Amirkabir University of Technology
(Tehran Polytechnic)

Cloud Computing

5-4-3 Principles of Cloud computing

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Syllabus

- **Introduction to Cloud Computing: 5-4-3 Principles of Cloud computing**
- Virtualization
- Containers
- Kubernetes
- Programming Models and MapReduce
- Hadoop Yarn and Apache Spark
- OpenStack
- Load balancing and auto-scaling

NIST
National Institute of
Standards and Technology
U.S. Department of Commerce

Special Publication 800-145

The NIST Definition of Cloud Computing

Recommendations of the National Institute of Standards and Technology

Peter Mell
Timothy Grance

NIST Definition of a Cloud (cont.)

- U.S. National Institute of Standards and Technology (NIST) Definition:

"Cloud computing is a model for enabling ubiquitous, convenient, ***on-demand*** *network access to a* ***shared pool*** *of* ***configurable*** *computing* ***resources*** *(e.g., networks, servers, storage, applications, and services) that can be* ***rapidly provisioned*** *and released with* ***minimal management*** *effort or* ***service provider interaction****."*

Intro:
5-4-3 Principles of Cloud computing

- The 5-4-3 principles put forth by NIST describe:
  - The five essential characteristic features
  - The four deployment models
  - The three important and basic service offering models

5-4-3 Principles of Cloud computing

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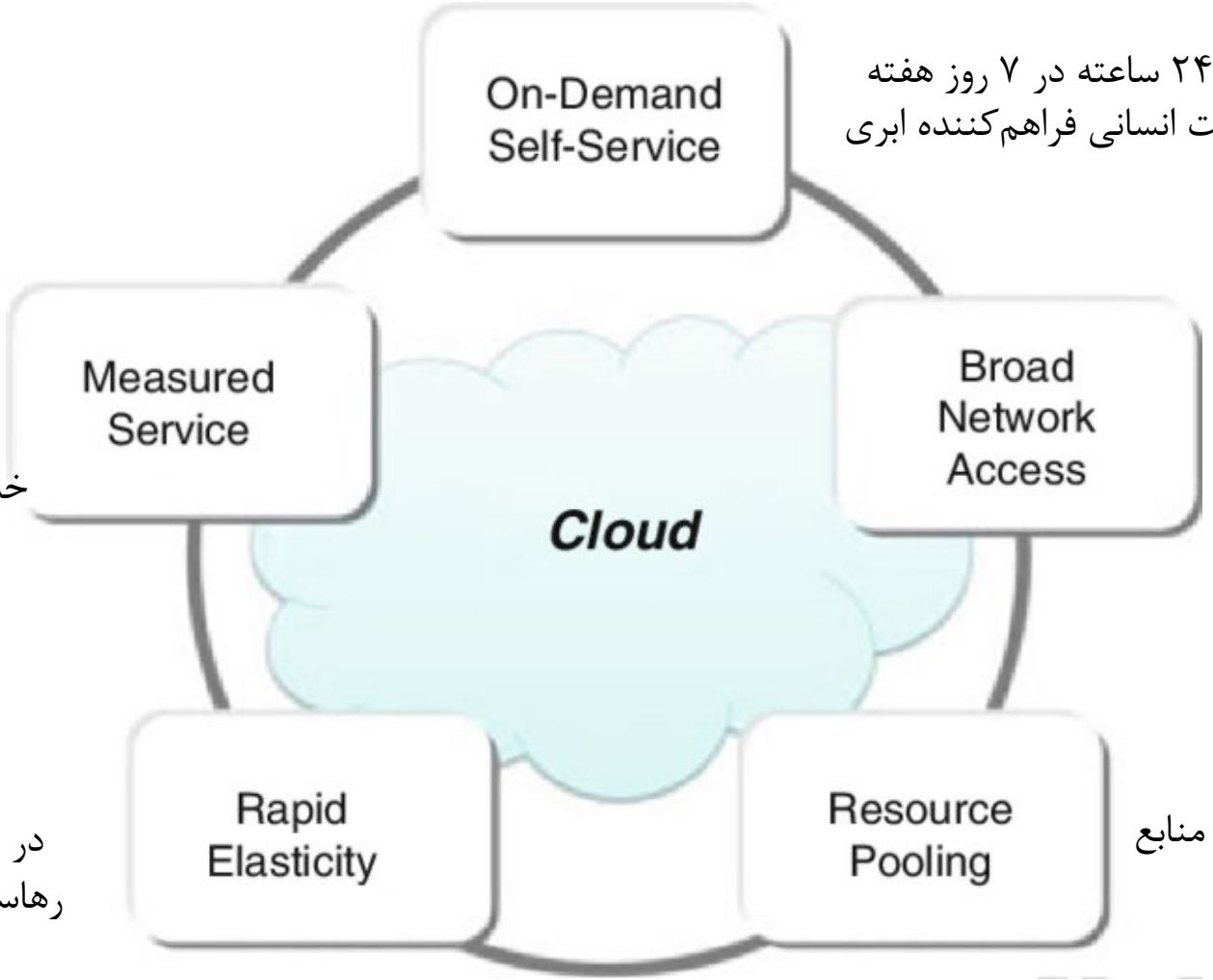
  - **The five essential characteristic features**
  - The four deployment models
  - The three important and basic service offering models

Five Essential Characteristics



دسترسی ۲۴ ساعته در ۷ روز هفته
بدون دخالت انسانی فراهم‌کننده ابری

دسترسی گسترده
روی شبکه

استخرسازی منابع

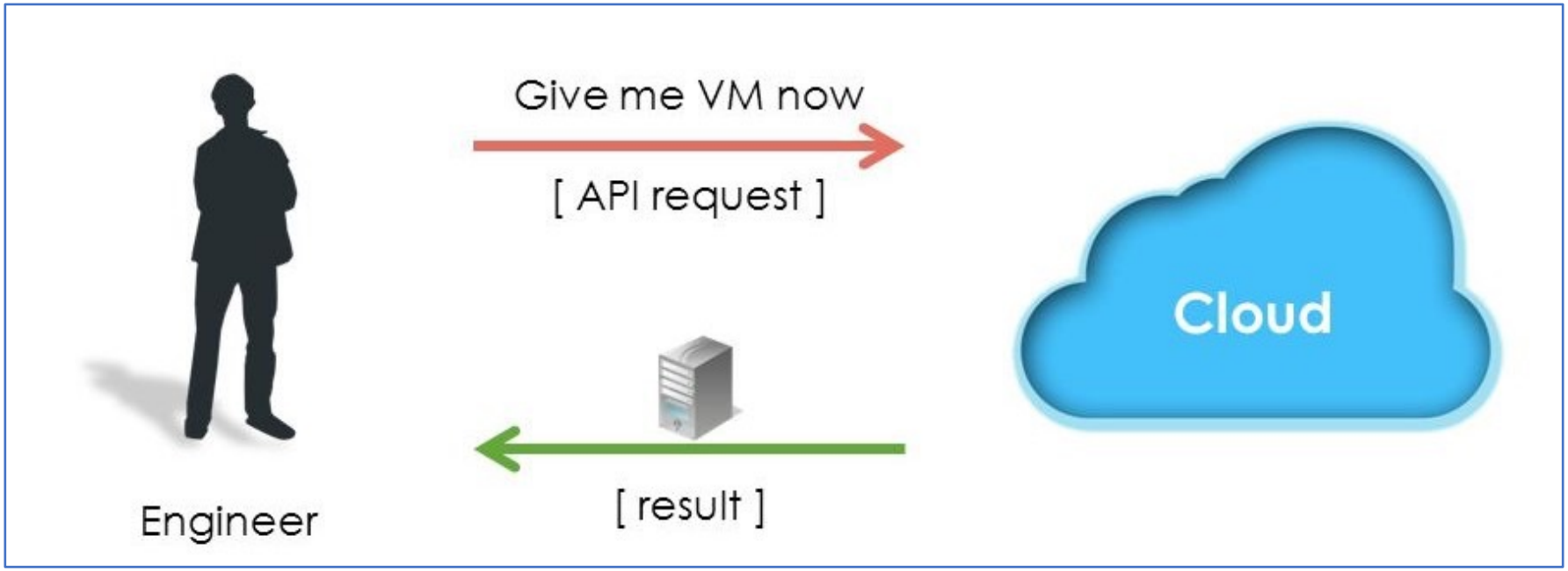
در اختیار گرفتن و
رهاسازی سریع منابع

خدمت اندازه‌گیری‌شده

Five Essential Characteristics

1- On-demand self-service

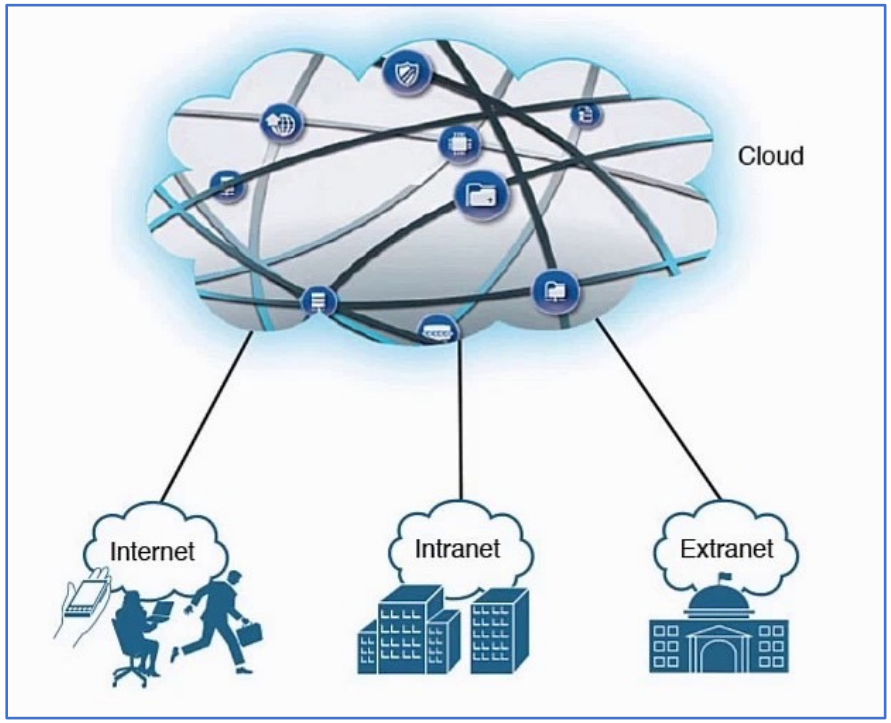
- Capabilities can be **provisioned automatically without requiring human interaction** with service providers.



Five Essential Characteristics

2- Broad network access

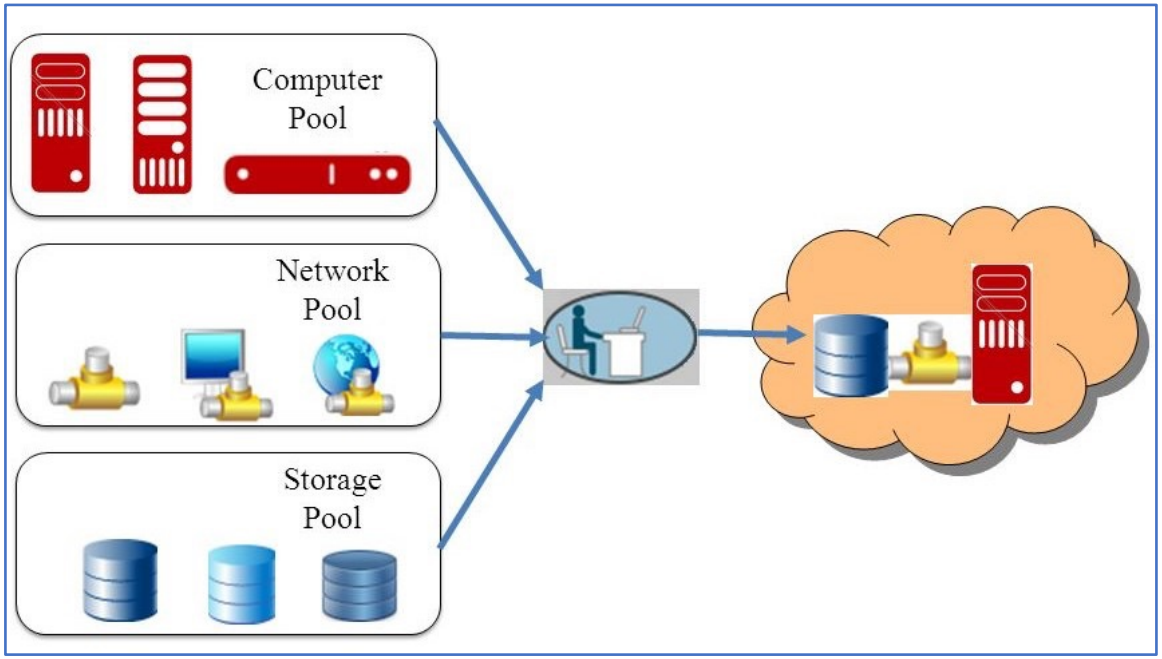
- Capabilities are **available over the network** and accessed through standard mechanisms.



Five Essential Characteristics

3- Elastic resource pooling

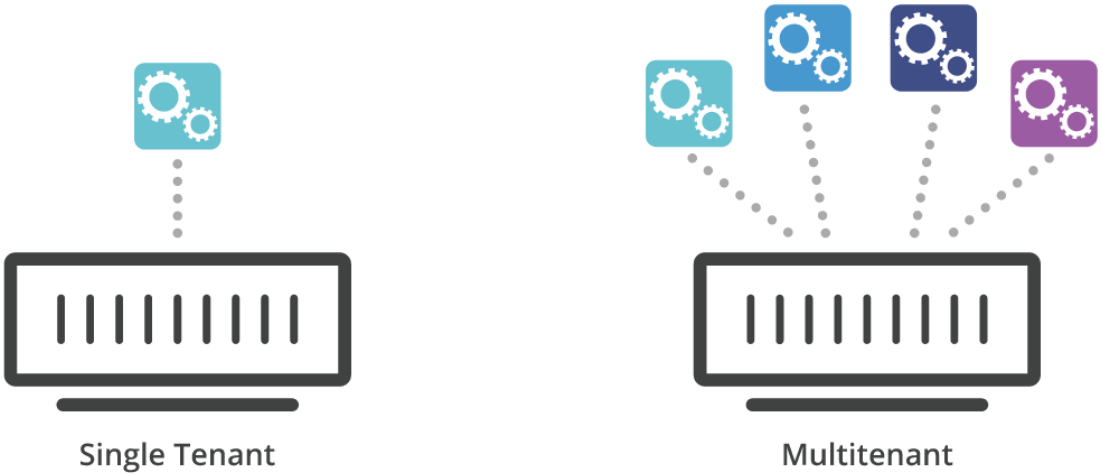
- The provider's computing resources are pooled to serve multiple consumers using a ***multitenant model***.



3- Elastic resource pooling (cont.)

Multitenancy

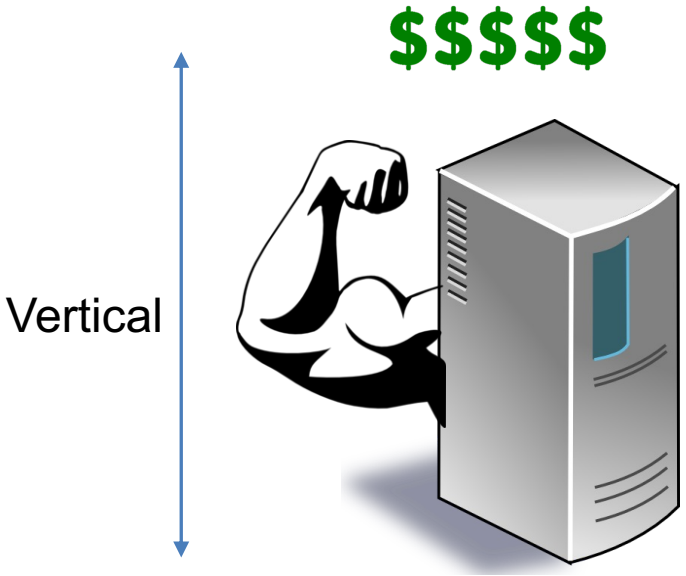
- Cloud computing is ***a shared resource*** that draws on *resource pooling* as an important feature.
- Use of same resources ***by multiple consumers***, so called *tenants*.



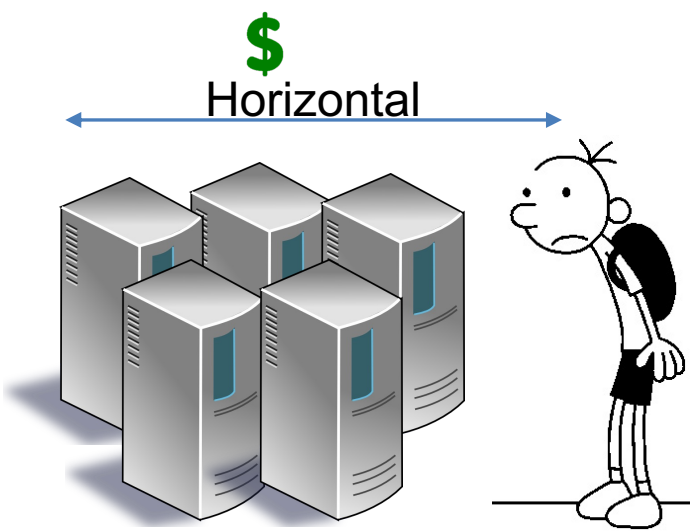
4- Rapid elasticity

- Capabilities can be rapidly and elastically provisioned to *quickly* ***scale out*** and rapidly released to quickly ***scale in***.

  - scale in/out vs. scale up/down ?



Scale up: one machine with high hardware configuration

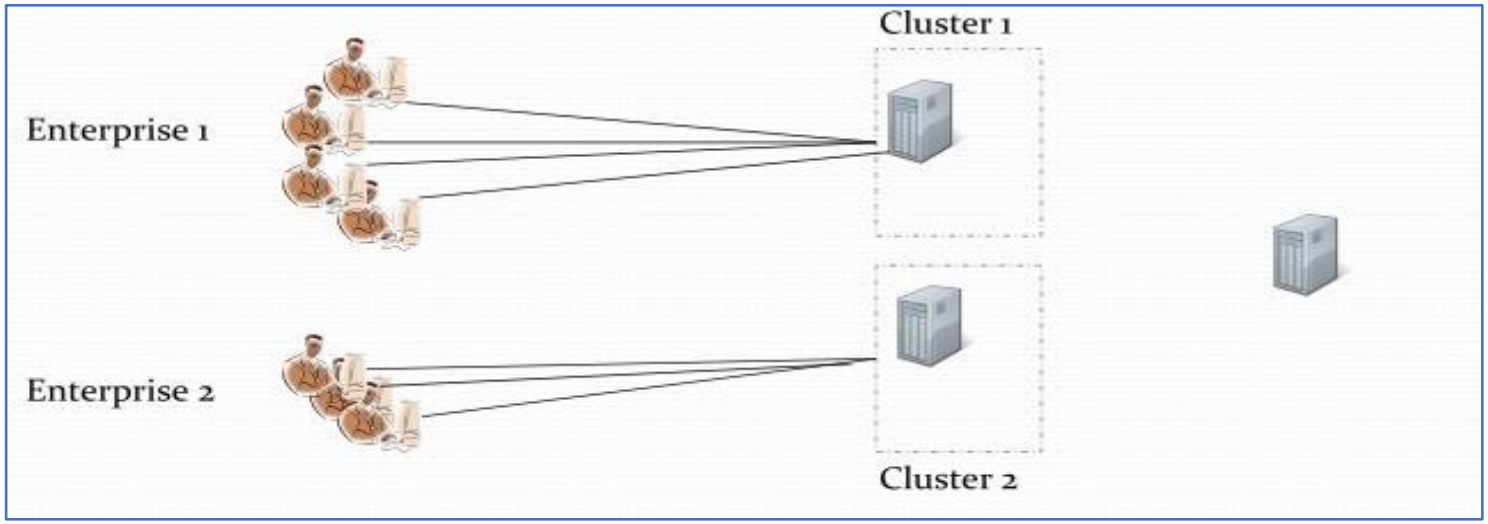


Scale out: cluster composed by wimpy machines

Five Essential Characteristics

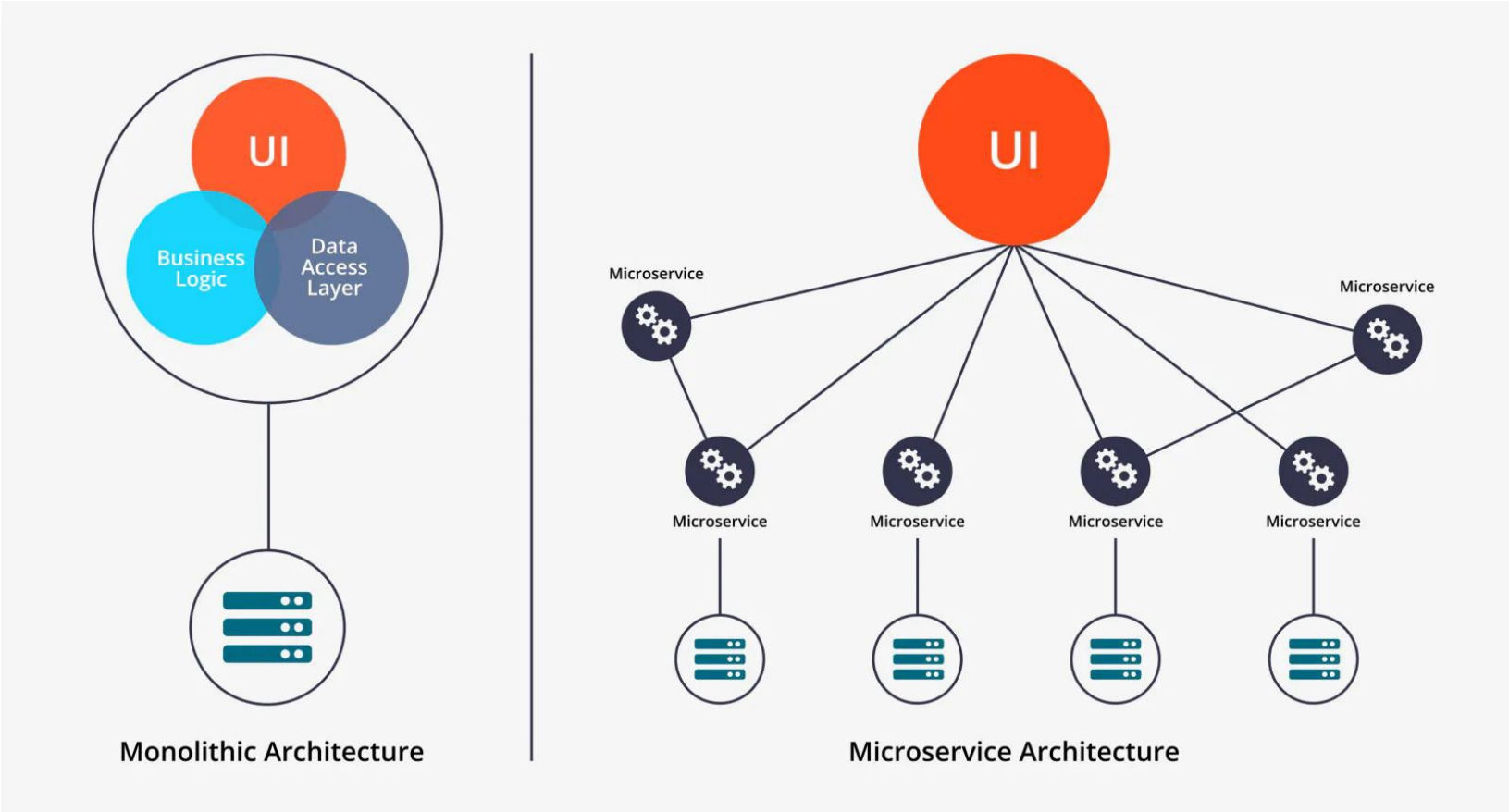
4- Rapid elasticity

- To consumers, the capabilities often appear to be ***unlimited*** and can be purchased in any quantity at any time.



Five Essential Characteristics

4- Rapid elasticity (cont.)



Read more

Five Essential Characteristics

4- Rapid elasticity (cont.)

- Scale in/out vs. scale up/down ?

		Example action
Vertical scaling	Scale up	Adding more RAMs to a HW
	Scale down	Removing RAM chips
Horizontal scaling	Scale out	Adding more VMs/Containers
	Scale in	Shutting down one or VMs/Containers

Five Essential Characteristics

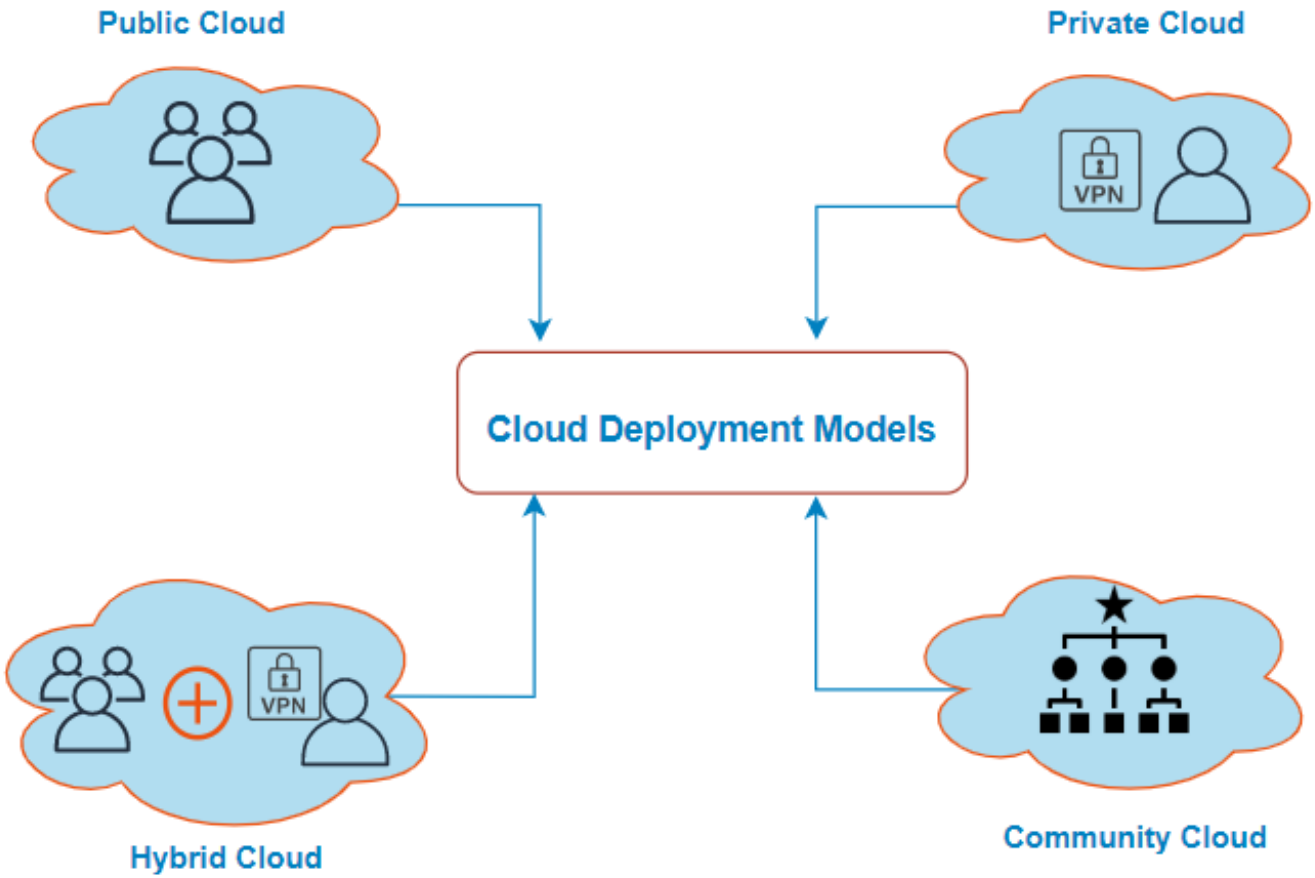
5- Measured service

- Cloud systems automatically control and optimize resource use.
- Using metering capability at some level of abstraction appropriate to the type of service.
  - e.g., storage, processing, bandwidth, and active user accounts.

5-4-3 Principles of Cloud computing

- The 5-4-3 principles put forth by NIST describe:
  - The five essential characteristic features
  - **The four deployment models**
  - The three important and basic service offering models

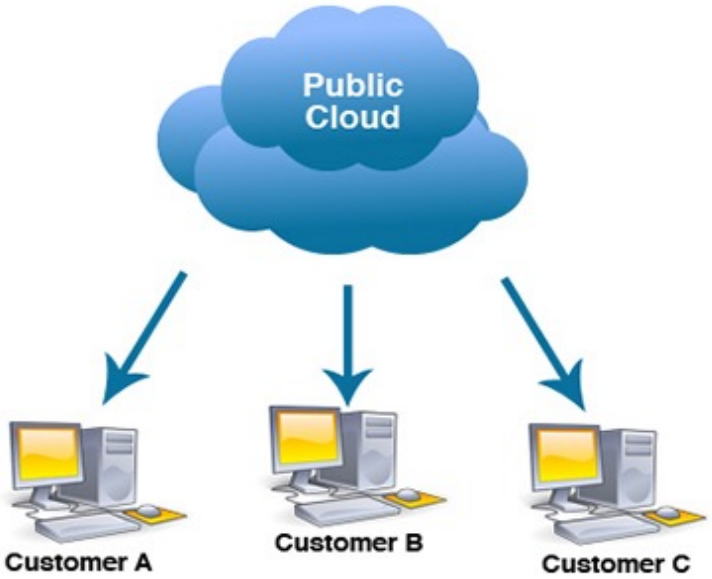
Four Cloud Deployment Models



Four Cloud Deployment Models

1- Public cloud

- Cloud infrastructure is provisioned for **open use by the general public**.
- It may be owned, managed, and operated by a business, academic, or government organization, or some combination of them.

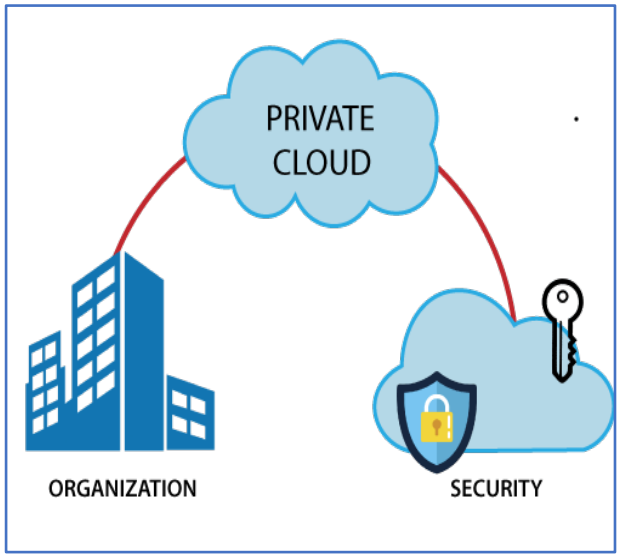


infrastructure	زیرساخت
owned	مالکیت
managed	مدیریت
operated	عملیاتی شدن

Four Cloud Deployment Models

2- Private cloud

- The cloud infrastructure is provisioned for ***exclusive use by a single organization*** comprising multiple consumers.
- It may be owned, managed, and operated by the organization, a third party, or some combination of them.



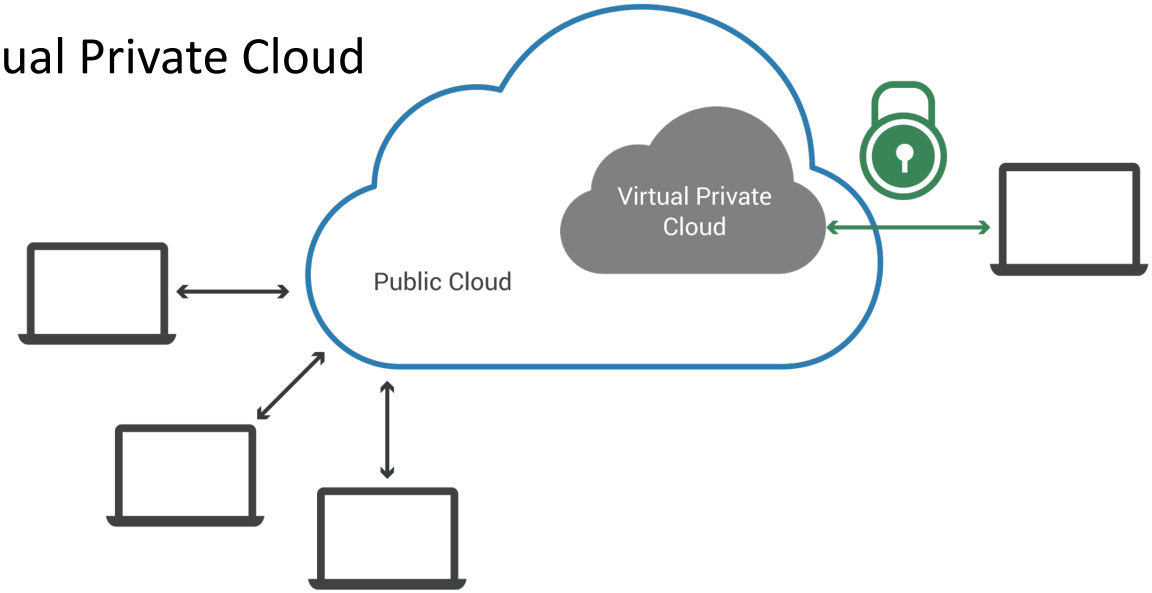
infrastructure	زیرساخت
comprising	شامل
Consumer	مشتری
owned	مالکیت
managed	مدیریت
operated	عملیاتی شدن

2- Private cloud (cont.)

Virtual Private cloud

- Is a segment of a public cloud, designated for a user ***with additional provisions and features*** for meeting that user's specific security and compliance requirements.
- Example: Amazon's Virtual Private Cloud

virtual	مجازی
security	امنیت
compliance	انطباق
requirements	نیازمندی‌ها

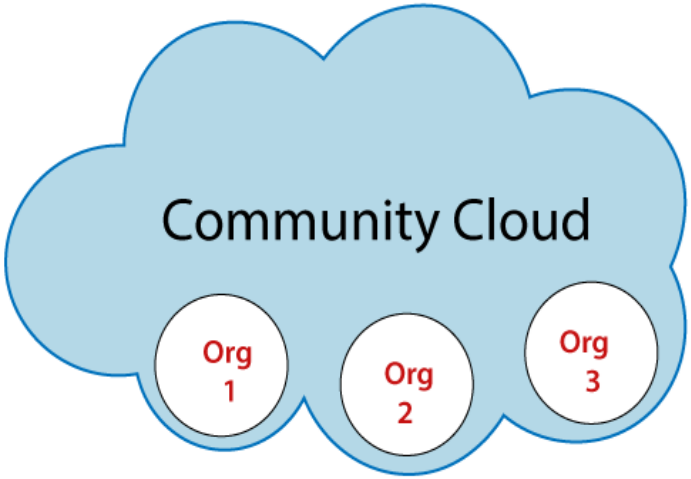


Read more

Four Cloud Deployment Models

3- Community cloud

- The cloud infrastructure is shared by several organizations and supports a specific community ***that has shared concerns***.
- Ex: finance sector, educational sector, scientific research, healthcare sector



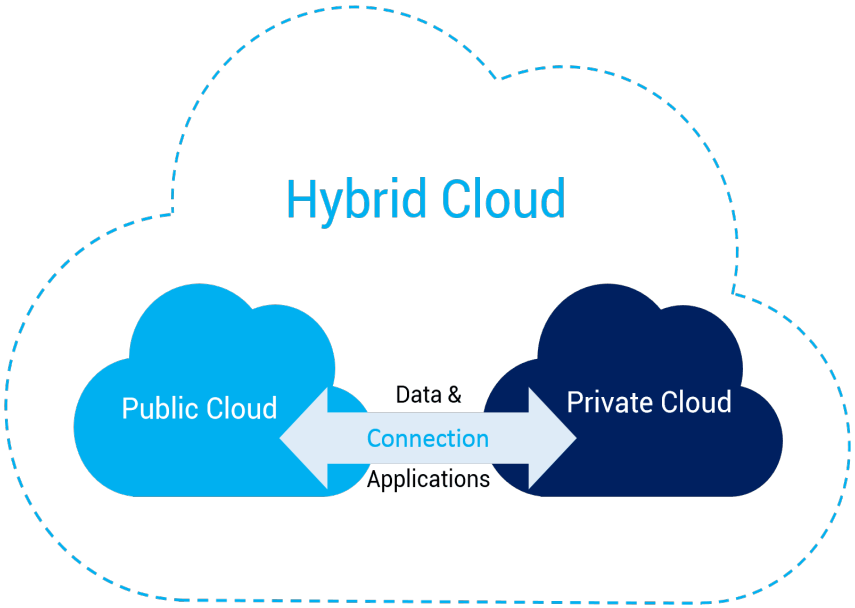
infrastructure	زیرساخت
Community	انجمن

Read more

Four Cloud Deployment Models

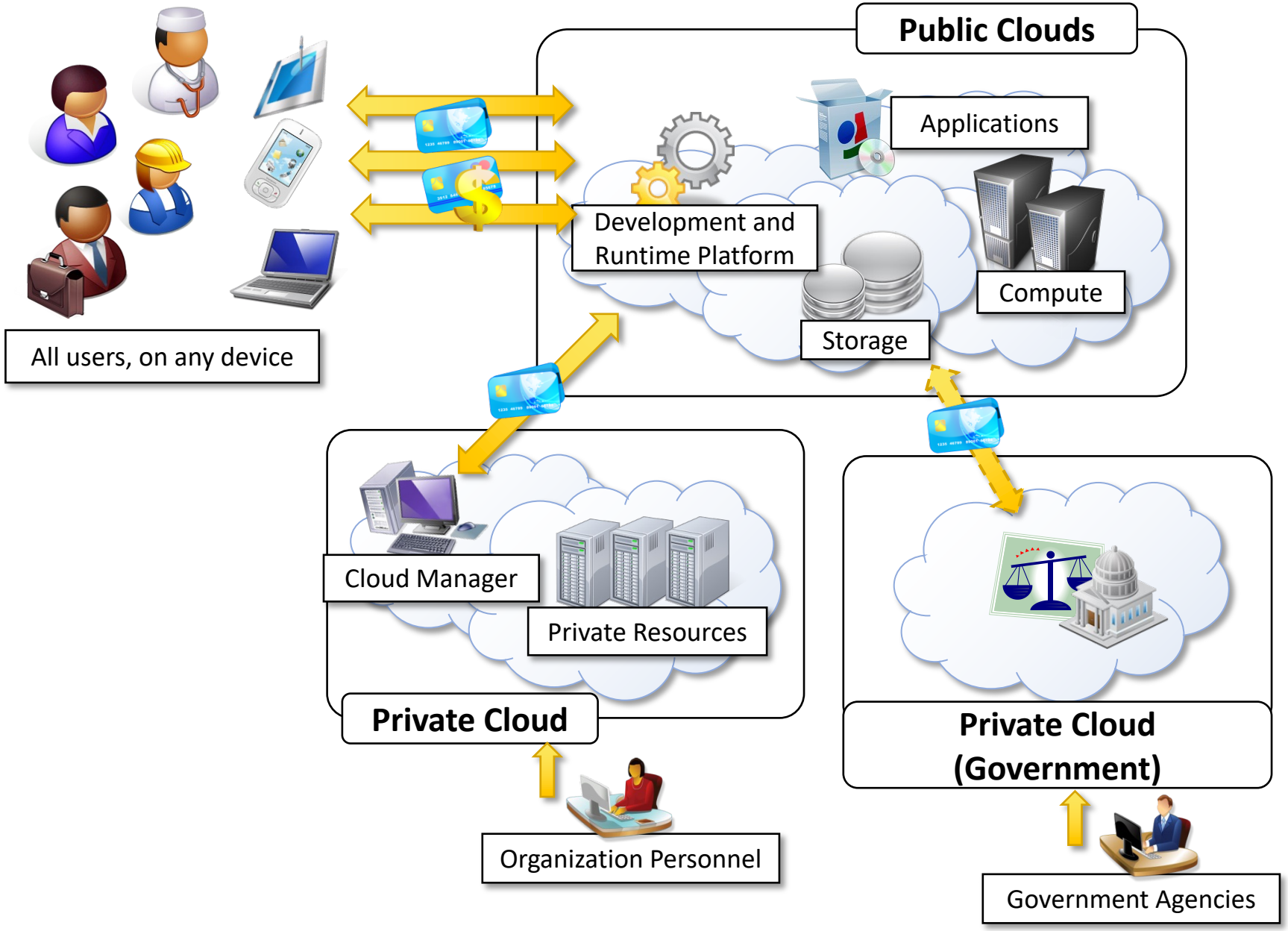
4- Hybrid cloud

- The cloud infrastructure is a composition ***of two or more distinct cloud infrastructures*** (private, community, or public).



infrastructure	زیرساخت
composition	ترکیب
distinct	متمایز

Read more


Public Clouds
Applications
Development and Runtime Platform
Compute
Storage
All users, on any device
Cloud Manager
Private Resources
Private Cloud
Private Cloud (Government)
Organization Personnel
Government Agencies

5-4-3 Principles of Cloud computing

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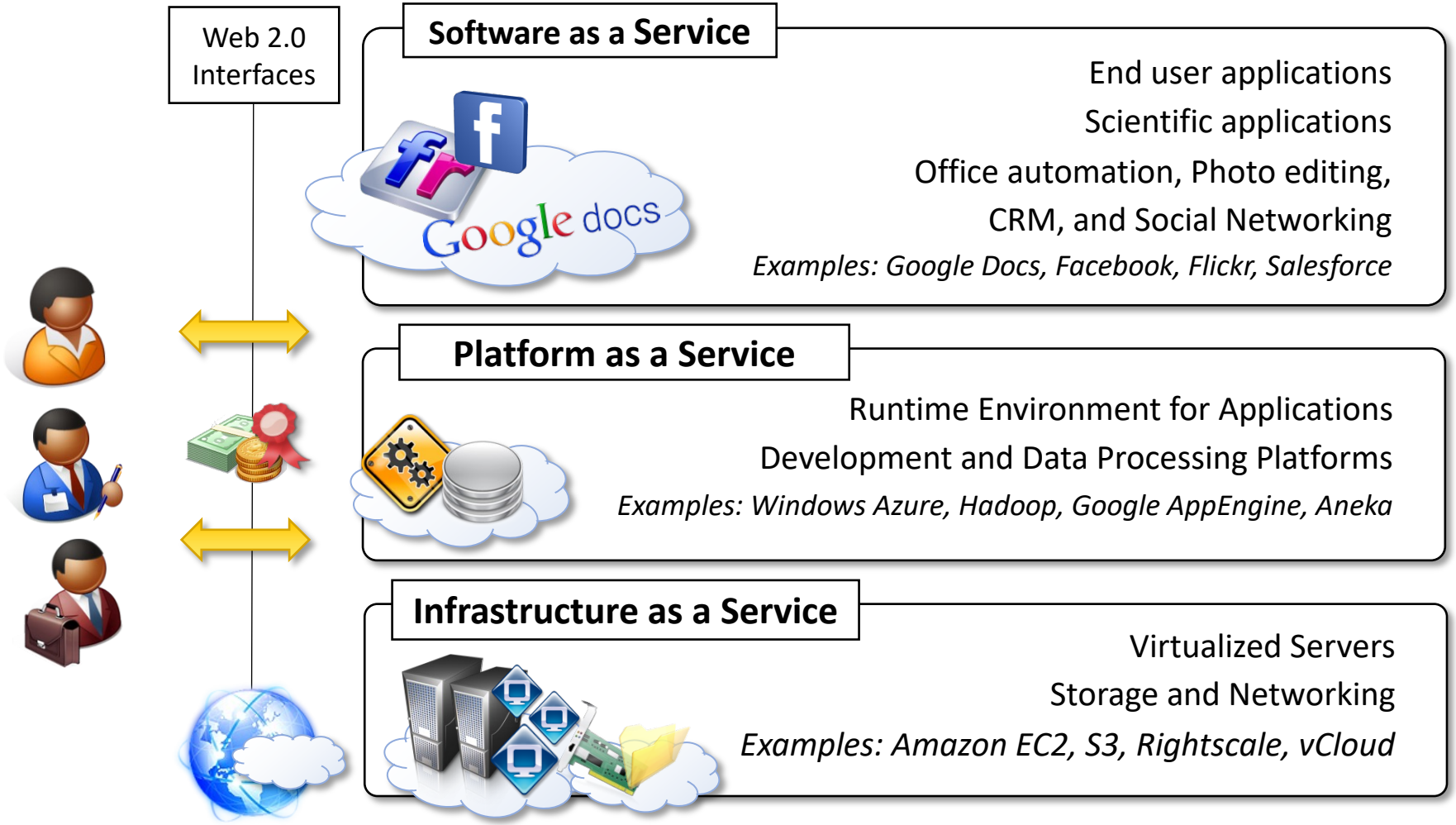
Three Service Offering Models

- A fundamental characteristic of cloud computing is the capability to deliver, ***on demand***, a variety of IT services that are ***quite diverse*** from each other.
- Cloud computing services categorize into three major categories:

Read more

fundamental	اساسی
characteristic	ویژگی
variety	تنوع
quite diverse	کاملا متنوع

Three Service Offering Models (cont.)



Three Service Offering Models

1- Software as a Service (SaaS)

- An application is hosted by a cloud vendor and delivered as a service to users, primarily via the Internet.

Cloud vendor	فراهم‌کننده ابر

Three Service Offering Models

1- Software as a Service (SaaS) (cont.)

- It eliminates the need to install and run the application locally.
  - No need for hardware and software maintenance and upgrades.
- Typical applications: Customer Relationship Management (CRM), business intelligence analytics, and online accounting software.
- Examples: SalesForce, Office 365, Google Apps

Three Service Offering Models

2- Platform as a Service (PaaS)

- The platform and tools for application development and middleware systems are hosted by a vendor and offered to application developers.

middleware	میان‌افزار

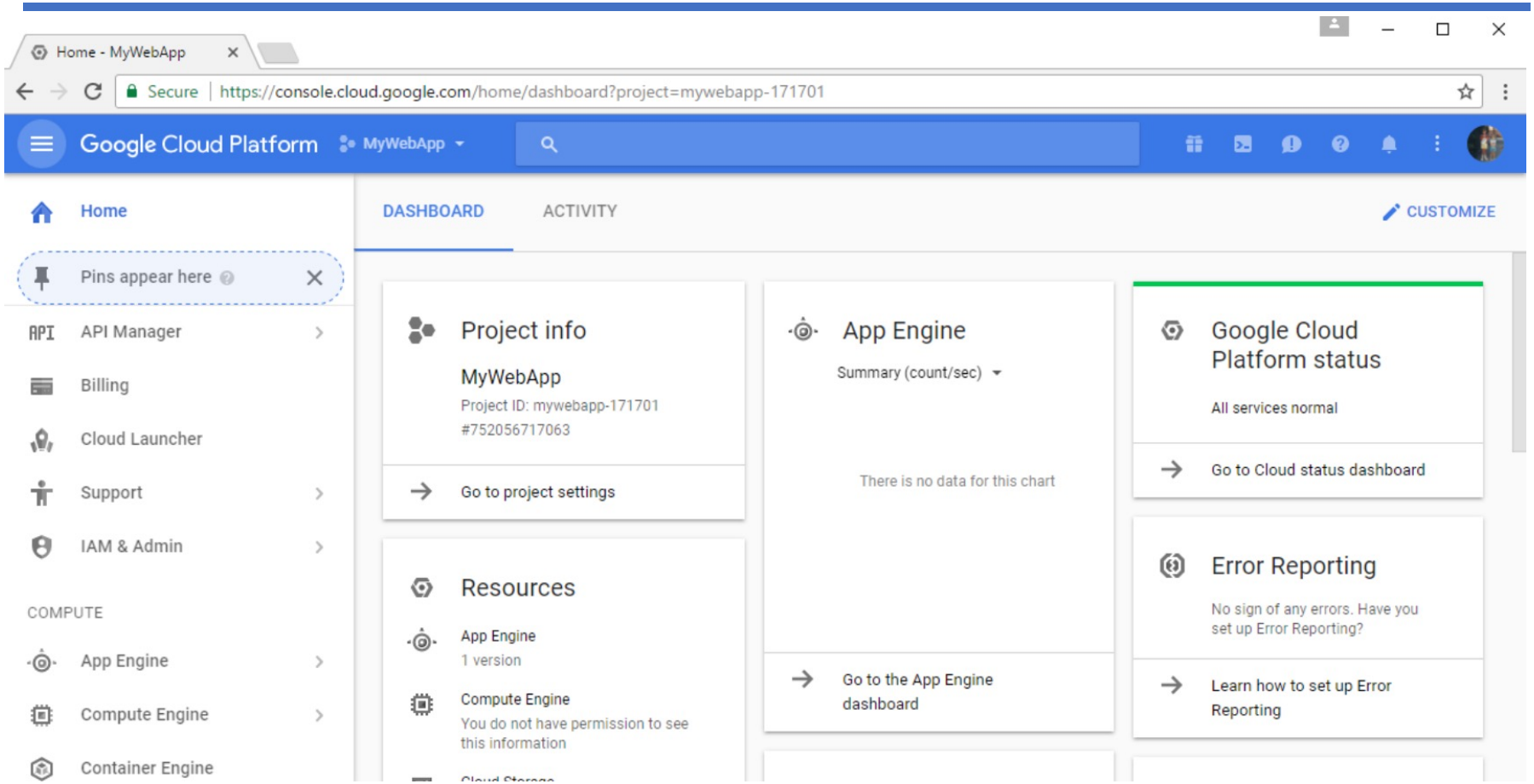
Three Service Offering Models

2- Platform as a Service (PaaS) (cont.)

- Developers simply code and deploy without directly interacting with the underlying infrastructure.
- Service provider are responsible to provide *scalability and to manage fault tolerance.*
  - Users instead ***focus on the logic of the application*** while leveraging the provider's APIs and libraries.
- Examples: Google App Engine, Microsoft Azure Services.

Three Service Offering Models

2- Platform as a Service (PaaS) (cont.)



Build web applications on Google's Infrastructure

3- Infrastructure as a Service (IaaS)

- Provisioning processing, storage, networks (and etc.) on a pay-per-use basis enabling users to deploy and run arbitrary software, which can *include operating systems and applications*.

arbitrary	دلخواه

Three Service Offering Models

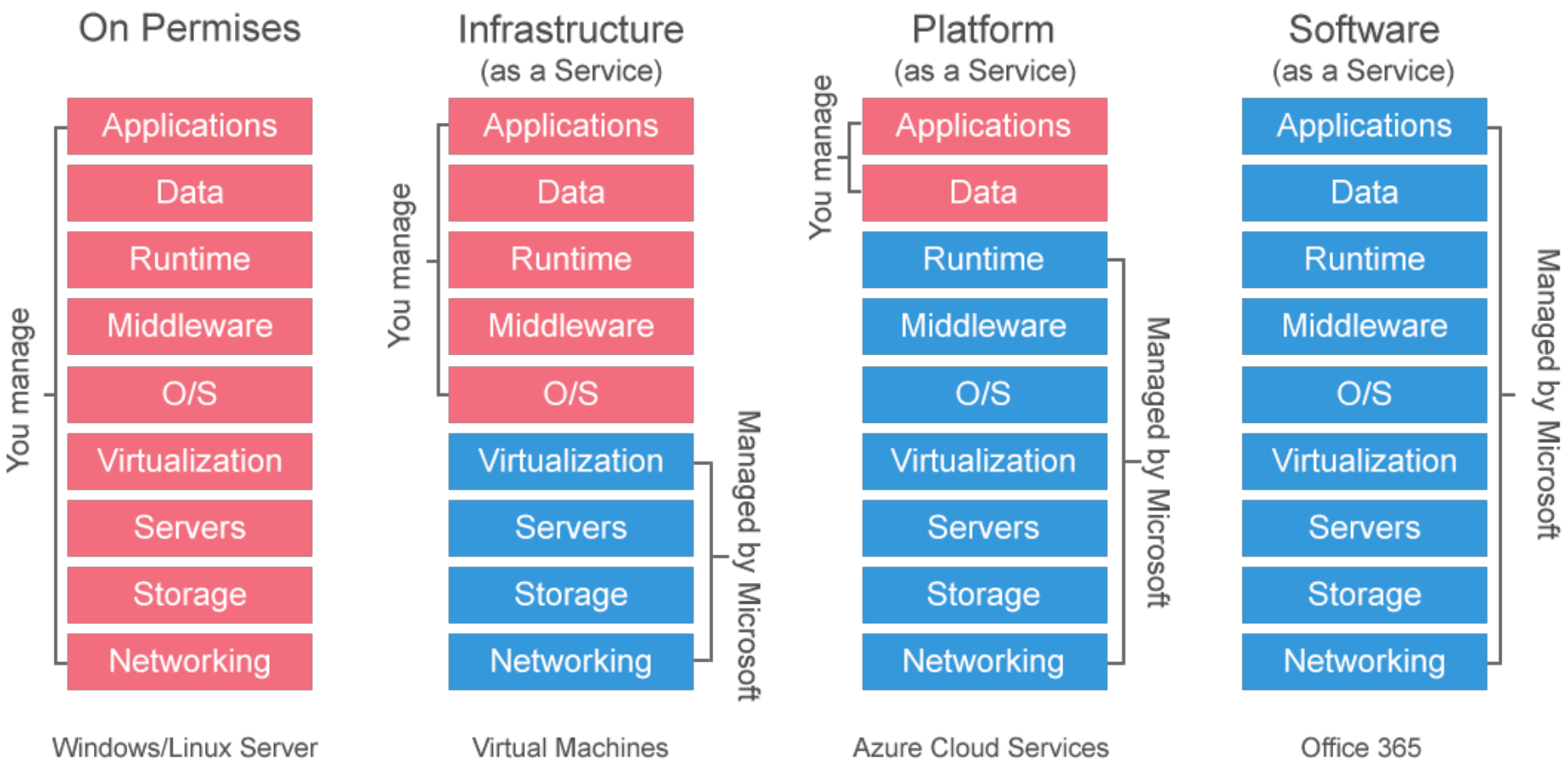
3- Infrastructure as a Service (IaaS) (cont.)

- Virtual hardware is utilized to provide compute on demand in the form of virtual machine instances.
- Virtual storage is delivered in the form of raw disk space or object store.
- Example: Amazon Elastic Compute Cloud (EC2), GoGrid, and FlexiScale.

Virtual hardware	سخت‌افزار مجازی
Virtual storage	ذخیره‌سازی مجازی
Raw disk	دیسک خام
Object store	ذخیره‌ساز شی

Three Service Offering Models

The Three Delivery Models of Cloud Computing



Three Service Offering Models

Anything as a Service (XaaS)

- Anything as a service, or XaaS, refers to the growing diversity of services available over the Internet via cloud computing.
- There are many services like
  - Desktop as a Service or Data as a Service (DaaS)
  - Communication as a Service (CaaS)
  - Monitoring as a Service (MaaS)
  - Testing as a Service (TaaS)
  - Security as a Service (SecaaS)
  - Analytics as a Service (AaaS)
  - **Function as a Service (FaaS)**
  - **Artificial Intelligence as a Service (AIaaS)**