10. CLOUD AND MOBILE TECHNOLOGIES

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10.1. Cloud Computing

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10.2. Mobile Cloud Computing

Learning Objectives

☐ Explain cloud computing in simple terms

☐ Describe infrastructure, platform and software

☐ Describe SaaS, PaaS, and IaaS

☐ List advantages and disadvantages of cloud computing

Cloud computing is…

- Internet-based computing

- Using web services for our computing needs

- Providing shared resources, software, and information to computers and other devices <u>on-demand through the Internet</u>.

Cloud computing provides…

- Software Applications
- Data storage
- Computing power
- Software platforms
- Virtual computers
- Virtualized infrastructure
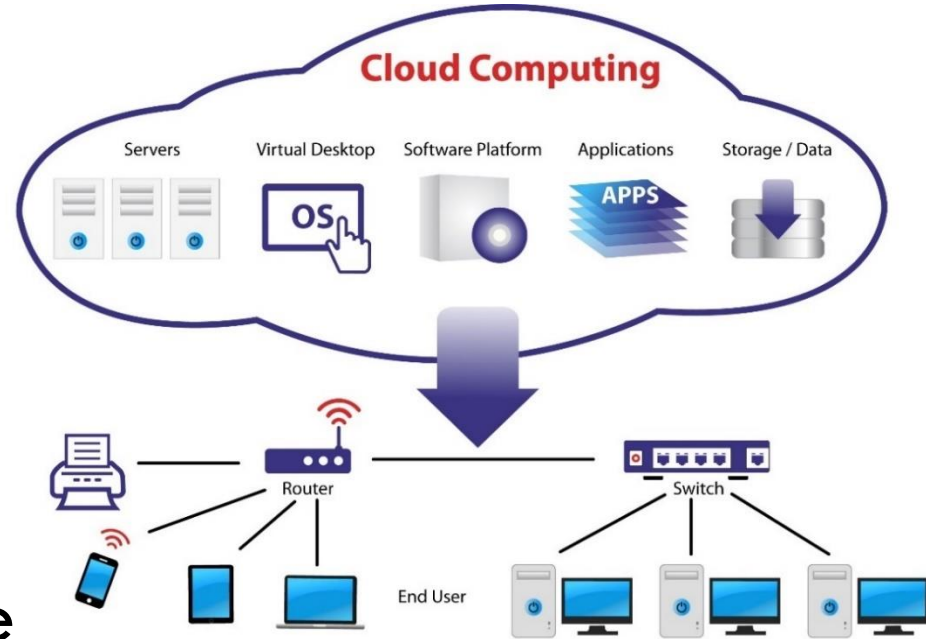
Cloud computing: Everyday usage

- Cloud computing is where computing will happen in the future

- However, you use it every day
  - Online email services (Gmail, Mail.ru, Yandex)
  - Online documents (Google Drive, OneDrive)
  - Online translation services
  - Video/audio streaming

Components

☐ Cloud computing has two main components
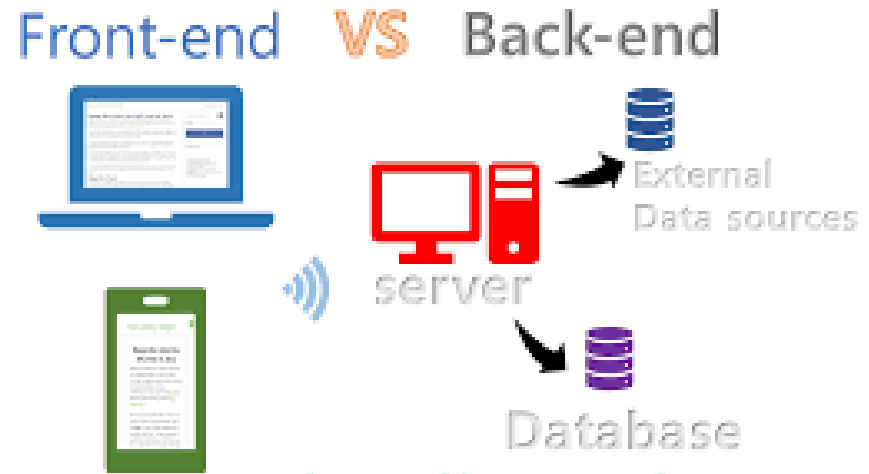
 ◻ Frontend

 ◻ Backend

Components: Frontend
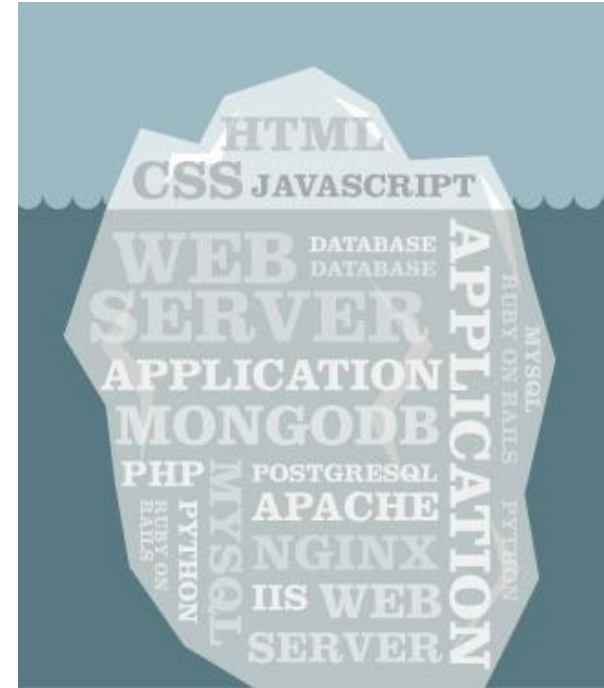
☐ The frontend of cloud computing is the part seen by the client (i.e., the computer user)

- ◘ Computing device
- ◘ Web browser
- ◘ Mobile application

Front-end VS Back-end

External Data sources

server

Database

Components: Backend

- The backend is the "cloud" itself
- Compromised of various computers, servers, and data storage devices
  - Web server
  - Databases
 - Storage devices

Cloud computing is a service

□ Services are not free

□ Someone always pays for the service

  ◘ For example, you pay your ISP for bandwidth to connect to the internet

□ What about "free" services?

□ Your pay by

  ◘ giving away your data

  ◘ viewing ads

□ What does Facebook get in return?

Cloud Computing Model (1)

- Cloud computing services are built on layers

- Each layer performs a specific function

- IaaS provides the foundation

END USERS — SaaS

APPLICATION DEVELOPERS — PaaS

NETWORK ARCHITECTS — IaaS
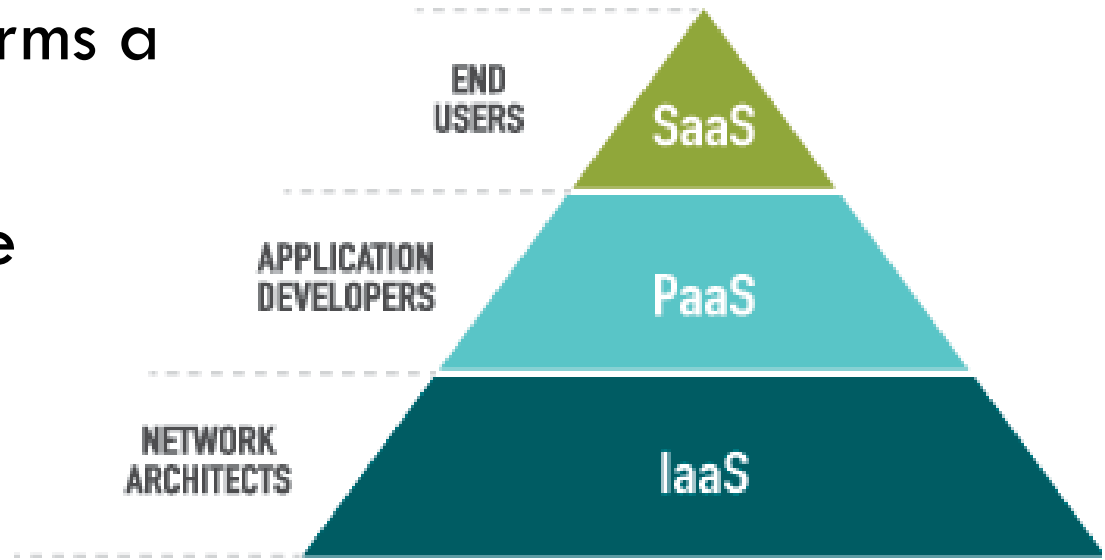
Cloud Computing Model (2)

- <u>Software</u> as a service (SaaS)
- <u>Platform</u> as a service (PaaS)
- <u>Infrastructure</u> as a service (IaaS)

The cloud!
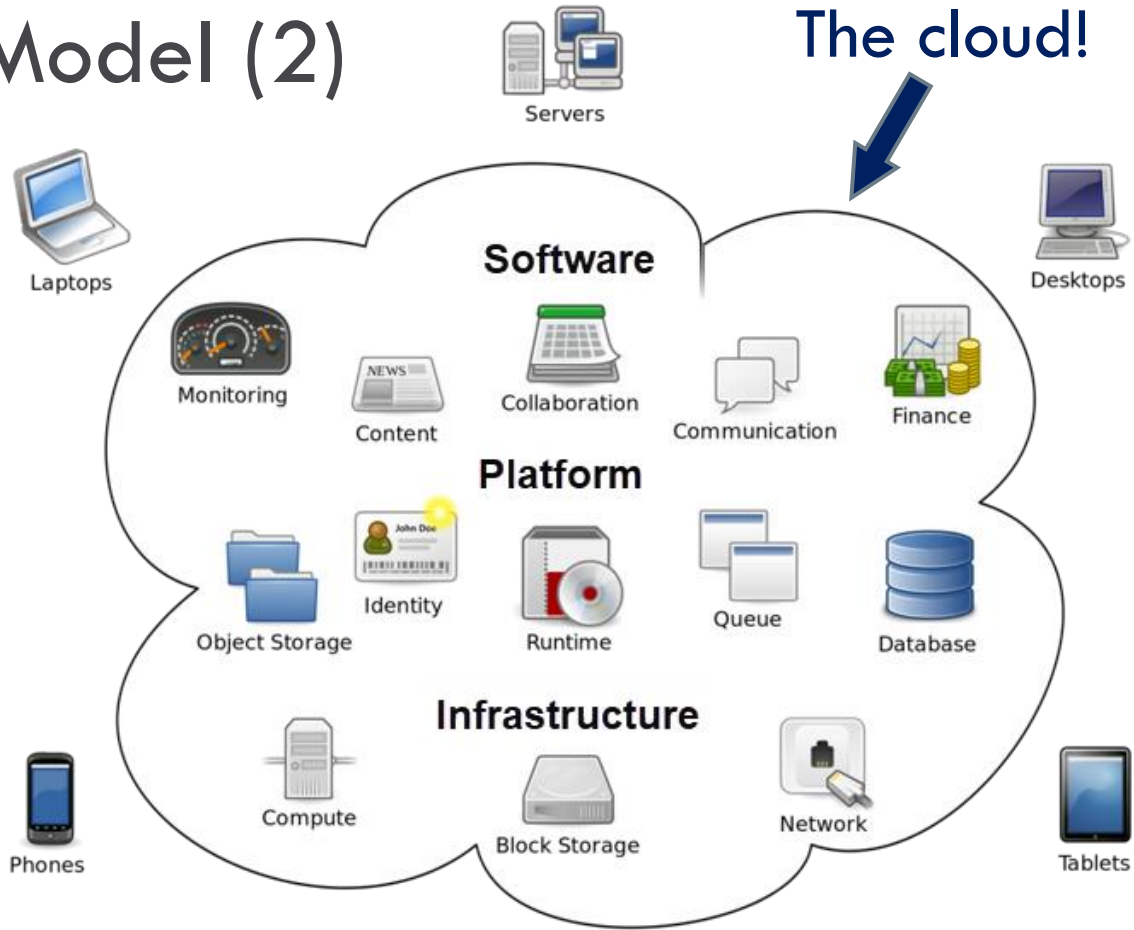
What is Infrastructure?

- The <u>essential physical</u> and <u>organizational structures</u> and facilities (e.g., buildings, roads, and power supplies) <u>needed for the operation of a society or enterprise</u>

Internet Infrastructure

- The **internet infrastructure** is composed of resources that support the flow, storage, processing, and analysis of data

Data Centers (1)

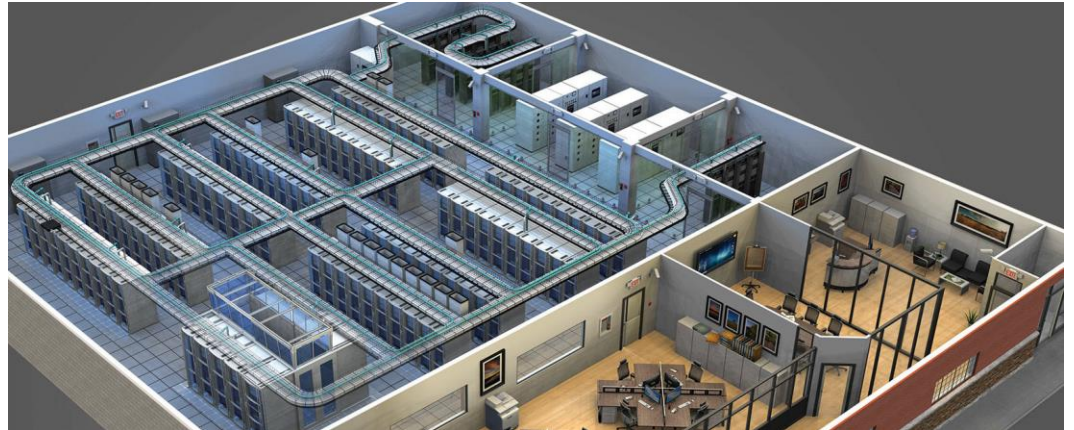- A data center is large group of networked servers for storing, processing, or distributing data.

Data Centers (2)

☐ It is a physical place that houses a computer network's most critical systems, including backup power supplies, air conditioning, and security applications.

Infrastructure as a Service (IaaS)

☐ Hardware **provided** by a service provider and **managed** for the service subscriber

☐ Physical or virtual

  ☐ Data centers

  ☐ Servers

  ☐ Storage devices

  ☐ Networking services
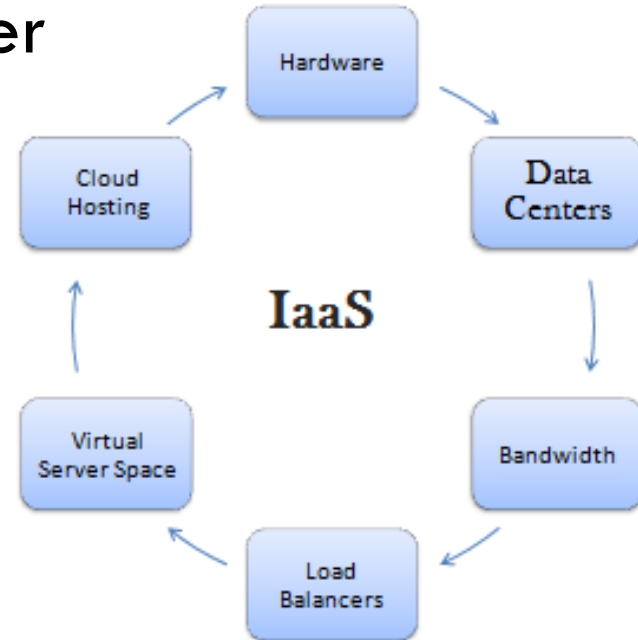
Who subscribes to or uses IaaS?

- Large companies who don't want to manage their own infrastructure
- VPN service providers
  - Primarily use networking services
- Developers who need aspects of an infrastructure
  - Scalable data storage and bandwidth
  - For example, hosting videos for a streaming service
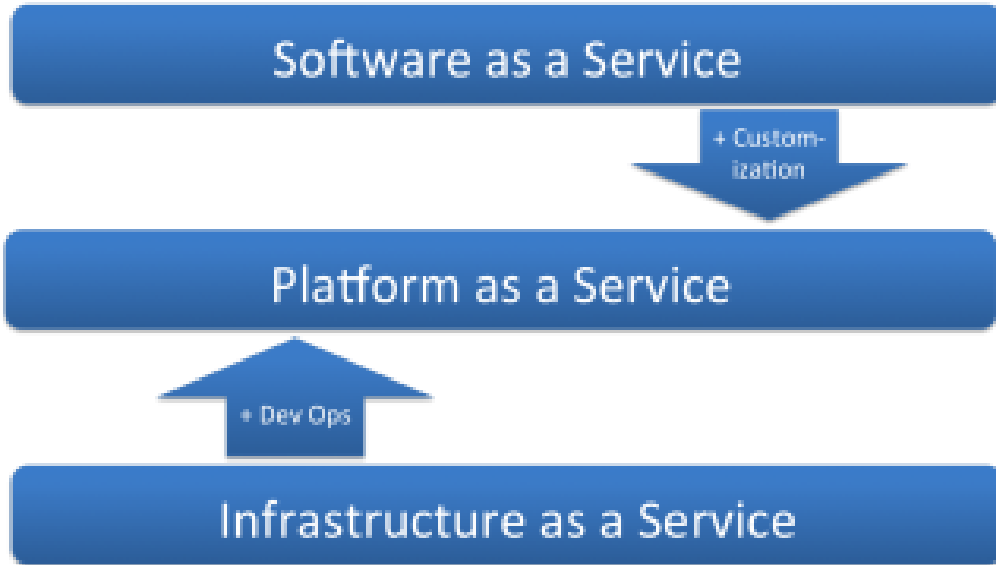
What is a computing platform?

- A **computing platform** is an environment in which a piece of software is executed

- It could be

  - The hardware, in the case of an embedded system

  - The operating system (OS) that hosts an application

  - An application, such as a web browser that runs web-based software

Platform as a Service (PaaS)

□ Used to host an application or service

Platform as a Service (PaaS)

□ Provides a **platform and environment** to allow developers so they can build applications and services over the internet

□ The developer does not manage or control the underlying cloud infrastructure but has control over the deployed applications

Who subscribes to or uses PaaS?

- Developers who create web-applications
  - Sell their services using SaaS
- Anyone who wants to host a web-application or internet service
  - Personal internet services, such as VPN (OpenVPN) or online backup (OwnCloud)
  - Web hosting using WordPress

Software as a service (SaaS)

- ☐ Applications that run on a server (web applications)

Software as a service (SaaS)

- Delivered as a service to the customer who can access the program from any online device
  - Eliminates the need to install and run the application on the customer's own computers
  - Simplifies maintenance and support

Who subscribes to or uses SaaS?

- □ You do!
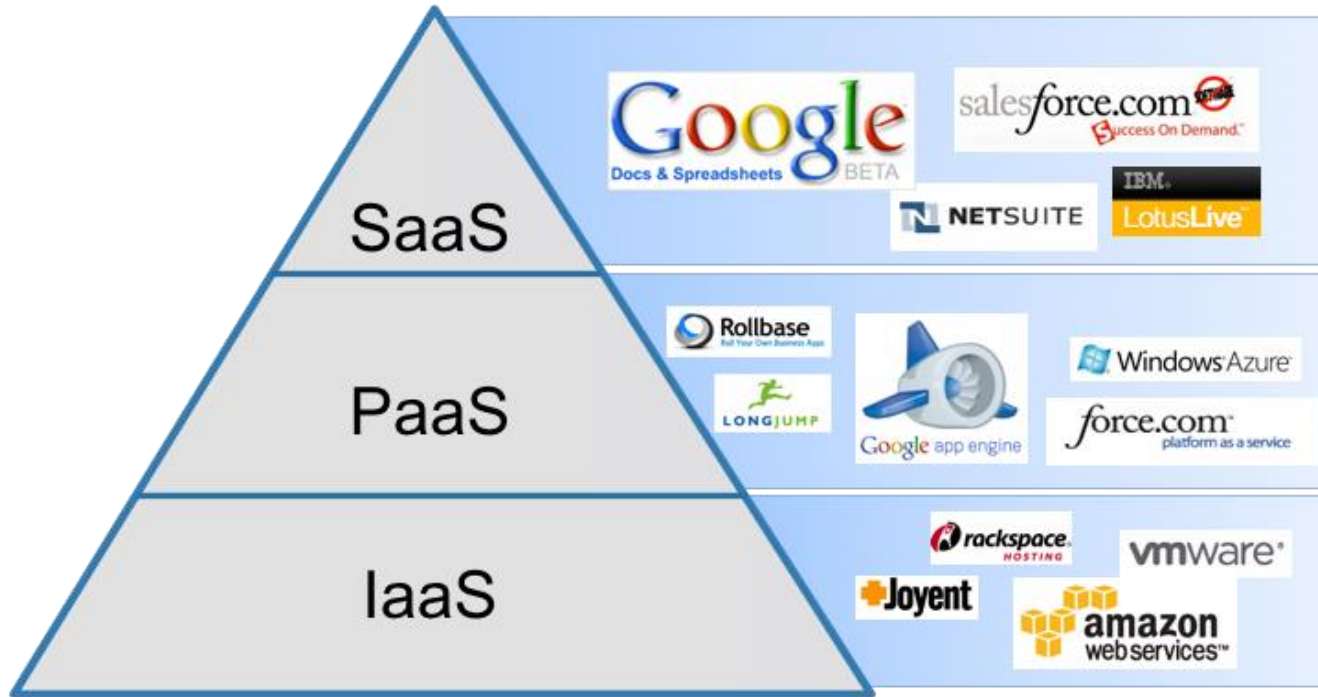
- □ Any end-user who uses a web application uses SaaS

Commercial Cloud Providers

Cloud Storage Services

- Dropbox
- Google Drive
- Yandex.Disk
- Облако@mail.ru
- iCloud and iCloud Drive
- OneDrive

Cloud Computing Characteristics

Common characteristics:

Scalability	**Resilient Computing**
Homogeneity	**Geographic Distribution**
Virtualization	**Service Orientation**
Low Cost Software	**Advanced Security**

Essential characteristics:

On-demand Self-Service

Broad Network Access	**Rapid Elasticity**
Resource Pooling	**Measured Service**

Deployment Models

- Private cloud
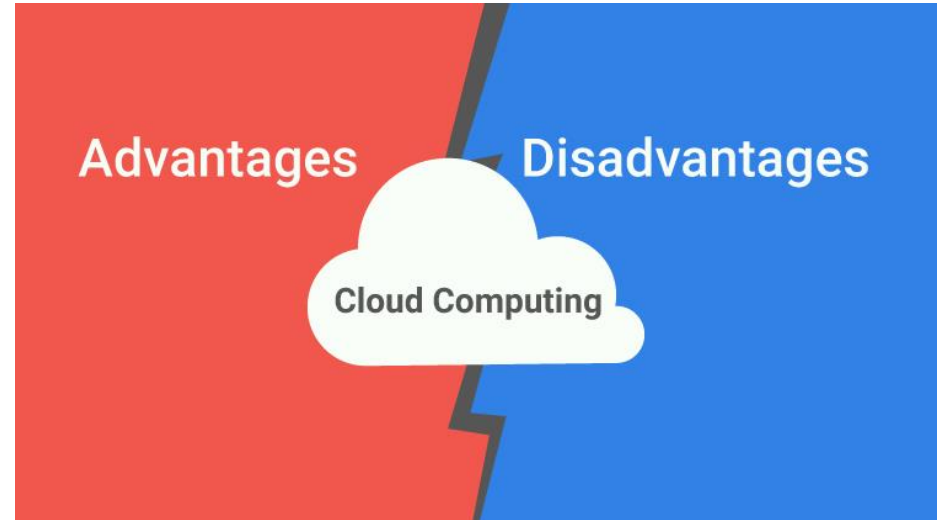- Community cloud
- Public cloud
- Hybrid cloud

Private Cloud

Community Cloud

Public Cloud
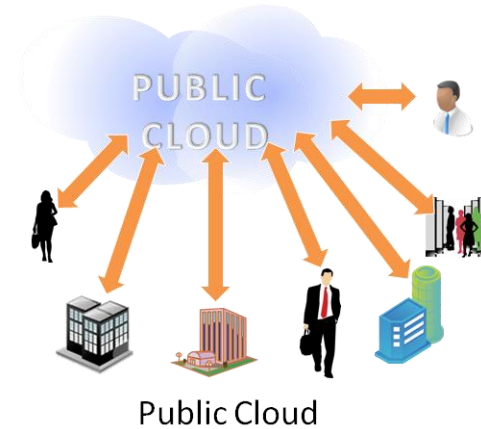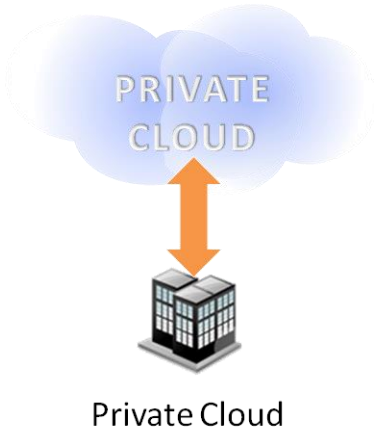
Advantages and Disadvantages

☐ What might be some of the advantages or disadvantages of cloud computing?

Advantages of Cloud Computing (1)

- Lower computer costs

- Improved performance

- Reduced software cost

- Instant software updates

- Unlimited storage capacity
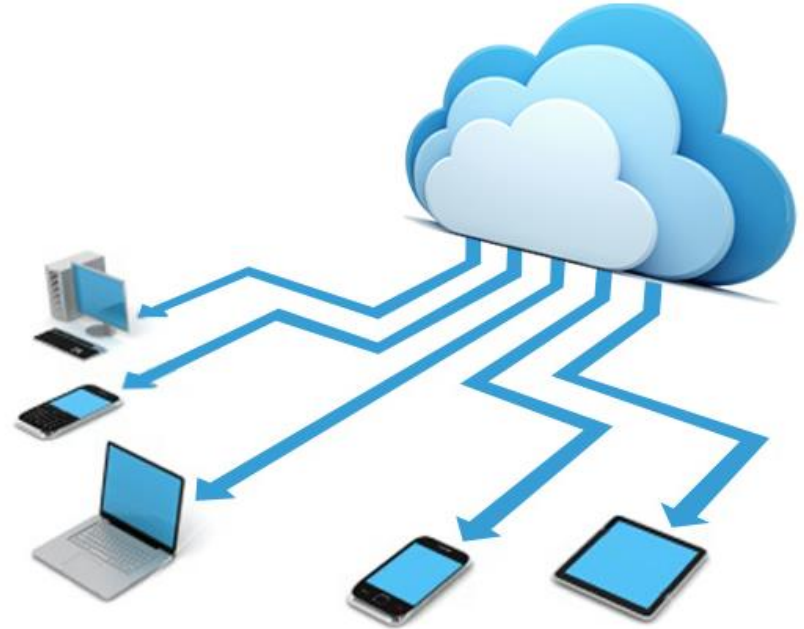
Advantages of Cloud Computing (2)

- Increased data reliability
- Universal document access
- Device independence
- Easier group collaboration

Disadvantages of Cloud Computing

- ☐ Requires an Internet connection

- ☐ Does not work well with low-speed connections

- ☐ Features might be limit

- ☐ Stored data might not be secure

Cloud computing Summary

- Cloud computing is internet-based computing
- IaaS provides and manages the hardware
- PaaS hosts an application or service
- SaaS runs software in the cloud
- Advantages: cost effective, data protection, device independent, and improved collaboration
- Disadvantages: requires internet connection, limited features, and security

10.2. Mobile Cloud Computing

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Learning Objectives

☐ Define mobile technology

☐ Explain how mobile devices communicate

☐ Explain mobile cloud computing (MCC)

☐ Describe advantages of MCC

☐ Describe disadvantages of MCC

Mobile Technologies

□ **Mobile technology** is exactly what the name implies - technology that is portable and can communicate

□ Examples of mobile devices include

   ▪ laptops and tablets

   ▪ mobile phones and smartphones,

   ▪ global positioning system (GPS) devices,

   ▪ wireless debit/credit card payment terminals

Mobile Technology Communication

☐ Mobile devices can be communicate in a variety of ways:

- ☐ Wireless fidelity (WiFi) – connects to a LAN
- ☐ Bluetooth – connects two mobile devices
- ☐ Cellular technologies
  - ◾ Modern: 3G, H+, 4G
  - ◾ Older: GSM, GPRS, Edge

Essential to our lives

- Mobile devices have become an essential part of human life.
- We rely on
  - Having access to information at our fingertips anywhere, anytime
  - On-demand communication

Mobile Cloud Computing (MCC)

□ Mobile Cloud Computing (MCC) is the combination of <u>cloud computing</u>, <u>mobile computing</u>, and <u>wireless networks</u>

□ MCC uses cloud computing to deliver cloud services to mobile devices

Mobile Cloud Computing (MCC)

□ MCC is nothing new or different from how you currently use your mobile devices

□ Many of you are mobile-first users (you are more comfortable using a mobile device than a computer)

□ The point is to understand the technology from a mobile perspective

Mobile and Cloud Comparison

Mobile characteristics	Cloud characteristics
☐ Ubiquitous and distributed	☐ Centralized
☐ Portability of physical devices	☐ Portability of software
☐ Limited storage	☐ Scalable storage
☐ Limited processing power	☐ Scalable processing power
☐ Limited bandwidth	☐ Scalable bandwidth
☐ Context-aware	☐ Context unaware

Network Division

Cloud computing

Mobile Network

Internet (Cloud)

Application (SaaS)
Software | Data | Information

Platform (PaaS)
Business | Support | Development

Infrastructure (IaaS)
Server | Database | Storage | Systems

Cloud Computing

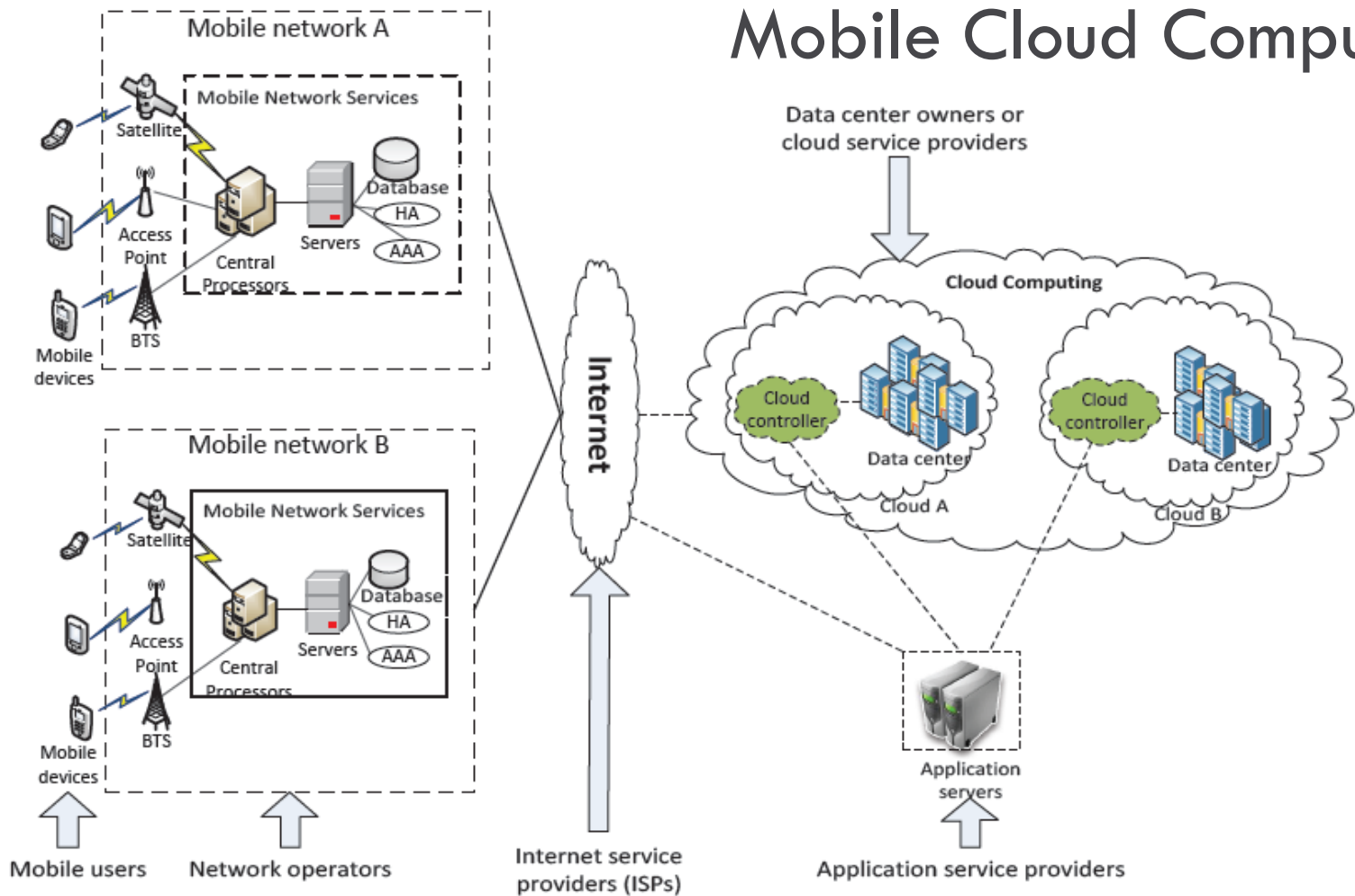Mobile Computing

Wireless Access Point
Radio Antenna/Transmission Tower

3G/WIFI/GPRS

Mobile Devices
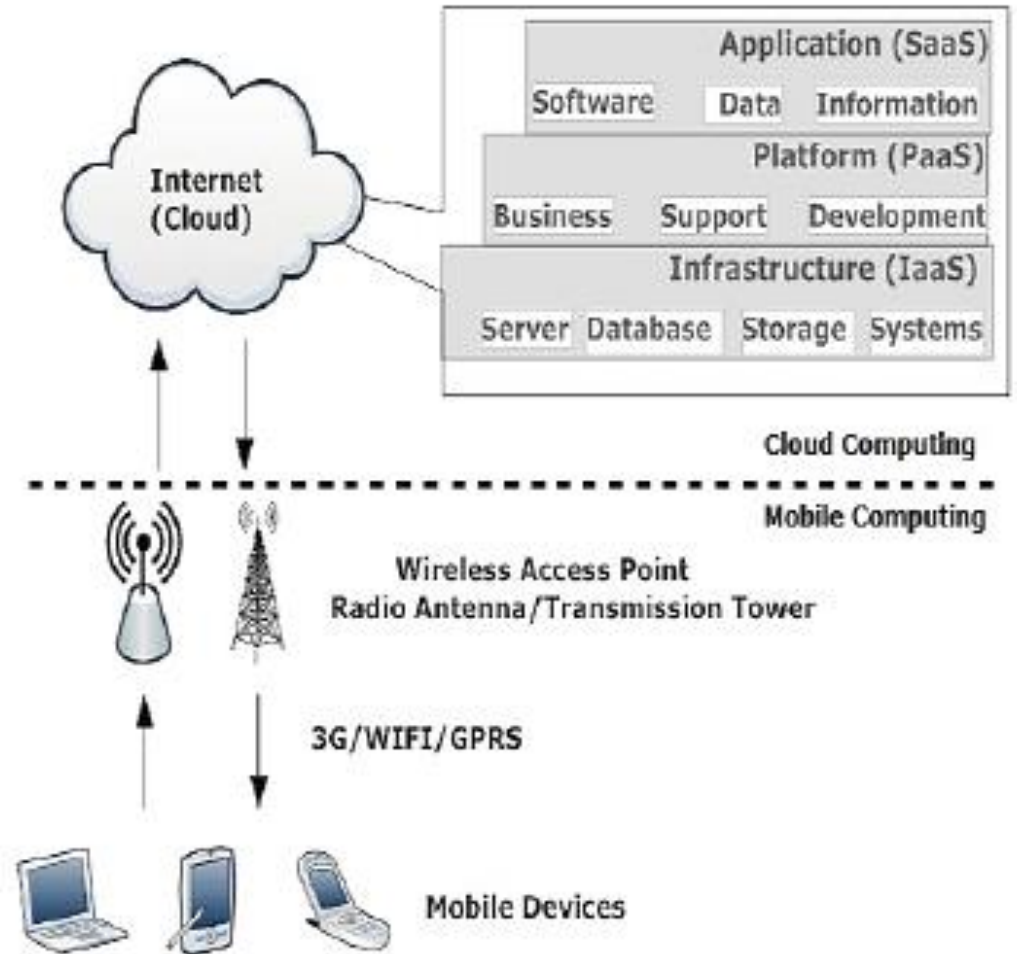
Mobile Cloud Computing

Advantages of MCC

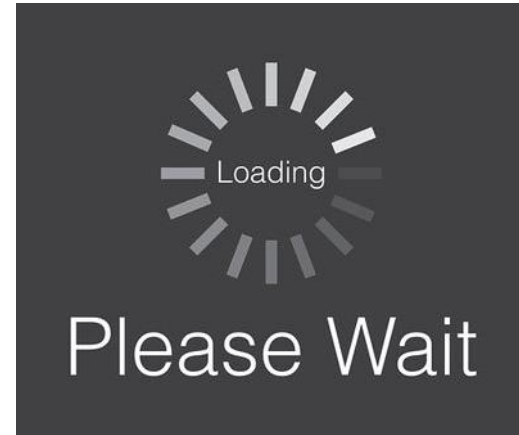- Extending battery lifetime
- Improving data storage capacity and processing power
- Improving reliability

Issues of Mobile Communication

- Network latency and limited bandwidth

- Network Availability

- Security risks

signal loss · signal weak · signal OK · signal strong

Loading Please Wait

Issues (1): Network Availability

□ Mobile users may not be able to connect to the cloud to obtain service due to

- ◘ traffic congestion
- ◘ network failures
- ◘ out-of-signal
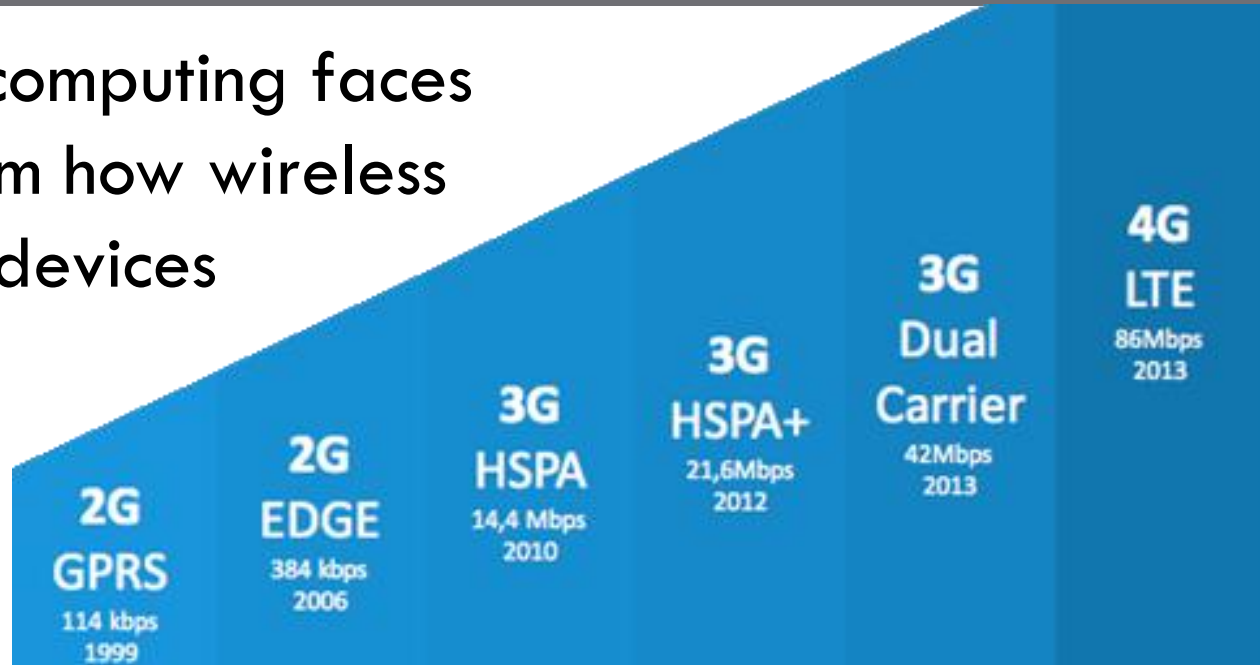
Full Signal   No Signal

OK Signal   Weak Signal
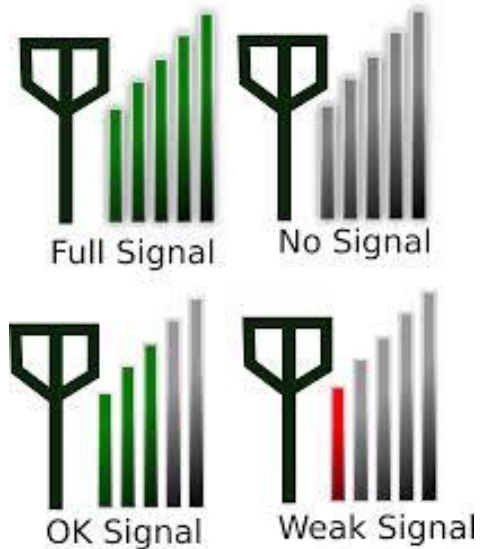
Issues (2): Network Limitations

- Mobile cloud computing faces challenges from how wireless networks and devices operate

Issues (3): Security Risks

- Security for mobile users
  - Security for mobile applications
  - Privacy
- Security of data in the cloud
  - Authentication

MCC Growth

- MCC continues to grow in popularity due to many factors, which include:
  - A focus on mobile technologies
    - Mobile-first websites
    - Mobile apps based on cloud data
  - Better smartphones
    - faster, lighter, longer battery life, more efficient to use
  - Enhanced mobile coverage and speeds

Mobile Cloud Computing Summary

- Mobile technology is technology that is portable
- Mobile devices communicate using WiFi, Bluetooth, or cellular technologies
- Mobile Cloud Computing (MCC) is the combination of cloud computing and mobile computing
- MCC advantages include saving battery consumption, processing power, and storage space
- MCC disadvantages include limited bandwidth, network availability, and security risks

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