# Cloud Fundamentals

## Chapter 3
## Cloud Computing Service Models

## 4 IA

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# Lesson plan

1    Definition of service models

2    Characteristics of service models

3    Comparing service models

# Service Models

- A Cloud service model represents a specific pre-packaged combination of IT resources offered by a cloud provider.

- NIST has defined three Service Models
  - Infrastructure as a Service IaaS
  - Platform as a Service PaaS
  - Software as a Service SaaS

- Various publications and different industry groups has defined alternate cloud service models based on IaaS, PaaS and SaaS for a certain specialized cloud services and capabilities.

- They provide : **NaaS**(Network), **DaaS**(Desktop), **IDaaS**, **StaaS**(Storage) …etc.

- However, these models eventually belong to one of the three primary cloud service models.

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# Service Models
## Cloud Consumer

- The cloud service consumer is a temporary runtime role assumed by a software program when it accesses a cloud service.

- Common types of cloud service consumers can include software programs and services capable of remotely accessing cloud services.
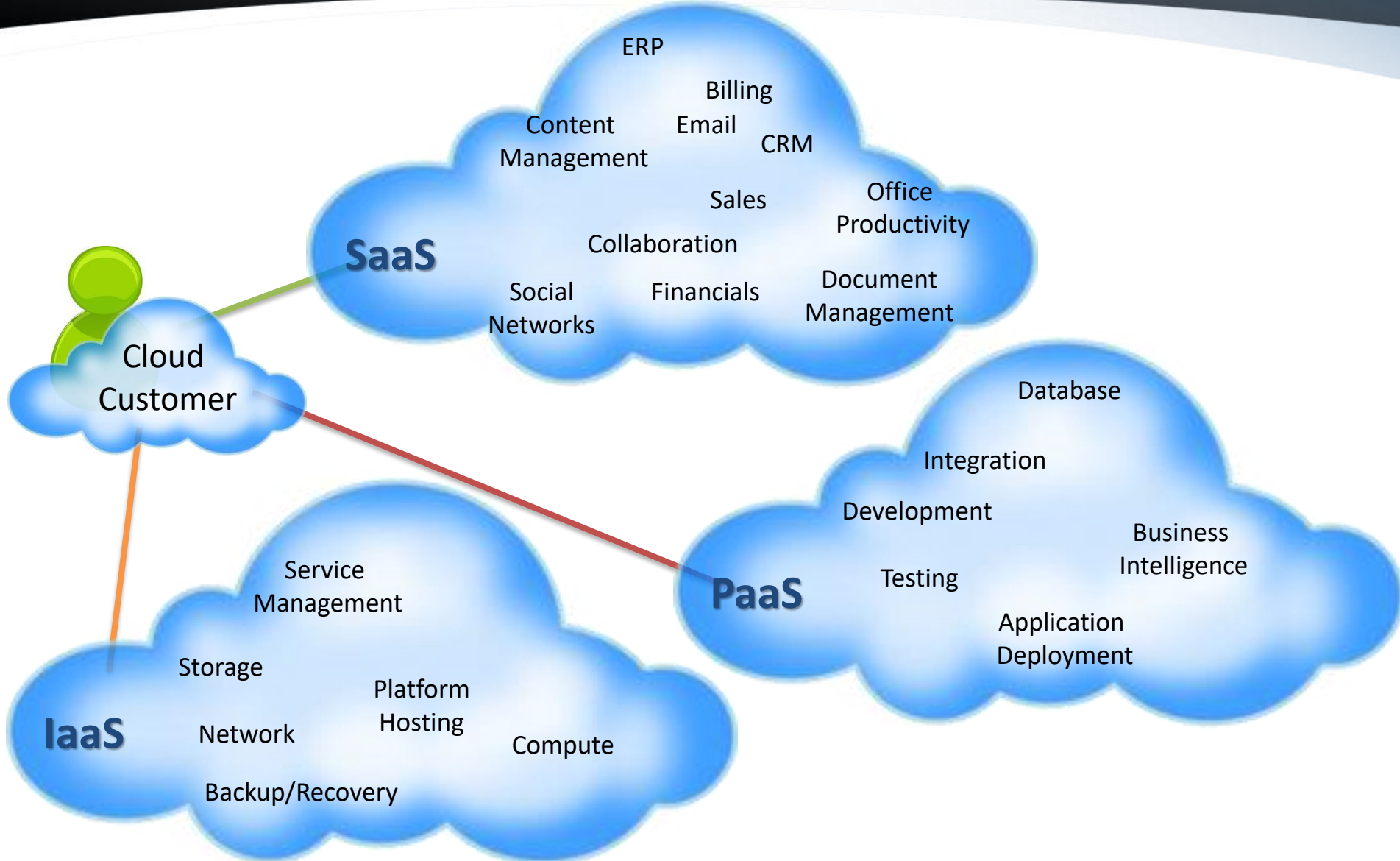
| software program | service | workstation | laptop | mobile device |

Service Models
Cloud Consumer

# Service Models
# Cloud Consumer

Organizations of any type, size, or industry use cloud computing. For example:
- Mobile apps companies
- Websites
- Large organizations with extended IT services
- Video streaming platforms Netflix, Hulu, youtube…
- Online video games
- Developers that need to work together in a shared environment



Mobile Apps

Large Organizations

Online Video Games

Websites

Video Streaming
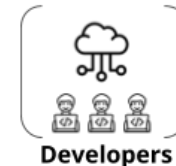
Developers

# Service Models
## Cloud Consumer

- IaaS
  - System, network and storage administrators
- PaaS
  - Application developers, testers and deployers
  - Application administrators
  - Application end users
- SaaS
  - Organizations providing  software applications to their members or employees
  - End users and software application administrators

# Service Models (1/3) - IaaS

- Consumer capabilities:
  - provision processing, storage, networks (and other fundamental computing resources)
  - ability to deploy and run arbitrary software ( can include operating systems and applications)

- Consumer management and control:
  - Not permitted at the underlying cloud infrastructure
  - Permitted over operating systems, storage, deployed applications
    - possibly limited control of select networking components (e.g., host firewalls).

# Service Models (2/3) - PaaS

- Consumer capabilities:
  - deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages and tools supported by the provider.

- Consumer management and control:
  - Not permitted at the underlying cloud infrastructure (network, servers, operating systems, or storage)
  - Permitted over the deployed applications
    - possibl⚠️pplication hosting environment configurations

# Service Models (3/3) - SaaS

- Consumer capabilities:
  - Make use of the applications and services offered on the cloud infrastructure.
    - Applications are accessible from various client devices (thin client interface or a program interface)

- Consumer is unable to manage or control the underlying cloud infrastructure:
  - network, servers, operating systems, storage and individual application
  - possible exception of limited user specific application configuration settings.

# Service models

- Control level in Service models



SaaS: web application

PaaS: application deployment

IaaS: virtualisation plateform

Applications

Runtimes

Middleware

O/S

Virtualisation

Serveurs

Stockage

Réseau
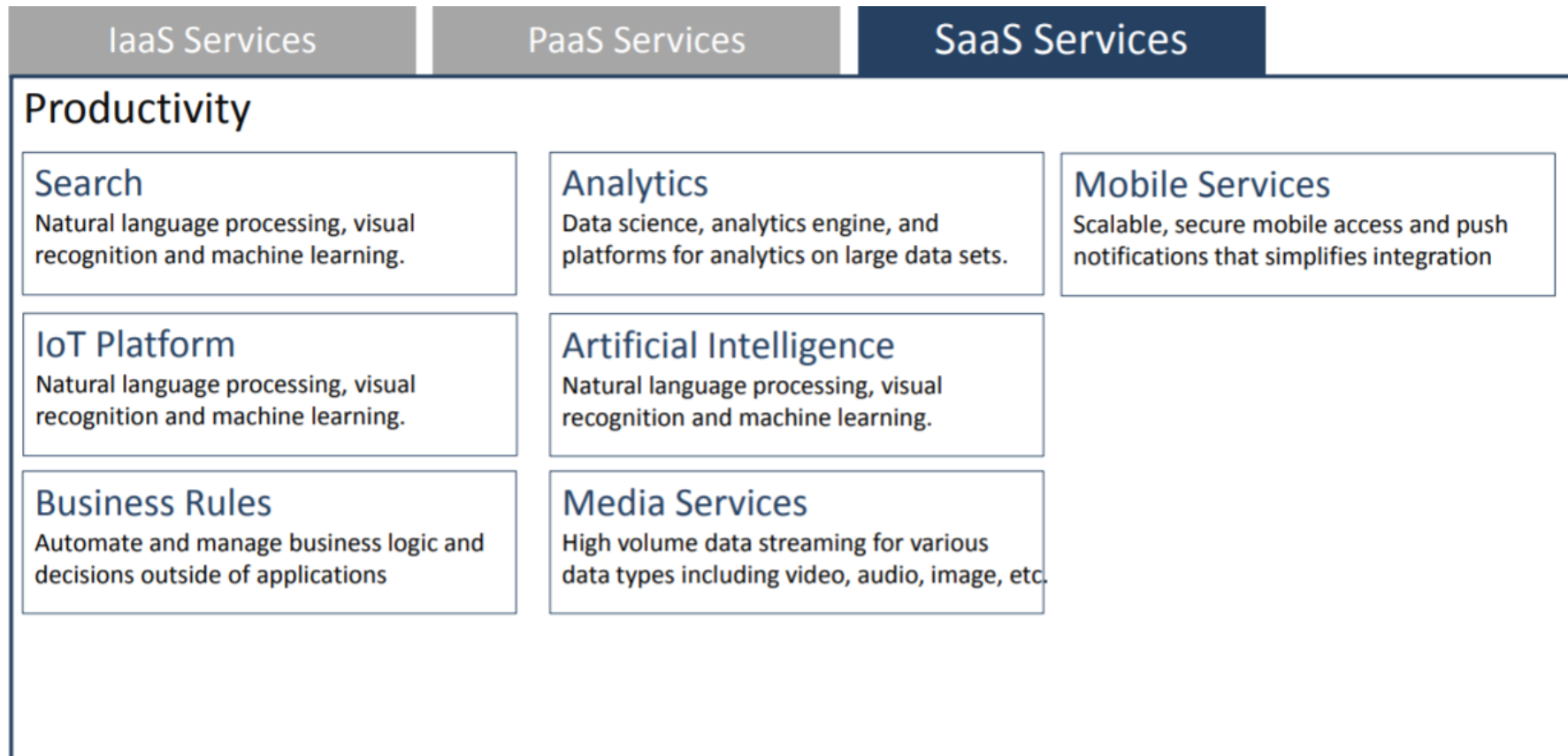
**Cloud Computing service models**

# Service models

| IaaS Services | PaaS Services | SaaS Services |
|---|---|---|

### Computing

**Servers**
High-performance cloud servers on hourly/monthly options

**Containers**
Orchestrate intelligent scheduling, self-healing and horizontal scaling

**Scaling**
Automatically grow or shrink cloud environment based on demand

**Functions / Executors**
Lets you run code without provisioning or managing servers.

### Networking

**Network Appliances**
Manage physical and virtual networks with routers, firewalls, VPN and load balancers

**Load Balancer**
Software-defined networking to manage traffic and distribute loads on each server

**Domain Name Service (DNS)**
Full service domain registration and administration

**Content Delivery Network(CDN)**
Decrease network latency by keeping data closer to users geography

### Storage

**Storage**
Flash-backed, durable, fast and flexible NFS-based storage

**Big Data Storage**
An unstructured data storage service designed for resiliency and security

# Service models



| IaaS Services | PaaS Services | SaaS Services |
|---|---|---|
| **Middleware** | **Security** | **DevOps** |
| **Operating Systems**<br>Open Source and enterprise Linux and Windows systems | **Identity and Access Mgmt.**<br>Manage user access and encryption keys | **Log Analysis**<br>Log collection and search that automatically collects application and services data |
| **Data Management**<br>SQL and NoSQL databases as well as information governance and migration tools | **SSL Certificates**<br>Encrypt data between the client and server applications | **Workload Scheduler**<br>Beyond cron, create workflows that run at specific times or on a regular or event basis |
| **Business Rules**<br>Automate and manage business logic and decisions outside of applications | **Hardware Security Module**<br>A physical device with key management and key storage | **CICD**<br>Provision toolchains, automate builds and tests and control quality with analytics |
| **Application Integration (APIs)**<br>Automate and manage business logic and decisions outside of applications | | **Cost Management**<br>Cost and usage data analysis to identify trends, cost drivers, & detect anomalies |

# Service models

| IaaS Services | PaaS Services | SaaS Services |
|---|---|---|

**Productivity**

**Search**
Natural language processing, visual recognition and machine learning.

**Analytics**
Data science, analytics engine, and platforms for analytics on large data sets.

**Mobile Services**
Scalable, secure mobile access and push notifications that simplifies integration

**IoT Platform**
Natural language processing, visual recognition and machine learning.

**Artificial Intelligence**
Natural language processing, visual recognition and machine learning.

**Business Rules**
Automate and manage business logic and decisions outside of applications

**Media Services**
High volume data streaming for various data types including video, audio, image, etc.

# Characteristics of IaaS

- Resources are distributed as a service

- Generally includes multiple users on a single piece of hardware

- Allows for dynamic scaling

-  Has a variable cost, utility pricing model

# Characteristics of IaaS

| Resource | Low Cost | High Cost |
|---|---|---|
| VM with local storage | $.015 per hour | $1.6 per hour |
| CPU hour | $.10 | $.96 |
| Data transfer into the cloud | $.08 per GB | $.10 per GB |
| Data transfer out of the cloud | $.10 per GB | $.22 per GB |
| Object data storage | $0.0 GET/HEAD/DELETE operations | $.01 per 1000 PUT/COPY/POST/LIST operations $.01 per 10,000 GET operations |
| Routable IP addresses | $.01 per hour when not in use (provider X) $.01 per hour if activated (provider Y) $.10 per address remap if excessive (provider X) | |

**Typical Cloud Resources and Billing Rates**

These values will continuously change as:
(1) the cost of hardware changes,
(2) hardware becomes more power efficient,
(3) the cost of utility power fluctuates,
(4) the cloud marketplace becomes more competitive.

# Characteristics of PaaS

- Web based user interface creation tools
- Multi-tenant architecture where multiple concurrent users utilize the same  development application.
- Builds on virtualization technology, so resources can easily be scaled up or down
- Usage fees calculated based on factors
  - Number and types of consumers (developers, tester, administrators …)
  - Time for which platform is in use

# Characteristics of PaaS

- The main functions/tools offered in such service by Cloud Service Providers (CSPs):

  - Runtime environments of multiple languages for application testing (for example, Python, Java)

  - A kit of software development tools (SDK)

  - An Administration Console for Cloud-Based App Management

  - A data storage, management and distribution repository ("data store")

# Characteristics of SaaS

- Accessible in a browser (sometimes even when the user is offline)

- Software delivered in a "one to many" model.

- Users not required to handle software upgrades and patches.

- Managed from a central location and hosted on a remote server

# Criteria for comparing cloud providers

- Vendor lock-in and Interoperability

- High availability
  - incident-reporting system
  - Backup solution

- Security and privacy
  - Access control
  - Integrity
  - Data location
  - Access via secured network
  - DDoS Protection Services

# Criteria for comparing cloud providers

- ## SLA & Support
  - Performance Guarantee
  - 24/7 Support
  - Minimum Outage Duration

- ## Supported Hosts /clients
  - Technologies, standards, …

- ## Supported deployment model
  - Public
  - Hybrid
  - Private
    - » Community

# Criteria for comparing cloud providers

- **Geographic Availability**
  - Cloud computing locations are worldwide. These locations called "regions" and "availability zones."
  - Each region is a separate geographic area. Within each region, there are multiple isolated locations known as availability zones.
  - This geographic spread provides the ability to place resources, such as compute and storage, closer to end-users for faster access and better performance.
  - The number of regions and the availability zones within them differs between cloud providers.
    - AWS has 18 regions and between 2-6 availability zones per region
    - GCP has 23 regions with at least 3 availability zones per region
    - Azure has 58 regions worldwide and is available in 140 countries all around the world
  - The geographic locations between each cloud providers are *different.*
    - One example is that currently the only cloud provider that can work in mainland China is AWS.
    - GCP offers a region in Hong Kong, but those resources are not always accessible from mainland China.

# Criteria for comparing cloud providers

**Pricing**

- The pricing models of the major cloud provides are similar:
  - On-demand, pay-as-you-go
  - Discounts for committed usage
  - Usage-based serverless resources
- On-demand pricing for the same compute (CPU-RAM-Disk) resources varies between cloud providers and is calculated on an hourly rate.
- Discounts also vary between cloud providers. For example,
  - AWS offers reserved instances that you can pre-purchase annually,
  - GCP offers "sustained use discount" whereby pricing goes down the more you use an instance.
- Serverless computing (Lambda on AWS, Functions on Azure, and Cloud Functions on GCP) are billed for the compute power you use, based on 100-millisecond increments.

# Workshop 2

- Each group will define and explain one of the deployment models:
    - Public, Private, Community, Hybrid.
- Each group should provide:
  - When we need to adopt the deployment model.
  - Which criteria are used to evaluate the choose of the model. (Elasticity, control level, cost, security,…)
  - Two or more success story.