployment models can exist. Examples include:

- *Virtual Private Cloud* – Also known as a "dedicated cloud" or "hosted cloud," this model results in a self-contained cloud environment hosted and managed by a public cloud provider, and made available to a cloud consumer.
- *Inter-Cloud* – This model is based on an architecture comprised of two or more inter-connected clouds.

SUMMARY OF KEY POINTS

- A public cloud is owned by a third party and generally offers commercialized cloud services and IT resources to cloud consumer organizations.
- A private cloud is owned by an individual organization and resides within the organization's premises.
- A community cloud is normally limited for access by a group of cloud consumers that may also share responsibility in its ownership.
- A hybrid cloud is a combination of two or more other cloud deployment models.