Cloud Computing
Unit 2

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Features of Cloud

- To employ new technologies effectively, such as **cloud computing**, organizations must understand what exactly they're getting.
- Five essential characteristics of cloud computing:

1. **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 provider.

2. **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, tablets, laptops and workstations).

3. **Resource pooling:** The provider's computing resources are pooled to serve multiple consumers using a multi-tenant 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 location at a higher level of abstraction (e.g., country, state or datacenter). Examples of resources include storage, processing, memory and network bandwidth.

4.Rapid elasticity: Capabilities can be elastically provisioned and released, in some cases automatically, to scale rapidly outward and inward commensurate with demand. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be appropriated in any quantity at any time.

5. **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 the provider and consumer.

Components of cloud

- Successful implementation of cloud computing requires proper implementation of certain components. Without any of these components, cloud computing will not be possible. These components can't be easily implemented by one person alone.
- Cloud Computing will require persons with different expertise, experiences and backgrounds. As it will require more people in the industry, it's no wonder why cloud computing is a very expensive venture. But even with the expenses that the company would often have to spend, the advantages provided by cloud computing is far more than the initial spending.
- Components have to be implemented with the expectation of optimal performance

The Client – The End User

- Everything ends with the client. The hardware components, the application and everything else developed for cloud computing will be used in the client. Without the client, nothing will be possible.
- The client could come in two forms: the hardware component or the combination of software and hardware components. Although it's a common conception that cloud computing solely relies on the cloud (internet), there are certain systems that requires pre-installed applications to ensure smooth transition. The hardware on the other hand will be the platform where everything has to be launched.
- Optimization is based on two fronts: the local hardware capacity and the software security. Through optimized hardware with security, the application will launch seamlessly.

The Service – the Functions in Cloud Computing

- Cloud computing always has a purpose. One of the main reasons cloud computing become popular is due to the adoption of businesses as the easier way to implement business processes. Cloud computing is all about processes and the services launched through cloud computing always has to deal with processes with an expected output.
- The optimization on services is based on two things: the proper development of the application and the end user. Sometimes, the service could be used by the user wherein their experience is greatly affected by their gadget.

The Application – Backbone of Service

- The service is often though as the application. Although it's partly correct given the fact that it provides the functions, the application is entirely different because it is through the application that the service is realized. This is where software developers have to focus in terms of ensuring the application will work as expected.

- Optimization of the application is based the actual coding of developers. Through extensive testing on load handling, security and functionality, the application could work as expected

Infrastructure" for the Application

- In regular websites or applications that don't deal with cloud computing, the application is directly connected to the server. In cloud computing, the application is still launched to another application called the platform. The platform usually comes as the programming language such as Ajax (Asynchronous JavaScript and XML) or Ruby on Rails.
- At this point, those who opted to seek cloud computing providers will have to follow the set programming languages that could be run in the platform. Although most programming languages could be launched in different platform, a powerful application with real time updating capability is a must for cloud computing.

Warehouse of Cloud Computing

- Everything that the application knows and the functions that could be provided by service are possible through storage. The storage holds pertinent data and information on function on how they will be implemented.
- Optimization on storage is based on how the storage facility protected from different attacks and availability of back-up. Could computing is always about consistency and availability of service which will naturally require the storage to be available all the time.

Backbone of Cloud Computing

- Every function, service and the ability of storage to provide the needed data is only possible through optimized infrastructure. This could be considered as the platform behind the storage as the infrastructure helps the storage deal with load problems.
- The infrastructure is a platform wherein it weights the ability of the storage against the number of requests. The infrastructure has the ability to make some changes by load balancing and even management.

Types Of Cloud

- Cloud computing is typically classified in two ways:

  Location of the cloud computing

  Type of services offered

Location Of Cloud

- **Public cloud**: In Public cloud the computing infrastructure is hosted by the cloud vendor at the vendors premises. The customer has no visibility and control over where the computing infrastructure is hosted. The computing infrastructure is shared between any organizations

- **Private cloud**: The computing infrastructure is dedicated to a particular organization and not shared with other organizations. Some experts consider that private clouds are not real examples of cloud computing. Private clouds are more expensive and more secure when compared to public clouds.
- Private clouds are of two types: On-premise private clouds and externally hosted private clouds. Externally hosted private clouds are also exclusively used by one organization, but are hosted by a third party specializing in cloud infrastructure. Externally hosted private clouds are cheaper than On-premise private clouds.

- **Hybrid cloud** Organizations may host critical applications on private clouds and applications with relatively less security concerns on the public cloud. The usage of both private and public clouds together is called hybrid cloud. A related term is Cloud Bursting. In Cloud bursting organization use their own computing infrastructure for normal usage, but access the cloud using services like Salesforce cloud computing for high/peak load requirements. This ensures that a sudden increase in computing requirement is handled gracefully.
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- **Community cloud** involves sharing of computing infrastructure in between organizations of the same community. For example all Government organizations within the state of California may share computing infrastructure on the cloud to manage data related to citizens residing in California.

Classification based on service provided

- Infrastructure as a service (IaaS) involves offering hardware related services using the principles of cloud computing. These could include some kind of storage services (database or disk storage) or virtual servers. Leading vendors that provide Infrastructure as a service
  are Amazon EC2, Amazon S3,Rackspace
  Cloud Servers and Flexiscale.

- Platform as a Service (PaaS) involves offering a development platform on the cloud. Platforms provided by different vendors are typically not compatible. Typical players in PaaS are Googles Application
  Engine, Microsofts Azure,

  Salesforce.com force.com .

- Software as a service (SaaS) includes a complete software offering on the cloud. Users can access a software application hosted by the cloud vendor on pay-per-use basis. This is a well-established sector. The pioneer in this field has been Salesforce.coms offering in the online Customer Relationship Management (CRM) space. Other examples are online email providers like Googles gmail andMicrosofts hotmail, Google docs and Microsofts online version of office called BPOS (Business Productivity Online Standard Suite).
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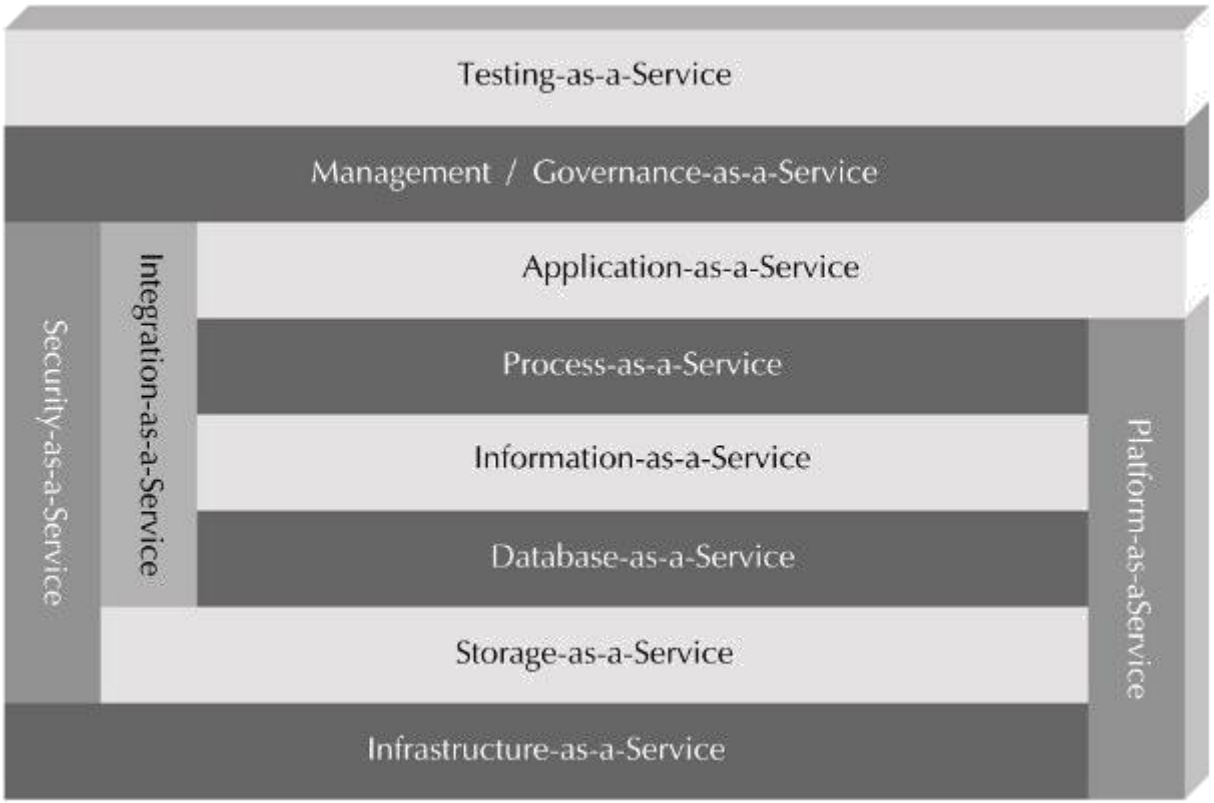
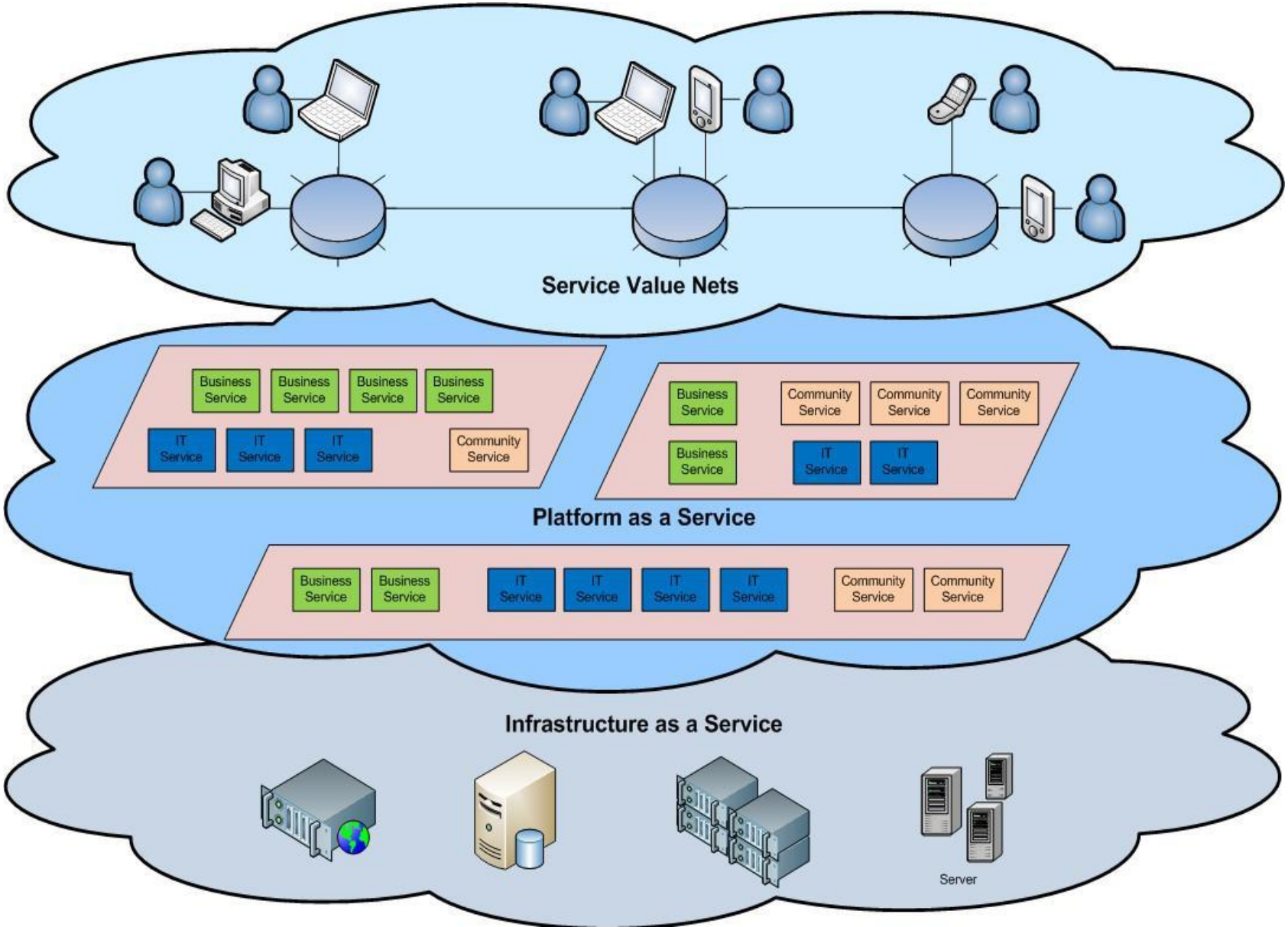
David Linthicum describes a more granular classification on the basis of service provided. These are listed below:

- Storage-as-a-service
- Database-as-a-service
- Information-as-a-service
- Process-as-a-service
- Application-as-a-service
- Platform-as-a-service
- Integration-as-a-service
- Security-as-a-service
- Management/Governance-as-a-service
- Testing-as-a-service
- Infrastructure-as-a-service


Testing-as-a-Service
Management / Governance-as-a-Service
Application-as-a-Service
Process-as-a-Service
Information-as-a-Service
Database-as-a-Service
Storage-as-a-Service
Infrastructure-as-a-Service
Security-as-a-Service
Integration-as-a-Service
Platform-as-aService

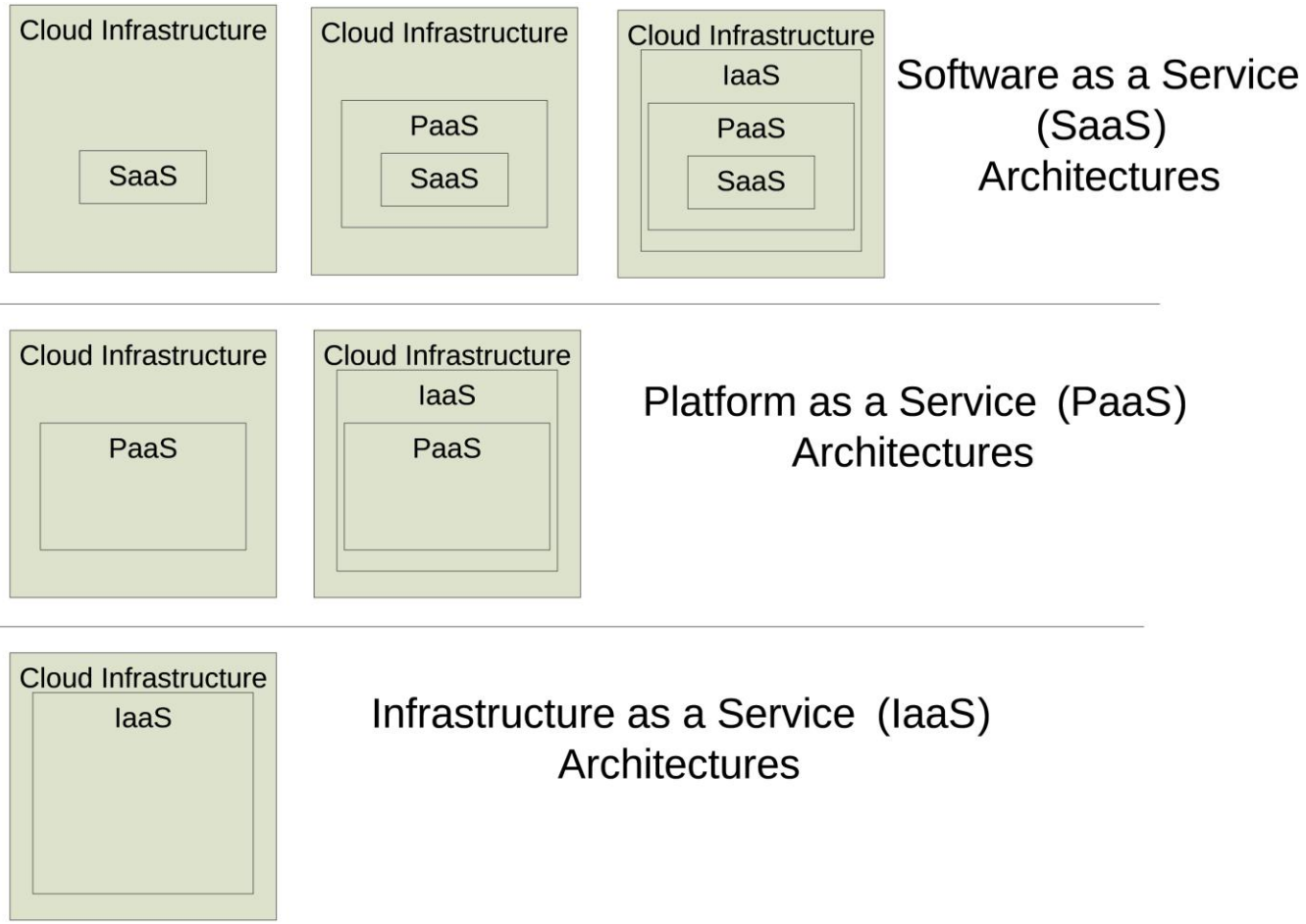
Cloud Architecture



3 Cloud Service Models

- Cloud Software as a Service (SaaS)
  - The **capability provided to the consumer is to use the provider's applications** running on a cloud infrastructure and accessible from various client devices through a thin client interface such as a Web browser (e.g., web- based email). The consumer does not manage or control the underlying cloud infrastructure, network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user- specific application configuration settings.
- Cloud Platform as a Service (PaaS)
  - The **capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created applications using programming languages and tools supported by the provider** (e.g., Java, Python, .Net). The consumer does not manage or control the underlying cloud infrastructure, network, servers, operating systems, or storage, but the consumer has control over the deployed applications and possibly application hosting environment configurations.
- Cloud Infrastructure as a Service (IaaS)
  - The **capability provided to the consumer is to rent processing, storage, networks, and other fundamental computing resources** where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, deployed applications, and possibly select networking components (e.g., firewalls, load balancers).
- To be considered "cloud" they must be deployed on top of cloud infrastructure that has the key characteristics

Service Model Architectures



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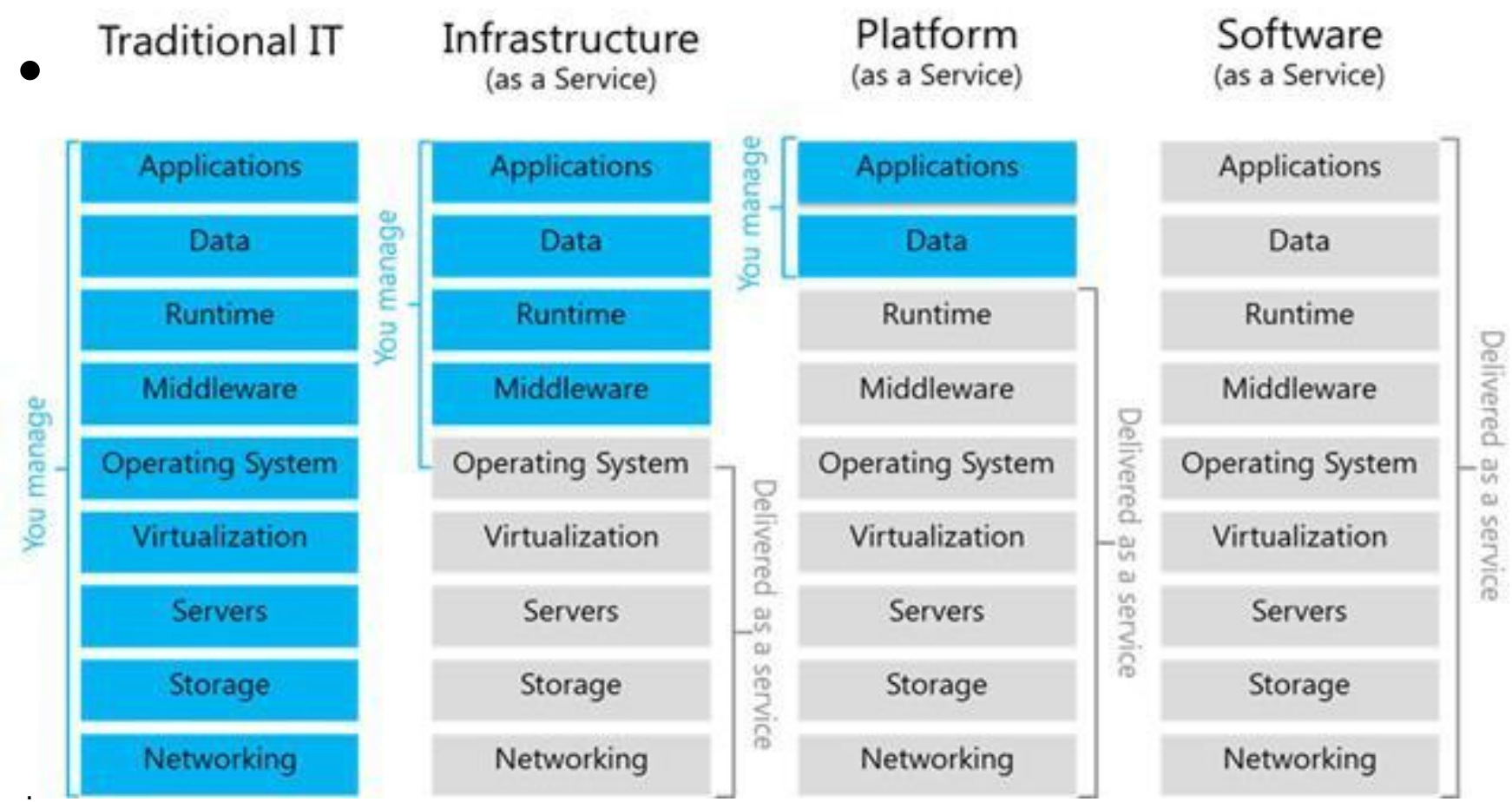
Saas, PaaS, IaaS



3 Features of Mature SaaS Applications

- SaaS is hosting applications on the Internet as a service (both consumer and enterprise)
- Features of Mature Saas applications:
- **Scalable**
  - Handle growing amounts of work in a graceful manner
- **Multi-tenancy**
  - One application instance may be serving hundreds of companies
  - Opposite of multi-instance where each customer is provisioned their own server running one instance
- **Metadata driven configurability**
  - Instead of customizing the application for a customer (requiring code changes), one allows the user to configure the application through metadata

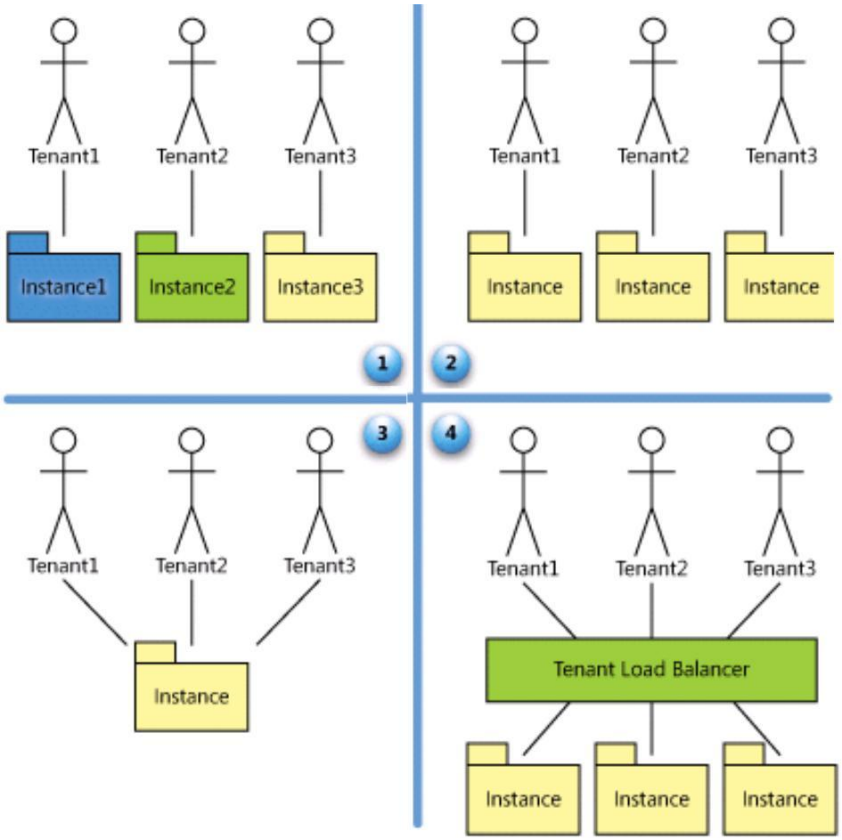
SaaS Maturity Model

Level 1: Ad-Hoc/Custom – One Instance per customer

Level 2: Configurable per customer

Level 3: configurable & Multi-Tenant-Efficient

Level 4: Scalable, Configurable & Multi-Tenant-Efficient



Source: Frederick Chong and Gianpaolo Carraro, “Architectures Strategies for Catching the Long Tail”

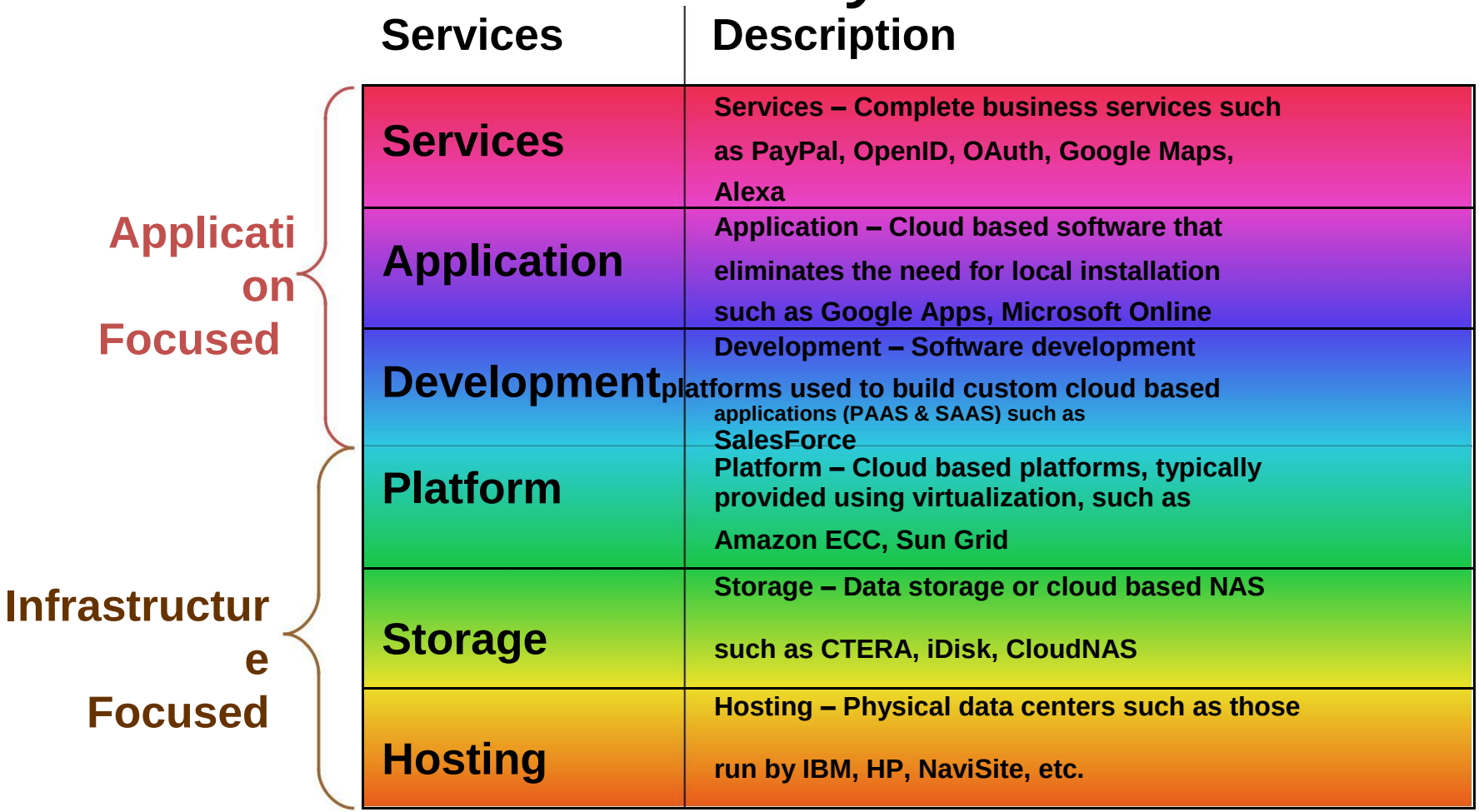
Software as a Service (SaaS)

- SaaS is a model of software deployment where an application is hosted as a service provided to customers across the Internet.
- Saas alleviates the burden of software maintenance/support
  - but users relinquish control over software versions and requirements.
- Terms that are used in this sphere include
  - **Platform as a Servic**e (PaaS) and
  - **Infrastructure as a Service** (IaaS)

Different Cloud Computing Layers

Application Service (SaaS)	MS Live/ExchangeLabs, IBM, Google Apps; Salesforce.com Quicken Online, Zoho, Cisco
Application Platform	Google App Engine, Mosso, Force.com, Engine Yard, Facebook, Heroku, AWS
Server Platform	3Tera, EC2, SliceHost, GoGrid, RightScale, Linode
Storage Platform	Amazon S3, Dell, Apple, ...

Cloud Computing Service Layers



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Deployment Model

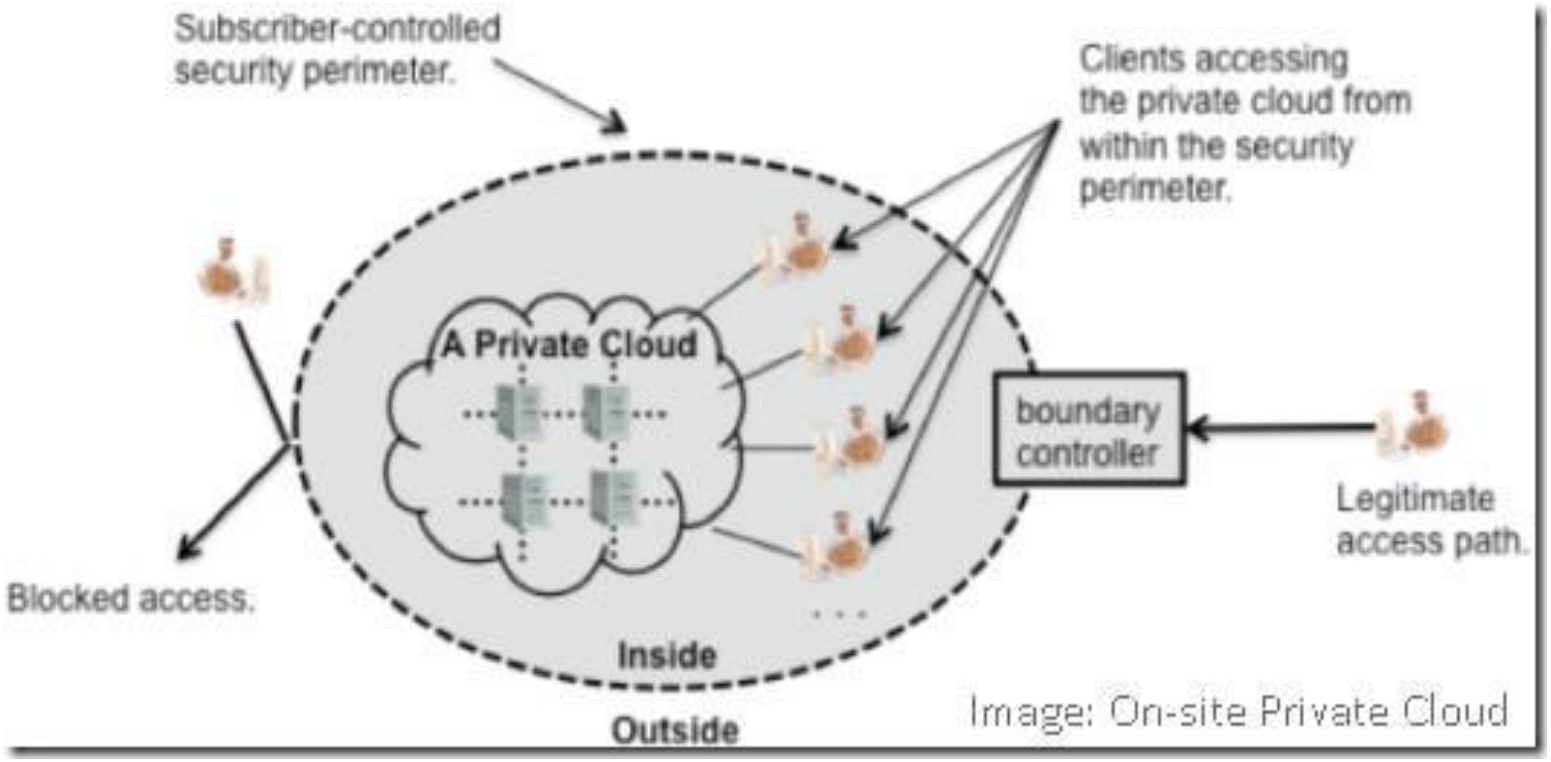
Private Cloud

- *The cloud infrastructure is operated solely for an organization.* Thus, two private cloud scenarios exist, as follows:
- On-site Private Cloud
  - Applies to private clouds implemented at a customer's premises.
- Outsourced Private Cloud
  - Applies to private clouds where the server side is outsourced to a hosting company.

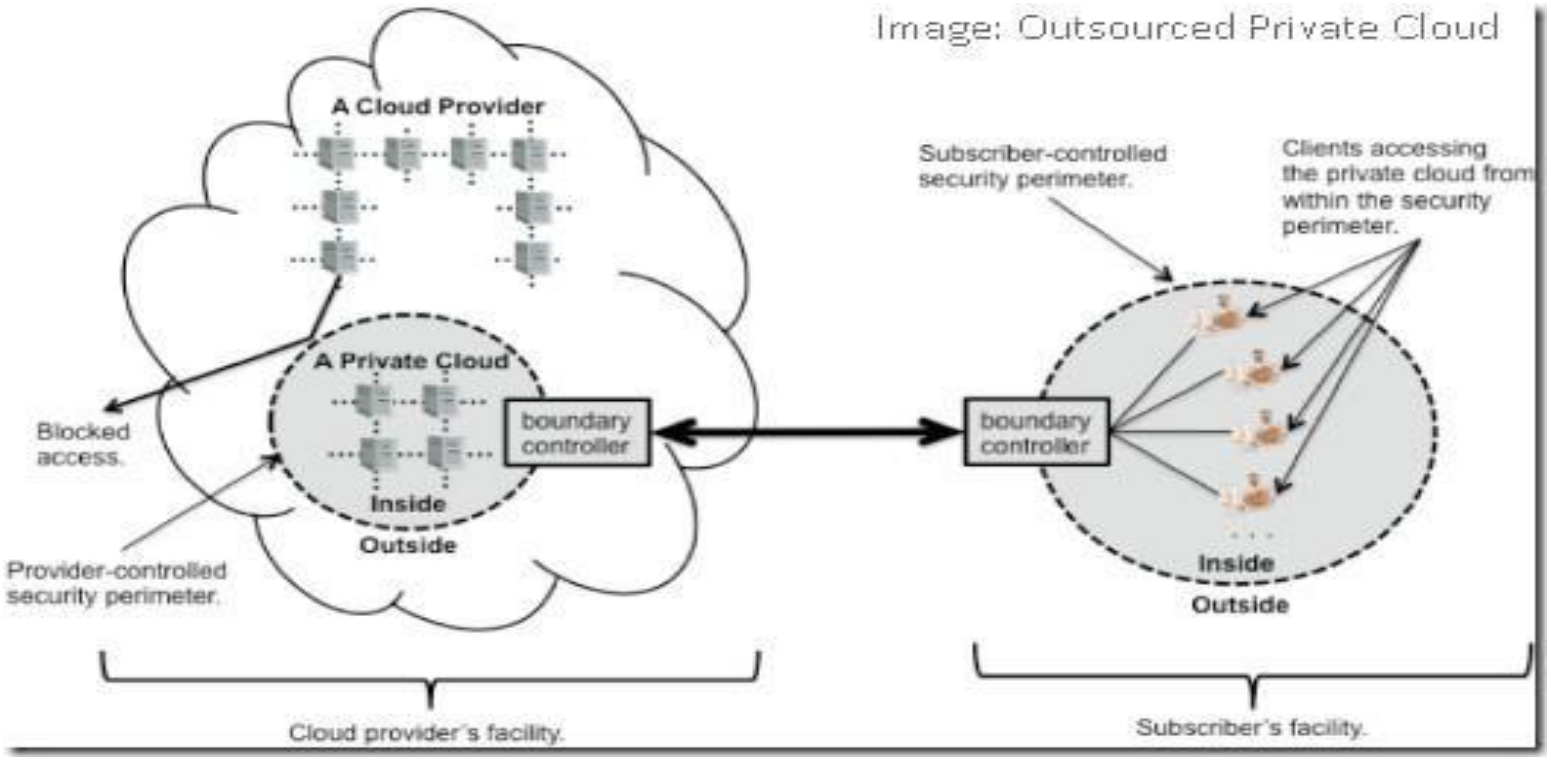
Examples of Private Cloud:

- Eucalyptus
- Ubuntu Enterprise Cloud - UEC (powered by Eucalyptus)
- Amazon VPC (Virtual Private Cloud)
- VMware Cloud Infrastructure Suite
- Microsoft ECI data center.

On Site Private Cloud



Out Souce Private Cloud



Community Cloud

- he 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). Government departments, universities, central banks etc. often find this type of cloud useful. Community cloud also has two possible scenarios:
- On-site Community Cloud Scenario
  - Applies to community clouds implemented on the premises of the customers composing a community cloud
- Outsourced Community Cloud
  - Applies to community clouds where the server side is outsourced to a hosting company.

Examples of Community Cloud:

- Google Apps for Government
- Microsoft Government Community Cloud

On-site Community Cloud Scenario

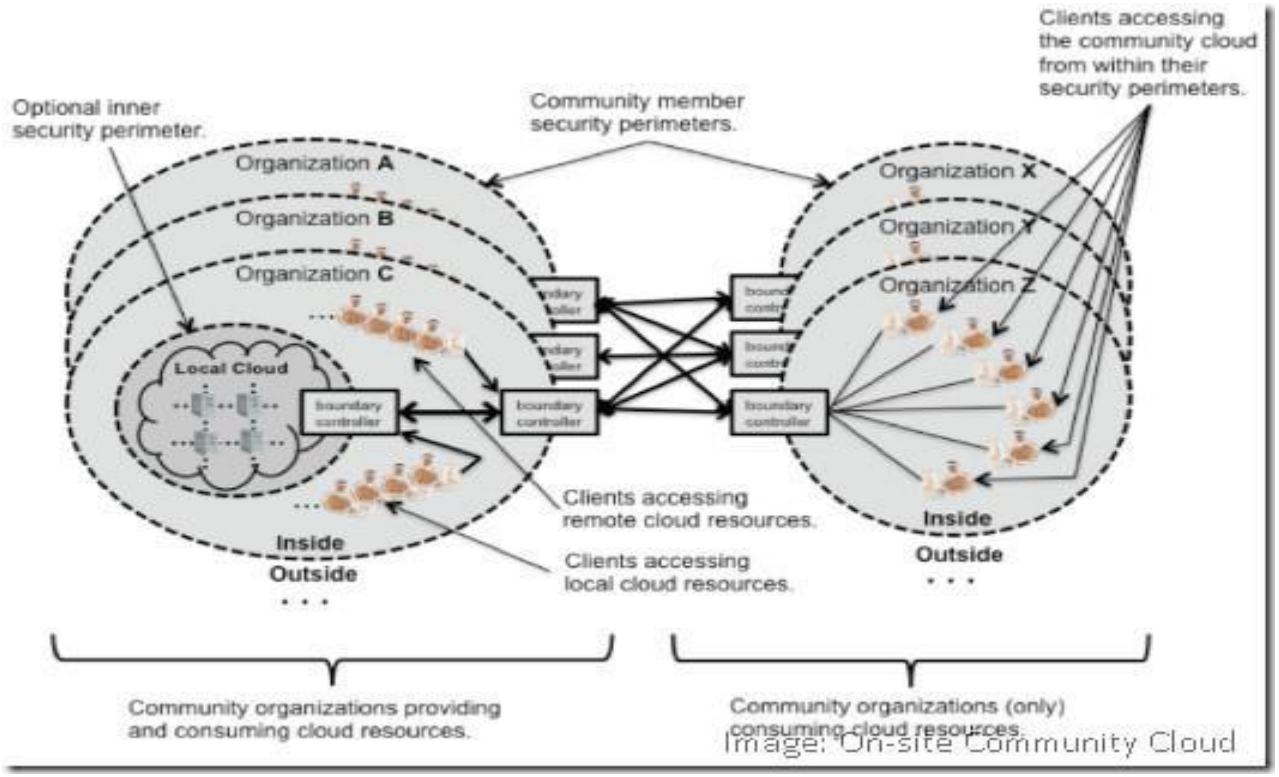
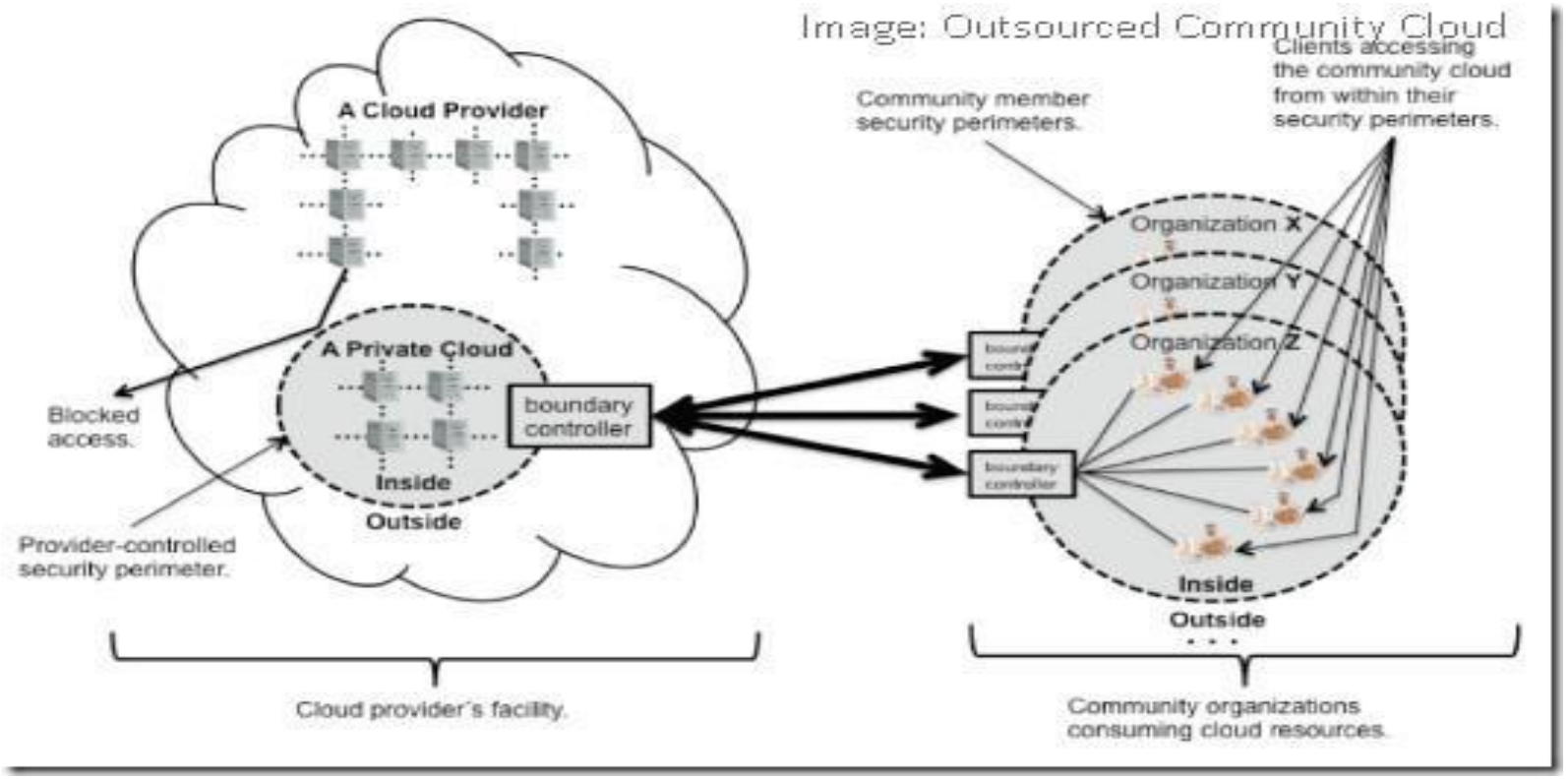


Image: On-site Community Cloud

Outsourced Community Cloud



Hybrid Cloud

- The cloud infrastructure is a composition of two or more clouds (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).

- Examples of Hybrid Cloud:

  Windows Azure (capable of Hybrid Cloud)

  VMware vCloud (Hybrid Cloud Services)

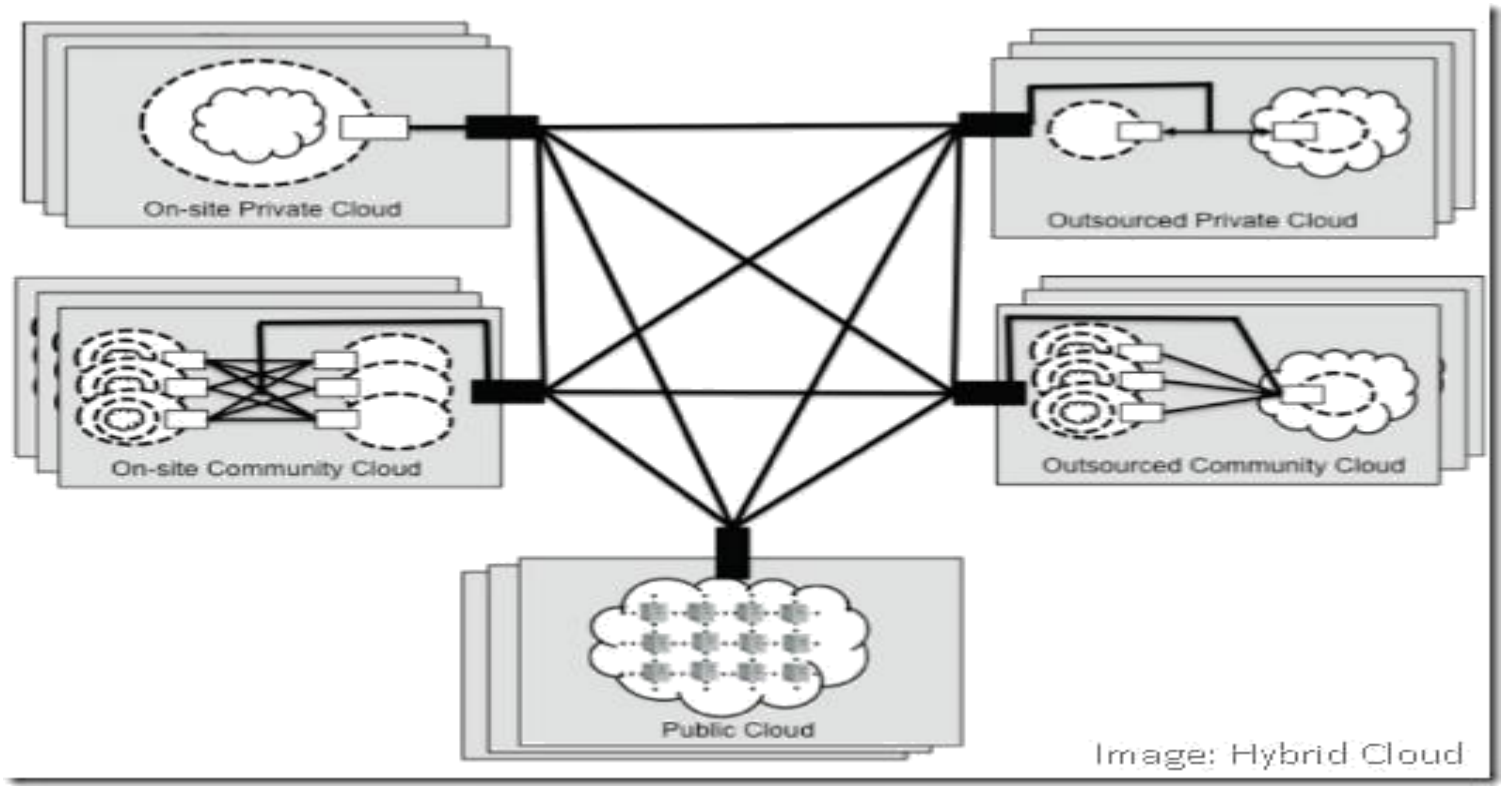


Image: Hybrid Cloud

Private Cloud

- The most ubiquitous, and almost a synonym for, cloud computing. The cloud infrastructure is made available to the general public or a large industry group and is owned by an organization selling cloud services.
- Examples of Public Cloud:

  Google App Engine

  Microsoft Windows Azure

  IBM Smart Cloud Amazon

  EC2

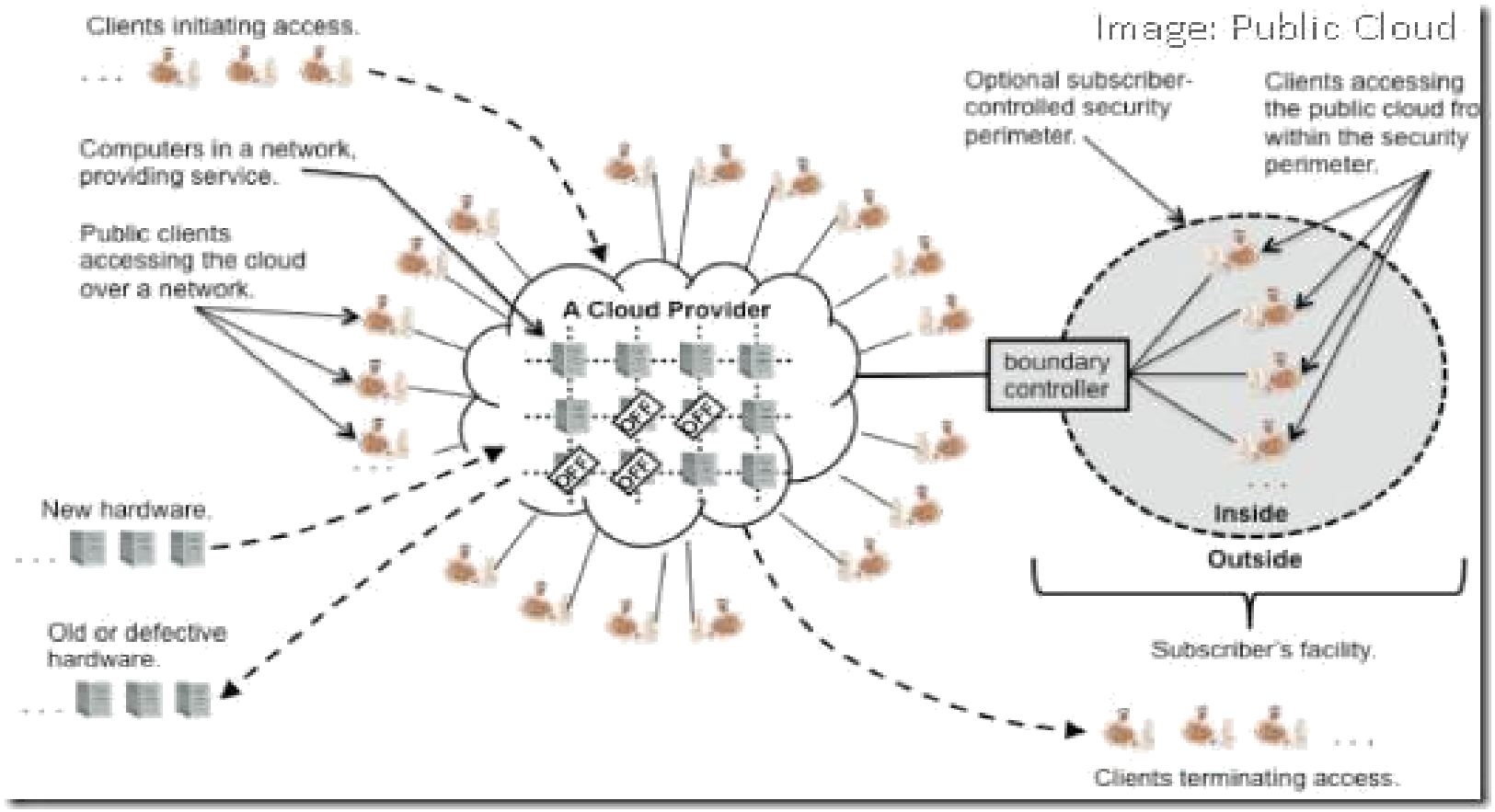


Image: Public Cloud
Clients initiating access.
Computers in a network, providing service.
Public clients accessing the cloud over a network.
A Cloud Provider
Optional subscriber-controlled security perimeter.
Clients accessing the public cloud fro within the security perimeter.
boundary controller
Inside
Outside
Subscriber's facility.
New hardware.
Old or defective hardware.
Clients terminating access.

Cloud Deployment Implications

- **Network Dependency** – Whether you choose, on-site or off-shore, a reliable and secure network is highly desirable for good performance.
- **Subscribers still need IT skills** – You can't just offer a pink-slip to all your IT resources. To manage various user devices that access cloud, resources with traditional IT skills are required, though in lesser number. Additionally, your existing resources may need to update themselves with new skills for working in cloud.

- **Risk from multi-tenancy** – On-site private cloud mitigates this security risk by restricting the number of possible attackers as all the clients are typically the members of one subscriber organization. In a public cloud scenario, a single machine may be shared by the workloads of any combination of subscribers. This indeed raises the security risk as the number of potential attackers increases with number of subscribers. Therefore we can safely conclude that risk due to multi-tenancy increases in an order which can be stated as Private, Community, Hybrid, Public cloud

- **Data import/export and performance limitations** – Generally the on-demand bulk data import/export is limited by the cloud's network capacity. In the on-site private cloud scenario, however, these limits may be adjusted, although not eliminated, by provisioning high-performance and/or high-reliability networking within the subscriber's infrastructure.
- **Workloads Locations** – Workloads refers to managing hardware resources efficiently. Generally, cloud migrates workloads between machines without any inconvenience to the clients, i.e., it's hidden from the client. Generally, the cloud vendors take care of this but you must explicitly check with your vendor if it manages the resources efficiently.

Cloud Management Platform

- When developing a cloud strategy, the most efficient option for today's enterprise is a Cloud Management Platform (CMP), an all-in-one suite of integrated tools that provides federated access to and governance for private and public clouds. CMPs facilitate the operation and build out of cloud services by consolidating cloud silo specific interfaces. A CMP offers a unified API and web interface for developers and IT users to access and manage infrastructure resources distributed across numerous public and private clouds, such as Amazon Web Services and OpenStack. An all-in-one solution delivers superior results from individual components as well, especially as information can be compared across clouds, and shared across teams.
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