CHAPTER ONE

INTRODUCTION

Content of Lecture One

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1. Introduction

1.1 Mobile Computing

Mobile computing can be defined **as a computing environment over physical mobility.** The user of a mobile computing environment will be able **to access data**, **information** or other **logical objects** from any device in any network while on the move. Mobile computing system allows a user to **perform a task from anywhere** using **a computing device** in the public (the Web), corporate (business information) and personal information spaces (medical record, address book). While on the move, the preferred device will be a **mobile device**, while back at home or in the office the device could be a **desktop computer**. To make the mobile computing environment **ubiquitous**, it is necessary that the communication bearer is spread over both wired and wireless media. Be it for the **mobile workforce**, **enterprises**, or **rural population**, the access to information and virtual objects through mobile computing are absolutely **necessary for optimal use of resource and increased productivity.**

Mobile computing is used in different situations with different names. The most common names are:

• ***Mobile Computing*:** The computing environment is **mobile** and **moves along with the user**. This is similar to the telephone number of a **GSM** (**Global System for Mobile communication**) **phone,** which moves with the phone.

• ***Anywhere, Anytime Information*:** This is the generic definition of **ubiquity**, where the information is available anywhere, all the time**.**

• ***Nomadic Computing*:** The computing environment is **nomadic** and moves along **with the mobile user**. This is true for both **local and remote** services.

• ***Pervasive Computing*:** A computing environment, which is **Pervasive in nature** and can be made available in any environment

• ***Ubiquitous Computing*:** A **disappearing** (nobody will notice Its presence) **everyplace computing environment**. User will be able to use both local and remote services.

• ***Global Service Portability*:** Making a service portable and available in every environment. **Any service of any environment will be available globally**.

• ***Wearable Computers***: Wearable computers are those **computers that may be adorned by humans like a hat, shoe or clothes** (these are **wearable accessories**). Wearable computers need to have **some additional attributes** compared to standard mobile devices. Wearable computers are always on; operational while on **move**; **hands free**, context aware (with different types of sensors). Wearable computers need to be equipped with proactive attention and notifications. The ultimate wearable computers will have sensors implanted within the body and supposedly integrate with the human nervous system.

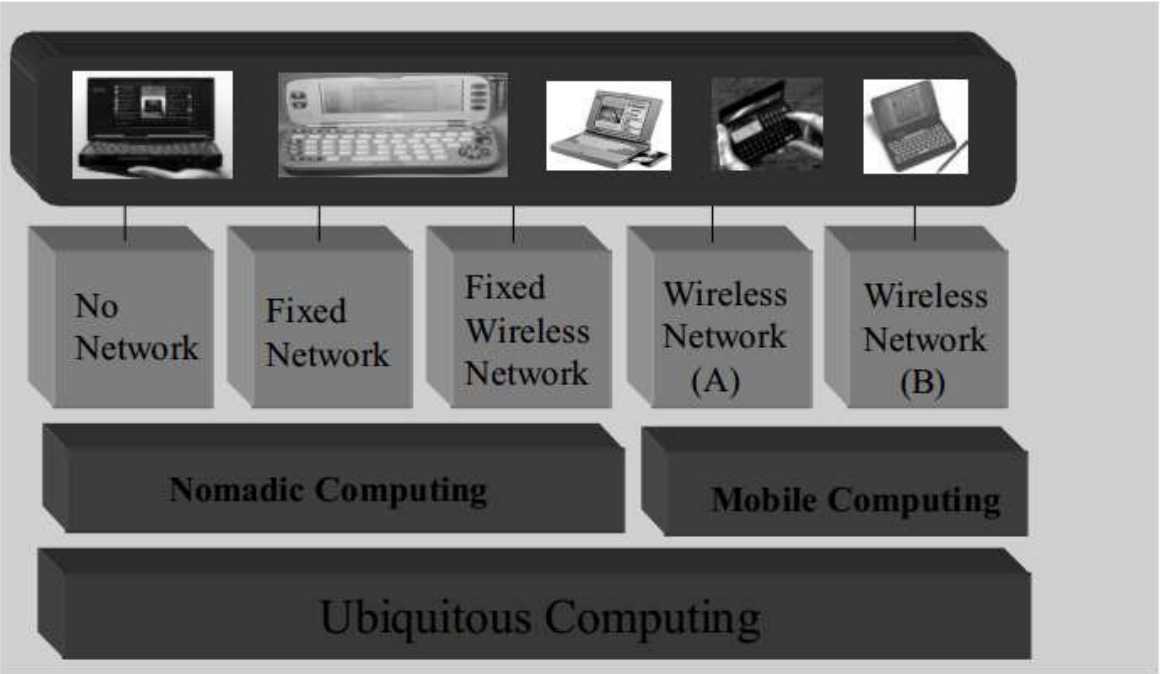
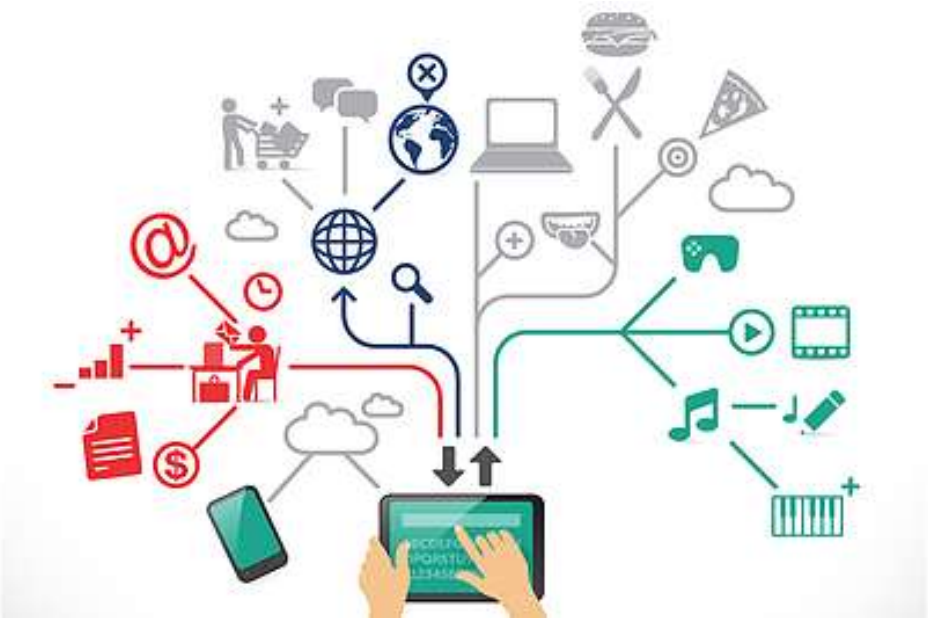


Figure 1.1: Nomadic, Mobile Computing and Ubiquitous

1.2 Mobility

The ability to change locations while connected to the network increases the **volatility** of some information. Certain data considered static for stationary computing becomes dynamic for mobile computing. For example, although a **stationary computer** can be **configured statically** to prefer the **nearest server**, a mobile computer needs a **mechanism to determine which server to use.**

As **volatility increases**, cost-benefit tradeoff points shift, **calling for appropriate modifications in the design**. For lower ratios, it makes less sense **to cache the data**, or even to store it at all if it can be recomputed from scratch easily enough. **The following three sections discuss the main problems introduced by mobility**: the network address of a mobile computer changes dynamically; its current location affects configuration parameters as well as answers to user queries; and as it wanders away from a nearby server, **the communication path between the two grows.**



1. Address Migration

As people move, their **mobile computers will use different network access points**, or '**addresses**.' Today's networking is not designed for dynamically changing addresses. Active network connections usually cannot be moved to a new address. **Once an address for a host name is known to a system**, it is typically **cached with a long expiration time.** In the Internet Protocol (**IP**), for example, a host IP name is inextricably bound with its network address, **moving to a new location means acquiring a new IP name**. Human intervention is often required to coordinate the use of addresses.

In order to communicate with a mobile computer, **messages must be sent to its most recent address**. **There are four basic mechanisms for determining the current address of a mobile computer**: **broadcast**, **central services**, **home bases**, and **forwarding pointers** [5]. These are the building blocks of the current proposals for 'mobile-IP' schemes.

1.Selective Broadcast: If a mobile computer is known to be in **a set of cells**, **then a message could be 'broadcasted' to these known cells** asking the required mobile unit to reply with its current network address.

2.Central Services: A logically **centralized database** contains the **current addresses** of all mobile units. Whenever a mobile computer changes its address, **it sends a message to update the database**.

3.Home Bases: This is essentially the **limiting case of distributing a central service,** i.e. only a **one server** knows the **current location** of a mobile computer.

4.Forwarding Pointers: This method **places a copy of the new address at the old location**. Each message is forwarded along the **chain of pointers** leading to the mobile computer. This requires an active entity at the old address to receive and forward messages.

2. Location Dependent Information

Because traditional computers do not move, information that depends on location is **configured statically**, such as the **local name server**, **available printers**, and **the time zone**. **A challenge for mobile computing** is to factor

out this **information intelligently** and provide mechanisms to obtain configuration data appropriate to the **present location.**

3. Migrating Locality:

Mobile computing **creates** a new kind of locality that migrates as users move. Even if a **mobile computer spends the effort to find the server that is nearest** for a given service, over time it may **stop to be the nearest** due to migration. Because the physical distance between two points does not necessarily reflect the network distance, **the communication path can grow disproportionately to actual movement**. For example, **a small movement** can result in a **much longer path** when crossing network **administrative boundaries**. A longer network path means communication traverses more intermediaries, resulting in **longer latency** and **greater risk** of **disconnection. This also consumes more network capacity**, even though the bandwidth between the mobile unit and the server may not degrade.

To avoid these disadvantages, **service connections may be dynamically transferred to servers that are closer** [3]. When many mobile units converge, such as during meetings, load balancing concerns may outweigh the importance of communication locality.

1.3 Natural Evolution of Computing

Wireless information systems represent the next logical step in the natural

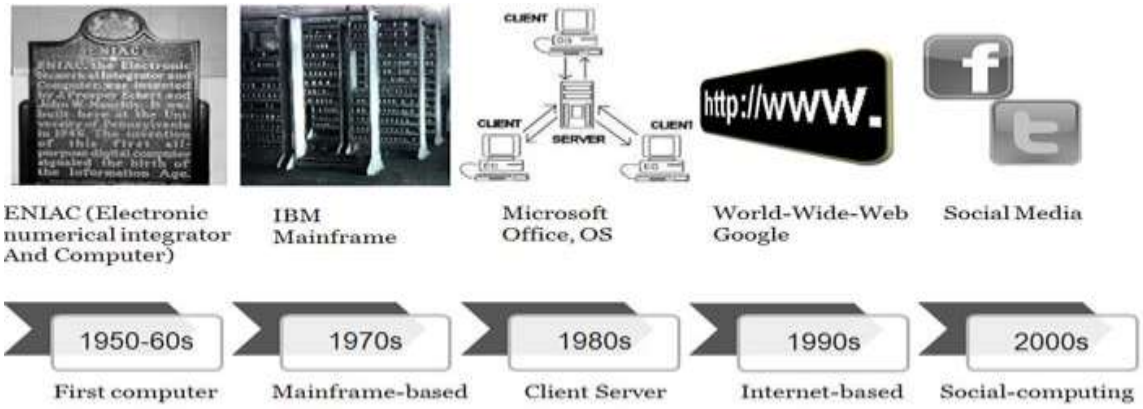


Figure 1.3: The computing evolution

evolution of computing systems. Over time, the user has been freed from the need to be collocated in time and space with the computing system he or she will use. Early computers were **mammoth machines** that required the user to be **physically located** at the machine to use it, as these early machines only ran a single user operating system, not only did the user need to be collocated in space, **but also in time**. In effect, the computing resource could not be effectively used by more than on user at a time. As usage restrictions are reduced, multiuser collaborative activities are better enabled. Over time, the evolution of computing has decreased the tight coupling between the user and his or her computing resource and environment (see Figure 1.4). **Batch processing freed the user in time**

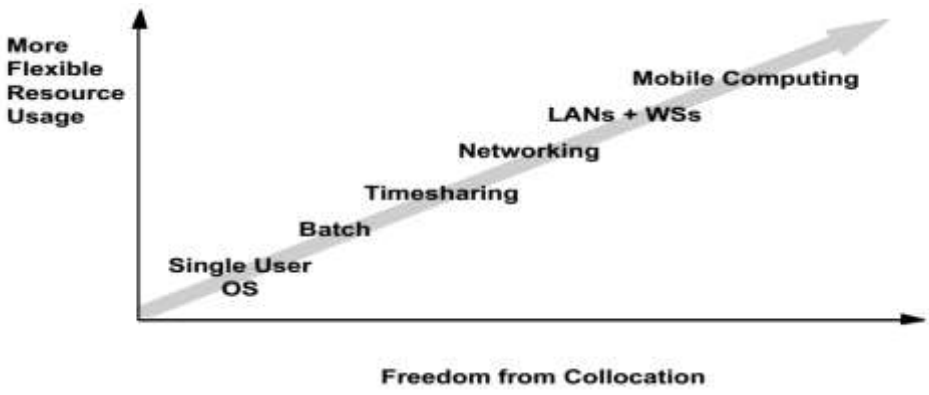


Figure1.4: Evolution of Computing Systems

1.4 Constraints of Mobility

Mobile computing is characterized by four constraints:

● **Mobile elements are resource-poor relative to static elements.** For a given cost and level of technology, considerations of **weight, power**, **size** and **ergonomics** will exact a penalty in computational resources such as **processor speed**, **memory size**, and **disk capacity**. While mobile elements will improve in absolute ability, they will always be resource-poor **relative to static elements.**

● **Mobility is inherently hazardous.**

A Wall Street stockbroker is more mugged on the streets of Manhattan likely to be and have his laptop stolen than to have his workstation in a locked office be physically subverted. In addition **to security concerns**, **portable computers are more vulnerable to loss or damage.**

● **Mobile connectivity is highly variable in performance and reliability.**

Some buildings may offer **reliable, high-bandwidth wireless connectivity** while others may only **offer low-bandwidth connectivity**. Outdoors, a mobile client may have to rely on a low-bandwidth wireless network with gaps in coverage.

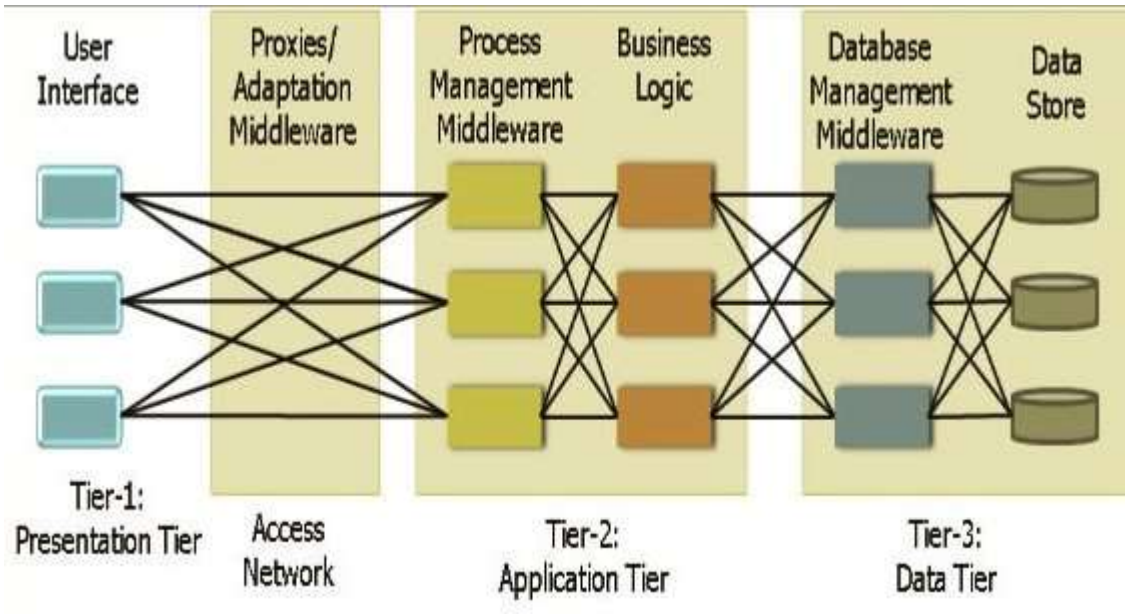
● **Mobile elements rely on a limited energy source.**

While battery technology will improve over time, the need to be sensitive to power consumption will not reduce. **Concern for power consumption must** span many levels of **hardware and software to be fully effective**.

These constraints are not artifacts of current technology, but are intrinsic to mobility. Together, **they complicate the design** of **mobile information systems** and **require us to rethink traditional approaches to information access**.

1.5 Architecture of Mobile Computing

There are three tiers architecture contains the **user interface or the presentation tier**, the **process management or the application tier** and the **data management tier.**



1.5.1 Presentation Tier (user interface tier)

- Responsible for presenting the information to the end user
- Run on the client device and offer all the user interfaces
- Includes web browsers, WAP browsers and client programs

1.5.2 Application Tier (process management tier)

- Independent of presentation and database management
- Handles functions related to middleware
- Middleware layer of software sitting between the operating System and user facing software
- Many types of middleware: Message Oriented Middleware, Transaction Processing Middleware, Communication Middleware,
- Distributed Objects and Components, Transcoding Middleware, Web Services, etc.

1.5.3 Data Tier

- Used to store data needed by the application and acts as a Repository for both temporary and permanent data
- Can use XML (**Extensible Markup Language**) for interoperability of data with other systems
  And data sources
- Might incorporate the use of Database Middleware and Sync ML (**Machine Language**)
- Database Middleware : interfaces application programs and the database
- Database Middleware : helps business logic run independent and transparent from database technology and database vendor

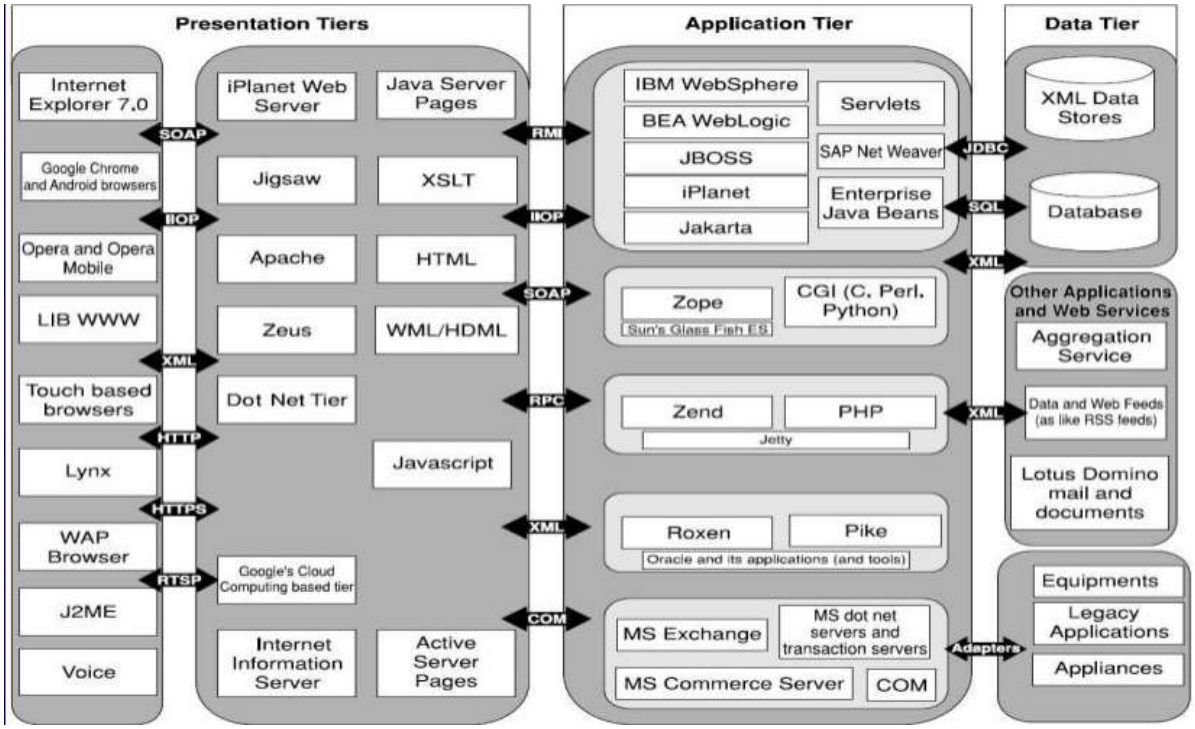


Figure1.6 The three layer of Mobile Computing Architecture

1.7 Networks in Mobile computing

Mobile computing will use different types of networks. These can be fixed telephone network, GSM, GPRS, ATM (Asynchronous Transfer Mode), Frame Relay, ISDN (Integrated Service Digital Network), CDMA, CDPD (Cellular Digital Packet data), DSL (Digital Subscriber Loop), Dial-up, Wi-Fi (Wireless Fidelity), 802.11, Bluetooth, Ethernet, Broadband, etc.

1.7.1 Wireline Networks

This is a network, which is designed over wire or tangible conductors. This network is called fixed or wireline network. Fixed telephone networks over copper and fiber-optic will be part of this network family. Broadband networks over DSL or Cable will also be part of wireline networks. Wireline network are generally public networks and cover wide areas. Though microwave or satellite networks do not use wire, when a telephone network uses microwave or satellite as a part of its infrastructure, it is considered part of wireline networks. When we connect to ISPs it is generally a wireline network. The Internet backbone is a wireline network as well.

1.7.2 Wireless Networks

Mobile networks are generally termed as wireless network. This includes wireless networks used by radio taxis, one way and two-way pager, cellular phones. Example will be PCS (Personal Cellular System), AMPS (Advanced Mobile Phone System), GSM, CDMA, DoCoMo, GPRS etc. WILL (Wireless in Local Loop) networks using different types of technologies are part of wireless networks as well. In a wireless network the last mile is wireless and works over radio interface. In a wireless network other than the radio interface rest of the network is wireline, this is generally called the PLMN (Public Land Mobile Network).

Figure 1.11 Wireless Networks

1.7.3 Ad-hoc Networks

In Latin, *ad hoc* literally means `for this purpose only'. An ad-hoc (or spontaneous) network is a small area network, especially one with wireless or temporary plug-in connections. In these networks some of the devices are part of the network only for the duration of a communication session. An ad-hoc network is also formed when mobile, or portable devices, operate in close proximity of each other or with the rest of the network. When we beam a business card from our PDA (Personal Digital Assistant) to another, or use an IrDA (Infrared Data Association) port to print document from our laptop, we have formed an ad hoc network. The term 'ad hoc' has been applied to networks in which new devices can be quickly added using, for example, Bluetooth or wireless LAN (802.11x). In these networks devices communicate with the computer and other devices using wireless transmission. Typically based on short-range wireless technology, these networks don't require subscription services or carrier networks.

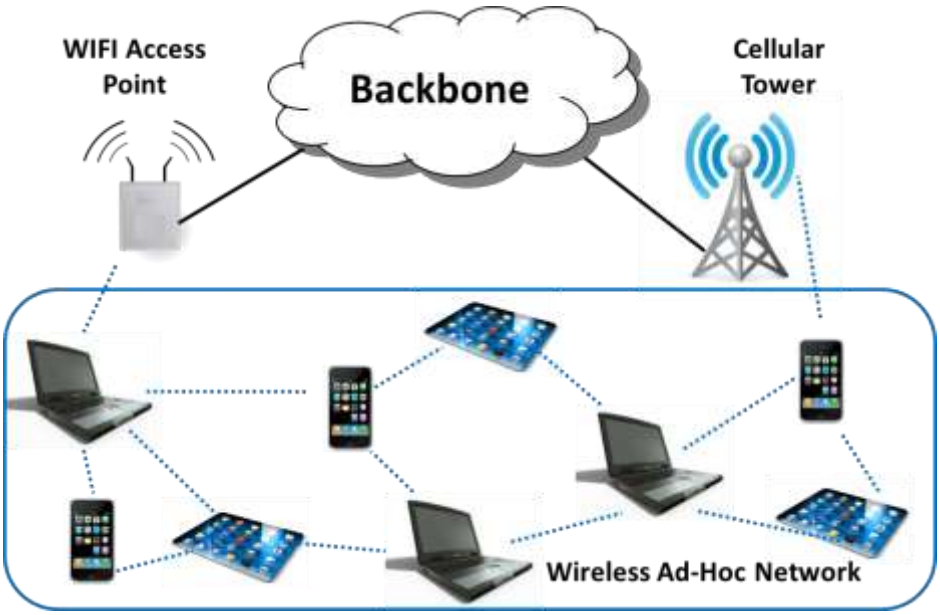


Figure 1.12 Wireless Ad-Hoc Network

1.8 Overlay Networking

Figure 1.13 shows an example of a wireless overlay network. Lower levels are comprised of high- bandwidth wireless cells that cover a relatively small area. Higher levels in the hierarchy provide a lower bandwidth per unit area connection over a larger geographic area. this system has three overlay levels. The lowest level is comprised of a collection of disjoint room-size high-bandwidth networks, which provide the highest bandwidth per-unit-area: one Mb/s or more per room. The second level consists of building size high-bandwidth networks that provide approximately the same bandwidth as the room-size networks, but cover a larger area, for example, a single floor of a building. The final level is a wide-area data network, which provides a much lower bandwidth connection, typically tens of kilobits, over a much wider geographic area. that support “mobile” wired networks, such as dynamically connecting to a local Ethernet subnet via DHCP.

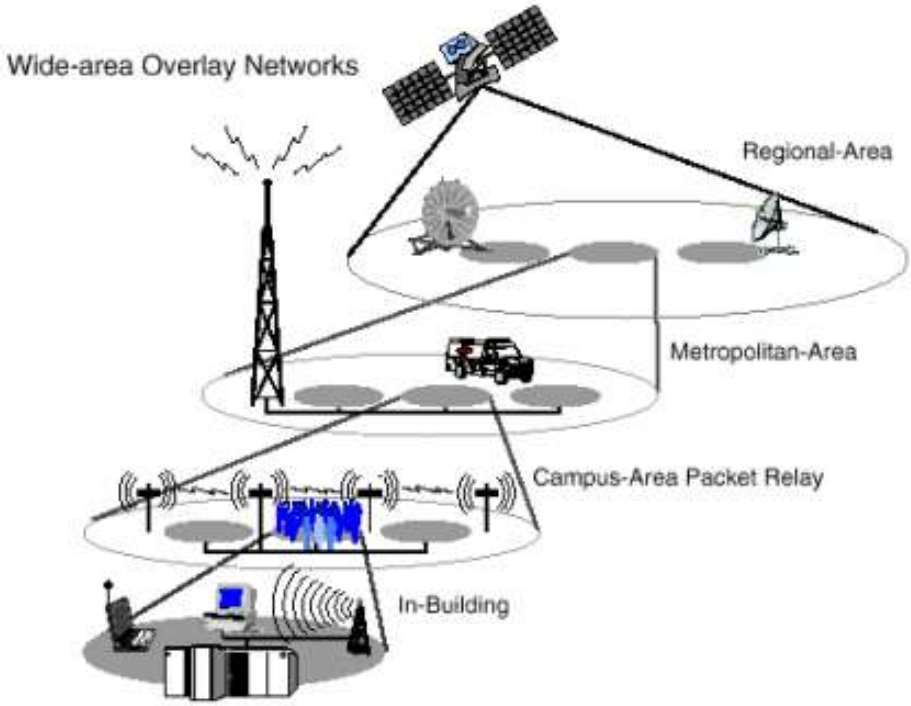


Figure 1.13 Wireless Overlay Network Structure

1.9 The Handoff in mobile computing

Handoff refers to a process of transferring an ongoing call or data session from one channel connected to the core network to another, and Cellular communication is a technology which mainly makes the mobile phones to communicate with each other. In Cellular communication the end user that is the mobile phone user doesn't stay at a particular place but moves from one place to another.

Reasons for a Handoff to be conducted:

- To avoid call termination when the phone is moving away from the area covered by one cell and entering the area covered by another cell.
- W hen the capacity for connecting new calls of a given cell is used up
- When there is interference in the channels . due to the different phones using the same channel in different cells
- When the user behaviors change
- Etc

Importance of Handling Handoff:

Customer satisfaction is very important in cellular communication and handling handoff is directly related to customer satisfaction. Effective handling of handoff leads to improved reception and fewer dropped calls and results in customer satisfaction which is very important in Mobile communication. Handoff is very common and most frequently occurred in cellular communication so it should be handled efficiently for desired performance of the cellular network. Handoff is very important for managing the different resources in Cellular Systems. Handoffs should not lead to significant interruptions even though resource shortages after a handoff cannot be avoided completely. Thus handling handoffs is very much important for a desired interruption free cellular communication.

Design Considerations for handoff:

- — Power Consideration
- — Traffic Consideration
- — Channel Quality Consideration
- — Distance Consideration
- — Administrative Consideration

Handoffs may be classified into two types:

- **Hard Handoff:** Characterized by an actual break in the connection while switching from one cell or base station to another. The switch takes place so quickly that it can hardly be noticed by the user. Because only one channel is needed to serve a system designed for hard handoffs, it is the more affordable option. It is also sufficient for services that can allow slight delays, such as mobile broadband Internet.
- **Soft Handoff**: Entails two connections to the cell phone from two different base stations. This ensures that no break ensues during the handoff. Naturally, it is more costly than a hard handoff.

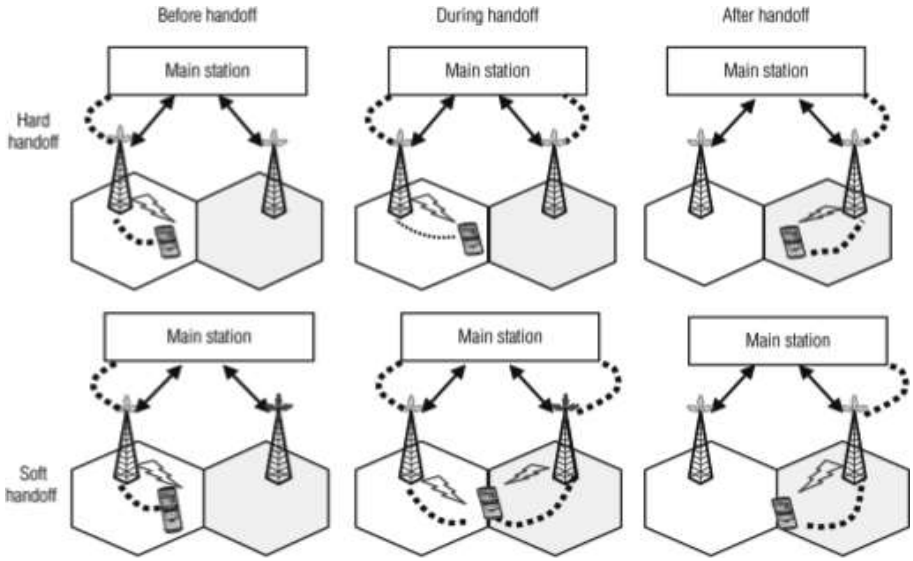


Figure 1.15 Comparison of hard handoff and soft handoff

1.10 Application and Services (Contents)

Personal: belongs to the user (wallet, life-tool, medical records, diary).

Perishable: time sensitive and relevance passes quickly (general news, breaking news, weather, sports, business news, stock quotes).

Transaction Oriented: transactions need to be closed (bank transactions, utility bill payment, mobile shopping).

Location Specific: information related to current geographical location (street direction map, restaurant guide).

Corporate: corporate business information (mail, ERP, inventory, directory, business alerts, reminders).

1.11 Security Manager

The Security Manager provides secure connection between the client device and the origin server. Depending on the security policies of an organization, if the security requirements are not met, some content may not be viewable. Security manager will ensure security with respect to:

- **Confidentiality**: the message being transacted needs to be confidential. Nobody will be able to see it.
- **Integrity:** the message being transacted needs to be tamper-resistant Nobody will be able to change any part of the message.
- **Availability:** the system will be available. Nobody will be able to stop the service.
- **Non-repudiation:** the users of the system can be identified. Nobody after using the system can claim otherwise.
- **Trust:** there **are complex issues of knowing what** resources, services or agents to trust. The system will be trusted.

Confidentiality is managed by encryption. Using encryption techniques, we change the message to some other message so that it cannot be understood. There are different types of encryption algorithms and standards. In a defined environment like enterprise LAN or a **VPN (Virtual Private Network),** we can standardize some encryption algorithm like 128 bits AES to be used. However, in a ubiquitous environment, the environment is unpredictable with ad hoc groups of devices. Also, the networks and their security level cannot be guaranteed all the time. **Integrity** can be managed using different hashing algorithms. **Availability** relates to peripheral security related to Web server, firewall etc. The **non-repudiation** can be managed with digital signature. For trust we may need to establish some sort of third-party recommendation system. Third-party rating system can also help establish **trust**. The security manager needs to manage all these aspects.

1.12 Advantages and Disadvantages of mobile Computing

1.12.1 Advantages:

1) **Increase in Productivity**- Mobile devices can be used out in the field of various companies, therefore reducing the time and cost for clients and themselves.
2) **Entertainment**- Mobile devices can be used for entertainment purposes, for personal and even for presentations to people and clients.
3) **Portability**- this would be one of the main advantages of mobile computing, you are not restricted to one location in order for you to get jobs done or even access email on the go.
4) **Cloud Computing**- This service is available for saving documents on a online server and being able to access them anytime and anywhere when you have a connection to the internet and can access these files on several mobile devices or even PCs at home.

1.12.2 Disadvantages:

1. **quality of connectivity:** as one of the disadvantages, mobile devices will need either WiFi connectivity or mobile network connectivity such as GPRS, 3G and in some countries even 4G connectivity that is why this is a disadvantage because if you are not near any of these connections your access to the internet is very limited.
2. **Security concerns:** Mobile VPNs are unsafe to connect to, and also syncing devices might also lead to security concerns. accessing a WiFi network can also be risky because WPA and WEP security can be bypassed easily.
3. **Power Consumption**: due to the use of batteries in these devices, these do not tend to last long, if in a situation where there is no source of power for charging then that will certainly be a letdown.

1.13 Challenges of Mobile Computing

Mobile wireless device is characterized by four constraints:

1. **Mobile elements are resource-poor relative to static elements:** For a given cost and level of technology, considerations of weight, power, size & ergonomics will exact a penalty in computational resources such as processor speed, memory size, and disk capacity. Mobile elements will always be resource-poor relative to static elements.
2. **Mobility is inherently hazardous:** A stockbroker is more mugged on the streets and has his laptop stolen than to have his workstation in a locked office be physically subverted. In addition to security concerns, portable computers are more vulnerable to loss or damage.
3. **Mobile connectivity is highly variable in performance and reliability:** Some buildings may offer reliable, high bandwidth wireless connectivity while others may only offer low-bandwidth connectivity. Outdoors, a mobile client may have to rely on a low-bandwidth wireless network with gaps in coverage.
4. **Mobile elements rely on a finite energy source:** While battery technology will undoubtedly improve over time, the need to be sensitive to power consumption will not diminish. Concern for power consumption must span many levels of hardware and software to be fully effective.

1.14 Limitations of mobile computing

1) Insufficient bandwidth: Mobile Internet access is generally slower than direct cable connections higher speed wireless LANs are inexpensive but have very limited range.

2) Security standards: When working mobile, one is dependent on public networks, requiring careful use of VPN. Security is a major concern while concerning the mobile computing standards on the fleet. One can easily attack the VPN through a huge number of networks interconnected through the line.

3) Power consumption: When a power outlet or portable generator is not available, mobile computers must rely entirely on battery power. Combined

with the compact size of many mobile devices, this often means unusually expensive batteries must be used to obtain the necessary battery life.

4) Transmission interferences: Weather, terrain, and the range from the nearest signal point can all interfere with signal reception. Reception in tunnels, some buildings, and rural areas is often poor.

5) Potential health hazards: People who use mobile devices while driving are often distracted from driving and are thus assumed more likely to be involved in traffic accidents. (While this may seem obvious, there is considerable discussion about whether banning mobile device use while driving reduces accidents or not.) Cell phones may interfere with sensitive medical devices. There are allegations that cell phone signals may cause health problems.

6) Human interface with device: Screens and keyboards tend to be small, which may make them hard to use. Alternate input methods such as speech or handwriting recognition require training.

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