Distributed Systems

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Distributed Systems

Course Overview

&

Introduction to Distributed Systems

List of topics

- Course overview

- Introduction to distributed systems
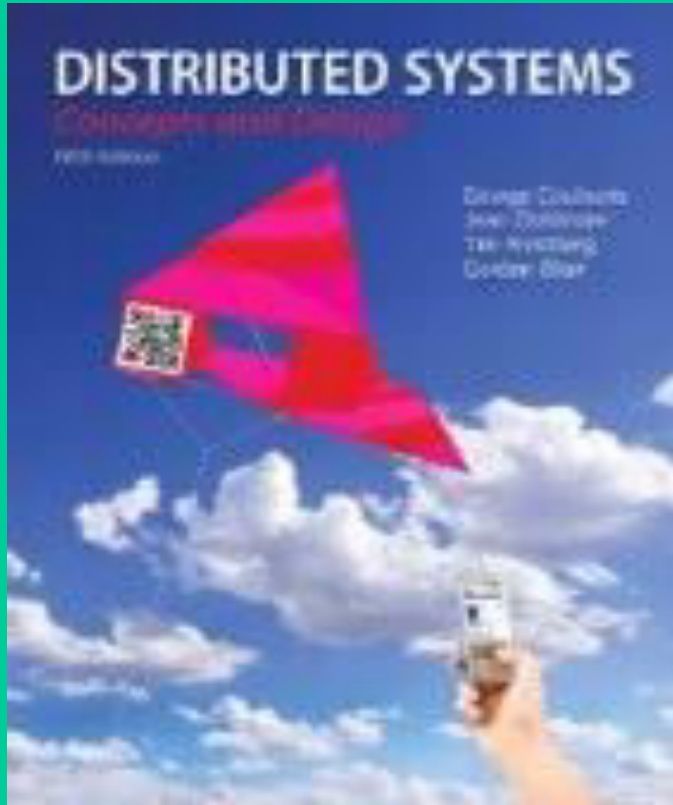
- Introduction to Cloud Computing

Topic 1: Course Overview

Grading based on

- **Course work** 30%
  - Midterm 15%
  - Section 15%
- **Final Exam** 70%

Course Book

Distributed Systems: Concepts and Design, (Fifth Edition), Coulouris G., J. Dollimore and T. Kindberg published by Addison Wesley, May 2011.

Additional reading

- **Distributed Systems: Principles and Paradigms** (2nd edition), Andrew S. Tanenbaum, Maarten Van Steen, 2007.

- Reliable Distributed Programming, Rachid Guerraoui and Luis Rodrigues 2011.

- Software Modeling and Design: UML, Use Cases, Patterns, and Software Architectures, Hassan Gomaa , 2011.

Topic 1: Course Overview

- This course addresses issues of software engineering topics in a distributed environment and distributed software applications, include web applications as well as other network environments.

- The course examines issues that exist because of the complexity of software running simultaneously and asynchronously on multiple heterogeneous networks.

- At the end of the course, students will have a deeper understanding of software engineering topics in a distributed environment. They will be better equipped to design, develop, test, and analyze the performance of distributed applications.

Topic 3: Introduction to Cloud Computing

Definition

Cloud computing is the delivery of computing as a service rather than a product, whereby shared resources, software, and information are provided to computers and other devices as a metered service over a network (typically the Internet).

Wikipedia

Topic 3: Introduction to Cloud Computing

Our Data Now…

Documents and Media

Personal Data

Emails, Calendars, Contacts, Location Information, etc…

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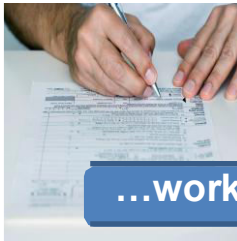
Using Diverse Interfaces & Devices

…and even appliances

Consumer

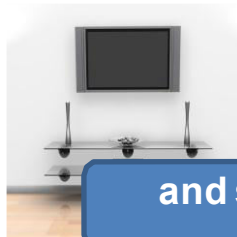> We also want to access, share and process our data from all of our devices, anytime, anywhere!

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How will you…

…work on documents?

…get your news & info?

and share media?

…navigate?

…communicate with friends and family?

…live in an intelligent home?

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How Will We Manage Our Data?

Manage it ourselves?	• Personal, but time consuming.
How would you get access to your data wherever you are?	• Would you keep it on your devices? • or would you keep it online?
What if it's managed by someone else?	• and you can get this "service" for free or with a subscription?

Topic 3: Introduction to Cloud Computing

A Cloud is …

- A data center hardware and software that the vendors use to offer the computing resources

and services

Topic 3: Introduction to Cloud Computing

Cloud Computing

Cloud Computing is the delivery of computing as a service rather than a product,

whereby shared resources, software, and information are provided to computers and other devices,

as a metered service over a network.

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The promise of the Cloud

- Transformation of IT from a product to a service

- Revolutionizing for health care, financial systems, scientific research, and society

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Why Cloud Computing?

| **Pay-as-You-Go** economic model	**Simplified IT** management	**Scale** quickly and effortlessly	**Flexible o**ptions	**Resource Utilization** is improved	**Carbon Footprint decreased**
• Reduce capital expenditure • No upfront cost • Reduced Time to Market	• All you need is access to the internet. • It's the providers responsibility to manage the details.	• Resources can be rented and released as required • Software Controlled • Instant scalablility	• Configure software packages, instance types operating systems. • Any software platform • Access from any machine connected to the Internet	• Reduce Idle resources by sharing and conolidation • Better utilization of CPU / Storage and Bandwidth.	• Sharing of resources means less servers, less power and less emissions.
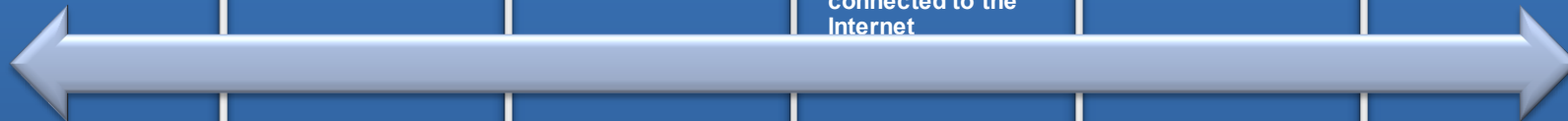
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Cloud Properties

- Pooled resource

- Network accessible

- Virtualization

- Elasticity

- Automation

- Metered billing

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Cloud Challenges

- Quality of Service

- Network Dependence

- Vendor Lock-In, Storage Lock-in & Computation Lock-in

- Non-standardized

- Security Risks

- Privacy

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IT as a Service

- **How do you offer IT as a service?**
- **Different users have different needs**
- **Consider the needs of:**
  - **Average End User**
  - **Mobile Application Developer**
  - **Enterprise System Architect**

> **Let us look at some of the typical service models**

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Cloud Service Models

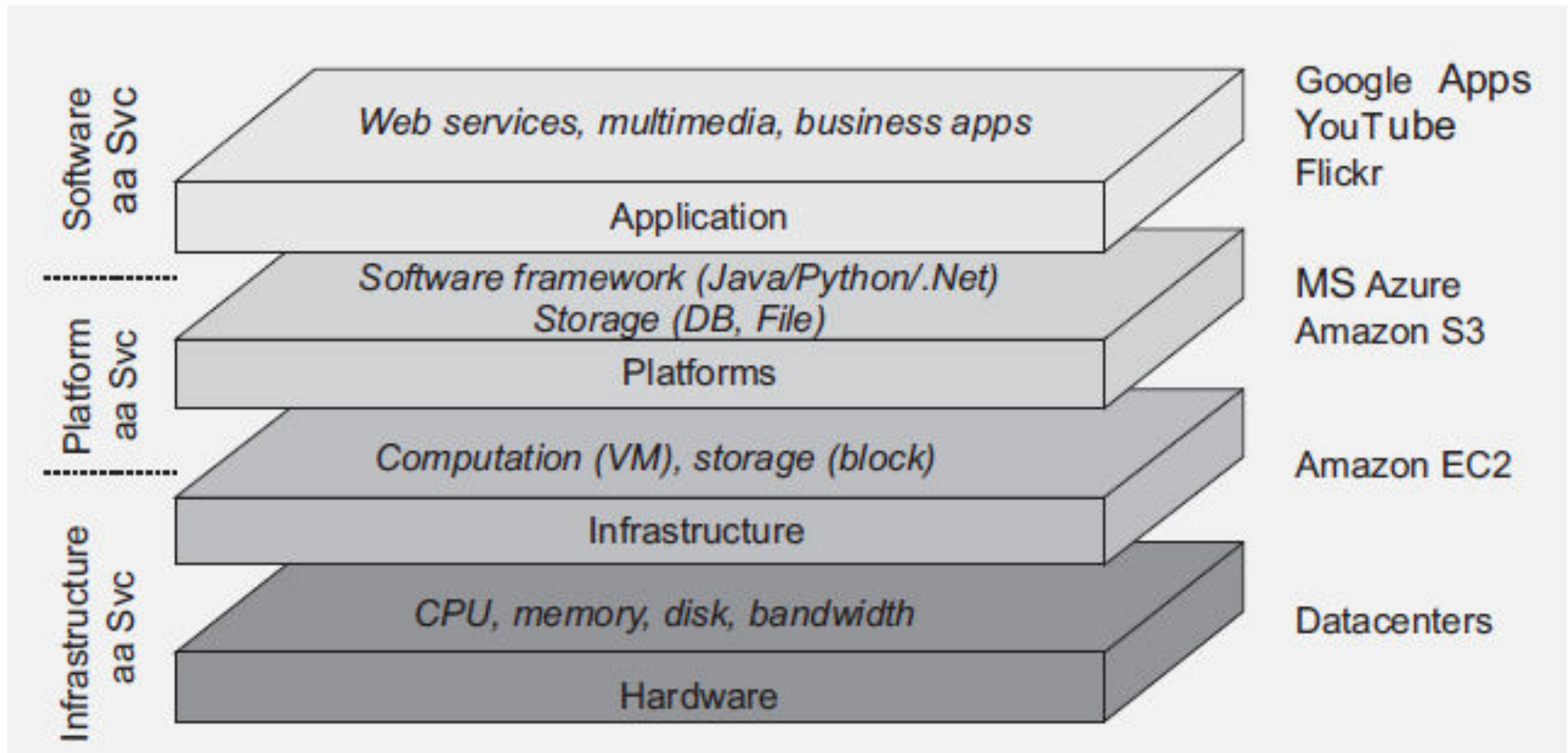**SaaS**

- **Software-as-a-Service**
  - **User** applications running on browsers

PaaS

- **Platform-as-a-Service**
  - A software platform that is made available to **developers** to build cloud applications

IaaS

- **Infrastructure-as-a-Service**
  - Basic computing resources such as CPU/Memory/Disk, made available to users in the form of Virtual Machine Instances
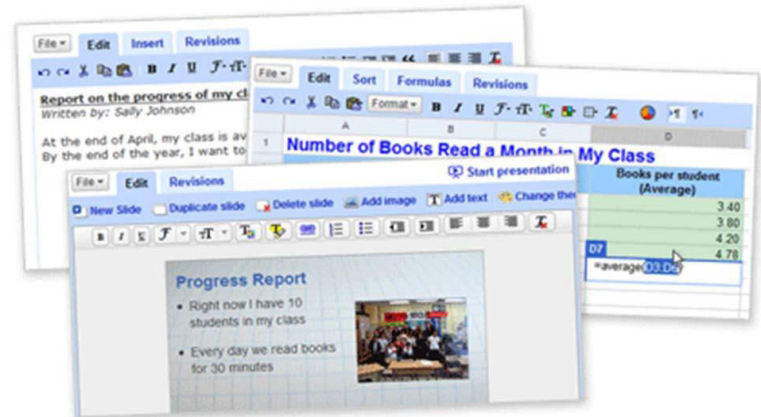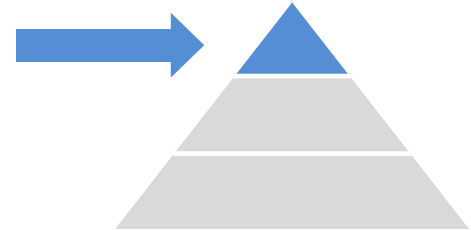
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Clouds

Topic 3: Introduction to Cloud Computing
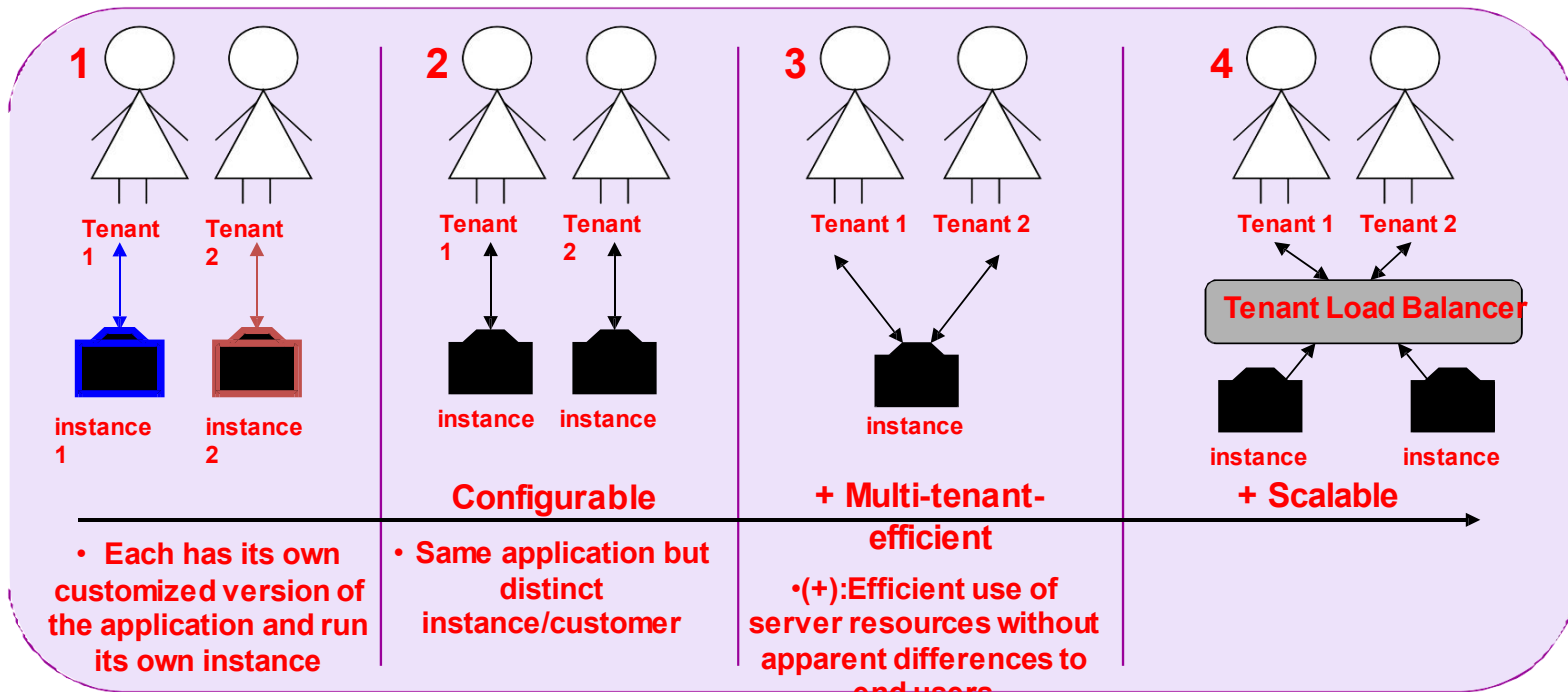
SaaS

- **You are most familiar with this!**

- **Software is delivered as a service over the Internet, eliminating the need to install and run the application on the customer's own computer**

- **This simplifies maintenance and support**

- **Examples: Gmail, YouTube, and Google Docs, among others**

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SaaS Maturity Levels

- **Distinguishing attributes: configurability, multi-tenant efficiency, scalability**


1

Tenant 1 — instance 1
Tenant 2 — instance 2

- **Each has its own customized version of the application and run its own instance**

2

Tenant 1 — instance
Tenant 2 — instance

Configurable

- **Same application but distinct instance/customer**

3

Tenant 1 / Tenant 2 — instance

+ Multi-tenant-efficient

- **(+):Efficient use of server resources without apparent differences to end users**

4

Tenant 1 / Tenant 2 — **Tenant Load Balancer** — instance / instance

+ Scalable

- **(-): scalability limits**

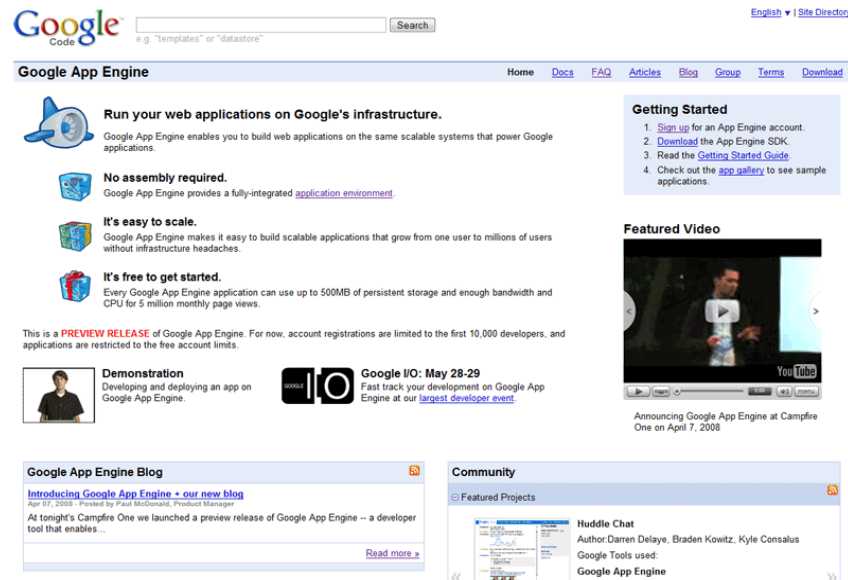# Topic 3: Introduction to Cloud Computing

PaaS

- **The Cloud provider exposes a set of tools (a platform) which allows users to create SaaS applications**

- **The SaaS application runs on the provider's infrastructure**

- **The cloud provider manages the underlying hardware and requirements**
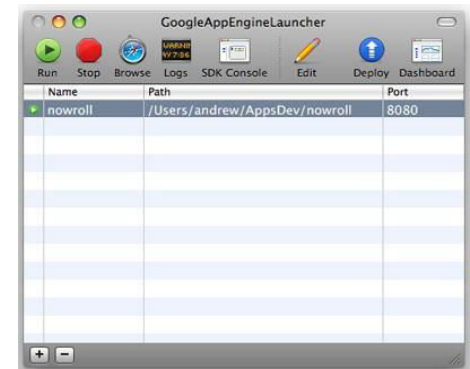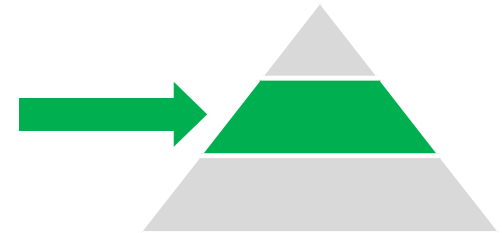
Topic 3: Introduction to Cloud Computing
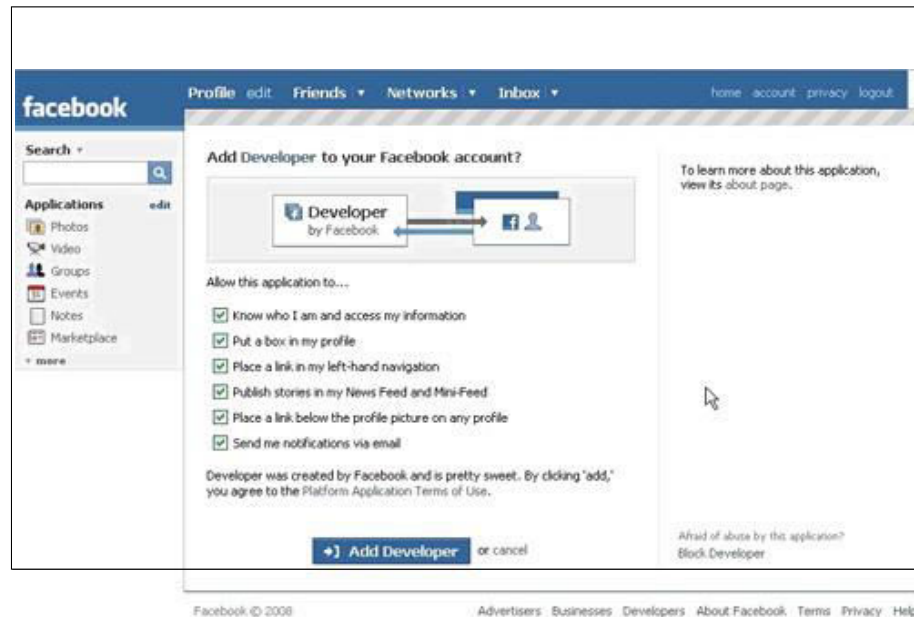
PaaS Example I

- **Google App Engine**

Build web applications on Google's Infrastructure

PaaS Example II

- **The Facebook Developer Platform**

Set of APIs that allow you to create Facebook Applications

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IaaS (1/2)

- **The cloud provider leases to users Virtual Machine Instances (i.e., computer infrastructure) using the *virtualization* technology**

- **The user has access to a standard Operating System environment and can install and configure all the layers above it**

Cloud Provider
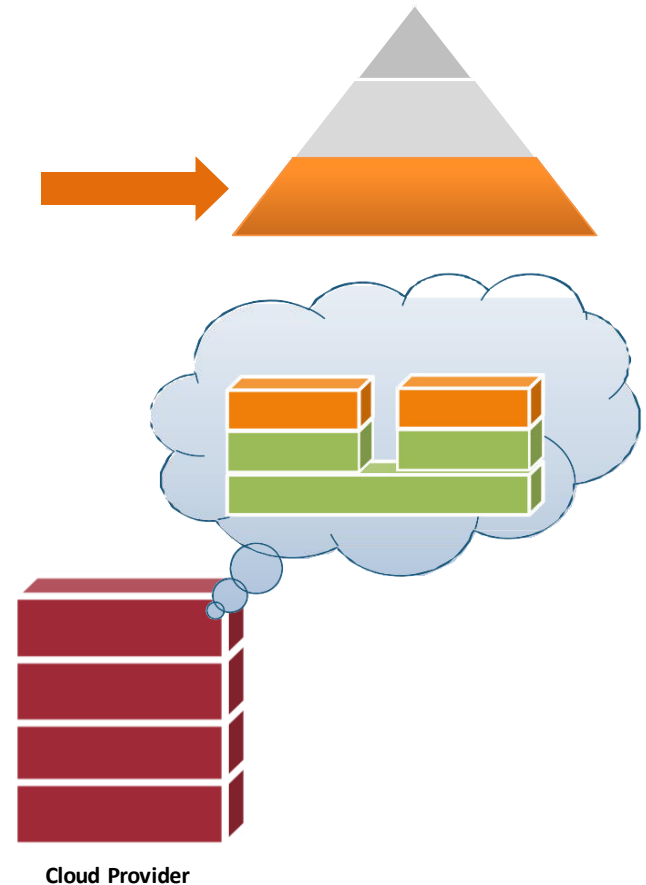
IaaS (2/2)

- **The virtualization technology is a major enabler of IaaS**
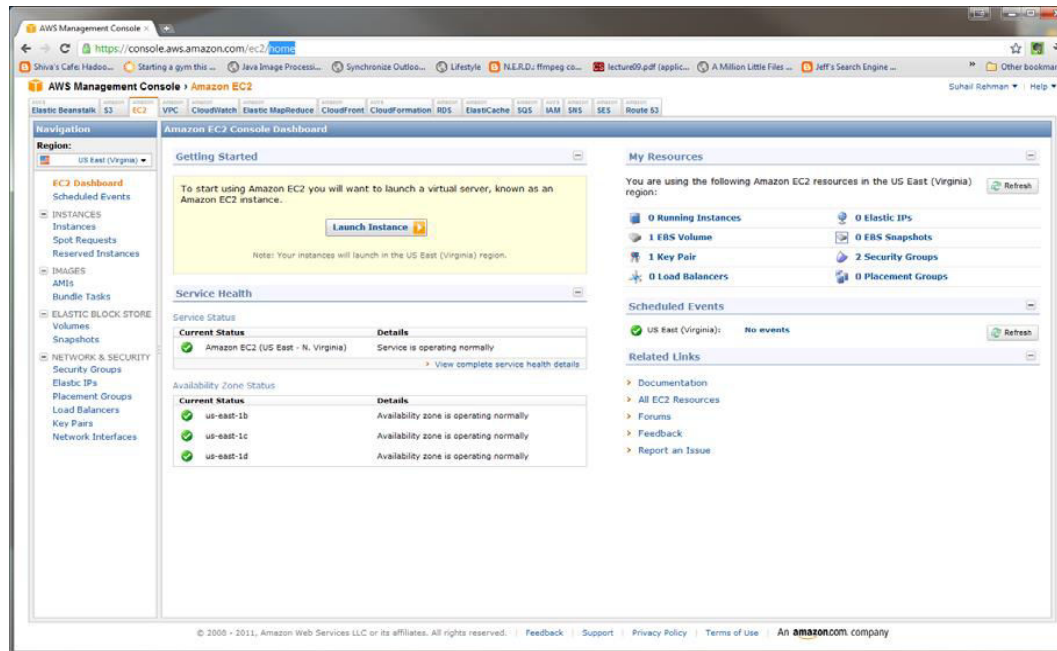

Virtual machines

Physical machine
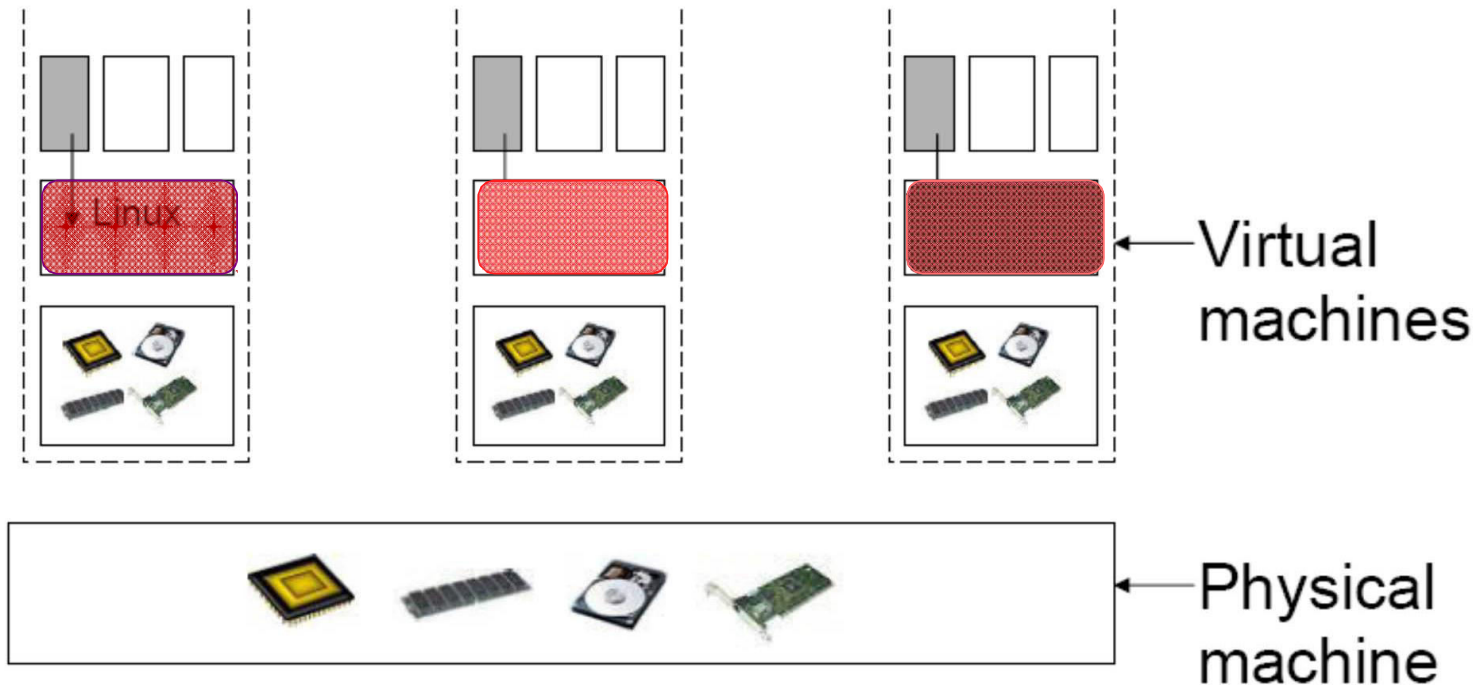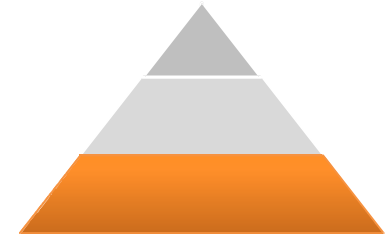
HARDWARE

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IaaS Example

- Amazon Web Service Elastic Compute Cloud (EC2)

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Other Service Models

- **Database-as-a-Service**
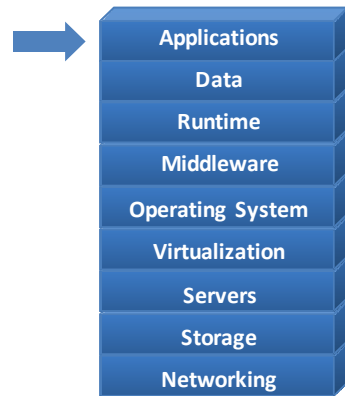- **Sensing-as-a-Service**
- **XaaS**
  - "X" as a Service

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The Cloud Software Stack

Applications
Data
Runtime
Middleware
Operating System
Virtualization
Servers
Storage
Networking

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Applications

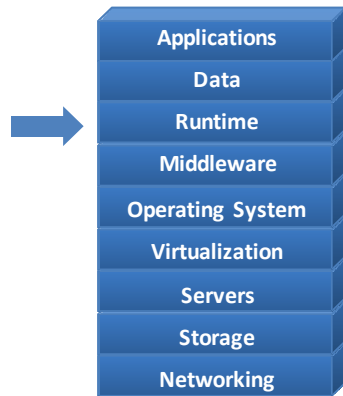|		
Applications		▪ **Cloud applications can range from Web applications to scientific computational jobs**
Data		
Runtime		
Middleware		
Operating System		
Virtualization		
Servers		
Storage		
Networking		

Topic 3: Introduction to Cloud Computing
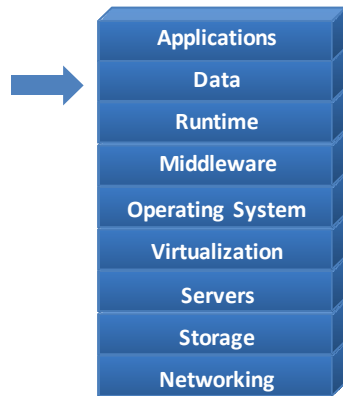
Data

- **Data Management**
- **New generation cloud-specific databases and management systems**
- **E.g., Hbase, Cassandra, Hive, Pig etc.**

Applications
Data
Runtime
Middleware
Operating System
Virtualization
Servers
Storage
Networking

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Runtime Environment

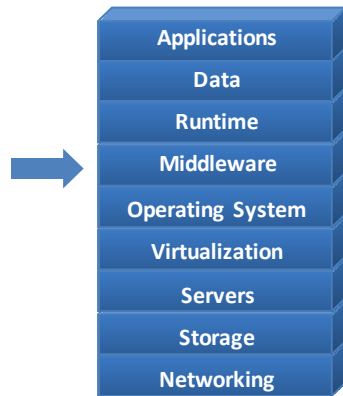| |
|---|
| Applications |
| Data |
| Runtime |
| Middleware |
| Operating System |
| Virtualization |
| Servers |
| Storage |
| Networking |

- **Runtime platforms to support cloud programming models**
- **E.g., MPI, MapReduce, Pregel etc.**
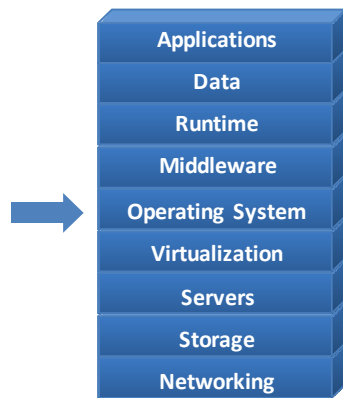
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Middleware for Clouds

Applications
Data
Runtime
Middleware
Operating System
Virtualization
Servers
Storage
Networking

- **Management platforms that enable:**
  - **Resource Management**
  - **Monitoring**
  - **Provisioning**
  - **Identity Management and Security**

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Operating Systems

| Applications |
|---|
| Data |
| Runtime |
| Middleware |
| **Operating System** |
| Virtualization |
| Servers |
| Storage |
| Networking |

- **Standard Operating Systems used in Personal Computing**
- **Packaged with libraries and software for quick deployment and provisioning**
- **E.g., Amazon Machine Images (AMI) contain OS as well as required software packages as a "snapshot" for instant deployment**
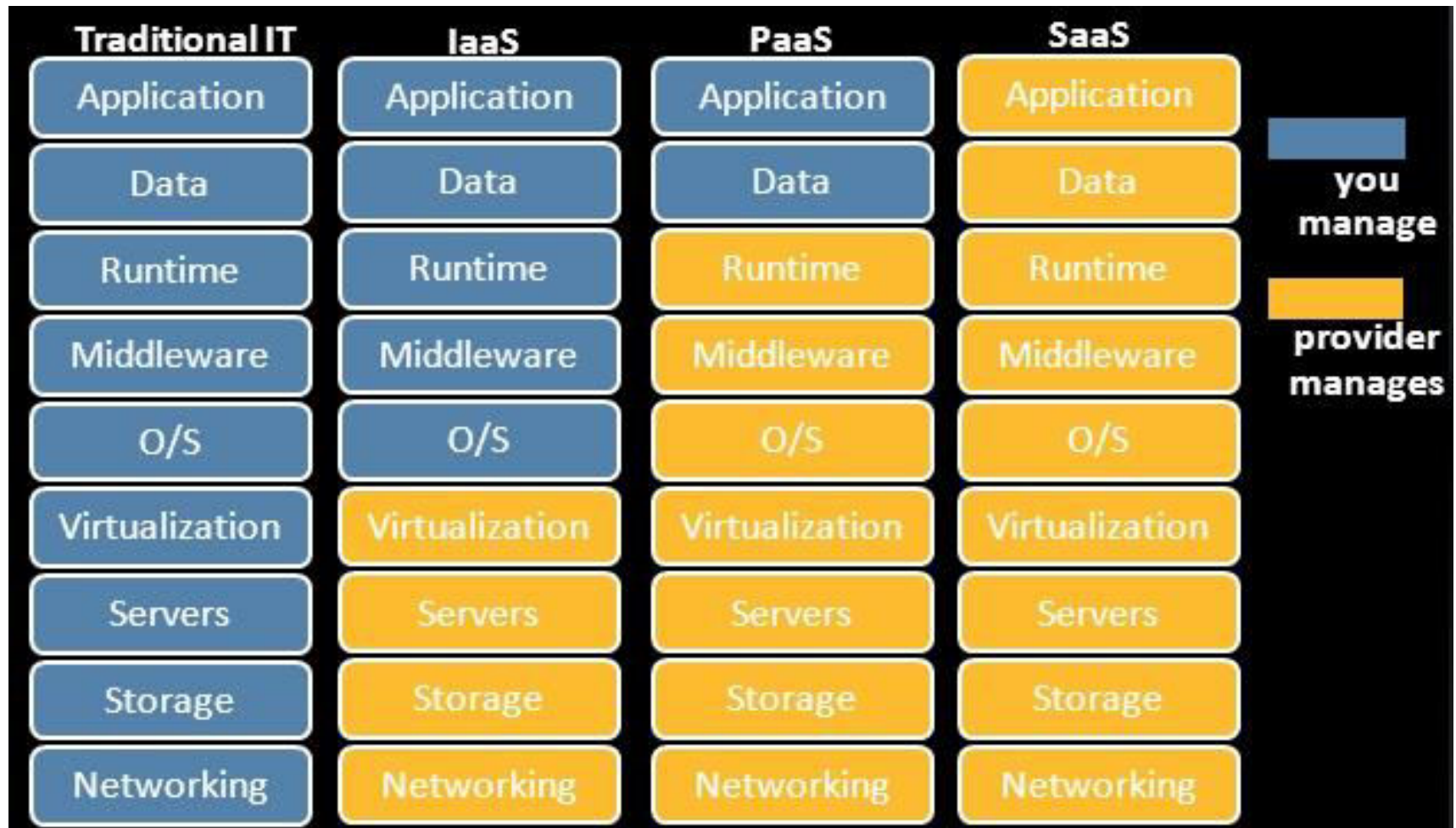
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Virtualization
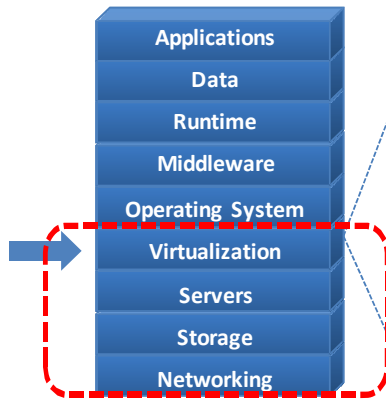
- Key Component
- Resource Virtualization
- Amazon EC2 is based on the Xen virtualization platform
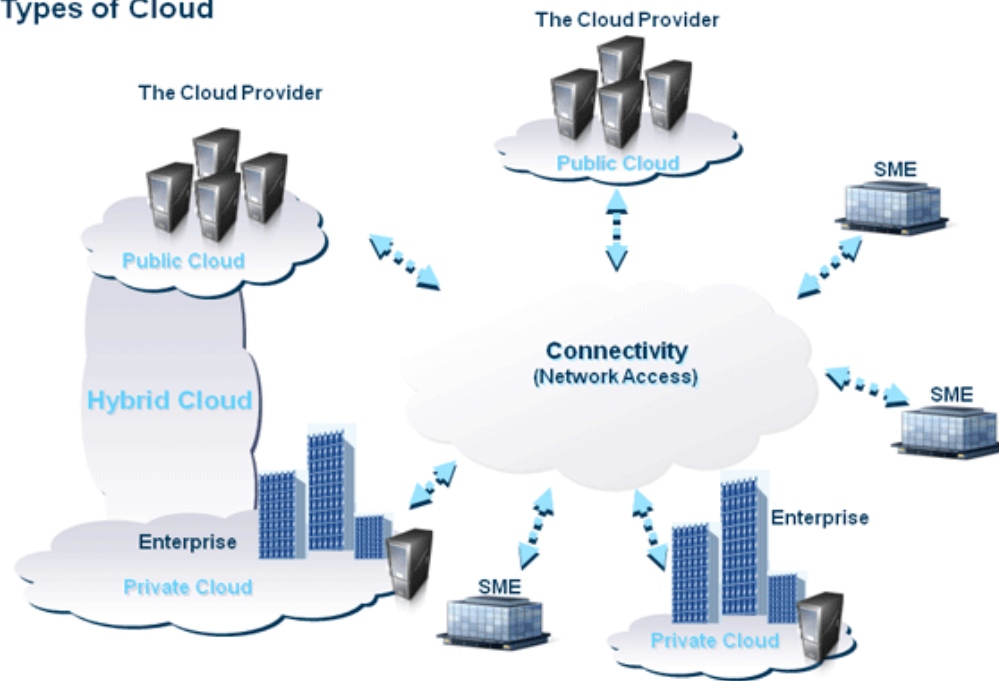
Three Cloud Service Models

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Cloud Deployment Models
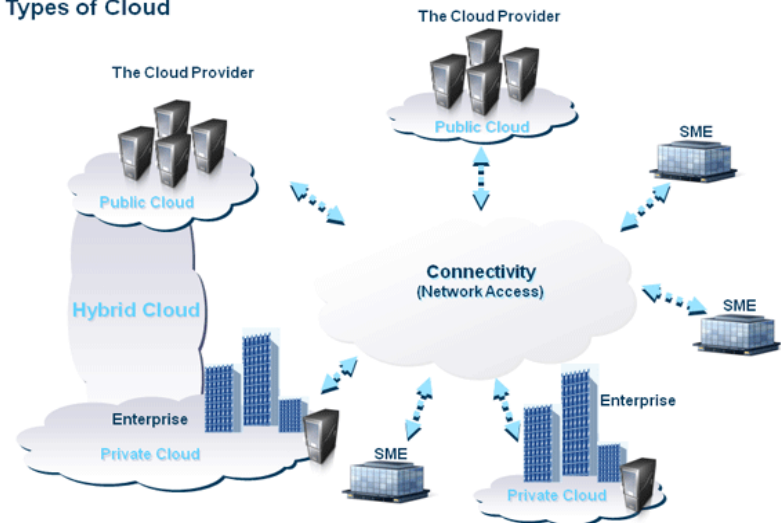
- **Public**
- **Private**
- **Hybrid**

Types of Cloud

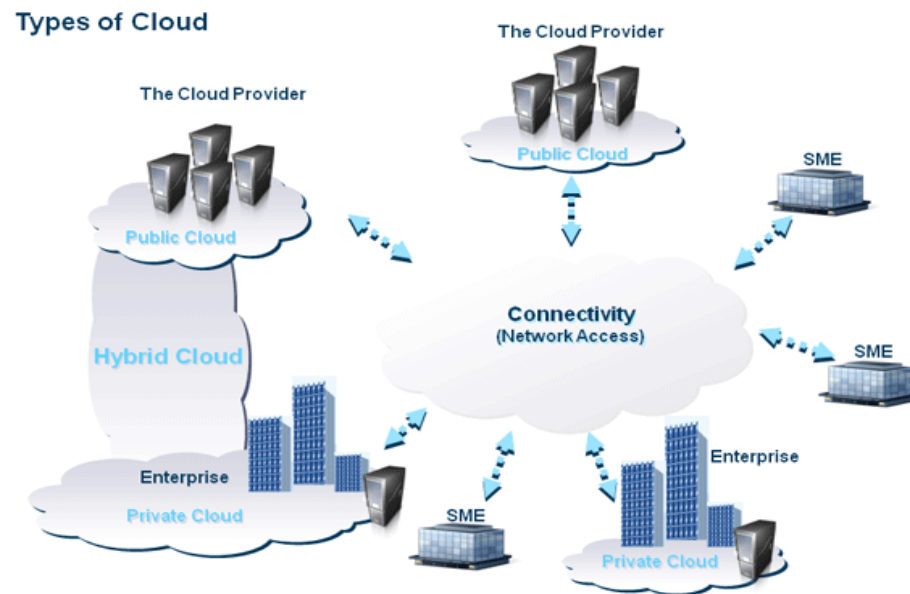# Topic 3: Introduction to Cloud Computing

- ## Public (external) cloud
  - **Open market for on demand computing and IT resources**
  - **Concerns: Limited SLA, reliability, availability, security, trust and confidence**
  - **Examples: IBM, Google, Amazon, …**

Types of Cloud

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- **Private (Internal) cloud**
  - **For enterprises/corporations with large scale IT**

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- **Hybrid cloud**
  - Extend the private cloud(s) by connecting it to other external cloud vendors to make use of their available cloud services

- **Cloud Burst**
  - Use the local cloud, and when you need more resources, burst into the public cloud