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Unit-I

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Syllabus: Mobile Computing - Brief Overview, Evolution, Classification, Advantages, Mobile Devices And Systems, Architectures: Mobile phones, Digital Music Players, Handheld Pocket Computers, Handheld Devices, Operating Systems, Smart Systems, Limitations of Mobile Devices, Automotive Systems. Security Issues

1. Mobile Computing - Brief Overview

Mobile Computing is a technology that allows transmission of data, voice and video via a computer or any other wireless enabled device without having to be connected to a fixed physical link. The main concept involves −

- Mobile communication
- Mobile hardware
- Mobile software
- Mobile communication

The mobile communication in this case, refers to the infrastructure put in place to ensure that seamless and reliable communication goes on. These would include devices such as protocols, services, bandwidth, and portals necessary to facilitate and support the stated services. The data format is also defined at this stage. This ensures that there is no collision with other existing systems which offer the same service.

Mobile Communication
Since the media is unguided/unbounded, the overlaying infrastructure is basically radio wave-oriented. That is, the signals are carried over the air to intended devices that are capable of receiving and sending similar kinds of signals.

Mobile Hardware
Mobile hardware includes mobile devices or device components that receive or access the service of mobility. They would range from portable laptops, smartphones, tablet PC's, Personal Digital Assistants.

These devices will have a receptor medium that is capable of sensing and receiving signals. These devices are configured to operate in full- duplex, whereby they are capable of sending and receiving signals at the same time. They don't have to wait until one device has finished

communicating for the other device to initiate communications.

Above mentioned devices use an existing and established network to operate on. In most cases, it would be a wireless network.

Mobile software

Mobile software is the actual program that runs on the mobile hardware. It deals with the characteristics and requirements of mobile applications. This is the engine of the mobile device. In other terms, it is the operating system of the appliance. It's the essential component that operates the mobile device.


Since portability is the main factor, this type of computing ensures that users are not tied or pinned to a single physical location, but are able to operate from anywhere. It incorporates all aspects of wireless communications.

2. Evolution

In today's computing world, different technologies have emerged. These have grown to support the existing computer networks all over the world. With mobile computing, we find that the need to be confined within one physical location has been eradicated. We hear of terms such as telecommuting, which is being able to work from home or the field but at the same time accessing resources as if one is in the office.

The advent of portable computers and laptops, Personal Digital Assistants (PDA), PC tablets and smartphones, has in turn made mobile computing very convenient. The portability of these devices ensure and enable the users to access all services as if they were in the internal network of their company. For example, the use of Tablet PC and iPads. This new technology enables the users to update documents, surf the internet, send and receive e-mail, stream live video files, take photographs and also support video and voice conferencing.

The constant and ever increasing demand for superior and robust smart devices has been a catalyst for market share. Each manufacturer is trying to carve a niche for himself in the market. These devices are invented and innovated to provide state-of-the-art applications and services. For instance, different manufacturers of cellular phones have come up with unique smartphones that are capable of performing the same task as computers and at the same processing speed. The market share for different competitors is constantly being fought for. For example, the manufacturers of Apple's iPhone OS, Google's Android' Microsoft Windows Mobile, Research In Motion's Blackberry OS, are constantly competing to offer better products with each release.

OS Share of Smartphone Sales
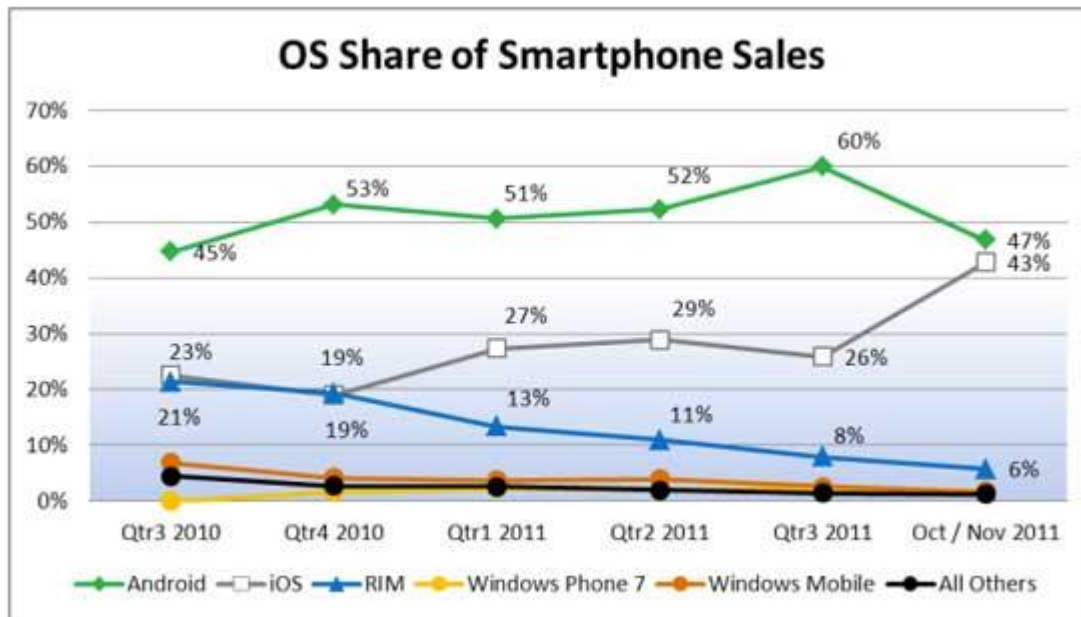
The need for better, portable, affordable, and robust technology has made these vendors to constantly be innovative. Market figure and statistics show an ever growing need to purchase and use such devices for either professional or personal use. It is in this light that services to suit long-term implementation are developed or innovated. It has also pushed other industry vendors to adopt services that will provide better services. For example, cellular service providers are forced to improve and be innovative to capture more subscribers. This can be in terms of superior services such as high speed internet and data access, voice and video service etc. Hence the adoption of different generations of networks like of 2G, 2.5G, 3G, 4G network services.

The essence of mobile computing is to be able to work from any location. The use of iPads, tablets, smartphones, and notebooks, have pushed the demand for these devices. Modern day workers have such devices that enable them to carry out their work from the confines of their own location. These devices are configured to access and store large amounts of vital data. Executive and top management can take decisions based on ready information without going to the office. For example, sales reports and market forecasts can be accessed through these devices or a meeting can take place via video or audio conferencing through these devices. With such features being high in demand, manufacturers are constantly coming up with applications geared to support different services in terms of mobile computing.

3. Classification

Mobile computing is not only limited to mobile phones, but there are various gadgets available in the market that are built on a platform to support mobile computing. They are usually classified in the following categories −

Personal Digital Assistant (PDA)

The main purpose of this device is to act as an electronic organizer or day planner that is portable, easy to use and capable of sharing information with your computer systems.

PDA is an extension of the PC, not a replacement. These systems are capable of sharing information with a computer system through a process or service known as synchronization. Both devices will access each other to check for changes or updates in the individual devices. The use of infrared and Bluetooth connections enables these devices to always be synchronized.

With PDA devices, a user can browse the internet, listen to audio clips, watch video clips, edit and modify office documents, and many more services. The device has a stylus and a touch sensitive screen for input and output purposes.

Smartphones

This kind of phone combines the features of a PDA with that of a mobile phone or camera phone. It has a superior edge over other kinds of mobile phones.

Smartphones have the capability to run multiple programs concurrently. These phones include high-resolution touch screens, web browsers that can access and properly display standard web pages rather than just mobile-optimized sites, and high-speed data access via Wi-Fi and high speed cellular broadband.

The most common mobile Operating Systems (OS) used by modern smartphones include Google's Android, Apple's iOS, Nokia's Symbian, RIM's BlackBerry OS, Samsung's Bada, Microsoft's Windows Phone, and embedded Linux distributions such as Maemo and MeeGo. Such operating systems can be installed on different phone models, and typically each device can receive multiple OS software updates over its lifetime.

Tablet PC and iPads

This mobile device is larger than a mobile phone or a PDA and integrates into a touch screen and is operated using touch sensitive motions on the screen. They are often controlled by a pen or by the touch of a finger. They are usually in slate form and are light in weight. Examples would include ipads, Galaxy Tabs, Blackberry Playbooks etc.

They offer the same functionality as portable computers. They support mobile computing in a far superior way and have enormous processing horsepower. Users can edit and modify document files, access high speed internet, stream video and audio data, receive and send e-mails, attend/give lectures and presentations among its very many other functions. They have excellent screen resolution and clarity.

4. Advantages

Mobile computing has changed the complete landscape of our day-to-day life. Following are the major advantages of Mobile Computing –

Location Flexibility
This has enabled users to work from anywhere as long as there is a connection established. A user can work without being in a fixed position. Their mobility ensures that they are able to carry out numerous tasks at the same time and perform their stated jobs.

Saves Time
The time consumed or wasted while travelling from different locations or to the office and back, has been slashed. One can now access all the important documents and files over a secure channel or portal and work as if they were on their computer. It has enhanced telecommuting in many companies. It has also reduced unnecessary incurred expenses.

Enhanced Productivity
Users can work efficiently and effectively from whichever location they find comfortable. This in turn enhances their productivity level.

Ease of Research
Research has been made easier, since users earlier were required to go to the field and search for facts and feed them back into the system. It has also made it easier for field officers and researchers to collect and feed data from wherever they are without making unnecessary trips to and from the office to the field.

Entertainment

Video and audio recordings can now be streamed on-the-go using mobile computing. It's easy to access a wide variety of movies, educational and informative material. With the improvement and availability of high speed data connections at considerable cost, one is able to get all the entertainment they want as they browse the internet for streamed data. One is able to watch news, movies, and documentaries among other entertainment offers over the internet. This was not possible before mobile computing dawned on the computing world.

Streamlining of Business Processes

Business processes are now easily available through secured connections. Looking into security issues, adequate measures have been put in place to ensure authentication and authorization of the user accessing the services. Some business functions can be run over secure links and sharing of information between business partners can also take place. Meetings, seminars and other informative services can be conducted using video and voice conferencing. Travel time and expenditure is also considerably reduced.

5. Mobile Computing - Security Issues

Mobile computing has its fair share of security concerns as any other technology. Due to its nomadic nature, it's not easy to monitor the proper usage. Users might have different intentions on how to utilize this privilege. Improper and unethical practices such as hacking, industrial espionage, pirating, online fraud and malicious destruction are some but few of the problems experienced by mobile computing.

Mobile Security

Another big problem plaguing mobile computing is credential verification. As other users share username and passwords, it poses as a major threat to security. This being a very sensitive issue, most companies are very reluctant to implement mobile computing to the dangers of misrepresentation.

The problem of identity theft is very difficult to contain or eradicate. Issues with unauthorized access to data and information by hackers, is also an enormous problem. Outsiders gain access to steal vital data from companies, which is a major hindrance in rolling out mobile computing services.

No company wants to lay open their secrets to hackers and other intruders, who will in turn sell the valuable information to their competitors. It's also important to take the necessary precautions to minimize these threats from taking place. Some of those measures include −

- Hiring qualified personnel.
- Installing security hardware and software
- Educating the users on proper mobile computing ethics
- Auditing and developing sound, effective policies to govern mobile computing
- Enforcing proper access rights and permissions

These are just but a few ways to help deter possible threats to any company planning to offer mobile computing. Since information is vital, all possible measures should be evaluated and implemented for safeguard purposes.

In the absence of such measures, it's possible for exploits and other unknown threats to infiltrate and cause irrefutable harm. These may be in terms of reputation or financial penalties. In such cases, it's very easy to be misused in different unethical practices.

If these factors aren't properly worked on, it might be an avenue for constant threat. Various threats still exist in implementing this kind of technology.

6. Mobile Devices And Systems

Mobile Communication:

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.

Mobility and portability will create an entire new class of applications and, possibly, new massive markets combining personal computing and consumer electronics.

Mobile communication entails transmission of data to and from handheld devices. The location of the device can vary either locally or Globally.

Mobile Communication takes place through a wireless, distributed or diversified network and it is a two-way transmission or reception of data streams. Signals from a system can be transmitted through a fiber, wire, or wireless medium

6.1 GUIDED TRANSMISSION:

- Metal wires and optical fibres guided or wired transmission of data.
- Guided transmission of electrical signals takes place using four types of cables
    - Optical fiber, Coaxial cable, Twisted-pair cable, Power line
- Fibre- and wire- based transmission and their ranges Advantages:
- Transmission along a directed path from one point to another
- Practically no interference in transmission from any external source or path
- Using multiplexing and coding, a large number of signal-sources simultaneously transmitted along an optical fibre, a coaxial cable, or a twisted-pair cable

Disadvantages:
- Signal transmitter and receiver fixed.
- Number of transmitter and receiver systems limits the total number of interconnections possible

6.2 UNGUIDED (WIRELESS) TRANSMISSION:

- Wireless or unguided transmission is carried out through radiated electromagnetic energy.
- Electromagnetic energy flows in free space (air or vacuum).
- The radiated energy is of frequency in MHz or GHz spectrum range.
- Spectrum means a set of frequencies in a range.

a) Signal Propagation Frequencies:

- Electrical signals transmitted by converting them into electromagnetic radiation.

- These radiations are transmitted via antennae that radiate electromagnetic signals.
- There are various frequency bands within the electromagnetic spectrum.
- The various types of frequencies are,
    - Long Wavelength (LW) radio, very low frequency.
    - Medium Wavelength (MW) radio, medium frequency.
    - Short Wavelength (SW) radio, high frequency.
    - FM radio band frequency.
    - Very High Frequency (VHF).
    - Ultra High Frequency (UHF).
    - Super High microwave Frequency (SHF).
    - Extreme High Frequency (EHF).
    - Far infrared
    - Infrared
    - Visible Light and Ultra-violet

b) Antennae:

- Devices that transmit and receive electromagnetic radiations.
- Most antennae function efficiently for relatively narrow frequency ranges.
- If an antenna not properly tuned to the frequency band in which the transmitting system connected to it operates, the transmitted or received signals may be impaired.
- The forms of antennae used are chiefly determined by the frequency ranges they operate in and can vary from a **single piece of wire** to a **parabolic dish.**
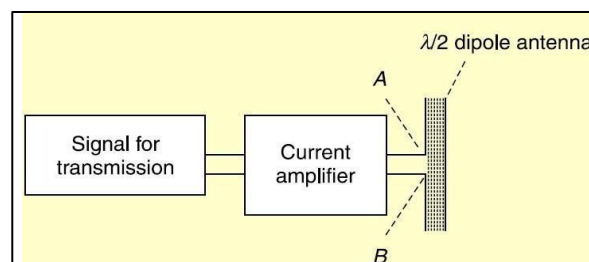
c) Modulation:
- Modulation means modification to original action so that the modification in the action is clearly presented.
- For example, a professor's voice is modulated and reflects his command over the subject.
- Similarly, electrical signals are modulated with information or electrical signals which is then communicated over long distances.
- Types of modulation are,
    - Analog signal modulation, Digital signal modulation, Amplitude modulation
    - Amplitude shift keying, Frequency modulation, Frequency shift keying
    - Phase modulation, Phase shift keying
    - Binary phase shift keying, Gaussian minimum shift keying,
    - Quadrature phase shift keying, Eight phase shift keying
    - Quadrature amplitude modulation (QAM).
    - 64-QAM

d) **Modulation methods and standards for voice-oriented data communication standards:**

1G:- Devices have only voice-oriented communication.

2G:- 2G devices communicate voice as well as data signals.
-Came onto the market in 1988.
-Support data rates up to 14.4 kbps.

2.5G and 2.5G+: -Support data rates up to 100 kbps.

3G:
-Higher data rates than 2G and 2.5G.
-Uses 2 Mbps or Higher for short distance transmission.
-Uses 384 Kbps for long distance transmission.
-Supports voice, data and multimedia streams.
-enable transfer of video clips and faster multimedia communication.

4G:
-Higher data rates than 3G.
-Support streaming data for video.
-Enables multimedia news paper, high resolution mobile TV.
-Support data rates up to 100 Mbps.

GSM and CDMA based standards and mobile communication network for long distance communication:

GSM: Global System for Mobile communication. It was developed by Groupe Speciale Mobile (GSM) and Founded in Europe in 1982. It Support data rates up to 14.4 Kbps and Supports Cellular networks.

GSM900: It is using GMSK for transmitting 1's and 0's.
-Uses FDMA for channels and TDMA for user access in each deployed channel.

ii) EDGE and GPRS 2.5G and 3G:
-GSM has been enhanced to tri-band series and packet oriented data communication.
-GPRS is a packet-oriented service for data communication of mobile devices.
-Utilizes the unused channels in the TDMA mode in a GSM network.
-EDGE is an enhancement of the GSM phase 2.
-it has the data rates up to 48Kbps per 200KHz channel.
EGSM – Extended GSM.
GPRS – General Packet Radio Service.
EDGE – Enhanced Data rates for GSM Evolution. EGPRS – Enhanced GPRS.

e) Modulation methods and standards for data and voice communication:
- CDMA – Code Division Multiple Access,
- FDMA – Frequency Division Multiple Access,
- TDMA – Time Division Multiple Access,

- WCDMA – Wireless CDMA
- UMTS – Upgraded WCDMA methods for downlink and uplink:
- High Speed Packet Data Access is provided by HSPDA and HSUPA.

<u>Mobile Computing</u> is a technology that allows transmission of data, voice and video via a computer or any other wireless enabled device without having to be connected to a fixed physical link.

Mobile Computing is also an umbrella 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 betweendifferent wireless networks. Most technologies discussed in this book dealwith this type of device and the networks supporting them. Today's most successful example for this category is GSM with more than 800 million users.

7. MOBILE COMPUTING ARCHITECTURE
- It represents the architectural requirements for programming a mobile device.
- The requirements are Programming Languages, Functions of OS, and Functions of middleware for mobile systems.

- Mobile computing Architectural Layers, protocols and Layers

i) Programming Languages:
- A variety of programming languages are used in mobile computing architecture.
- Popular language used is Java
- J2ME and Javacard (Java for smartcard)
- J2EE is used for web and enterprise server-based applications of mobile services.
- DOTNET and Python 2.7 are also used.

ii) Functions of OS:
- An OS enables the user to run an application without considering the hardware specifications and functionalities.
- Scheduling multiple tasks.
- Management functions for tasks and memory.
- Interfaces for communication.
- Configurable libraries for the GUI in the device.
- Middleware.

iii) Functions of middleware for mobile systems:

- Middleware are the software components that link the application components with the network-distributed components.
- Mobile OS also provides middleware components.
- Examples are
    - -to discover the nearby Bluetooth device, discover the nearby hotspot.
    - -to retrieve data from a network database.
    - -for service discovery

Mobile computing Architectural Layers:
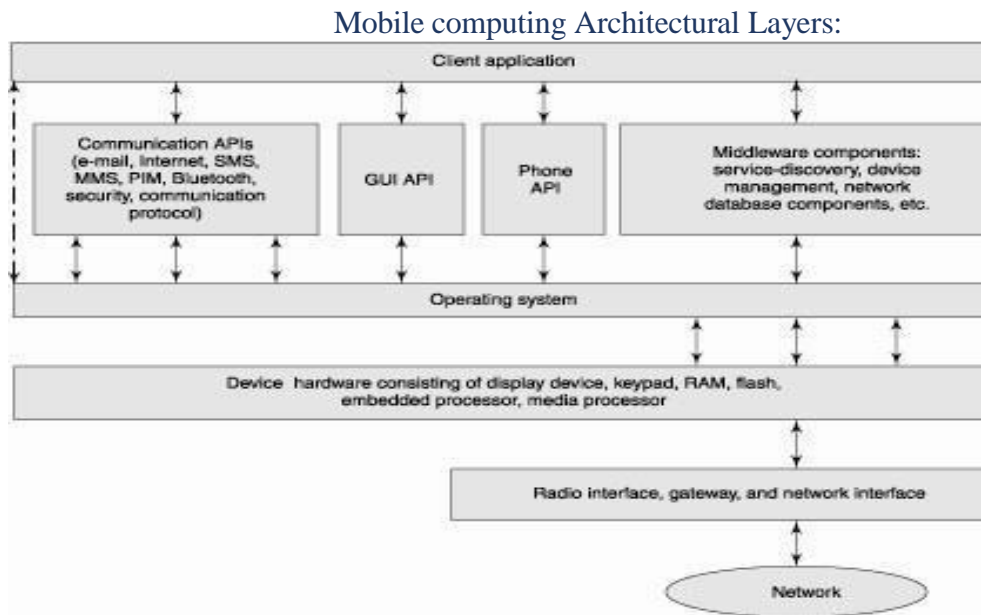
- It refers to defining various layers between the user applications, interfaces, devices and network hardware.
- A well-defined architecture is necessary for systematic computations and access to data and software objects in the layers.

Protocols:
- GSM900, GSM900/1800/1900, CDMA, WCDMA, HSPA, UMTS, i-Mode, LTE, and
WiMax.
- WPAN protocols such as Bluetooth, IrDA, and Zigbee.
- WLAN protocols such as 802.11a, and 802.11b and WAP

Layers: The OSI (open standard for interchange) seven-layer format is
    - -Physical for sending and receiving signals (TDMA or CDMA coding)
    - -Data link (Multiplexing), Networking (for linking to the destination)
    - -Wireless transport layer security (for establishing end-to-end connectivity)
    - -Wireless transaction protocol, Wireless session protocol, and Wireless application environment (for running a mob.appln., e.g., mobile e-business)

8. Mobile Computing Applications
- A large number of applications are available.
- Recently made mobile TV realizable and developed ultra-mobile PC in march-2006
- Some applications include,
    - Smart-phones, Enterprise solutions, Music, Video and E-books, Mobile

Cheque, Mobile Commerce, and Mobile based supply chain management.

SmartPhones:

- A Smartphone is a mobile phone with additional computing functions so as to enable multiple applications.
- For example, **Blackberry 8530 curve** has additional computational capabilities
  - -SMS, MMS, phone, email, address book, web browsing
  - -PIM software
  - -Integrated attachment viewing
  - -QWERTY style layout
  - -Send/End keys
  - -Bluetooth capability for hand-free talking via headset, ear buds, and car kits

Speakerphone:

- -polyphonic ringtones for personalizing your device
- -bright high resolution display, supporting over 65,000 colours
- -WiFi 802.11b and WiFi 802.11g
- -GPS Tracker
- -Media voice or video or camera picture recording and communication
- -Live TV
- -MicroSD card 256MB

Enterprise Solutions:

- Enterprises or large business networks have huge database and documentation requirements.
- The term 'enterprise solutions' therefore refers to business solutions for corporations or enterprises.
- It includes specialized hardware or software programming for,
  - -Storage management
  - -Security
  - -Revision
  - -Distribution and so on.

Music, Video and E-books:

- The Apple iPods or iPhones or iPads have made it possible to listen one's favourite tunes anytime anywhere.
- iPads have made it possible to read one's favourite book anytime anywhere.
- Besides storing music these players can also be used to view photo albums, slide shows and video clips.

Mobile Cheque and Mobile Commerce:

- Mobile Cheque is a mobile based payment system employed during a purchase.
- The service is activated through text message exchanges between the customer, a designated retail outlet, and the mobile service provider.

- M-commerce is also a new trend, such as buying or selling of items through mobile internet between customers and organizations.
- Mobile devices also used for e-ticketing, i.e, for booking cinema, train, flight and bus tickets.

Mobile-based Supply Chain Management:
- The producer-consumer problem is called as SCM problem.
- Leading IT companies have developed mobile device software for SCM systems.
- The sales force and the manufacturing units use such mobile devices to maintain SCM.

9.   Limitations of Mobile Computing:
- Resource Constraints : Battery
- Interference: Radio transmission cannot be protected against interference using shielding and result in higher loss rates for transmitted data or higher bit error rates respectively.
- Bandwidth: Although they are continuously increasing, transmission rates are still very low for wireless devices compared to desktop systems. Researchers look for more efficient communication protocols with low overhead.
- Dynamic changes in communication environment: variations in signal power within a region, thus link delays and connection losses
- Network issues: discovery of the connection-service to destination and connection stability
- Interoperability issues:
- 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.

A simplified reference model

The figure shows the **protocol stack** implemented in the system according to the reference model. **End- systems** (such as the PDA and computer) need a full protocol to handle the application layer, transport layer, network layer, data link layer, and physical layer? Applications on the end- systems communicate with each other using the lower layer services. **Intermediate systems**, such as the interworking unit, do not necessarily need all of the layers.

A Simplified Reference Model

Physical layer: This is the lowest layer in a communication system and is responsible to convert the stream of bits into signals that can be transmitted on the sender side. The physical layer of the receiver then transforms the signals back into a bit stream. For wireless communication, the physical layer is responsible for frequency selection, generation of the carrier frequency, signal detection, modulation of data onto a carrier frequency and encryption.
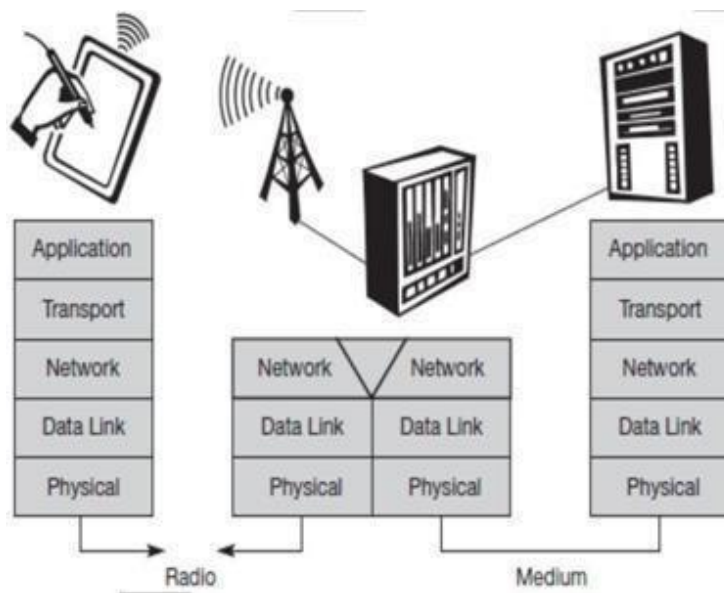
- **Data link layer**: The main task of this layer is to access the medium, multiplexing of different data streams, correction of transmission errors, and synchronization (i.e., detection of a data frame).

Therefore, the data link layer is responsible for a reliable point-to-point connection between two devices or a point-to-multipoint connection between one sender and several receivers.

- **Network layer**: This third layer is responsible for routing packets through a network or establishing a connection between two entities over many other intermediate systems. Important functions are addressing, routing, device location, and handover between different networks.

- **Transport layer**: This layer is used in the reference model to establish an end-to-end connection

- **Application layer**: Finally, the applications are situated on top of all transmission oriented layers. Functions are service location, support for multimedia applications, adaptive applications that can handle the large variations in transmission characteristics, and wireless access to the world-wide web using a portable device.