Introduction to Mobile Computing

The rapidly expanding technology of cellular communication, wireless LANs, and satellite services will make information accessible anywhere and at any time. Regardless of size, most mobile computers will be equipped with a wireless connection to the fixed part of the network, and, perhaps, to other mobile computers. The resulting computing environment, which is often referred to as ***mobile or nomadic computing***, no longer requires users to maintain a fixed and universally known position in the network and enables almost unrestricted mobility. Mobility and portability will create an entire new class of applications and, possibly, new massive markets combining personal computing and consumer electronics.

Mobile Computing is term used to describe technologies that enable people to access network services anyplace, anytime, and anywhere.

A communication device can exhibit any one of the following characteristics:

- **Fixed and wired**: This configuration describes the typical desktop computer in an office. Neither weight nor power consumption of the devices allow for mobile usage. The devices use fixed networks for performance reasons.

- **Mobile and wired**: Many of today's laptops fall into this category; users carry the laptop from one hotel to the next, reconnecting to the company's network via the telephone network and a modem.

- **Fixed and wireless**: This mode is used for installing networks, e.g., in historical buildings to avoid damage by installing wires, or at trade shows to ensure fast network setup.

- **Mobile and wireless**: This is the most interesting case. No cable restricts the user, who can roam between different wireless networks. Today's most successful example for this category is GSM with more than 800 million users.

Applications of mobile computing

In many fields of work, the ability to keep on the move is vital in order to utilise time efficiently. The importance of Mobile Computers has been highlighted in many fields of which a few are described below:

a. **Vehicles:** Music, news, road conditions, weather reports, and other broadcast information are received via digital audio broadcasting (DAB) with 1.5 Mbit/s. For personal communication, a universal mobile telecommunications system (UMTS) phone might be available offering voice and data connectivity with 384 k bit/s. The current position of the car is determined via the global positioning system (GPS). Cars driving in the same area build a local ad-hoc network for the fast exchange of information in emergency situations or to help each other keep a safe distance. In case of an accident, not only will the airbag be triggered, but the police and ambulance service will be informed via an emergency call to a service

provider. Buses, trucks, and trains are already transmitting maintenance and logistic information to their home base, which helps to improve organization (fleet management), and saves time and money.

b. **Emergencies**: An ambulance with a high-quality wireless connection to a hospital can carry vital information about injured persons to the hospital from the scene of the accident. All the necessary steps for this particular type of accident can be prepared and specialists can be consulted for an early diagnosis. Wireless networks are the only means of communication in the case of natural disasters such as hurricanes or earthquakes. In the worst cases, only decentralized, wireless ad-hoc networks survive.

c. **Business**: Managers can use mobile computers say, critical presentations to major customers. They can access the latest market share information. At a small recess, they can revise the presentation to take advantage of this information. They can communicate with the office about possible new offers and call meetings for discussing responds to the new proposals. Therefore, mobile computers can leverage competitive advantages. A travelling salesman today needs instant access to the company's database: to ensure that files on his or her laptop reflect the current situation, to enable the company to keep track of all activities of their travelling employees, to keep databases consistent etc. With wireless access, the laptop can be turned into a true mobile office, but efficient and powerful synchronization mechanisms are needed to ensure data consistency.

d. **Credit Card Verification**: At Point of Sale (POS) terminals in shops and supermarkets, when customers use credit cards for transactions, the intercommunication required between the bank central computer and the POS terminal, in order to effect verification of the card usage, can take place quickly and securely over cellular channels using a mobile computer unit. This can speed up the transaction process and relieve congestion at the POS terminals.

e. **Replacement of Wired Networks**: wireless networks can also be used to replace wired networks, e.g., remote sensors, for tradeshows, or in historic buildings. Due to economic reasons, it is often impossible to wire remote sensors for weather forecasts, earthquake detection, or to provide environmental information. Wireless connections, e.g., via satellite, can help in this situation. Other examples for wireless networks are computers, sensors, or information displays in historical buildings, where excess cabling may destroy valuable walls or floors.

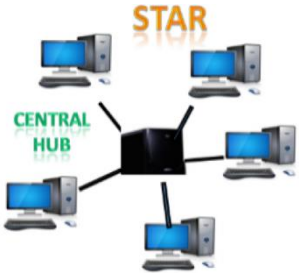
f. **Infotainment**: wireless networks can provide up-to-date information at any appropriate location. The travel guide might tell you something about the history of abuilding (knowing via GPS, contact to a local base station, or triangulation where you are) downloading information about a concert in the building at the same evening via a local wireless network. Another growing field of wireless network applications lies in entertainment and games to enable, e.g., ad-hoc gaming networks as soon as people meet to play together.

Limitations of Mobile Computing

- Resource constraints: Battery
- Interference: Radio transmission cannot be protected against interference usingshielding and result in higher loss rates for transmitted data or higher bit error ratesrespectively
- Bandwidth: Although they are continuously increasing, transmission rates are stillvery low for wireless devices compared to desktop systems. Researchers look formore efficient communication protocols with low overhead.
- Dynamic changes in communication environment: variations in signal power within aregion, thus link delays and connection losses
- Network Issues: discovery of the connection-service to destination and connectionstability
- Interoperability issues: the varying protocol standards
- Security constraints: Not only can portable devices be stolen more easily, but the radio interface is also prone to the dangers of eavesdropping. Wireless access must always include encryption, authentication, and other security mechanisms that must be efficient and simple to use.

Wired Networks

- Wired networks, also called Ethernet networks, are the most common type of local area network (LAN) technology. A wired network is simply a collection of two or more computers, printers, and other devices linked by Ethernet cables. Ethernet is the fastest wired network protocol, with connection speeds of 10 megabits per second (Mbps) to 100 Mbps or higher.
- Wired networks can also be used as part of other wired and wireless networks. To connect a computer to a network with an Ethernet cable, the computer must have an Ethernet adapter (sometimes called a network interface card, or NIC). Ethernet adapters can be internal (installed in a computer) or external (housed in a separate case).
- Typically the range of a wired network is within a 2,000-foot-radius.
- The disadvantage of this is that data transmission over this distance may be slow or non existent.
- The benefit of a wired network is that bandwidth is very high and that interference is very limited through direct connections. Wired networks are more secure and can be used in many situations; corporate LANs, school networks and hospitals.
- The biggest drawback to this type of network is that it must be rewired every time it is moved.
- There are three basic network topologies that are most commonly used today Star, Bus and Ring Network



The Star network, a general more simplistic type of topology, has one central hub that connects to three or more computers and the ability to network printers. The major disadvantage is the star network is its vulnerability. All data must pass through one central host computer and if that host fails the entire network will fail.

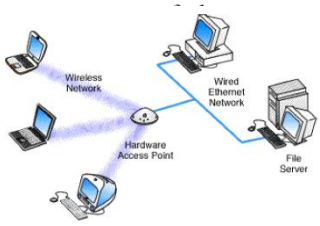
The Bus network has no central computer and all computers are linked on a single circuit. This type broadcasts signals in all directions and it uses special software to identify which computer gets what signal. One disadvantage with this type of network is that only one signal can be sent at one time, if two signals are sent at the same time they will collide and the signal will fail to reach its destination. One advantage is that there is no central computer so if one computer goes down others will not be affected and will be able to send messages to one another.

The Ring network is similar to the bus network, the ring network does not rely on a central host computer either. Each computer in the network can communicate directly with any other computer, and each processes its own applications independently. A ring network forms a closed loop and data is sent in one direction only and if a computer in the network fails the data is still able to be transmitted.

Wireless Networks

- A wireless network, which uses high-frequency radio waves rather than wires to communicate between nodes, is another option for home or business networking.
- Individuals and organizations can use this option to expand their existing wired network or to go completely wireless.
- Wireless allows for devices to be shared without networking cable which increases mobility but decreases range.
- There are four basic types of transmissions standards for wireless networking. These types are produced by the Institute of Electrical and Electronic Engineers (IEEE). These standards define all aspects of radio frequency wireless networking. They have established four transmission standards; 802.11, 802.11a, 802.11b, 802.11g.
- The basic differences between these four types are connection speed and radio frequency. 802.11 and 802.11b are the slowest at 1 or 2 Mbps and 5.5 and 11Mbps respectively. They both operate off of the 2.4 3 GHz radio frequency.
- 802.11a operates off of a 5 GHz frequency and can transmit up to 54 Mbps
- The 802.11g operates off of the 2.4 GHz frequency and can transmit up to 54 Mbps.
- There are two main types of wireless networking; peer to peer or ad-hoc and infrastructure.

An ad-hoc or peer-to-peer wireless network consists of a number of computers each equipped with a wireless networking interface card. Each computer can communicate directly with all of the other wireless enabled computers.



An infrastructure wireless network consists of an access point or a base station. In this type of network the access point acts like a hub, providing connectivity for the wireless computers. It can connect or bridge the wireless LAN to a wired LAN, allowing wireless computer access to LAN resources, such as file servers or existing Internet Connectivity.

Evolution of wireless networks

When we describe mobile communications, we refer to the overall technology, speed, frequency and system in numeric generations such as 3G, 4G or 5G. Each generation have unique technologies that define them.

1G

The very first generation of commercial cellular network was introduced in the late 70's with fully implemented standards being established throughout the 80's. The radio signals used by 1G are analogue, meaning the voice of a call is modulated to a higher frequency rather than being encoded to digital signals.

Analogue signals degrade over time and space meaning that voice data can very often lack quality within a call. In comparison, digital is a representation of analogue stored as signals, meaning larger amounts of data can be carried more effectively.

2G

The second generation saw the introduction of GSM (Global System for Mobile Communication) technologies as a standard in the early 90's. It allowed for digital voice and data to be sent across the network and allowed users to roam for the first time.

2G also used Signalling and Data Confidentially and Mobile Station Authentication to ensure improved security and privacy of telephone calls.

The advance in technology from 1G to 2G introduced many of the fundamental services that we still use today, such as SMS, internal roaming, conference calls, call hold and billing based on services e.g. charges based on long distance calls and real time billing.

2.5G

Between the year 2000 and 2003, an upgrade in technologies introduced the packet network which provided high speed data transfer and internet and became known as 2.5G. The standards included GPRS (General Packet Radio Service) and EDGE (enhanced Data Rates in GSM).

GPRS supports flexible data transmission rates and provides continuous connection with the network. It also allows for the service provider to charge for the amount of data that is sent rather than their connection time.

3G

Introduced commercially in 2001, the goals set out for third generation mobile communication were to facilitate greater voice and data capacity, support a wider range of applications, and increase data transmission at a lower cost.

For the first time, this generation supported high speed wide band internet access as well as fixed wireless internet access and allowed for video calls, chatting and conferencing, mobile TV, video on demand services, navigational maps, email, mobile gaming, music and digital services such as movies.

Significantly greater security features were introduced within 3G, including Network Access and Domain Security and Application Security.

4G

Initiated in 2010, the fourth generation is an all IP based network system. Its purpose is to provide high speed, high quality and high capacity to users while improving security and lower the cost of voice and data services, multimedia and internet over IP.

The major benefit of an IP based network is that it is able to seamlessly handover, for voice and data to GSM, UMTS and CDMA2000 technologies from the previous different generations infrastructure.

4G introduced the LTE standard which only support packet switching and an all IP Network. There are a significant amount of infrastructure changes needed to be implemented by service providers in order to supply because voice calls in GSM, UMTS and CDMA2000 are circuit switched, so with the adoption of LTE, carriers will have to re-engineer their voice call network.

5G

5G is the next generation of commercial cellular network, set to greatly increase internet connectivity speeds. At this time, there aren't any publicly agreed definitive standards that have been set as with previous generations so not a great deal of information is known about the specific technologies that are going to be used.

Different estimations have been made for the date of commercial introduction of 5G networks, but they are generally around the year 2020.

One of the main benefits of increased connectivity being plugged as the underlying selling point of 5G is IoT (Internet of Things), which would make the most of the higher speed of connectivity to allow for seamless integration of devices on a scale never been achievable before.

Speed (data rates) = 1Gbps to 10Gbps (claimed by service providers in lab conditions)

Middleware

Any software layered between a user application and operating system is a middleware. In a mobile computing context we need different types of middleware components and gateways at different layers of the architecture. These are :

1. Communication Middleware
2. Transaction processing middleware
3. Behaviour management middleware
4. Communication gateways

1. Communication Middleware

The application will communicate with different and services through different communication middleware. Different connectors for different services will fall in this category. E.g. TN3270 for IBM mainframe services , Java mail connector for IMAP or POP3 services.

2. Transaction Processing Middleware

In many cases a service will offers session oriented dialogue (SoD). For a session we need to maintain a state over the stateless Internet this is done through an application server. The user may be using a device, which demands a session less dialogue (SID) made of short session less transactions whereas the service at the backend offers a SoD. In such cases a separate middleware component will be required to convert SoD to a SID.

3. Behaviour management middleware

This Middleware will identify the device properly and handle all device specific rendering independent of the application. The system may be required to have some context awareness, which will be handled by the behaviour management middleware.

4. Communication gateways

Between the device and the middleware there will be a system of networks. Gateways are deployed when there are different transport bearers or networks with dissimilar protocols.

Paging System

- Paging Systems are wireless communication systems that are designed to send brief messages to a subscriber.
- It's a one-way messaging system in which Base Station send messages to all subscribers.
- The Paging System transmits the message also known as Page, along with Paging System access number, throughout the service area using Base Station, which broadcast the page on a radio link.
- Types of Paging Systems The Paging Systems can be of two types. Manual Paging System and Automatic Paging System.
- In a manual paging system, a message is sent to the paging operator through telephone call by the caller. The message is then delivers to the pager through paging network by the operator.
- Automatic Paging System: In an automatic paging system, the incoming requests are automatically processed by the paging terminal and then this information is delivers to the pager. Automatic Paging Systems are mostly used.

Messages in Paging Systems

- One of the following four types of information messages can be delivered in a Paging System. Alert Tone Message, Voice Message, Digital String Message, Text String Message Alert Tone Message.
- In the alert tone message, a dedicated telephone number is assigned to the receiver, which is also known as Tone Pager. The pager is triggered by dialing the number. To generate tone-type messages, the advantage of tone paging is that it utilizes a small amount of airtime.
- Voice Message: In the voice message, a voice message can be transmitted in some tone paging systems after the beep.
- Digital String Message: In digital string message, the receiver is a Numeric Pager. The string can be the telephone number of the caller or a coded message. This coded message is generated on request of the caller by the paging centre and is decoded by a codebook built into the pager. This type of paging takes less amount of airtime.