Could Computing, ITNT404

Lecturer: Dr. Omar Abusada

E-mail: omar.abusaeeda@uot.edu.ly

Mobile Cloud Computing (MCC)

What is Mobile Cloud Computing?

- **Mobile Cloud Computing (MCC)** refers to an infrastructure where both the **data storage** and **data processing** *happen* outside of the mobile device.

- Mobile cloud applications move the computing power and data storage away from the mobile devices and into powerful and centralized computing platforms located in clouds.

- Data is then accessed over the wireless connection.

- **MOBILE CLOUD COMPUTING = MOBILE COMPUTING + CLOUD COMPUTING**

Dr. Omar Abusada

What is Mobile Cloud Computing?

- MCC is a combination of **cloud technology**, **mobile computing** and **wireless networks**.

- MCC at simplest refers to infrastructure where **data storage** and **process happen outside** of the **mobile device**.

Dr. Omar Abusada

Why is Mobile Cloud Computing?

- Mobile devices face many **resource challenges** (battery life, storage, bandwidth, CPU speed.. etc.)

- Cloud computing offers advantages to users by allowing them to use infrastructure, platforms and software by cloud providers at **low cost** and elastically in an **on-demand** fashion **(PAYG)**.

- Mobile cloud computing provides mobile users with data storage and processing services in clouds, **avoiding the need to have** a powerful device configuration (e.g. CPU speed, memory capacity etc), as all resource-intensive computing can be performed in the cloud.

Dr. Omar Abusada

MCC Architecture

- Mobile devices are connected to the mobile networks via base stations that establish and control the connections and functional interfaces between the networks and mobile devices.

- Mobile users' requests and information are transmitted to the central processors that are connected to servers providing mobile network services.

- The subscribers' requests are delivered to a cloud through the Internet.

- In the cloud, cloud controllers process the requests to provide mobile users with the corresponding cloud services.

Dr. Omar Abusada

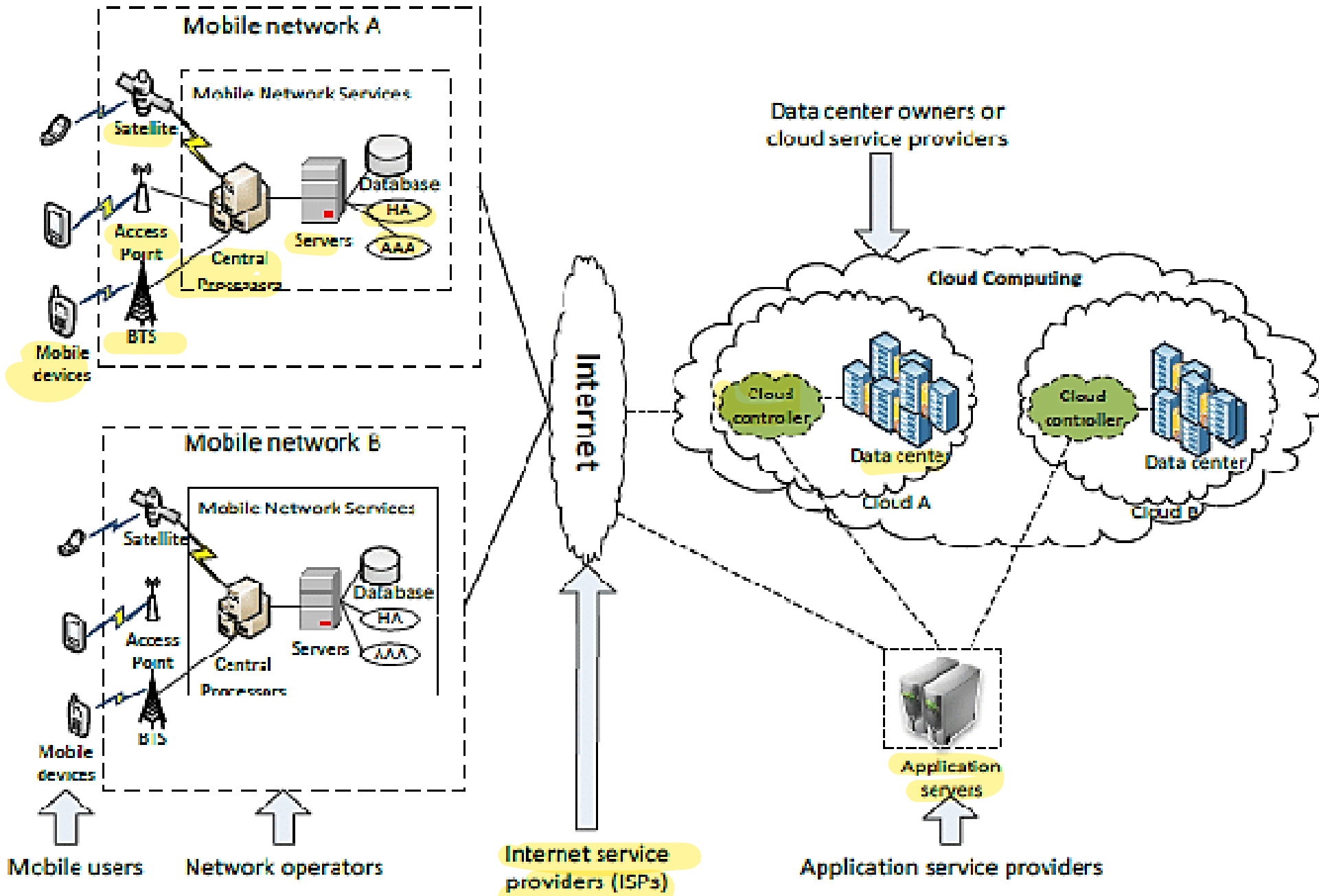# MCC Architecture

Dr. Omar **Abusada**
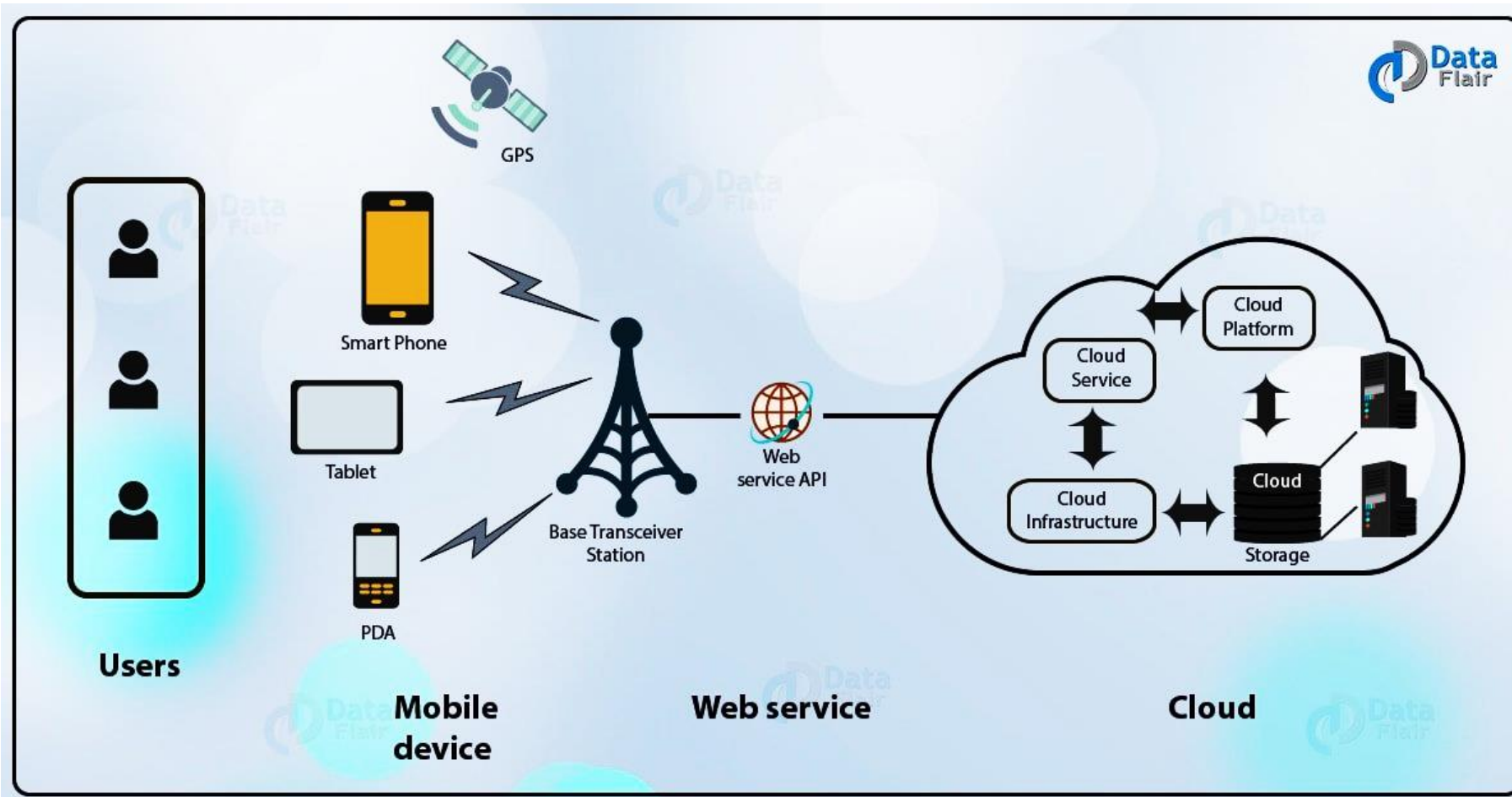
MCC Architecture

- HA, home agent provides the IP of any mobile device connected to the network.

- Authentication, Authorization, and Accounting (AAA) is a security management framework for network access control.
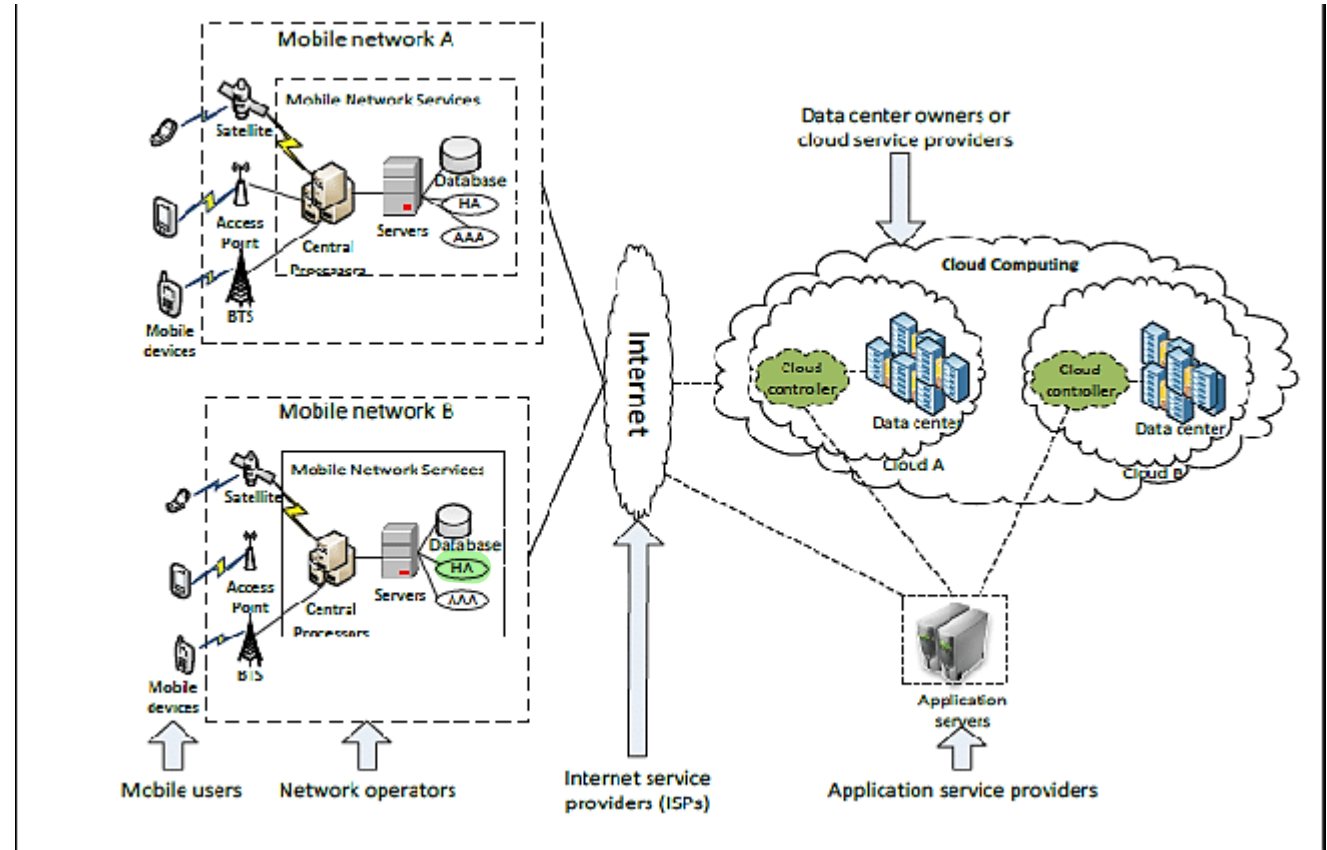
Mobile Network operator

Dr. Omar Abusada

Advantages of MCC

Extending battery lifetime:

- Computation offloading large computations and complex processing from resource-limited devices (i.e., mobile devices) to resourceful machines (i.e., servers in clouds).

- Remote application execution can save energy significantly.

- Many mobile applications take advantages from task migration and remote processing.

Dr. Omar Abusada

Advantages of MCC

Improving data storage capacity and processing power:

- MCC enables mobile users to store/access large data on the cloud.

- MCC helps reduce the running cost for computation intensive applications.

- Mobile applications are not **controlled by storage capacity** on the devices because their data now is stored on the cloud.

Dr. Omar Abusada

Advantages of MCC

Improving reliability and availability:

- Keeping data and application in the clouds reduces the chance of **lost on the mobile devices**.

- MCC can be designed as a comprehensive data security model for both service providers and users:
  - Protect copyrighted digital contents in clouds.
  - Provide security services such as virus scanning, malicious code detection, authentication for mobile users.

- With data and services in the clouds, then are always(almost) available even when the users are moving.

Dr. Omar Abusada

Advantages of MCC

Dynamic provisioning:

- Dynamic on-demand provisioning of resources on a fine-grained, self-service basis

- No need for advanced reservation

Scalability:

- Mobile applications can be performed and scaled to meet the unpredictable user demands.

- Service providers can easily add and expand a service.

Dr. Omar Abusada

Advantages of MCC

- Service providers can **share the resources and costs to support a variety of applications and large No. of users**.

مشاركة متنوعة عن التطبيقات مستخدمين

Ease of Integration:

- Multiple services from **different providers** can be integrated easily through the cloud and the Internet to meet the users' demands.

ITNT404

Dr. Omar Abusada

MCC Applications

Mobile Commerce

- The term mobile commerce was originally coined in **1997 by Kevin Duffey**, to mean:

"**the delivery of electronic commerce capabilities directly into the consumer's hand, anywhere, via wireless technology**"

How about if Mobile Commerce is integrated with Cloud Services?

Dr. Omar Abusada

MCC Applications

Mobile Commerce

- **M-commerce** allows business models for commerce using mobile devices.

- M-commerce applications face various challenges (low bandwidth, high complexity of devices, security, …)

- Integrated with cloud can help address these issues

- Example: Combining **4G** and **cloud** to increase **data processing speed** and **security level**.

Dr. Omar Abusada

MCC Applications

Mobile Learning

- M-learning combines **e-learning** and **mobility**

- Traditional m-learning has limitations:
  - High cost of devices/network,
  - Low transmission rate,
  - Limited educational resources

- Cloud-based m-learning can solve these limitations

Dr. Omar Abusada

MCC Applications

Mobile Learning

- Enhanced communication quality between **students** and **teachers**

- Help learners access remote **learning resources**

- A natural **environment for collaborative learning.**

Mobility of Learner

Mobile Learning

Mobility of Learning

Mobility of Technology

Dr. Omar Abusada
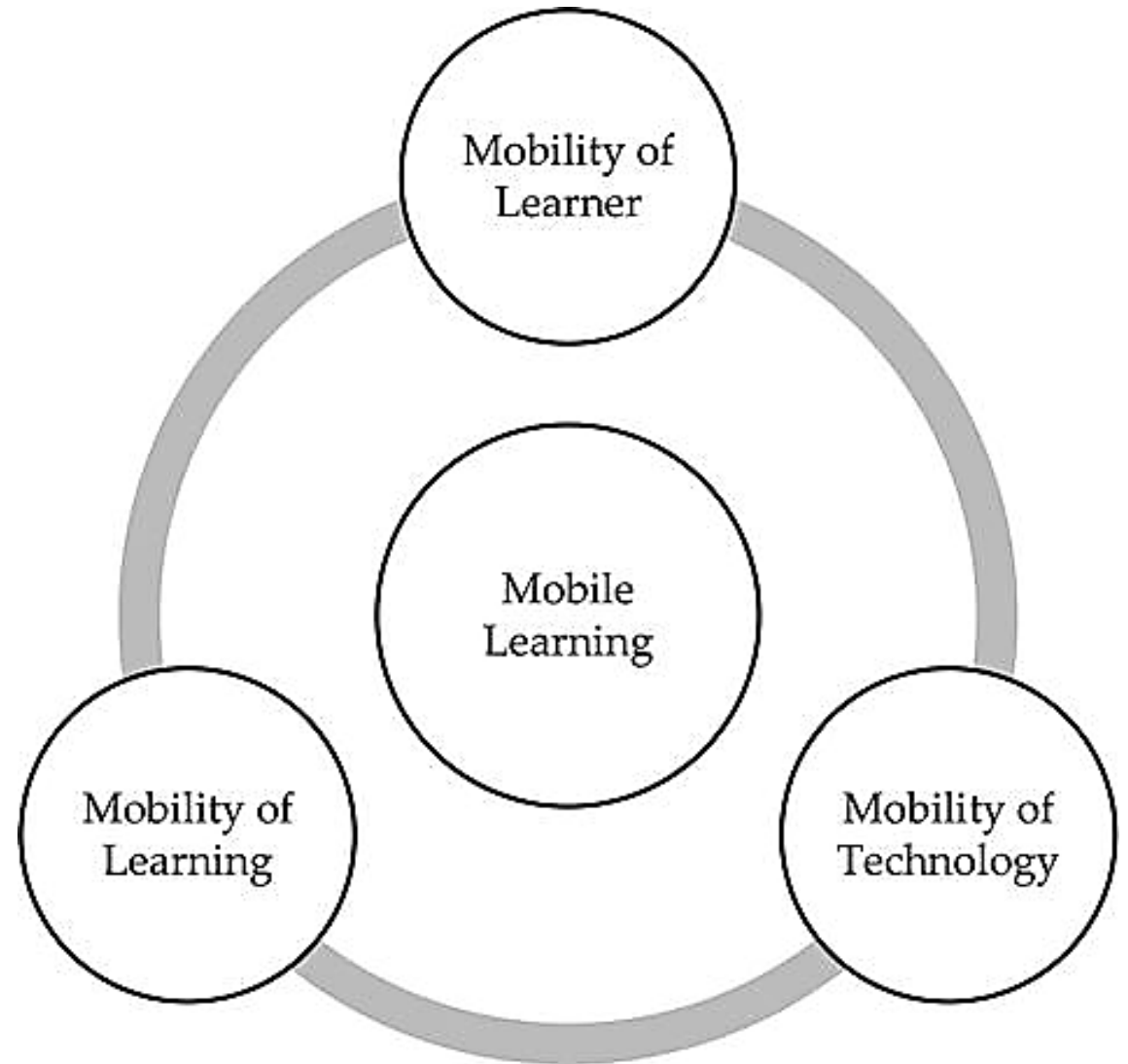
MCC Applications

Mobile Healthcare

- M-healthcare is to minimize the limitations of traditional medical treatment (eg. Small storage, security/privacy, medical errors, …)

- M-healthcare provides mobile users with convenient access to resources (eg. medical records).

Dr. Omar Abusada

MCC Applications

Mobile Healthcare

M-healthcare offers hospitals and healthcare organizations a variety of on-demand services on clouds

Dr. Omar Abusada
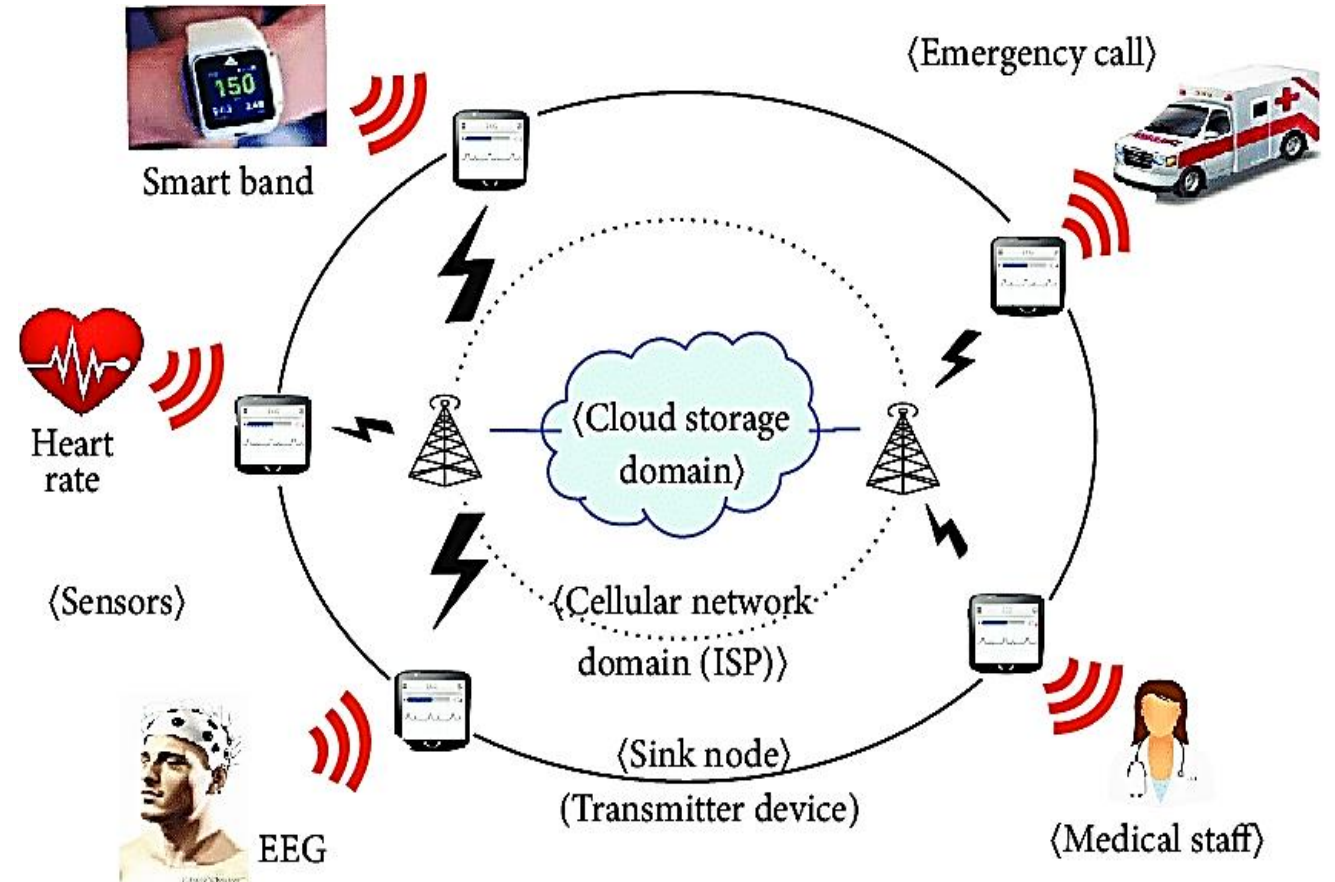
MCC Applications

Examples on Mobile Healthcare

- **Examples**:

  - Comprehensive health monitoring services

  - Intelligent emergency management system

  - Health-aware mobile devices (detect pulse-rate, blood pressure, level of alcohol etc)

  - Extensive access to healthcare information

  - Extensive lifestyle incentive management (to **manage healthcare expenses**)

Dr. Omar Abusada

MCC Applications

Mobile Gaming

- M-game is a high **potential market generating incomes** for service providers.

- Can completely **offload** game engine requiring large computing resource (e.g., **graphic rendering**) to the **server in the cloud.**

- **Offloading** can also **save energy** and **increase game playing time**

- A lot of adaptation technique can dynamically adjust the game rendering parameters based on communication restrictions and gamers' demands.

Dr. Omar Abusada

MCC Applications

Other applications

- Sharing photos/videos

- Keyword-based, voice-based, tag-based searching

- Monitoring a house, smart home systems

  - Heating system

  - Air-conditioning

  - Refrigerator

  - Alarm system

Dr. Omar Abusada

MCC Issues

Mobile communication issues

- **Low bandwidth:** One of the biggest issues, because the radio resource for wireless networks is much more scarce than wired networks.

- **Service availability:** Mobile users **may not be able to connect to the cloud** to obtain a service due to **traffic congestion**, **network failures**, **mobile signal strength problems**

- **Heterogeneity:** Handling wireless connectivity with highly heterogeneous networks to satisfy MCC requirements (**always-on connectivity, on-demand scalability, energy efficiency**) is a difficult problem.

Dr. Omar Abusada

MCC Issues

Computing issues

Computation offloading:

- One of the main features of MCC

- Offloading is not always effective in saving energy

- It is critical to determine whether to offload and which **portions of the service codes to offload.**

Dr. Omar Abusada

MCC Issues

Computational offloading is a cloud computing technique that is used to run programs and provide content when there is a computing-powered-restricted environment .

Complex tasks require higher computing power. If the target device has insufficient computing power, the QoS of the provided contents/programs decreases.

Dr. Omar Abusada
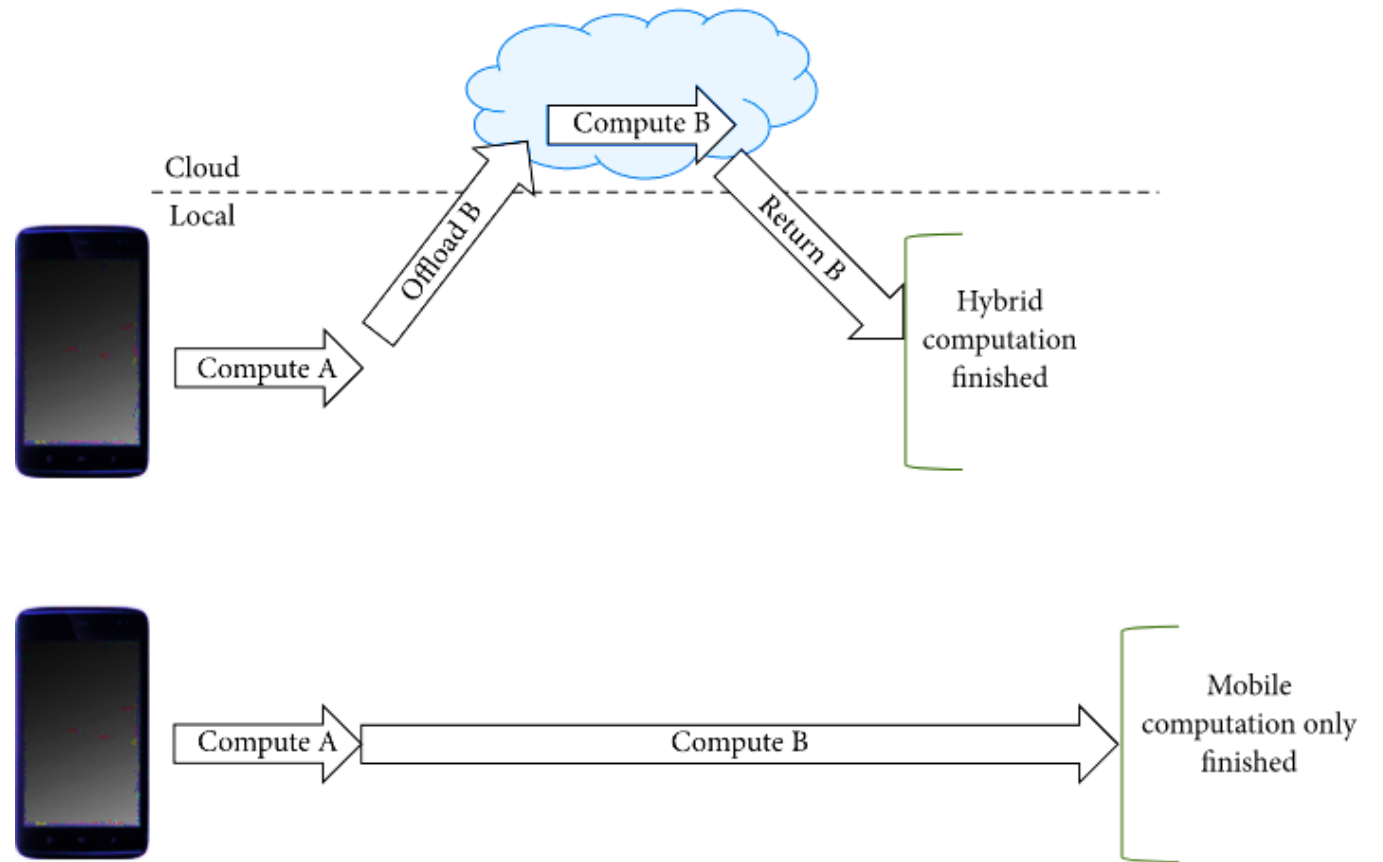
MCC Security Issues

- Protecting user **privacy** and **data/application** secrecy from adversaries is key to establish and **maintain consumers' trust in the mobile platform**, especially in MCC.

- **MCC security issues have two main categories:**

  - **Security for mobile users**

  - **Securing data on clouds (Cloud Service Provider)**

Dr. Omar Abusada

Security for Mobile Users

- Mobile devices are exposed to numerous security threats like **malicious codes** and their **dependence**.

- **Security for mobile applications:**

  - Installing and running security software are the simplest ways to detect security threats.

  - Mobile devices are resource constrained, protecting them from the threats is always a big concern.

Dr. Omar Abusada

MCC Security Issues

- **Securing data on clouds (Cloud Service Provider)**

ITNT404   Dr. Omar Abusada
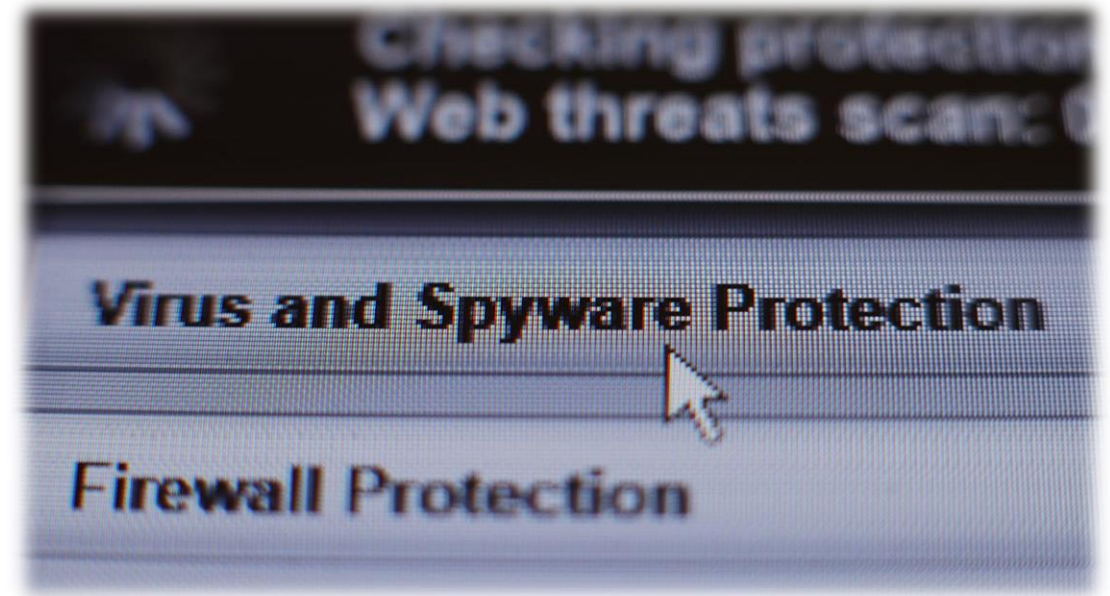
Mobile User Security Approaches

- **Oberheide** et al. present an approach to move the threat detection capabilities to clouds.

- An extension of the **CloudAV** platform consisting of:

  - Host agent.

  - Network service components.

- Host agent runs on mobile devices to inspect the file activity on a system.

- If an identified file is not available in a cache of previous analyzed files, this file will be sent to the **incloud** network service for verification.

- **J. Oberheide, K. Veeraraghavan, E. Cooke, J. Flinn, and F. Jahanian**. "Virtualized in-cloud security services for mobile devices," in Proc 1st Workshop on Virtualization in Mobile Computing (MobiVirt), pp. 31-35, June 2008.

Dr. Omar Abusada

Mobile User Security Approaches

- The term **"CloudAV"** refers to the ability of a product to automatically perform scans on the cloud.

- **CloudAV** is an anti-virus program that runs as an Internet service and facilitates the use of multiple anti-virus programs **without running on a local machine** and impacting performance. **CloudAV** is proven effective against the majority of virus and malware.

Mobile User Security Approaches

- Developed at the University of Michigan, **CloudAV** uses the following components to produce a high-quality anti-virus system in the cloud, in which a network service with **10 anti-virus engines**.

- **CloudAV** uses a technique known as **N-version protection**, which uses multiple versions of the same anti-virus detection engines to identify malicious software.

- This protection mechanism scans received files before they are opened by a user.

- checking the system against a continuously **updated database** of known threats.

ITNT404

Dr. Omar Abusada

Mobile User Security Approaches

Dr. Omar Abusada
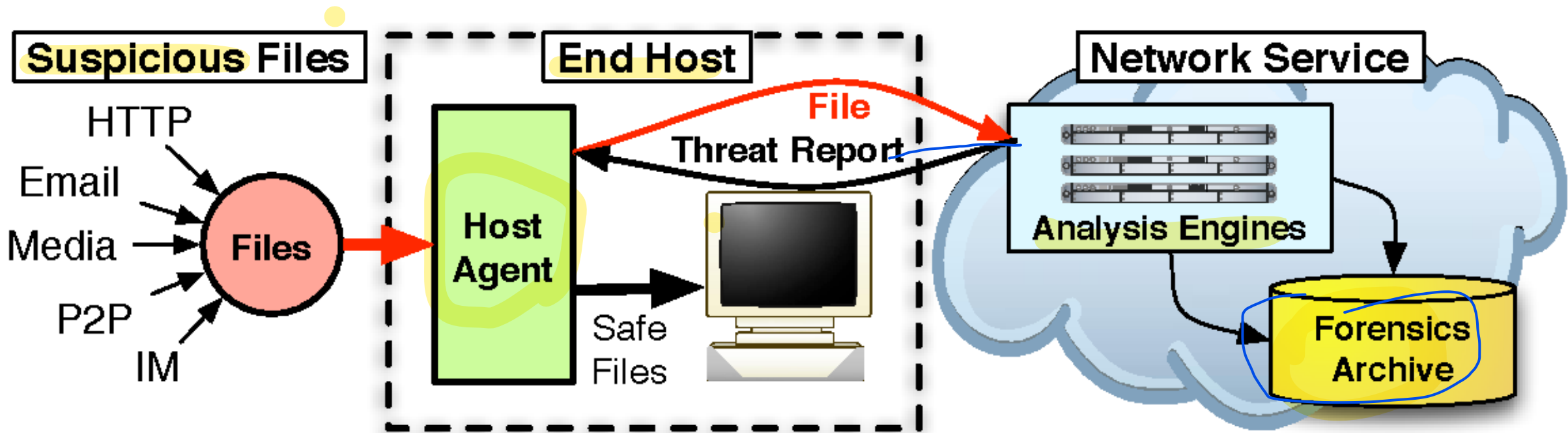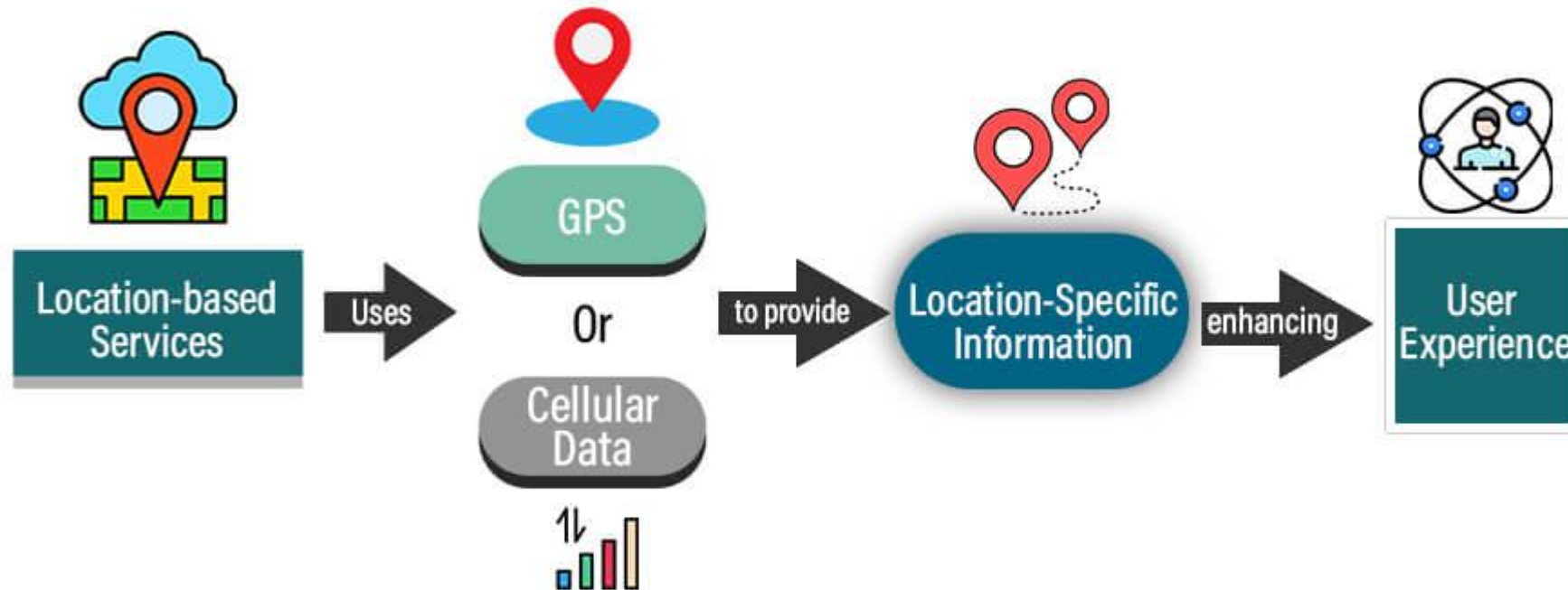
Mobile User Security Approaches

- **CloudAV** was designed to send programs or documents to a network cloud where multiple antivirus and behavioural detection programs are used simultaneously in order to improve detection rates. Parallel scanning of files using potentially incompatible antivirus scanners is achieved by spawning a virtual machine per detection engine and therefore eliminating any possible issues. **CloudAV** can also perform "retrospective detection", whereby the cloud detection engine rescans all files in its file access history when a new threat is identified thus improving new threat detection speed. Finally, **CloudAV** is a solution for effective virus scanning on devices that lack the computing power to perform the scans themselves

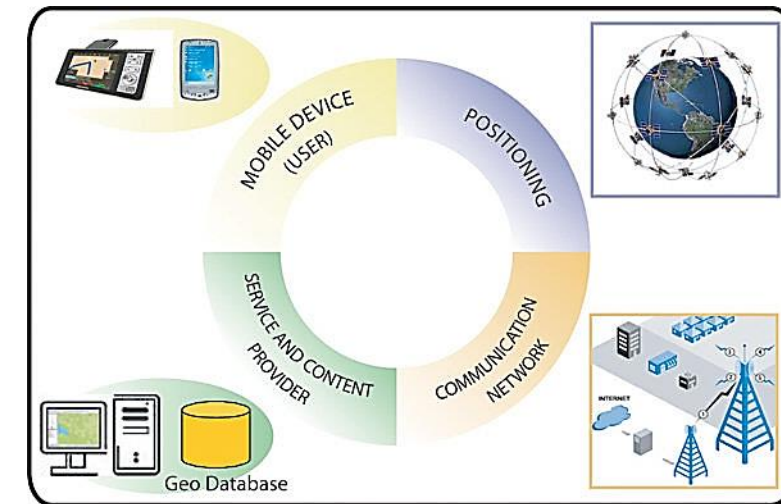Dr. Omar Abusada
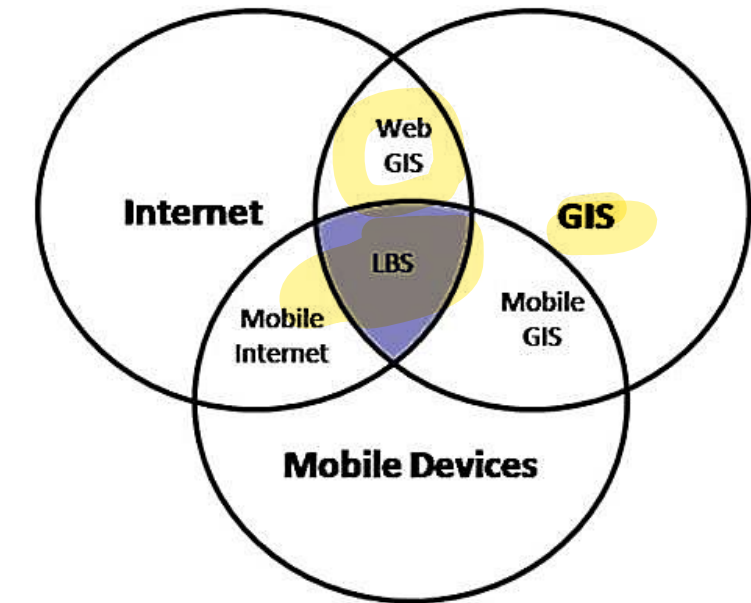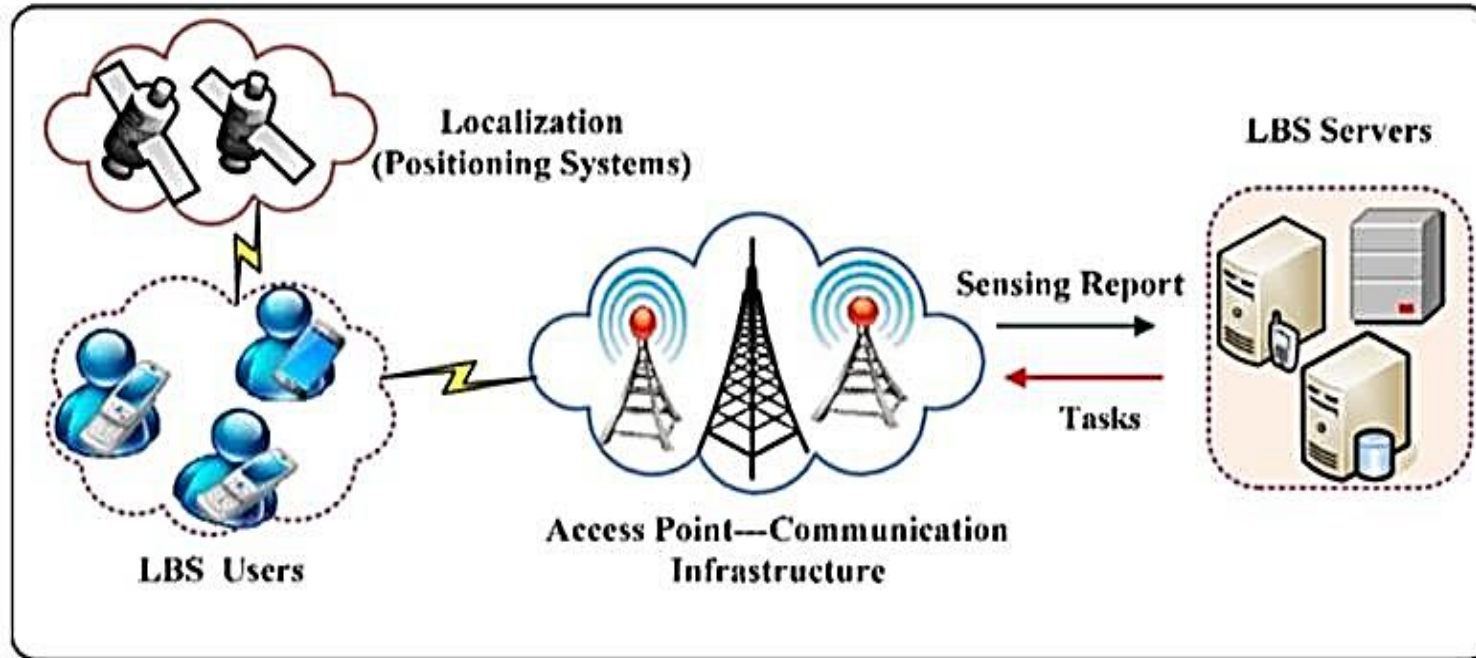
Privacy Issues in MCC

- Location Based Services (LBS) faces a privacy issue on mobile users' provide private information such as their current location.

- A location-based service (LBS) is a software service for mobile device applications that requires knowledge about where **the mobile device is geographically located**. The application collects **geodata**, which is data gathered in Real Time using one or more location tracking technologies (such as **GPS** and **Wi-Fi access point triangulation**)

- This problem becomes even worse if an adversary knows user's important information.

Dr. Omar Abusada

Privacy Issues in MCC

Location-Based Services

Location-based Services → Uses → GPS Or Cellular Data → to provide → Location-Specific Information → enhancing → User Experience

EDUCBA

Dr. Omar Abusada

Privacy Issues in MCC

Privacy Issues in MCC

- **Zhangwei and Mingjun** propose the **Location Trusted Server (LTS) approach**.

- After receiving mobile users' requests, LTS collects their location information and hide the information called "cloaked region" to conceal user's information.

- The "cloaked region" is sent to LBS, so LBS knows only general information about the users but cannot identify them.

- **H. Zhangwei and X. Mingjun,** "A Distributed Spatial Cloaking Protocol for Location Privacy," in Proc 2nd Intl Conf on Networks Security Wireless Communications and Trusted Computing (NSWCTC), vol. 2, pp. 468, June 2010.

Dr. Omar Abusada

Open Issues in MCC

Quality of Service

- How to ensure **QoS** is still a big issue, especially on network delay.

- **CloneCloud** and **Cloudlets** are expected to reduce the network delay.

- **CloneCloud** uses nearby computers or to increase the speed of smart phone applications.

- The idea is to clone the entire set of data and applications from the smartphone onto the cloud and to selectively execute some operations on the clones, reintegrating the results back into the smartphone.

Dr. Omar Abusada

Open Issues in MCC

Quality of Service (QoS…. CloneCloud)

- **CloneCloud** consists of off-loading some tasks from your mobile to the cloud, where they will be executed in a cloned image of the system of your device.

- A "copy" of your smartphone is first made in the cloud-computing world on distant server(s).

- Processes will be sent via your high speed smartphone connectivity (Wifi, 3G, 4G) to the distant servers to be executed there instead of local execution on the phone.

- The results will be reintegrated to the smartphone upon completion in a fraction of the time. This concept transforms a single-machine execution to a distributed execution.

ITNT404   Dr. Omar Abusada

Open Issues in MCC

Quality of Service (QoS…. CloneCloud)

Dr. Omar Abusada
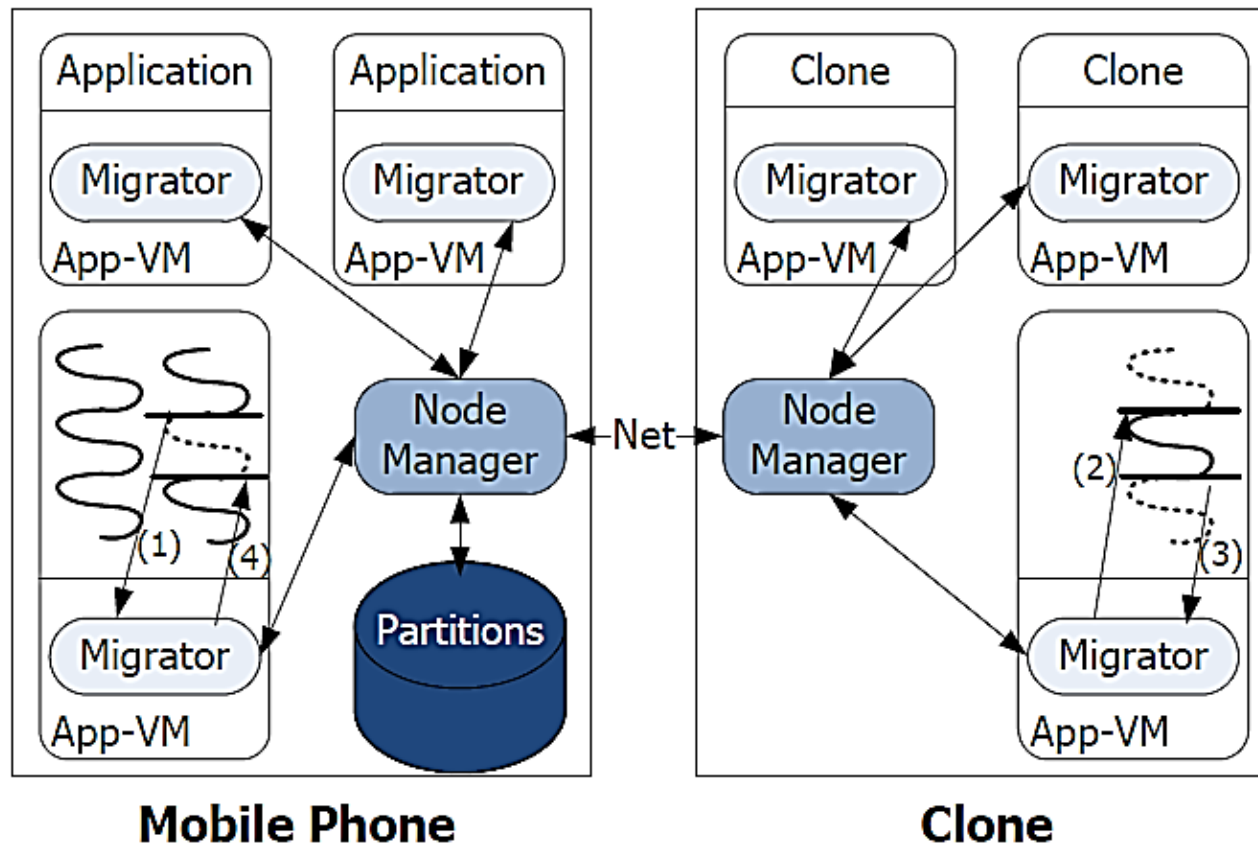
Open Issues in MCC

Quality of Service

- A **cloudlet** is a trusted, resource-rich computer or cluster of computers which is well-connected to the Internet and available for use by nearby mobile devices with on one-hop wireless connection.

-

- A cloudlet is a small-scale data centre or cluster of computers that quickly provides cloud computing services to mobile devices, such as smartphones, tablets and wearable devices, within close geographical proximity.

ITNT404   Dr. Omar Abusada

Open Issues in MCC

Quality of Service

Dr. Omar Abusada
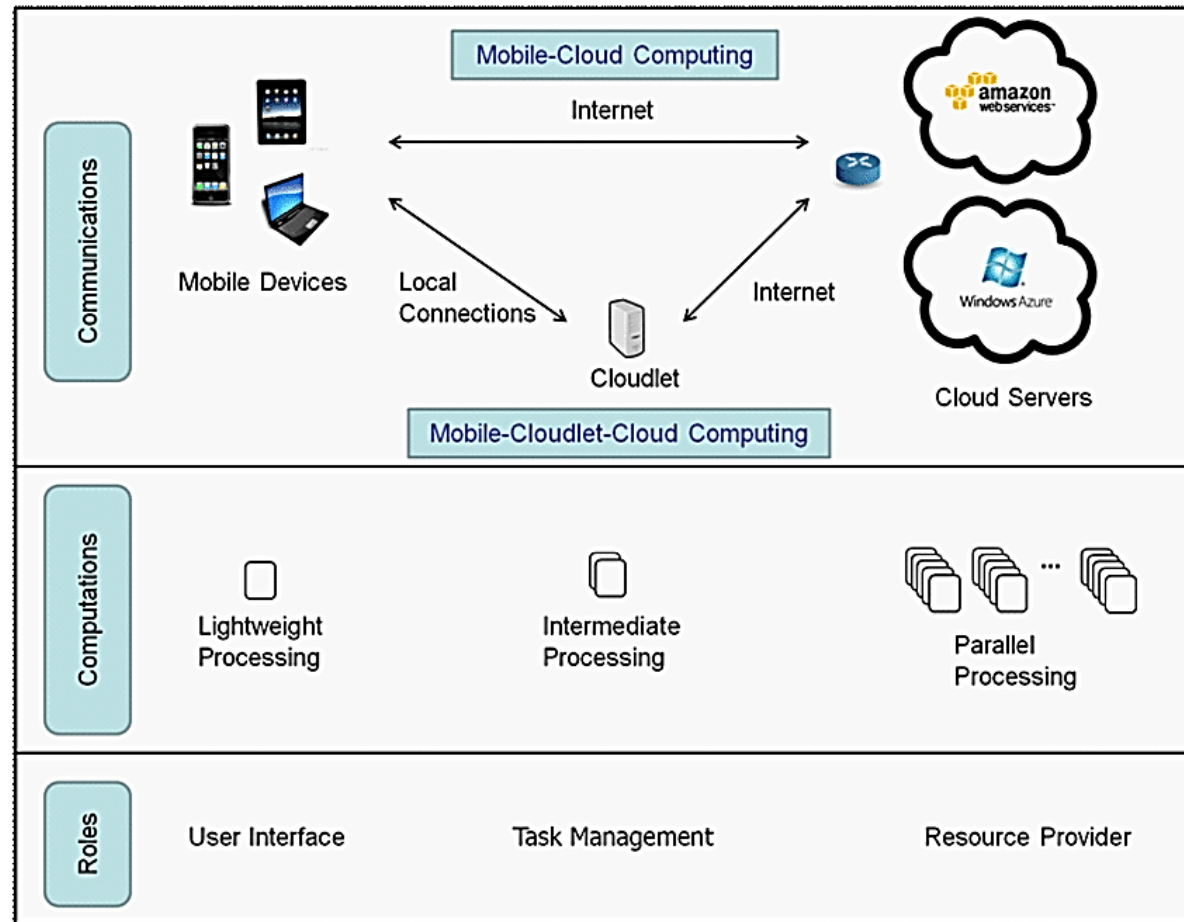
Open Issues in MCC

Pricing

- MCC involves with both mobile service provider (MSP) and cloud service provider (CSP) with different services management, customers management, methods of payment and prices.

- This will lead to many issues.

- The business model including pricing and revenue sharing has to be carefully developed for MCC.

Dr. Omar Abusada

Open Issues in MCC

Standard Interface

- Interoperability becomes an important issue when mobile users need to interact with the cloud.

- Web interfaces may not be the best option.

- It is not specifically designed for mobile devices.

- Compatibility among devices for web interface could be an issue.

- Standard protocol, signaling, and interface for interacting between mobile users and cloud would be required. (HTML5 & CSS3)

Dr. Omar Abusada

Open Issues in MCC

Service Convergence

- Services will be differentiated according to the types, cost, availability and quality.

- A single cloud may not be enough to meet mobile user's demands.

- New scheme is needed in which the mobile users can utilize multiple cloud in a unified fashion.

- The scheme should be able to automatically discover and compose services for user.

Dr. Omar Abusada

Open Issues in MCC

Service Convergence

- **Sky computing** is a model where resources from multiple clouds providers are leveraged to create a large scale distributed infrastructure.

- The mobile sky computing will enable providers to support a **cross-cloud communication** and enable users to implement mobile services and applications.

- **Service integration** (i.e., convergence) would need to be explored.

... Thank you ...