

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

Ans)

2) Define microkernel OS. Give some reasons to prefer microkernel for Developing mobile OS.

Ans) To overcome the disadvantages of the monolithic kernel design the microkernel design approach has been proposed. 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. Unlike the user-level code, the kernel code is very difficult to debug. An important reason for this is that since a bug in a kernel code can crash the operating system. This would also crash the debugger and the programmer would have no way but to reboot the OS. On the other hand, while debugging the user mode application, the bug may at most crash the application, but the debugger and the operating system continue to run and one can easily check the application state at the time of crash. 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 micro-kernel operating system could be expected to be more reliable than a comparable monolithic kernel operating system. The overall architectural difference between a monolithic kernel and microkernel architecture has schematically been shown in Fig. 9.1. 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.

3) Write a short on the following commercial OS

- a. Windows Mobile**
- b. Palm OS**
- c. Symbian OS**
- d. IOS**
- e. Android**
- f. Kernel**
- g. Blackberry OS**

ans Windows Mobile

Microsoft Corporation developed an operating system in the year 1996 targeted specifically at these devices. Since then, this operating system has undergone several enhancements and modifications over successive generations. The main feature of Windows CE operating system, which sets it apart from other traditional operating systems, is the support that it provides for deterministic scheduling of time-constrained tasks. Based on the Microsoft Windows CE operating system, the company designed the Pocket PC 2000 operating system in the year 2000. It was targeted for PDAs and not mobile phones.

Since the usage of mobile phones was increasing at a brisk rate, Microsoft introduced its Windows Mobile operating system in the year 2003. It was developed based on Pocket PC 2000 and was targeted specifically as an operating system for mobile phones which the different cell phone vendors can use in their cell phones. Unlike Apple's iOS and RIM's Blackberry OS which are essentially confined to use on Apple's iPhone and the Blackberry, Microsoft intended the Windows mobile operating system to be used across a wide cross section of mobile phone manufacturers. Since the Windows Mobile operating system was developed to be suitable for use on multiple vendor platforms, 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.

Palm OS

→ It is essentially a simple single tasking operating system. As a result only one application can run at a time. The implications of this are many and easily noticeable. 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 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

iOS

In January 2007, Apple unveiled its sleek innovative mobile device-the iPhone-causing a storm in the Smartphone marketplace. The iPhone was designed to replace Apple's highly successful iPod. Apple had developed as iPhone's operating system and was originally known as iPhone OS, but later renamed iOS. iOS is a derivative of Apple Inc's highly successful Mac OS. Mac OS was later extended for use in other Apple devices such as the iPod touch, iPad and Apple TV.

iOS is a closed and proprietary operating system fully owned and controlled by Apple and not designed to be used by various mobile phone vendors on their systems. Apple does not license iOS for installation on third-party hardware. However, the overwhelming popularity of iPhone has given iOS a significant market presence. It provided several innovative features that grabbed the market attention. For example, 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 that are supported by the iOS include 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

---→ Since mobile manufacturers use different user interfaces and interaction styles for their mobile devices depending on the customer segment targeted, Android provided the ability to seamlessly use either a phone-based keyboard or a touch screen.

--→ 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. However, Android scores over those 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. For example an application on iOS has to be approved by Apple before it can be offered to the users as outlined in the SDK agreement. Apple does not, in fact, facilitate third party application development and is implicitly promoting 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. Has several innovative pre-installed applications such as Gmail, Maps, voice search, etc.

Android kernel has been developed based on a version of Linux kernel. However, it has excluded the X Window System and does not support the full set of standard GNU libraries. Obviously, this makes it difficult to reuse the existing Linux applications or libraries on Android. Based on the Linux kernel code, Android implements its own device drivers, memory management, 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. This layer is the one that is commonly used by the cell phone users.

Google initially maintained the kernel code they contributed to in the Linux public distribution. Since 2010, Google no longer maintains its Android kernel extensions in the Linux public distribution. Now Google maintains its own code tree. This has marked the branching of Android from Linux code in the public distribution.

Blackberry Operating System

Blackberry operating system is a proprietary operating system designed for BlackBerry smart phones 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 on-device hardware-based message encryption.

Symbian OS

→ 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.

→ It supports pre-emptive multitasking scheduling and memory protection. Symbian is a microkernel-based operating system.

→ CPU is switched into a low power mode when the application is not responding to an event.

→ It is optimized for low-power and memory requirements. Applications and the OS itself, follow an object-oriented design paradigm.

→ 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. It essentially works as an Eclipse plug-in and contains editor, compiler, emulator, libraries and header files required for Symbian OS development. Development kits are available at Nokia and the Symbian Foundation websites.

4) Comparison of features of various mobile OS.

TABLE 9.1 A Comparison of the Features of Three Popular Mobile Operating Systems

Feature	Android	Symbian OS	Windows Phone 7
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
Preemptive scheduling	Yes	Yes	Yes
Demand paging	Yes	Yes	Yes
CPU architecture supported	ARM, MIPS, x 86	ARM	ARM

5. Explain the important ways in which the operating system for a sensor network is different from a traditional operating system.

6) List and explain the special constraints of mobile OS

Ans) Special Constraints are:

1. 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. The size of the kernel is, therefore, considered to be a very important figure of merit of a mobile OS.

2. 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

3. Small keypad :

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 or by using a stylus. In both these arrangements, typing in the documents and entering long string commands is rather difficult. This mandates the provision of some facility for word completion prompts and availability of capabilities for free form handwriting recognition and ionic command issue.

4. 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.

5. 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

6. 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 affected by atmospheric noise, and thereby causes high bit error rates. Therefore, the speed of communication (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.

7. Real-time data streaming

Beyond the 3G operating systems, real-time data streaming support is becoming important for applications such as mobile TV.

st and explain the special service requirements of mobile OS.

(ns) Special Service Requirements are:

1. **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.
2. **Support for a variety of input mechanisms**
A miniature keyboard forms the main user input mechanism for an expensive mobile device. Sophisticated mobile devices (smart phones) usually support the QWERTY keyboard. Many recent mobile devices also support touch screen or even stylus-based input mechanisms along with the handwriting recognition capability.
3. **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..
4. **Extensive library support**
The cost-effective development of third party applications requires extensive library support by the OS. At the minimum, the expected library support includes the availability of programmer callable primitives for email, SMS MMS, Bluetooth, multimedia, user interface primitives, and GSM/GPRS functionalities.
5. **Support for integrated development environment (IDE)**
Traditional operating systems work on many processor and hardware configurations. Therefore, general purpose integrated development environments (IDES) such as Eclipse can be satisfactorily be used to develop applications. However, mobile operating systems need have their own IDE for effective software development and good performance of the developed software.