Amirkabir University of Technology
(Tehran Polytechnic)

Cloud Computing

Introduction

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Based on slide deck of Dr. Abrishami (Ferdowsi Uni. of Mashhad)

My Background and Contact Details

➢Seyyed Ahmad Javadi

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➢Postdoc from University of Cambridge

➢Interest: Cloud computing, performance analysis

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Course Introduction

- Saturday and Monday (15-16:30pm)
  - Attend class on time
  - No more than 3/16 absence is allowed

- Course web page
  - Check the webpage on regular basis
  - Everything will be posted on CW
  - Post All your Questions on CW Forums
    - Check forum history before posting any question

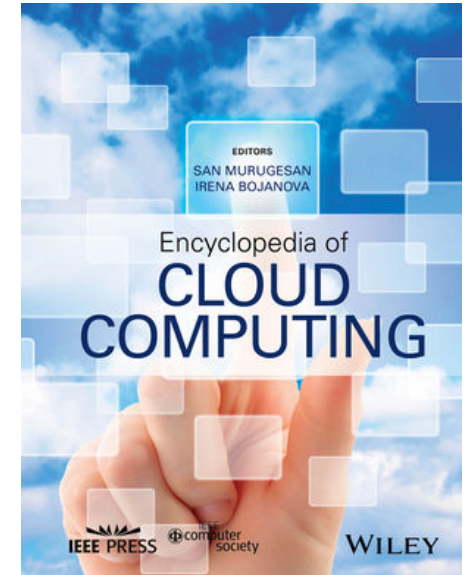- Office hours and TA classes
  - TBD

Resources
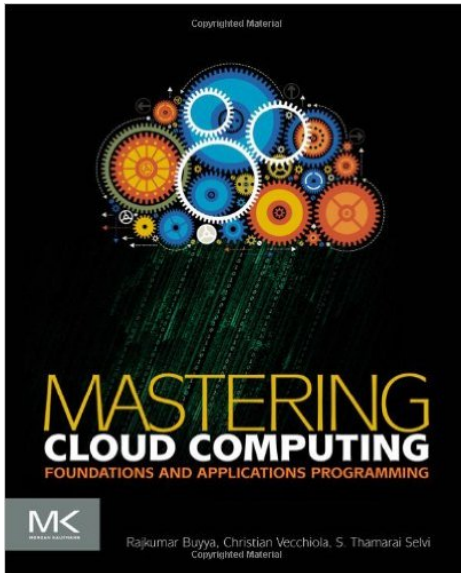
"**Mastering Cloud Computing: Foundations and Applications Programming**", Buyya et. al.
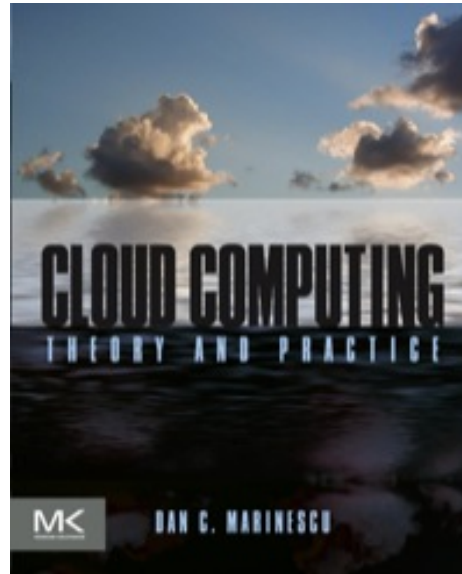
"**Cloud Computing, Theory and Practice**" Marinescu et. al.

"**Encyclopedia of Cloud Computing**", Murugesan et. al.

Course Logistics

Section	Grade
Assignments	3
Midterm exam	4
Team project	4+1
Final exam	8
Quiz	0.5
Class participation	0.5

Harsh penalty for plagiarism and cheating

Syllabus

➢ Introduction to Cloud Computing

➢ Virtualization

➢ Containers

➢ Programming Models and MapReduce

➢ Hadoop Yarn

➢ OpenStack

➢ Load balancing and auto-scaling

Part1

Cloud Computing at a Glance

➤ Leonard Kleinrock, (ARPANET, 1969):

"As of now, computer networks are still in their infancy, but as they grow up and become sophisticated, we will probably see the spread of 'computer utilities' which, like present electric and telephone utilities, will service individual homes and offices across the country."

Cloud Computing at a Glance (Cont.)

➢ A model consisting of services commoditized and delivered in a manner like utilities, such as water, electricity, gas, and telephony.

➢ Users (consumers) need to pay service providers only when they access the computing services.

➢ Users access services based on their *requirements*, regardless of where the services are hosted.

➢ *Cloud computing* is the most recent emerging paradigm promising to turn the vision of "computing utilities" into a reality.

Cloud Computing at a Glance (Cont.)

➢ The term cloud often denotes the infrastructure as a "cloud"

- Businesses and users can access applications as services from *anywhere in the world and on demand.*

➢ Cloud computing can be summarized as follows:

"I don't care where my servers are, who manages them, where my documents are stored, or where my applications are hosted. I just want them always available and access them from any device connected through the Internet. Indeed I am willing to pay for this service for as a long as I need it."

The Vision of Cloud Computing (Cont.)

➤ Cloud computing allows anyone with a credit card to provision virtual hardware, runtime environments, and services.

- These are used for as long as needed, with no up-front commitments required.

➤ The entire stack of a computing system is transformed into a collection of utilities:

- Can be provisioned and composed together to deploy systems in *hours* rather than days

- *With virtually no maintenance costs*.

The Vision of Cloud Computing (Cont.)

The Vision of Cloud Computing (Cont.)

➢ Use of cloud computing is often limited to a single service at a time
- Or a set of related services offered by the same vendor.

➢ The long-term vision of cloud computing is that IT services are traded as utilities in an open market.
- Nowadays, the discovery of services is mostly done by human intervention.

➢ Simply entering our request in a global digital market trading cloud computing services.

Defining a Cloud

➢ The term cloud has historically been used in the telecommunications industry as an abstraction of the network in system diagrams.

➢ It then became the symbol of the Internet.
- Also applies to cloud computing referring to an Internet-centric way of computing.

Defining 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."

Practical Examples

➢ Large enterprises can offload some of their activities to cloud-based systems.

➢ Start-ups can afford to translate their ideas into business results more quickly, without excessive up-front costs.

➢ System developers can concentrate on the business logic rather than dealing with the complexity of infrastructure management and scalability.

➢ End users can have their documents accessible from everywhere and any device.

5-4-3 Principles of Cloud computing

➢ The 5-4-3 principles put forth by NIST describe:

- The five essential characteristic features that promote cloud computing.

- The four deployment models that are used to narrate the cloud computing opportunities for customers while looking at architectural models.

- The three important and basic service offering models of cloud computing.

Five Essential Characteristics

➢ **On-demand self-service**
- ▪ Consumers can provision computing capabilities automatically without requiring human interaction with each service's provider.

➢ **Broad network access**
- ▪ Capabilities are available over the network and accessed through standard mechanisms.

➢ **Elastic resource pooling**
- ▪ The provider's computing resources are pooled to serve multiple consumers using a multitenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand.

Five Essential Characteristics (Cont.)

➢ **Rapid elasticity**

- Capabilities can be rapidly and elastically provisioned, in some cases automatically, to quickly scale out and rapidly released to quickly scale in.

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

➢ **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).

Another Important Characteristic

➢ **Multitenancy**

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

Four Cloud Deployment Models

➢**Public cloud**

- The 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.

➢**Private cloud**

- The cloud infrastructure is provisioned for exclusive use by a single organization comprising multiple consumers (e.g., business units).

- It may be owned, managed, and operated by the organization, a third party, or some combination of them.

Four Cloud Deployment Models (Cont.)

➤ **Private cloud**

- ▪ 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 (VPC)
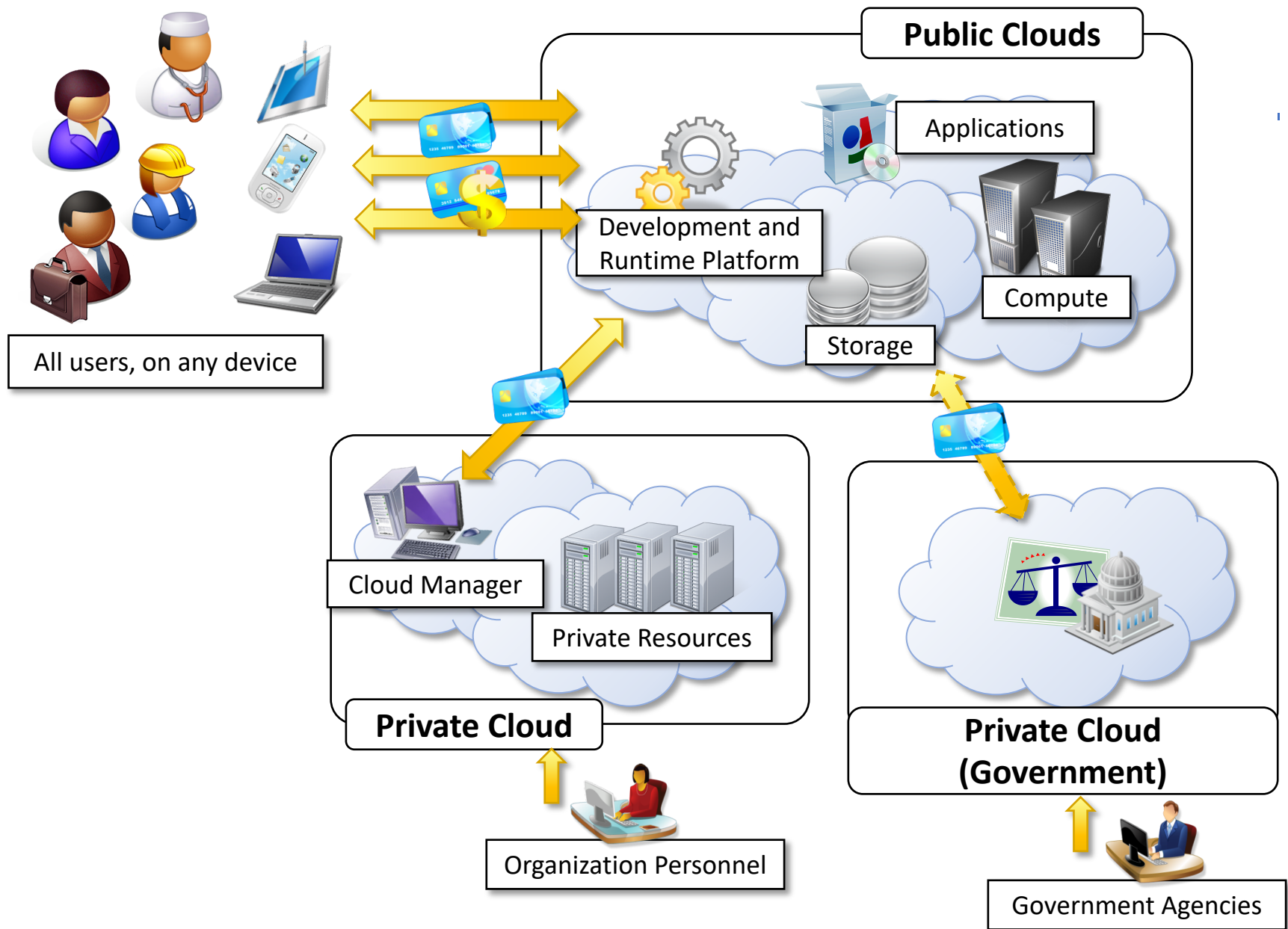
Four Cloud Deployment Models (Cont.)

➢ **Community cloud**

 ▪ The cloud infrastructure is shared by several organizations

  and supports a specific community that has shared concerns.

➢ **Hybrid cloud**

 ▪ The cloud infrastructure is a composition of two or more

  distinct cloud infrastructures (private, community, or public).
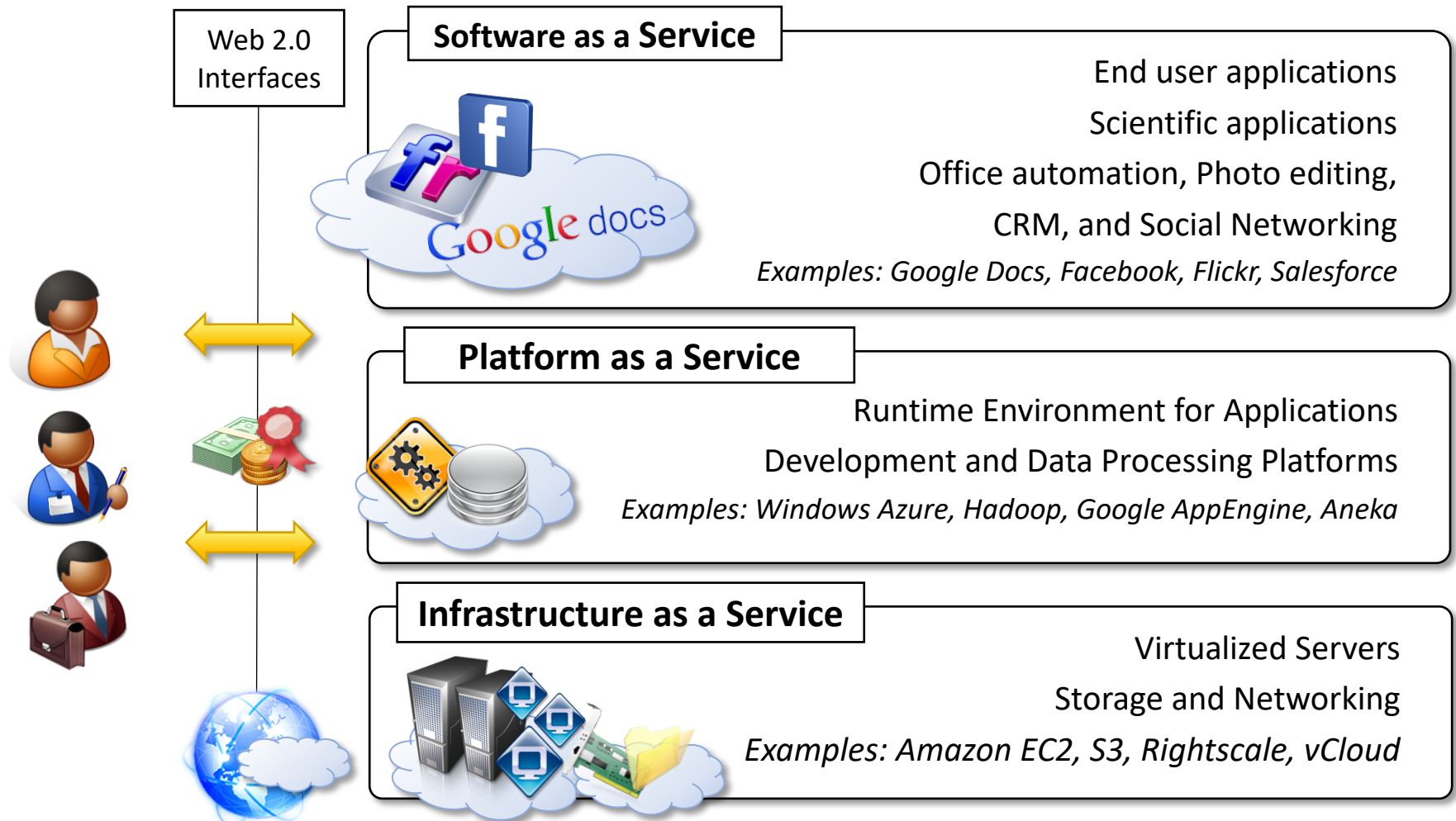
Public Clouds

Applications

Development and Runtime Platform

Compute

Storage

All users, on any device

Cloud Manager

Private Resources

Private Cloud

Organization Personnel

Private Cloud (Government)

Government Agencies

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:

- Infrastructure-as-a-Service (IaaS)

- Platform-as-a-Service (PaaS)

- Software-as-a-Service (SaaS)

Three Service Offering Models

Web 2.0
Interfaces

Software as a Service

End user applications

Scientific applications

Office automation, Photo editing,

CRM, and Social Networking

Examples: Google Docs, Facebook, Flickr, Salesforce

Platform as a Service

Runtime Environment for Applications

Development and Data Processing Platforms

Examples: Windows Azure, Hadoop, Google AppEngine, Aneka

Infrastructure as a Service

Virtualized Servers

Storage and Networking

Examples: Amazon EC2, S3, Rightscale, vCloud

Software as a Service (SaaS)

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

➢ 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

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.

- 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.

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*.

➢ 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.

The Three Delivery Models of Cloud Computing
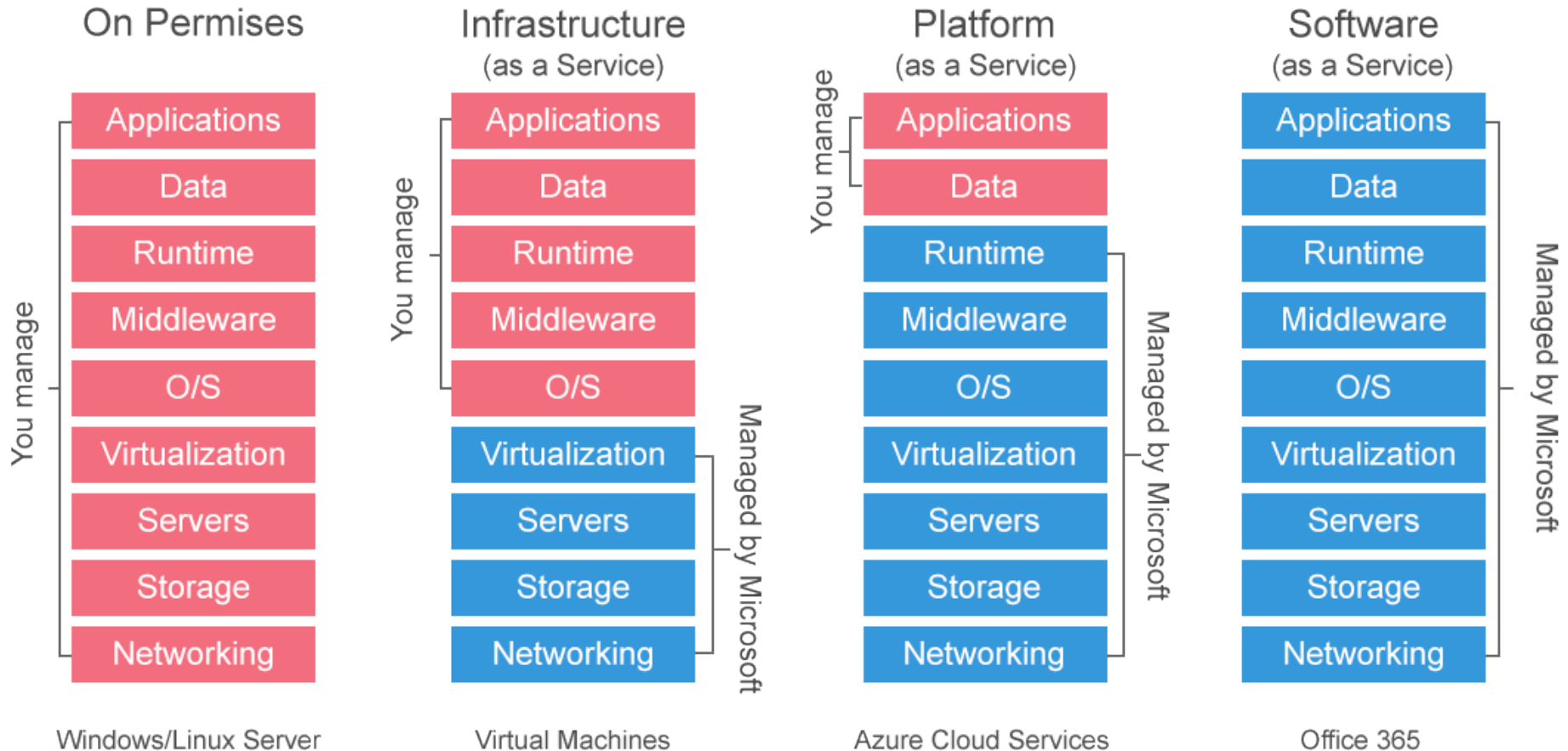
Anything as a Service (XaaS)

➢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)

Anything as a Service (XaaS)

➢Cloud users can use services from more than one service provider, aggregate those services, and integrate them with each other and with the organization's legacy applications/systems.

Benefits of Cloud Computing

➢ No up-front commitments

➢ Reduced capital and operational cost

➢ On-demand access and scalability

➢ Simplified application acceleration and scalability

➢ Availability of vast cloud resources for every kind of application or use

➢ Efficient resource allocation

➢ Energy efficiency

Drawbacks of Cloud Computing

➢ Security and Privacy

➢ Performance unpredictability

➢ Interoperability and standardization

➢ Availability and reliability of service

➢ Vendor lock-in

➢ Need for a reliable, high-speed network access

➢ Data transfer bottlenecks

Summary

➢ Cloud computing realizes "computing utilities"

➢ Main cloud deployment models

- Public cloud

- Private cloud

➢ Main cloud service models

- Software as a Service (SaaS)

- Platform as a Service (PaaS)

- Infrastructure as a Service (IaaS)