UNIT 6

MOBILE PLATFORMS AND APPLICATIONS

Android and its advantages?

It is an open-sourced operating system that is used primarily on mobile devices, such as cell phones and tablets. It is a Linux kernel-**based system that's been equipped with rich components that allows** developers to create and run apps that can perform both basic and advanced functions.
Advantages
- Open-source
- Platform-independent
- supports various technologies (camera, Bluetooth, wifi, speech, EDGE)

Google Android SDK?

The Google Android SDK is a toolset that developers need in order to write apps on Android enabled devices. It contains a graphical interface that emulates an Android driven handheld environment, allowing them to test and debug their codes.

Android Architecture?

Android Architecture is made up of 4 key components:
– Linux Kernel
– Libraries
– Android Framework
– Android Applications

Android Framework.
The Android Framework is an important aspect of the Android Architecture. Here you can find all the classes and methods that developers would need in order to write applications on the Android environment.

use of an activityCreator?
An activityCreator is the first step towards the creation of a new Android project. It is made up of a shell script that will be used to create new file system structure necessary for writing codes within the Android IDE.

Describe Activities.

Activity: Each activity presents a GUI screen of an application. An activity is a single, focused thing that the user can do. Whenever user click on GUI the next Activity will be start and new GUI set base on coding.

For example, a chat application might have one activity that allows to create a chat, another to view the previous chat sessions, etc

Intents?

Intent is exactly what it describes. It's an "intention" to do an action. Intents displays notification messages to the user from within the Android enabled device. It can be used to alert the user of a particular state that curred. Users can be made to respond to intents.

Differentiate Activities from Services.

Activities can be closed, or terminated anytime the user wishes. On the other hand, services are designed to run behind the scenes, and can act independently. Most services run continuously, regardless of whether there are certain or no activities being executed.

POS. (Nov/Dec 2016)

Point-of-Sale (PoS) usually means a checkout counter in a shop or supermarket. More specifically, the point-of-sale often refers to the hardware and software used for handling customer purchases at the checkout desks. An example of a PoS terminal is an electronic cash register. Nowadays, the point-of-sale systems are used in almost every supermarket and are used in many retail stores too.

importance of Android in the mobile market?

Developers can write and register apps that will specifically run under the Android environment. This means that every mobile device that is Android enabled will be able to support and run these apps. With the growing popularity of Android mobile devices, developers can take advantage of this trend by creating and uploading their apps on the Android Market for distribution to anyone who wants to download it.

some disadvantages of Android?

Android is an open-source platform, and the fact that different Android operating systems have been released on different mobile devices, there's no clear cut policy to how applications can adapt with various OS versions and upgrades. One app that runs on this particular version of Android OS may or may not run on another version.
The mobile devices such as phones and tabs come in different sizes and forms, it poses a challenge for developers to create apps that can adjust correctly to the right screen size and other varying features and specs.

ADB

Adb is short for Android Debug Bridge. It allows developers the power to execute remote shell commands. Its basic function is to allow and control communication towards and from the emulator port.

four essential states of an activity?

Active – if the activity is at the foreground
Paused – if the activity is at the background and still visible
Stopped – if the activity is not visible and therefore is hidden or obscured by another activity
Destroyed – when the activity process is killed or completed terminated

Differentiate E-Commerce and M-Commerce.(Nov/Dec 2016)

E-commerce or electronic **commerce**, is the process of buying and selling goods, products and services over electronic systems such as internet, telephone and **e**-mail.

M-**Commerce** or **mobile commerce** is process of buying and selling products and services through wireless handheld devices such as cell phones or PDAs

Dalvik play role in Android development?

Dalvik serves as a virtual machine, and it is where every Android application runs. Through Dalvik, a device is able to execute multiple virtual machines efficiently through better memory management.

Radio Frequency Identification?

A Radio Frequency Identification (RFID) tag attached to a product, animal, or person for the purpose of identification and tracking, makes use of radio waves. Some tags can be read from several metres away and beyond the line of sight of the reader.

Do all mobile phones support the latest Android operating system?
Some Android-powered phone allows you to upgrade to the higher Android operating system version. However, not all upgrades would allow you to get the latest version. It depends largely on the capability and specs of the phone, whether it can support the newer features available under the latest Android version.

portable wifi hotspot?

Portable Wi-Fi Hotspot allows you to share your mobile internet connection to other wireless device. For example, using your Android-powered phone as a Wi-Fi Hotspot, you can use your laptop to connect to the Internet using that access point.

What is action?

In Android development, an action is what the intent sender wants to do or expected to get as a response. Most application functionality is based on the intended action.

Difference between a regular bitmap and a nine-patch image?

In general, a Nine-patch image allows resizing that can be used as background or other image size requirements for the target device. The Nine-patch refers to the way you can resize the image: 4 corners that are unscaled, 4 edges that are scaled in 1 axis, and the middle one that can be scaled into both axes.

language is supported by Android for application development?

The main language supported is Java programming language. Java is the most popular language for app development, which makes it ideal even for new Android developers to quickly learn to create and deploy applications in the Android environment.

Inventors of android: Andy Rubin, Rich Miner, Nick Sears

Features of Android OS
Live wallpaper , Camera , Messaging, Bluetooth, WIFI, Web Browsing, Music, **Alarm etc.**
- Google now (voice assistant)
- NFC (Near Field Communication)
- Unlock your phone by your face
- Use your phone with joystick to enjoy gaming experience
- Connect your phone with LED TV via MHL or micro HDMI cable
- Screen Capture
- Multitasking Future (Task Switcher)
- Data Usages (Check and also set limit from device)

Tools Required for Developing Android Apps?

Tools:
- Java Development Kit (**JDK**)
- Android Development Tools (**ADT**) - Android Studio by Google
- Software Development Kit (**SDK**)

Languages:
- Java
- XML

Android application main components are?

Components	Description
Activities	They dictate the UI and handle the user interaction to the smartphone screen
Services	They handle background processing associated with an application.
Broadcast Receivers	They handle communication between Android OS and applications.
Content Providers	They handle data and database management issues.

AVD

AVD Stand for Android Virtual Device (emulator), The Android SDK includes a mobile device emulator - a virtual mobile device that runs on your computer.

examples of Mobile OS

The mobile OS has to also facilitate third party development of application software and yet allow manufacturers of different brands of mobile devices to build their choice set of functionalities for the users.

Types of Mobile Operating System:

- ☐ Windows Mobile
- ☐ Palm OS
- ☐ Blackberry OS
- ☐ Symbian OS
  iPhone OS (iOS)
- ☐ Android OS

☐
M-Commerce

Mobile commerce, involves carrying out any activity related to buying and selling of commodities, services, or information using the mobile hand-held devices.

The popularity of m-commerce can be traced to the convenience it offers both to the buyers and sellers.

An important issue in M-commerce is how payments can be made securely and rapidly as soon as a buyer decides to make a purchase.

The use of computers and networking in trade related transactions has been limited to automatic teller machines (ATMs), banking networks, debit and credit card systems, electronic money and electronic bill payment systems (E-payment).

PART – B

Operating System Responsibilities in Mobile Devices And how the resources managed by the OS.

Managing Resources

The operating system of a mobile device is to facilitate *efficient utilization of the resources* of the device by performing multiple tasks. The resources that are managed by the operating system include processor, memory, files, and various types of attached devices such as camera, speaker, keyboard, and screen.

Typically, a mobile device is expected to run multiple applications at the same time and each application may in turn require running multiple tasks.

A task can have multiple threads. A few examples of such applications include voice communication, text messaging, e-mail, video play, music play, recording, web browsing, running remote applications, etc.

As an example *scenario of usage of a smartphone,* consider the following: a person might be listening to music, at the same time he might answer an incoming call, and an SMS might arrive at the same time which he might like to look-up while the call is still on.

Such a scenario requires *concurrent execution of multiple tasks*. When multiple tasks contend to use the same set of resources, the OS acts like a traffic cop—ensuring that different tasks do not interfere with each other.

Providing Different Interfaces

The operating system of a mobile device on the one hand provides a highly interactive interface to the user of the device and on the other interfaces with other devices and networks.

An important interface concerns control, data, and voice communications with the base station using different types of protocols.

An OS takes care of recognizing inputs from the keyboard, sending outputs to the display screen, and interfacing with peripheral devices such as other mobile devices, computers, printers, etc.

For the sake of brevity, we shall refer to the operating system used in a mobile hand-held device as a mobile OS.

The mobile OS marketplace is dominated by Symbian, Android, Windows mobile, Palm OS, iOS, and Blackberry OS.

components of Mobile Operating SystemMobile O/S—A Few Basic concepts

The operating system providing a set of services to the application programs. The operating system is usually structured into a kernel layer and a shell layer.

The shell essentially provides facilities for user interaction with the kernel. The kernel executes in the supervisor mode and can run privileged instructions that could not be run in the user mode.

During booting, the kernel gets loaded first and continues to remain in the main memory of the device. This implies that in a virtual memory system, paging does not apply to the kernel code and kernel data. Therefore the kernel is called the *memory resident* part of an operating system.

The shell programs are usually not memory resident. The kernel of the operating system is responsible for interrupt servicing and management of processes, memory, and files.

The traditional operating systems such as Unix and Windows are known to have a monolithic kernel design.

In a monolithic kernel OS design, the kernel essentially constitutes the entire operating system code, except for the code for the shell.

The principal motivation behind this monolithic design was the belief that in the supervisor mode, the operating system services can run more securely and efficiently.
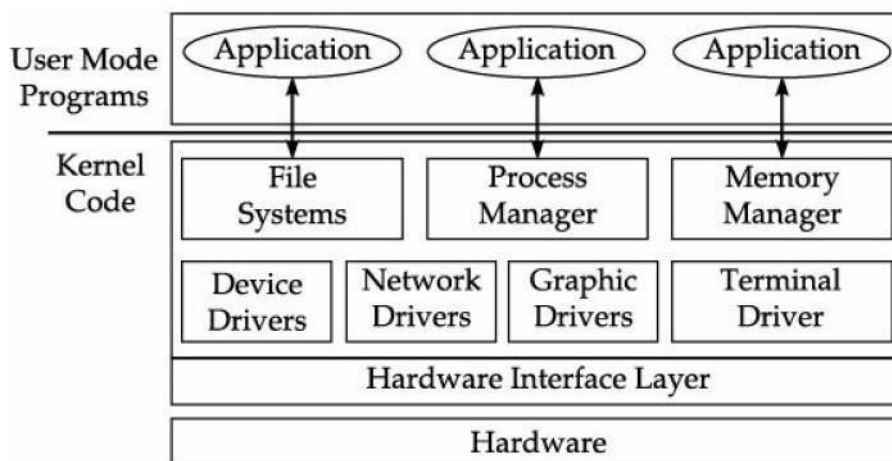
(a) Monolithic kernel
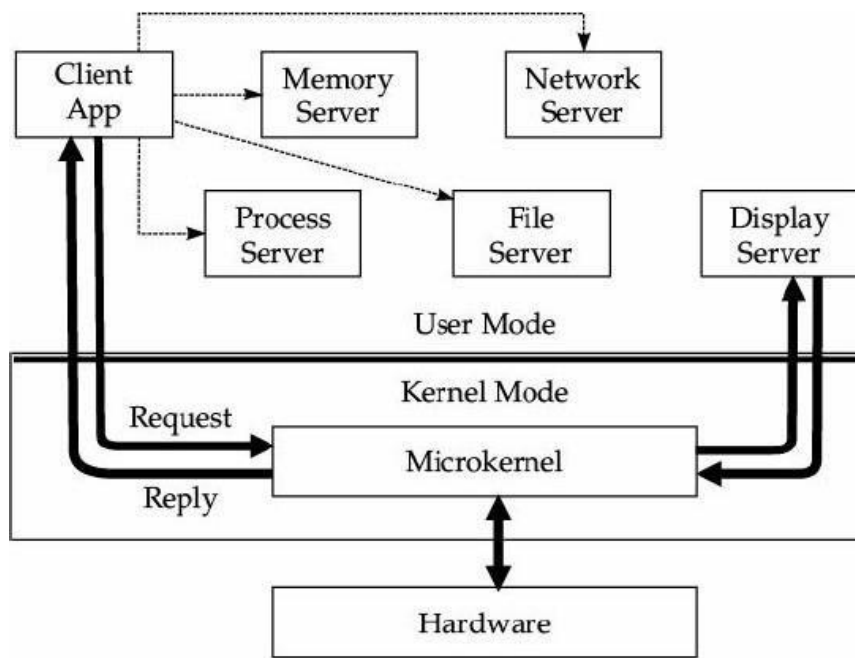
(b) Microkernel

Monolithic design versus microkernel design of an operating system.

The main problem with the monolithic kernel design is that it makes the kernel massive, non-modular, hard to tailor, maintain, extend, and configure.

The microkernel design approach tries to minimize the size of the kernel code. Only the basic hardware-dependent functionalities and a few critical functionalities are implemented in the kernel mode and all other functionalities are implemented in the user mode.

Most of the operating system services run as user level processes. The main advantage of this approach is that it becomes easier to port, extend, and maintain the operating system code.

The kernel code is very difficult to debug compared to application programs. The reason for this is that a bug in a kernel code can crash the system, thus crashing the debugger too.

Further, even when some operating system service crashes while being used by a user, it does not bring down the entire system. This is one reason as to why a microkernel operating system could be expected to be more reliable than an equivalent monolithic kernel operating system.

The overall architectural difference between a monolithic kernel and a microkernel architecture is: To restrict the size of the kernel of a mobile OS to the minimum, most mobile OS are, to different extents, based on the microkernel design.

special features that an operating system for a mobile device needs to support compared to the features provided by a traditional operating system.

Special Constraints and Requirements of Mobile O/S

A few special features that are required to be supported by a mobile OS, but are not present in traditional operating systems. A mobile device is powered by severely limited energy stored in a tiny battery.

Limited memory

A mobile device usually has much less permanent and volatile storage compared to that of a contemporary desktop or laptop. To cope with the limited memory of a mobile device, the OS must be as small as possible and yet provide a rich set of functionalities to meet user demands.

Limited screen size

The size of a mobile handset needs to be small to make it portable. This limits the *size of the display screen*. Consequently, new innovative user interfaces need to be supported by the mobile OS to overcome this constraint and minimize user inconveniences.

For example, many handsets provide easy configurability of the interface to suit individual preferences, switching between menu and iconic interfaces, etc.

Miniature keyboard

Mobile handsets are either provided with a small keypad or the small-sized display screen is designed to be used as a keyboard in a touch screen mode using a stylus. In both these arrangements, typing in the documents and entering the string commands is difficult. This mandates the provision of some facility for word completion prompts and availability of capabilities for free form handwriting recognition.

Limited processing power

A vast majority of modern mobile devices incorporate ARM-based processors. These processors are certainly energy efficient, powerful, and cheaper compared to the desktop or laptop processors, yet these are significantly slower. The sizes of the on-chip and off-chip memory are also restricted.

The cope with the restricted processing power, storage, and battery power, usually the operating system is made to provide only a limited number of functionalities that are useful in the actual operation of the mobile.

Activities such as mobile application development that require use of memory-intensive utility programs, such as editors and compilers, are carried out on a desktop or laptop, and only after the application is completely simulated and tested, it is cross-compiled and downloaded onto the mobile device.

Limited battery power

Mobile devices need to be as lightweight as possible to increase their portability. Due to the severe restrictions that are placed on their size and weight, a mobile device usually has a small battery and often recharging cannot be done as and when required.

In spite of the small battery, a mobile phone is expected to support long talk time without the need to recharge frequently.

Consequently, the operating system for a mobile device needs to be not only computationally efficient, but also at the same time expected to minimize power consumption.

The techniques used by an OS to *reduce power consumption* include putting the processor and display screen into sleep mode within a few seconds of inactivity, and varying the intensity of transmitted antennae power as per requirement, etc.

Limited and fluctuating bandwidth of the wireless medium

The operating system of a mobile handset needs to run complex protocols due to the inherent problems caused by mobility and the wireless medium.

A wireless medium is directly susceptible to atmospheric noise, and thereby causes high bit error rates.

The bandwidth of a wireless channel may fluctuate randomly due to atmospheric noise, movement of some objects, or the movements of the mobile handset itself. This can show up as short-term fades.

There can be relatively longer-term disconnections due to handoffs. In this context, uninterrupted communication requires a special support for data caching, pre-fetching, and integration.

facilities that are not supported by a traditional operating system and are mandated to be supported by a mobile device and the specific <u>operating system service requirements</u> that it makes use of.

Special Service Requirements

Several facilities and services that are normally not expected to be supported by a traditional operating system are mandated to be supported by a mobile OS. We identify a few important ones in the following.

Support for specific communication protocols

Mobile devices are often required to be connected to the base station and various types of peripheral devices, computers and other mobile devices. This requires enhanced communication support.

The types of communication protocols used for communication with the base station depend on the generation of the communication technology (1G, 2G, etc.) in which the mobile device is deployed. For communication with other devices and with computers, TCP/IP and wireless LAN protocols also need to be supported.

For web browsing as well as communication with other personal devices such as pen drive and headphones, though mobile devices are equipped with USB and other types of ports, mobility constraints often make infrared or Bluetooth connections preferable. This mandates the operating system to support multiple interfacing protocols and hardware interfaces.

Support for a variety of input mechanisms

A miniature keyboard forms the main user input mechanism for an inexpensive mobile device. Sophisticated mobile devices (smartphones) usually support the QUERTY keyboard. Many recent mobile devices also support touchscreen or even stylus-based input mechanisms along with the handwriting recognition capability.

A mobile OS needs to support a variety of input mechanisms to make it generic and usable by different manufacturers of mobile devices.

Compliance with open standards

Adhering to an open standard facilitates the development of innovative applications by third-party developers. To facilitate the third party software development as well as to reduce the cost of development and time-to-market by the mobile handset manufacturers, the OS should adhere to open standards.

Smart phones come in many different shapes and sizes and have varying screen sizes and user input capabilities. Therefore, the user interface and networking capabilities of a mobile OS need to be designed keeping these diversities in view.

Extensive library support

The cost-effective development of third party applications requires extensive library support by the OS. Library support includes the availability of programmer callable primitives for email, SMS, MMS, Bluetooth, multimedia, user interface primitives, and GSM/GPRS functionalities.

commercial operating systems for mobile phones and mention the important characteristics of each one.

A Survey of Commercial Mobile Operating Systems

It is a challenging task to design a mobile OS with a set of core capabilities that are expected to be supported by mobile devices and with a consistent programming environment across all smart phones that install the OS.

The mobile OS has to also facilitate third party development of application software and yet allow manufacturers of different brands of mobile devices to build their choice set of functionalities for the users.

Types of Mobile Operating System:

- Windows Mobile
- Palm OS
- Blackberry OS
- Symbian OS
- iPhone OS (iOS)
- Android OS

Windows Mobile

- Windows CE (Compact Edtion) - designed specifically for handheld devices, based on Win32 API. It is run on Pocket PCs, Smartphones and Portable media centers.
- PDA (Personal Digital Assistant), palmtop computer, PocketPC were original intended platform for the Windows Mobile OS
- It provides ultimate interoperability.
- Users with various requirements are able to manipulate their data.
- It provides for *deterministic scheduling of time-constrained tasks.*
- Windows mobile operating system to be used across a wide cross section of mobile phone manufacturers.
- Microsoft defined a hardware specification for hand-held computers that can run its *Windows Mobile* operating system in order to simplify the design of the operating system and to reduce the number of versions of the operating system. It was also intended to make the cell phones manufactured by different vendors appear uniform.
- Microsoft later renamed its Pocket PC operating system to *Windows Mobile Classic*. Windows mobile classic operating systems support *touch screen-based user interface*.

A family of Windows Mobile support three operating systems:

Windows Mobile Standard and Windows Mobile Professional are targeted for use in smartphones, and *Windows Mobile Classic* is not targeted for cell phones, but for PDAs.

Many *third-party software applications* are available for Windows mobile. These software applications can be purchased via the *Windows Marketplace for mobiles*.

The marketplace is a website maintained by Microsoft, where different application developers can submit their applications for download by the subscribers.
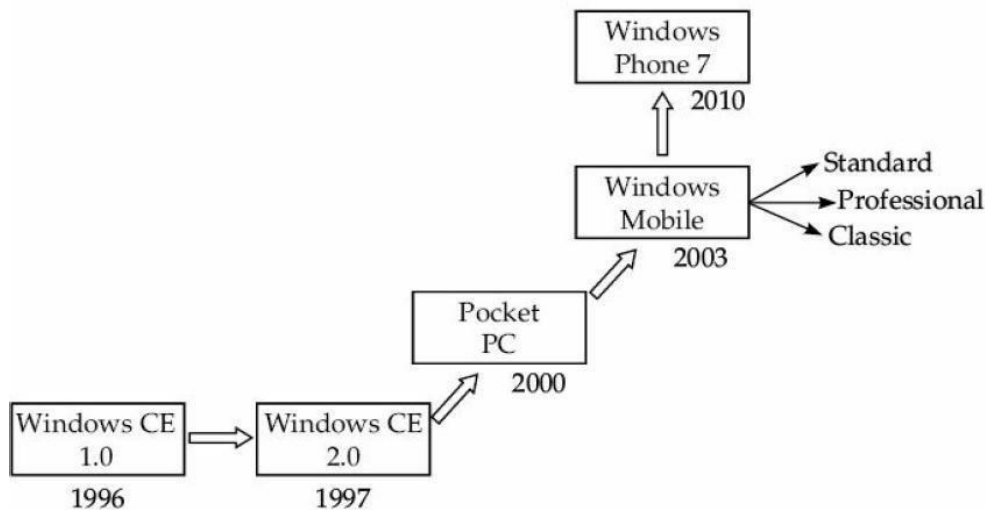
Evolution of Microsoft's mobile OS.

Microsoft passes on 70% of the fee received to the developers hosting their applications. Windows mobile has recently been superseded by Windows Phone7.

The Windows mobile was the joint announcement in 2011 by Microsoft and Nokia of a partnership between their companies. They announced that Windows Phone 7 operating system would be used as the operating system for Nokia smartphones.

The mobile OS marketplace would henceforth see a three horse race and named Android and iOS, the main competitors of Windows Phone 7.

Windows Phone 7 is a significant improvement over the Windows mobile operating system.

Microsoft has not maintained backward compatibility with the Windows mobile operating system, meaning that a mobile application that runs on the Windows mobile may not run on the Windows phone OS.

Microsoft has defined the hardware specifications that a Windows Phone 7 device must meet. For example, it should support a screen resolution of 800 X 480 pixels. Windows Phone 7 devices need to have an accelerometer and a compass.

Windows phone operating system provides a *touchscreen interface* with facilities for both command and text input. The operating system detects when a device has been rotated from portrait to landscape orientation.

A few important features of the Windows mobile OS are the following:

- The Graphics/Window/Event manager (GWE) component handles all input and output.
- Provides a virtual memory management.
- Supports security through the provision of a cryptographic library.
- Application development is similar to that in the Win32 environment.
- Many programmers have knowledge of Win 32-based application development.
- At present, it does not provide true multitasking. An application in the background goes into

hibernation and gets active only when it comes to foreground.

- Microsoft may support true multitasking in the future versions of the Windows Phone operating system.

Palm OS

Palm OS (also known as Garnet OS) is a proprietary operating system that was developed by Palm Computing in 1998 for its highly successful PDA called Palm Pilot. Palm OS was designed for ease of use with the provision of a touchscreen-based graphical user interface.

Palm OS was upgraded to facilitate installation in several different mobile devices, such as smartphones of different makes, wrist watches, hand-held gaming consoles, bar code readers and GPS devices.

The key features of the current Palm OS (named Garnet) are the following:

- It is essentially a simple single-tasking operating system. As a result, only one application can run at a time. For example, if you are on voice communication, you cannot use the calculator, or read an SMS.

- It has an elementary memory management system. To keep the operating system small and fast, Palm OS does not isolate the memory areas of applications from each other. Consequently, any misbehaving application can crash the system.

- Palm supplies Palm emulator, which emulates the Palm hardware on a PC. This allows Palm programs to be developed and debugged on a PC before being run on the Palm hardware.

- It supports a handwriting recognition-based system for user input.

- It supports a facility called HotSync technology for data synchronization with desktop computers.

- It supports sound playback and recording capabilities.

- It incorporates a very simple and rudimentary security model in which a device can be locked by password.

- The different interfaces supported include Serial port/USB, infrared, Bluetooth and Wi-Fi connections.

- It uses a proprietary format to store calendar, address, task and note entries and yet are accessible by third-party applications.

Blackberry Operating System

Blackberry operating system is a proprietary operating system designed for BlackBerry smartphones produced by Research In Motion Limited (RIM).

Being a proprietary operating system, details of its architecture have not been published. But, at the user level, the very good email system that it deploys is easily noticed.

It supports instant mailing while maintaining a high level of security through ondevice hardware-based message encryption

Symbian OS

Symbian operating system was developed through a *collaboration among a few prominent mobile device manufacturers* including Nokia, Ericsson, Panasonic, and Samsung.

Its objective was to develop a single industry standard operating system.

In 2008, Ericsson, Sony, Panasonic, and Samsung pulled out of the collaboration, selling their stake to Nokia. Around the same time, Google announced Android as an open operating system.

The Symbian source code was published under **Eclipse Public License (EPL) in February 2010**. This event was reported to be the largest codebase transition from proprietary to **Open Source in the entire history.**

Symbian OS is a real time, multitasking, pre-emptive, 32-bit operating system that runs on ARMbased processor designs.

Symbian comes in two major flavours.

(a) **Series 60:** It support large sized colour screen, easy-to-use interface and an extensive suite of applications make it well-suited to support advanced features such as rich content downloading and MMS (Multimedia Messaging Service). Series 60 was mainly being used on Nokia's smartphones and Samsung handsets.

(b) **UIQ interface:** UIQ (earlier known as User Interface Quartz) is a software package developed by UIQ Technology for Symbian OS. Essentially, this is a graphical user interface layer that provides capabilities for third-party application developers to develop applications and effortlessly create user interfaces.

A few other important features supported by the Symbian operating system are given below:

- It supports a number of communication and networking protocols including TCP, UDP, PPP, DNS, FTP, WAP, etc. For personal area networking, it supports Bluetooth, InfraRed and USB connectivity.
- Open standards and *interoperability.*
- Open application environment.
- Flexible User Interface Design
- It supports *pre-emptive multitasking scheduling and memory protection*.
- Symbian is a *microkernel-based operating system.* It is optimized for low-power and memory requirements.
- Fully object-oriented design paradigm and component based.
- All Symbian programming *is event-based*, and the CPU is switched into a low-power mode when the applications are not directly dealing with an event. This is achieved through a programming idiom called *active objects.*
- Carbide is an Integrated Development Environment (IDE) toolkit that is available for C++ application development on Symbian OS.
- Symbian works as an *Eclipse plug-in.* Development kits are available at Nokia and the Symbian Foundation websites.

iOS

- iOS Founder were Steve Wozniak and Steve Jobs.

- Developed and distributed by Apple. Inc.,

- Apples mobile operating system considered the foundation of the iPhone

- iPhone OS was first unveiled in Jan 2007 at the Macworld Conference and Expo

- Released June 2007

- Originally designed for the iPhone but now supports iPod touch, iPad, and Apple TV

- iOS is derived from Mac OS.

- Apple *does not license iOS for installation on third-party hardware.*

- The user interactions with OS include gestures such as *swipe*, *tap*, *pinch*, and *reverse pinch*, all of which have specific definitions within the context of the iOS operating system.

- The other innovative user interactions are internal accelerometers used by some applications for shaking the device as the undo command, rotating the device in three dimensions to switch the display mode from portrait to landscape, etc.
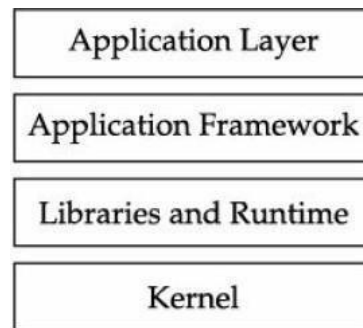
Android OS:

- Android is a Linux-based operating system for mobile devices such as smartphones and tablet computers. There are more than 4,00,000 apps in Android Markets
- Android specially developed for applications. Android has a better app market.
- The Android is an open source
- Android, Inc. found in Palo alto in California united states by Andy Rubin. - October 2003
- In 2005, Google acquired a small startup company called Android, which was developing an operating system for mobile devices based on Linux.

- The Open Handset Alliance, a group of serveral companies was formed – 5 Nov 2007. To develop the Android operating system as an open source software for mobile devices.
- Android Beta SDK Released – 12 Nov 2007.

- Android can run multiple apps at the Same Time. Also support optimized graphics VGA, 2D graphics and 3D graphics
- Google could embed its search engine into Android, the way Internet Explorer is *embedded into Windows.*
- Android provided the ability to seamlessly use either a phone-based keyboard or a touchscreen.
- Mobile users expect to browse real web pages, and not the simplified mobile versions of those pages.
- Many mobile handsets support browsing alternative sites provided by many website operators for mobile handsets with small screens and limited interfacing capabilities.
- Android operating systems by providing a built-in full web browser capable of rendering full web pages and not just small mobile versions.
- An important handicap of the competing operating systems is *the difficulty of development of third-party applications*.
- Apple does not facilitate *third party application development* and is implicitly promoting a *closed proprietary environment,* where the internal working of the operating system is not exposed to the developers.
- A prominent advantage that Android holds out is that Android SDK works in Eclipse environment. Since many developers are already exposed to these standard technologies, there is a **large pool of developers available** for working on projects on the **Android platform**.
- It provides an RDBMS SQLite for data storage and data sharing across various applications.

⊔   It has several innovative pre-installed applications such as Gmail, Maps, voice search, etc.
⊔   Android allows application developers to write code in the Java language. It facilitates the development of applications with the help of a set of core Java libraries developed by Google.

The Android code is structured into four different layers as shown in Fig. 9.3.

Android software stack.

Application layer

The Android operating system comes with a set of basic applications such as web browser, email client, SMS program, maps, calendar, and contacts repository management programs. All these applications are written using the *Java programming language J2ME.*

Application framework

An application framework is used to implement a standard structure for different applications. The application framework essentially provides a set of services that an application programmer can make use of. The services include managers and content providers.

Content providers enable applications to access data from other applications. A notification manager allows an application to display custom alerts on the status bar.

Libraries and runtime

The available libraries are written using multiple languages such as C and C++. These are called through a Java interface. These include a Surface Manager, 2D and 3D graphics, Media Codecs like MPEG-4 and MP3, an SQL database SQLite and the web browser engine called WebKit.

The Android runtime consists of two components.
1.   The core libraries of the Java language.
2.   Dalvik virtual machine.

⊔   Most applications that run on Android are written in Java.
⊔   Dalvik translates a Java application program into machine code of the mobile device and executes it by invoking the operating system.

- These can be compiled to ARM native code and installed using the Android native development kit (SDK).
  Every Android application runs its own process with its own instance of the Dalvik virtual machine.

Kernel

Android kernel has been developed based on a version of Linux kernel. However, it has excluded the Native X Window System and does not support the full set of standard GNU libraries.

Based on the Linux kernel code, Android implements its own device drivers, memory management, and process management and networking functionalities. Android is *multitasking* and allows applications to run concurrently.

For example, it is possible to hear music and read or write an email at the same time. Google initially maintained the kernel code they contributed to in the *Linux public distribution*. Google maintains its own code tree. This has marked the branching of Android from Linux code in the public distribution.

Compare and contrast the various Mobile OSTypes of Mobile Operating System:

- Windows Mobile
- Palm OS
- Blackberry OS
- Symbian OS
  iPhone OS (iOS)
- Android OS

Android provides a flexible UI and is rich in features, being based on the open source Linux. Windows Phone lacks many features provided by Android, and iOS.

A major reason behind Android's success is that it facilitated competitiveness of hardware makers without good software capabilities. The royalty-free Linux-based Android has been adopted by all the major Asian handset makers such as Samsung, HTC, LG, etc. as well as Motorola and Sony Ericsson.

All these operating systems have very small footprint, run on ARM-based processors, and support demand paging.

Feature	Android	Symbian OS	Windows Phone 7
Feature License	Public, Free, and Open Source	Initially was private, later became public	Proprietary
Footprint	250 KB	200 KB	300 KB
Change of UI	Possible	No	No
Power management	Yes	Yes	Yes
Kernel	Linux with minor changes	Proprietary	Win CE
True multitasking	Yes	Yes	No
Premeptive scheduling	Yes	Yes	Yes

Demand paging	Yes	Yes	Yes
. CPU architecture supported	ARM, MIPS, X86	ARM	ARM

how an operating system for a sensor network is different from a traditional operating system.

Operating Systems for Sensor Networks

A sensor node is tiny and needs to operate in an extremely power-constrained environment. Consequently, it deploys a rudimentary operating system and does not have a kernel mode of operation. It does not support dynamic memory allocation nor does it support virtual memory. It also does not use tasks, signals, and exceptions, but uses functional call in its place.
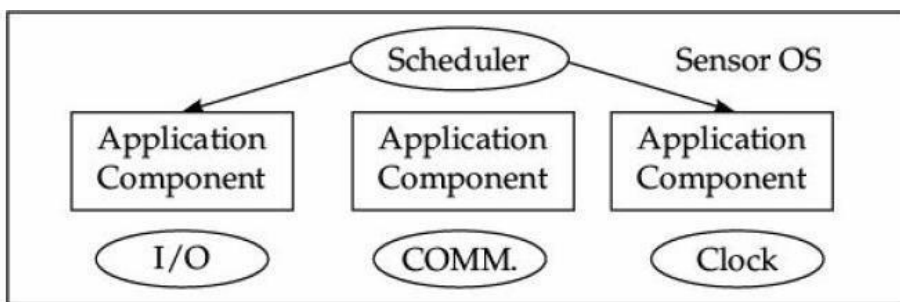
Schematic model of the structure of a sensor operating system.

Observe that the cheduler invokes the different application components in response to a specific event.The important operating systems that are available for sensor nodes include TinyOS, Contiki OS, Lite oS, and MANTIS.

Android SDK SDK Android Software Development Kit (SDK)

Cell phones are small in size and therefore can easily be carried everywhere like a wallet. Considering their portability and the powerful feature sets that they provide, they have now come to play an important **part in today's society.**

The mobile phones implement new and innovative functionalities. For example, many handsets provide facilities for radio and television reception, timer and clock, Internet access, camera, and calculator,etc.

A successful mobile operating system needs to facilitate the development of *third-party applications.* The open operating systems stand out in facilitating the development of third-party applications and Android application development tools have now been well received.

Android SDK Environment

The Android SDK (Software Development Kit) is a *mobile application development frame work* using which developers can create applications for the Android platform. The Android SDK provides the *tools and libraries necessary to develop applications* that can run on Android-based devices.

Advantages:
- ☐ Android SDK is the low processor of RAM requirements.
- ☐ Android SDK can be installed on almost all common operating systems such as Windows, Mac OS, and Linux.

The SDK comes with an Integrated Development Environment (IDE) and other tools which are required to develop applications. Android SDK converts Java byte **code to Android's Dalvik VM byte code.** The android-based applications, the developer codes the applications using Java.

The environment to develop applications for Android consists of the Android SDK, the IDE Eclipse and the Java Development Kit (JDK). After installing the SDK, which is done by simply extracting the downloaded ZIP file in a folder, the path to the SDK has to be set in the path environment variable. Eclipse can be used as the IDE, which also automatically installs the Android SDK as a plug-in.

Features of SDK

Using the SDK, one can either run the application on the actual Android device or a software emulator on the host machine. This is achieved by using the Android Debug Bridge (ADB) available with the SDK.

ADB is a client-server program and includes three main components:

- A client program which runs on the developer's (called host) machine. One can invoke a client from a shell by issuing an adb command.
- ☐ A daemon program which runs as a background process on each emulator or device instance.
- ☐ It is the part that actually manages the communication with the handset or the emulator and helps in executing the application.
- ☐ A server program which runs as a background process on the host machine. The server manages communication between the client and an adb daemon that runs on the emulator or the Android handset.

Android Application Components - Application components are the *essential building blocks* of an Android application.

The following are the *four components of an Android application.*

Activity: Each activity presents a GUI screen of an application. For example, a chat application might have one activity that allows to create a chat, another to view the previous chat sessions, etc. Different activities form a cohesive chat application.

Content providers: Content providers are used for reading and writing data that are either private to an application or shared across applications. By using the content provider, an application can query or modify the stored data.

Service: A service denotes a background task and not for interacting through a user interface. For example, a service might play music in the background while the user is interacting with a different application.

Broadcast receivers: The broadcast receiver responds to broadcast announcements by an application. For **example,** a battery monitoring application might broadcast that the *battery is low*. Based on this, the music

player might reduce the volume or the screen display may be dimmed.

Android Software Stack Structure
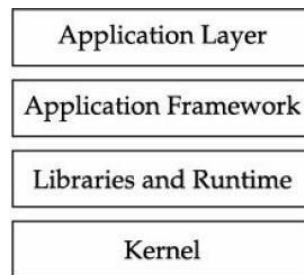
Android Stack Structure

To a user of a mobile handset, various functionalities are provided by a cooperative working of a number of application programs and system programs. These collections of programs can be decomposed into a hierarchy of four layers.

Advantages of Android

- The mobile platform Android is an open platform and can be ported on almost every type of cell phone.

- The Android SDK to develop applications is possible on every operating system. Android requires a low footprint of 250 KB.
- The emulator of the Android platform has a modern design and is easy to use.

- Application installation on the emulator/device is possible via Android Debug Bridge (ADB) or via Eclipse
- Google offers a very good documentation as well as many examples which cover the most basic and important techniques used to get in touch with Android and the application development on it.

- Android supports robust libraries for media access, communication and data transfer Android offers a real database SQLite using which meaningful data manipulation and data Sharing across applications is possible.

- Android has an integrated web browser which gives an experience similar to web browsing using a desktop PC.

- Android uses the standardized and open programming language Java.

M-commerce. advantages and disadvantages of M- Commerce.

Mobile Commerce

Mobile commerce, involves carrying out any activity related to buying and selling of commodities, services, or

information using the mobile hand-held devices.

The popularity of m-commerce can be traced to the convenience it offers both to the buyers and sellers.

An important issue in M-commerce is how payments can be made securely and rapidly as soon as a buyer decides to make a purchase.

The use of computers and networking in trade related transactions has been limited to automatic teller machines (ATMs), banking networks, debit and credit card systems, electronic money and electronic bill payment systems (E-payment).

Pros and Cons of M-Commerce

Advantages

1. For the business organization, the benefits of using M-commerce include customer convenience, cost savings, and new business opportunities.

2. From the customer's perspective, M-commerce provides the flexibility of *anytime, anywhere* shopping using just a lightweight device. The customer can save substantial time compared to visiting several stores for identifying the right product at the lowest price.

3. Mobile devices can be highly personalized, thereby providing an additional level of convenience to the customers. For example, a repeat order for some items can be placed at the touch of a button.

Disadvantages

1. Mobile devices do not generally offer graphics or processing power of a PC. The users are therefore constrained to use small screen and keyboard and low resolution pictures and videos.

2. The small screens of mobile devices limit the complexity of applications. For example, the menu choice, and text typing capability are severely constrained

3. The underlying network imposes several types of restrictions. For example, the available bandwidth is severely restricted, and international reach is prohibitively expensive.

4 Ps of commerce. different forms of commerce that are obtained by varying the interpretation of the Ps.

Money is now an important element of all business and trade. In older times, money did not exist. What existed was a simple "barter system" where things could be exchanged, say, fish for grains, The evolution of currency (money) gave birth to the concept of a "marketplace".

In a marketplace, commerce is a function of *4 Ps—Product, Price, Place and Promotions*. Once the marketplace came into existence, a few pioneers realized that people would be ready to pay extra if products could be delivered at the customer's doorsteps. A small change to two of the Ps, Price and Place, led to the convenience of getting products at customers' homes.

The concept of "Street Vendors" was born. When the postal system came into being, sellers found a new avenue and started using mails to describe their products. It ultimately led to the concept of *"Mail Order Cataloguing".*

A mail order catalogues buys goods and then sells those goods to the prospective customers. A mail order catalogue is a list of the goods that the cataloguer deals with. The evolution of the —**Teleshopping**‖ networks was inevitable with the development of the Internet.

The Internet has already reached the home of most customers. In this context, the distribution channel has started to assume a new meaning to thee-marketer. With options of *paying online* through debit and credit cards, on-line transactions have become purely electronic. The M-commerce has been adopted by the mobile phone users.

applications of M-commerce. Business-to-Consumer (B2C) Applications

Business-to-consumer (B2C) is a form of commerce in which products or services are sold by a business firm to a consumer. B2C is an important category of mobile commerce applications and is reported to be nearly half of the total M-commerce market (Varshney et al., 2000). A few examples ofB2C applications are given below:

Advertising

Using the demographic information collected by the wireless service providers and based on the current location of a user, a good targeted advertising can be done. The wireless service provider may also keep track of the history of the purchases made by customers by directing advertisements to mobile phones. Customers may also solicit specific advertisements.

For example, suppose a consumer in a shop is fascinated by a new electronic product and wishes to buy it but only after getting more details about it. For this purpose, he can view all the relevant advertisements for the product by taking the picture of the bar code using his mobile device.

Comparison shopping

Consumers can use their mobile phones to get a comparative pricing analysis of a product at different stores and also the prices of the related products.

For example, suppose consumers visiting a shop can use their mobile phones to access a web-based comparison shopping application. By scanning the bar code on a product, the consumer can see the price of this product at different shops in the adjacent area.

Information about a product

Consumers can access additional information about products through their mobile phones.

Assume that a consumer buys some medicine in a pharmacy shop, but cannot read the dosage instructions on the carton given in German and Spanish languages only. The consumer can, however, scan the barcode on the pack using the mobile device to read the dosage instructions in the English language, which he knows.

Mobile ticketing

Mobile phones can be used to purchase movie tickets (called m-tickets) using credit cards. After the payment is

received, a unique bar code is sent to the purchaser's mobile phone by an SMS. The purchase can gain entry to the movie hall by showing the bar code downloaded into the mobile device to a bar code reader at the entrance.

Loyalty and payment services

In this application, mobile phones can replace the physical loyalty cards. Having signed up for a supermarket loyalty scheme, a unique bar code is sent to a consumer's mobile phone. After shopping at the same supermarket, the consumer shows the bar code at the cash counter and accumulates points based on the total amount spent.

Mobile phones can be used to make payments. For example, consumers can buy canned drinks from a vending machine by moving their phones close to an RFID enabled phone reader. Payment is made **through the person's mobile phone bill. Consumers pay their bills by simply scanning the bar code on the** bill and using their mobile phones to process payment.

Interactive advertisements

In an interactive advertisement, customers can scan a bar code in an advertisement for a product appearing on a TV screen using their mobile phones. By scanning the bar code, the consumer can order the product by invoking an internet application.

Catalogue shopping

Mobile phones can be used to place orders for products listed in a catalogue. For example, a consumer might receive a catalogue by SMS from a catalogue shopping company. Each product on sale is accompanied by a unique bar code. By scanning the bar codes, the consumer can buy products directly from the catalogue shopping company.

Business-to-Business (B2B) Applications

Business-to-business (B2B) is a form of commerce in which products or services are sold from a company to its dealers.

For example, a company that manufactures TV sets would normally sell it through a dealer network rather than selling the product directly to the consumers. Here, the manufacturer and the dealers are said to be the B2B partners. A few examples of B2B applications of M-commerce are given below.

Ordering and delivery confirmation

The Mobile phones can be used by dealers to order products. The orders can be sent to the supplier in a standard format. By scanning the bar code on a product by using the camera of a mobile phone and specifying the quantity required through a simple application, a dealer can automatically re-order goods.

Mobile phones can be used to gather information about the status of consignments during the transport and delivery process. By reading the bar code on a packet using a mobile device, a truck driver can confirm in real-time that a consignment has been delivered.

Stock tracking and control

Mobile phones can be used to keep track of the stock in a distributed inventory system and send updates to a central database. By using a mobile phone to scan bar codes or RFID tags on products, employees can update

the stock in real time.

Mobile phones are the particularly attractive tools where the stock is stored in many locations.
For example, stock control of apparel items warehouse din the various department stores.

Supply Chain Management (SCM)

Information about the supply chain processes can be made available via mobile devices. By scanning an RFID tag using a mobile phone; it is possible for a manager or anyone in the supply chain to check information about a product's state in the supply chain. This kind of accurate information can help manage the business efficiently.

Mobile inventory management

An interesting new B2B application reported a —**rolling inventory**‖ consisting of multiple trucks carrying large amounts of goods. Whenever a store needs certain goods, it locates the nearest truck to take delivery of the required goods. This reduces the amount of inventory and cost for both the producers and the retailers. It also has the potential to drastically reduce the delivery times and help in just-in-time delivery of goods.

functionalities of the various layers of the architecture of a mobile commerce framework.

Structure of Mobile Commerce

- In mobile commerce, a content provider implements an application by providing two sets of programs:
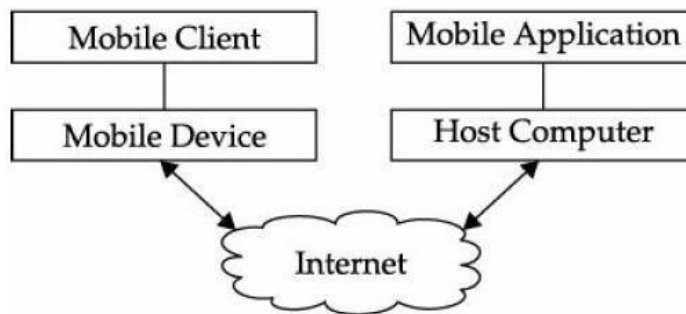
Architecture of a mobile commerce framework.

- **The client-side Programs**
    o The client-side programs run on the micro browsers installed on the users' mobile devices.
- **The server-side Programs**
    o To perform a database access and computations, reside on the host computer (servers).

Mobile devices

Hand-held devices essentially present user interfaces to the mobile users. The users specify their requests using the appropriate interface programs, which are then transmitted to the mobile commerce application on the Internet. The results obtained from the mobile commerce application are displayed in suitable formats.

Mobile middleware

The main purpose of mobile middleware is to seamlessly and transparently map the Internet content to mobile phones that may sport a wide variety of operating systems, markup languages, micro browsers, and protocols.

Most mobile middleware also handle encrypting and decrypting communication in order to provide secure transactions.

Network

Mobile commerce has become possible mainly because of the availability of wireless networks. User requests are delivered either to the closest wireless access point (in a wireless local area network environment) or to a base station (in a cellular network environment).

Wired networks are optional for a mobile commerce system. However, host computers (servers) are generally connected to wired networks such as the Internet. So user requests are routed to these servers using transport and/or security mechanisms provided by wired networks.

Host computers

Host computers are essentially servers that process and store all the information needed for mobile commerce applications. Most application programs used in the mobile commerce are hosted on these. These applications usually consist of three major components: web servers, database servers, and application programs and support software.

The web servers help interact with the mobile client. The database servers store data. The application program is the middleware that implements the business logic of the mobile commerce application.

Mobile Payment Schemes and Security Issues. Mobile Payment Systems

Mobile payments are a natural evolution of E-payment schemes. A mobile payment (or M-payment) may be defined as any payment instrument where a mobile device is used to initiate, authorize and confirm an exchange of financial value in return for goods and services.

Mobile devices include mobile phones, PDAs, and any other device that connects to a mobile network for making payments.

A mobile device can also be used for payment of bills (especially utilities and insurance premiums) with access to account-based payment instruments such as electronic funds transfer, Internet banking payments, direct debit and electronic bill presentment.

The simple message exchange via short messaging services (SMS) may prove more successful. The important payment solutions will be SMS-based, which can easily be charged to the mobile phone bill of customers.

The problems of M-payment schemes are those of security, privacy, and guarding against frauds. The challenges for providing secure transactions are many and range from physical theft of a mobile device which can be subsequently used for fraudulent payments.

Mobile Payment Schemes

Three popular types of M-payment schemes are currently being used:

      (a) Bank account based

      (b) Credit card based

      (c) Micropayment

In each of these approaches, a third party service provider (bank, Credit Card Company, or telecom **company)** makes a payment on the customer's behalf. An important question that needs to be answered is since the third party incurs an overhead in making the payment, how would it recover the cost.

First, the service provider may require pre-payment from users, leading to some financial gain through investment of this fund. A service provider may charge a small amount as service charge, which can decrease with increasing customer base.

Bank account based M-payment

The bank account of the customer is linked to his mobile phone number. When the customer makes an M-payment transaction with a vendor or in a shopping complex, based on a Bluetooth or wireless LAN connectivity with the vendor, the bank account of the customer is debited and the alue is credited to the vendor's account.

Credit card based M-payment

In the credit card based M-payment, the credit card number is linked to the mobile phone number ofthe customer. When the customer makes an M-payment transaction with a merchant, the credit card is charged and the value is credited to the merchant's account.

Micropayment

Micropayment is intended for payment for small purchases such as from vending machines. The mobile device can communicate with the vending machine directly using a Bluetooth or wireless LAN connection to negotiate the payment and then the micropayment is carried out.

A customer makes a call to the number of a service provider where the per call charge is equal to the cost of the vending item. Thus, the micropayment scheme is implemented through the cooperation of the mobile phone operator and a third party service provider. This approach has been used for vending from Coca-Cola machines.

Security Issues

Trace: Users of mobile devices can be difficult to trace because of roaming of the users. Also, the mobile devices go on-line and off-line frequently. Thus, attacks would be very difficult to trace.

Loss or Theft: A mobile device that is stolen or has fallen into wrong hands can cause frauds that are difficult to track and prevent. A major problem in this regard is the lack of any satisfactory mechanism to authenticate a particular user.

RFID.application in which RFID is useful.Radio Frequency Identification (RFID)

A Radio Frequency Identification (RFID) tag attached to a product, animal, or person for the purpose of identification and tracking, makes use of radio waves. Some tags can be read from several metres away and beyond the line of sight of the reader.

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