***VU1F14150\_\_***

***EXPT NO. 6***

***AIM:*** Case Study of Mobile Operating System.

***THEORY:***

***1. ANDROID***

**1] WHAT IS ANDROID ?**

Android is an open source and Linux-based Operating System for mobile devices such as smartphones and tablet computers. Android was developed by the *Open Handset Alliance*, led by Google, and other companies. Android offers a unified approach to application development for mobile devices which means developers need only develop for Android, and their applications should be able to run on different devices powered by Android. The first beta version of the Android Software Development Kit (SDK) was released by Google in 2007 where as the first commercial version, Android 1.0, was released in September 2008. On June 27, 2012, at the Google I/O conference, Google announced the next Android version, 4.1 Jelly Bean. Jelly Bean is an incremental update, with the primary aim of improving the user interface, both in terms of functionality and performance. The source code for Android is available under free and open source software licenses. Google publishes most of the code under the Apache License version 2.0 and the rest, Linux kernel changes, under the GNU General Public License version 2.

## **2] FEATURES OF ANDROID**

Android is a powerful operating system competing with Apple 4GS and supports great features. Few of them are listed below −

* Beautiful UI

Android OS basic screen provides a beautiful and intuitive user interface.

* Connectivity

GSM/EDGE, IDEN, CDMA, EV-DO, UMTS, Bluetooth, Wi-Fi, LTE, NFC and WiMAX.

* Storage

SQLite, a lightweight relational database, is used for data storage purposes.

* Media support

H.263, H.264, MPEG-4 SP, AMR, AMR-WB, AAC, HE-AAC, AAC 5.1, MP3, MIDI, Ogg Vorbis, WAV, JPEG, PNG, GIF, and BMP.

* Messaging

SMS and MMS

* Web browser

Based on the open-source WebKit layout engine, coupled with Chrome's V8 JavaScript engine supporting HTML5 and CSS3.

* Multi-touch

Android has native support for multi-touch which was initially made available in handsets such as the HTC Hero.

* Multi-tasking

User can jump from one task to another and same time various application can run simultaneously.

* Resizable widgets

Widgets are resizable, so users can expand them to show more content or shrink them to save space.

* Multi-Language

Supports single direction and bi-directional text.

* GCM

Google Cloud Messaging (GCM) is a service that lets developers send short message data to their users on Android devices, without needing a proprietary sync solution.

* Wi-Fi Direct

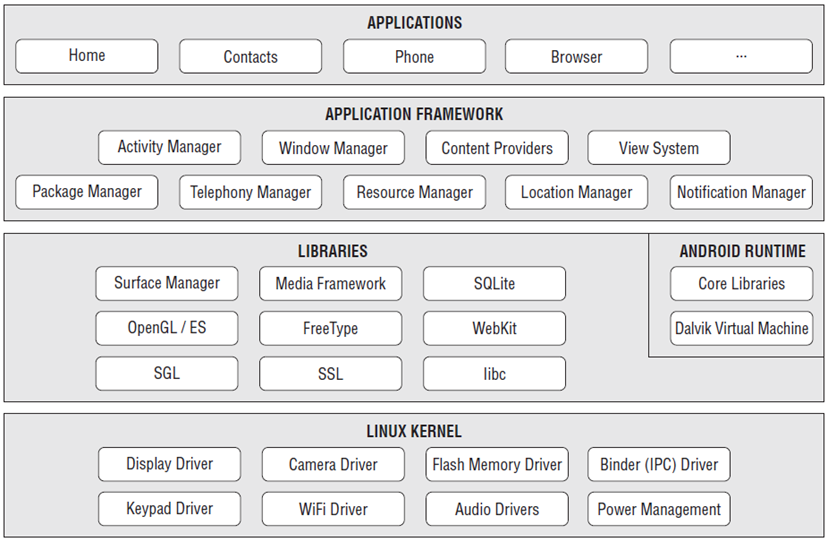
A technology that lets apps discover and pair directly, over a high-bandwidth peer-to-peer connection.

* Android Beam

A popular NFC-based technology that lets users instantly share, just by touching two NFC-enabled phones together.

**3] ARCHITECTURE OF ANDROID**

Android operating system is a stack of software components which is roughly divided into five sections and four main layers as shown below in the architecture diagram.



## **Linux kernel**

At the bottom of the layers is Linux - Linux 3.6 with approximately 115 patches. This provides a level of abstraction between the device hardware and it contains all the essential hardware drivers like camera, keypad, display etc. Also, the kernel handles all the things that Linux is really good at such as networking and a vast array of device drivers, which take the pain out of interfacing to peripheral hardware.

## **Libraries**

On top of Linux kernel there is a set of libraries including open-source Web browser engine WebKit, well known library libc, SQLite database which is a useful repository for storage and sharing of application data, libraries to play and record audio and video, SSL libraries responsible for Internet security etc.

## **Android Runtime**

This is the third section of the architecture and available on the second layer from the bottom. This section provides a key component called Dalvik Virtual Machine which is a kind of Java Virtual Machine specially designed and optimized for Android.

The Dalvik VM makes use of Linux core features like memory management and multi-threading, which is intrinsic in the Java language. The Dalvik VM enables every Android application to run in its own process, with its own instance of the Dalvik virtual machine.

The Android runtime also provides a set of core libraries which enable Android application developers to write Android applications using standard Java programming language.

## **Application Framework**

The Application Framework layer provides many higher-level services to applications in the form of Java classes. Application developers are allowed to make use of these services in their applications.

The Android framework includes the following key services −

* Activity Manager − Controls all aspects of the application lifecycle and activity stack.
* Content Providers − Allows applications to publish and share data with other applications.
* Resource Manager − Provides access to non-code embedded resources such as strings, color settings and user interface layouts.
* Notifications Manager − Allows applications to display alerts and notifications to the user.
* View System − An extensible set of views used to create application user interfaces.

# **4] RESOURCE MANAGEMENT OF ANDROID**

There are many more items which you use to build a good Android application. Apart from coding for the application, you take care of various other resources like static content that your code uses, such as bitmaps, colors, layout definitions, user interface strings, animation instructions, and more. These resources are always maintained separately in various subdirectories under res/ directory of the project.

Directory and Resource Type:

anim/

XML files that define property animations. They are saved in res/anim/ folder and accessed from the R.anim class.

color/

XML files that define a state list of colors. They are saved in res/color/ and accessed from the R.color class.

drawable/

Image files like .png, .jpg, .gif or XML files that are compiled into bitmaps, state lists, shapes, animation drawable. They are saved in res/drawable/ and accessed from the R.drawable class.

layout/

XML files that define a user interface layout. They are saved in res/layout/ and accessed from the R.layout class.

menu/

XML files that define application menus, such as an Options Menu, Context Menu, or Sub Menu. They are saved in res/menu/ and accessed from the R.menu class.

raw/

Arbitrary files to save in their raw form. You need to call *Resources.openRawResource()* with the resource ID, which is *R.raw.filename* to open such raw files.

values/

XML files that contain simple values, such as strings, integers, and colors. For example, here are some filename conventions for resources you can create in this directory −

* arrays.xml for resource arrays, and accessed from the R.array class.
* integers.xml for resource integers, and accessed from the R.integer class.
* bools.xml for resource boolean, and accessed from the R.bool class.
* colors.xml for color values, and accessed from the R.color class.
* dimens.xml for dimension values, and accessed from the R.dimen class.
* strings.xml for string values, and accessed from the R.string class.
* styles.xml for styles, and accessed from the R.style class.

Arbitrary XML files that can be read at runtime by calling *Resources.getXML()*. You can save various configuration files here which will be used at run time.

Alternative Resources

Your application should provide alternative resources to support specific device configurations. For example, you should include alternative drawable resources ( i.e.images ) for different screen resolution and alternative string resources for different languages. At runtime, Android detects the current device configuration and loads the appropriate resources for your application.

To specify configuration-specific alternatives for a set of resources, follow the following steps −

* Create a new directory in res/ named in the form <resources\_name>-<config\_qualifier>. Here resources\_name will be any of the resources mentioned in the above table, like layout, drawable etc. The qualifier will specify an individual configuration for which these resources are to be used. You can check official documentation for a complete list of qualifiers for different type of resources.
* Save the respective alternative resources in this new directory. The resource files must be named exactly the same as the default resource files as shown in the below example, but these files will have content specific to the alternative. For example though image file name will be same but for high resolution screen, its resolution will be high.

### **Accessing Resources in Code**

During your application development you will need to access defined resources either in your code, or in your layout XML files. When your Android application is compiled, a R class gets generated, which contains resource IDs for all the resources available in your res/ directory. You can use R class to access that resource using sub-directory and resource name or directly resource ID.

**5] ADVANTAGES OF ANDROID**

## **Android Google Developer**

The biggest advantage of the Android is Google. Android operating system is owned by Google. Google is one of the most trusted and reputed product on the internet. The name Google provide lots of trust for the users to buy Android device.

## **Android Users – Billion of USERS**

Android is the most used mobile operating system. It is used by over billion people. Android is also the fastest growing operating system on the earth. Android has billions of users. A number of users increase the number of applications and software under the name of Android.

## **Android Multitasking**

Most of us love this feature of the android. Users can do lots of tasks at once. Users can open several applications at once and manage them all too. Android has great UI which makes easy for users to do multitasking.

## **Google Play Store App free Download for Android – Millions of Apps**

The best part of the Android is the availability of millions of applications. Google Play store is reported as world’s largest mobile store. It has almost everything from movies to games and much more. These things can be easily downloaded and accessed through Android phone.

## **Android Notification – Easy Access**

One can easily get access to their notification of any kind of SMS, emails or calls on their home screen or the notification panel of the android phone. Its UI makes easy for the user to view more than 5 Android notification at once. The user can [view all the notificat](http://crazytechtricks.com/recover-deleted-notifications-android-mobile-phone-restore/)ion on the top bar.

## **Android Widget – Several Widgets**

Android operating system has plenty of widgets. This widget makes the user experience much better and helps in doing multitasking. You can add any widget depending upon the feature you want on your home screen. You can see notifications, messages, and much more use without even opening applications.

**6] DISADVANTAGES OF ANDROID**

* Little Memory for Storage

You do have a memory card in your phone, but the system storage is small and you have to be very careful with your storage. Sometimes we need to download large Games, but due to the small size of the system storage its very hard to Play the Game. Yes, You can move the app data in Memory Card but still there are many android device which doesn’t allow you to store app data in memory card. You need to root your device

* Force Close on Large App/Games

This is another drawbacks of android OS, When you run large apps/Games most of the time android shows error force close which is definitely annoying. However this is not always the case with high end devices.

* Data Connection

Android has large number of background process which runs in the background, which eats so much mobile data. And thus cost lots of money if your are not into unlimited data plan.

* Battery Problem

While android has many process running in the background this increase the usage of RAM and decreasing Battery Performance. While many top notch device has good battery backup (Lithium Batteries) but still that doesn’t mean it solved the problem.

## **Android Malware/Virus/Security**

Android device is not considered safe as compared to other applications. It is easy to target any Android Phone and every day millions of attempt are done on Android phone. Hackers keep on trying to steal your personal information.

## **7] APPLICATIONS OF ANDROID**

Android applications are usually developed in the Java language using the Android Software Development Kit.

Once developed, Android applications can be packaged easily and sold out either through a store such as Google Play, SlideME, Opera Mobile Store, Mobango, F-droid and the Amazon Appstore.

Android powers hundreds of millions of mobile devices in more than 190 countries around the world. It's the largest installed base of any mobile platform and growing fast. Every day more than 1 million new Android devices are activated worldwide.

This tutorial has been written with an aim to teach you how to develop and package Android application. We will start from environment setup for Android application programming and then drill down to look into various aspects of Android applications.

***2. WINDOWS***

**1] WHAT IS WINDOWS?**

Windows Phone is a proprietary mobile operating system developed by Microsoft. Windows Phone introduced a new design language, previously called Metro UI, but later renamed to simply Modern. Microsoft licenses the software to third-party hardware manufacturers, but keeps a stringent list of minimum requirements for the hardware it runs on to ensure the best user experience. In 2011 Nokia announced it has chosen Windows Phone as the OS for all its future smartphones providing a solid backing for the fledgling OS and in the same time betting all of its mobile phone business on its success. Windows Mobile is one of the major smartphone platforms and until recently the only touch-enabled smartphone platform. Windows Mobile actually has two distinct editions - Windows Mobile Standard and Windows Mobile Professional. Software written for either of the editions is not compatible with the other. The main difference between the editions is that Windows Mobile Professional supports touchscreen and handwriting recognition. Windows Mobile is a product created by Microsoft but as the company does not produce any phones itself, it licenses the platform to hardware manufacturers. Before version 6 was released the Windows Mobile Standard edition was known as Windows Mobile for Smartphone, while the Professional edition was referred to as Windows Mobile for PocketPC.

* Windows Phone 7

The initial announcement of Windows Phone 7 came in February, 2010. It was later launched in October the same year.

* Windows Phone 7.5 Mango

The next major update – Windows Phone 7.5 Mango – saw the light of day in May 2011. The update brought the frequently requested multi-tasking for third-party apps and added the updated Internet Explorer 9, Twitter integration and Windows Live SkyDrive access.

* Windows Phone 7.5 Tango

Another update followed in 2012, dubbed Tango, which lowered the minimum hardware requirements for the smartphones essentially allowing Windows Phones at lower price points. Other new features include the capability to create a Wi-Fi hotspot and flip-to-silence.

* Windows Phone 7.8

Reportedly, a Windows Phone 7.8 update is in the works. It should carry over some of the new features of Windows Phone 8 down to the lineup of previous smartphones, as those would not be updated to Windows 8.

The launch schedule is yet unannounced by Microsoft.

* Windows Phone 8

In October 2012 Microsoft released a major update to the mobile OS. Older devices are denied an update.

Windows 8 introduced much awaited features such as multi-core processor and multiple screen resolution support, removable memory card support, USB Mass storage mode, DivX/XviD video playback support, NFC support, Bluetooth file transfers, Kid's Corner, etc.

The new release also replaced the Windows CE-based architecture to a Windows NT kernel, allowing easy applications porting from the desktop Windows 8 to the mobile one, mainly benefiting the tablets running the new Windows 8 RT.

**2] FEATURES OF WINDOWS**

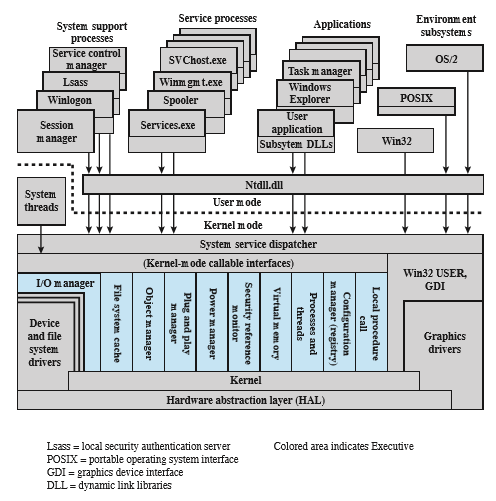
Most versions of Windows Mobile have a standard set of features, such as [multitasking](https://en.wikipedia.org/wiki/Computer_multitasking) and the ability to navigate a file system similar to that of [Windows 9x](https://en.wikipedia.org/wiki/Windows_9x) and [Windows NT](https://en.wikipedia.org/wiki/Windows_NT), including support for many of the same file types. Similarly to its [desktop counterpart](https://en.wikipedia.org/wiki/Windows_9x), it comes bundled with a set of applications that perform basic tasks. [Internet Explorer Mobile](https://en.wikipedia.org/wiki/Internet_Explorer_Mobile) is the default [web browser](https://en.wikipedia.org/wiki/Web_browser), and [Windows Media Player](https://en.wikipedia.org/wiki/Windows_Media_Player) is the default [media player](https://en.wikipedia.org/wiki/Media_player_(software)) used for playing [digital media](https://en.wikipedia.org/wiki/Digital_media). The mobile version of [Microsoft Office](https://en.wikipedia.org/wiki/Microsoft_Office), is the default [office suite](https://en.wikipedia.org/wiki/Office_suite).

[Internet Connection Sharing](https://en.wikipedia.org/wiki/Internet_Connection_Sharing), supported on compatible devices, allows the phone to share its Internet connection with computers via USB and Bluetooth. Windows Mobile supports [virtual private networking](https://en.wikipedia.org/wiki/Virtual_private_networking) over [PPTP](https://en.wikipedia.org/wiki/PPTP) protocol. Most devices with mobile connectivity also have a [Radio Interface Layer](https://en.wikipedia.org/wiki/Radio_Interface_Layer). The Radio Interface Layer provides the system interface between the Cell Core layer within the Windows Mobile OS and the radio protocol stack used by the wireless modem hardware. This allows OEMs to integrate a variety of modems into their equipment.

The user interface changed dramatically between versions, only retaining similar functionality. The *Today Screen*, later called the *Home Screen*, shows the current [date](https://en.wikipedia.org/wiki/Calendar_date), owner information, upcoming appointments, e-mails, and [tasks](https://en.wikipedia.org/wiki/Task_(project_management)). The taskbar display the current time as well as the volume level. Devices with a cellular radio also show the signal strength on said taskbar.

**3] ARCHITECTURE OF WINDOWS**

Windows does not have a pure microkernel architecture but what Microsoft refers to as a modified microkernel architecture. As with a pure microkernel architecture, Windows is highly modular. Each system function is managed by just one component of the operating system. The rest of the operating system and all applications access that function through the responsible component using a standard interface. Key system data can only be accessed through the appropriate function. In principle, any module can be removed, upgraded, or replaced without rewriting the entire system or its standard application program interface (APIs). However, unlike a pure microkernel system, Windows is configured so that many of the system functions outside the microkernel run in kernel mode. The reason is performance. The Windows developers found that using the pure microkernel approach, many non-microkernel functions required several process or thread switches, mode switches, and the use of extra memory buffers.



The kernel-mode components of Windows are the following:

* Executive: Contains the base operating system services, such as memory management, process and thread management, security, I/O, and interprocess communication.
* Kernel: Consists of the most used and most fundamental components of the operating system. The kernel manages thread scheduling, process switching, exception and interrupt handling, and multiprocessor synchronization. Unlike the rest of the Executive and the user level, the kernel's own code does not run in threads. Hence, it is the only part of the operating system that is not preemptible or pageable.
* Hardware abstraction layer (HAL): Maps between generic hardware commands and responses and those unique to a specific platform. It isolates the operating system from platform-specific hardware differences. The HAL makes each machine's system bus, direct memory access (DMA) controller, interrupt controller, system timers, and memory module look the same to the kernel. It also delivers the support needed for symmetric multiprocessing (SMP), explained subsequently.
* Device drivers: Include both file system and hardware device drivers that translate user I/O function calls into specific hardware device I/O requests.
* Windowing and graphics system: Implements the graphical user interface (GUI) functions, such as dealing with windows, user interface controls, and drawing.

The Windows Executive includes modules for specific system functions and provides an API for user-mode software. Following is a brief description of each of the Executive modules:

* I/O manager: Provides a framework through which I/O devices are accessible to applications, and is responsible for dispatching to the appropriate device drivers for further processing. The I/O manager implements all the Windows I/O APIs and enforces security and naming for devices and file systems (using the object manager).
* Cache manager: Improves the performance of file-based I/O by causing recently referenced disk data to reside in main memory for quick access, and by deferring disk writes by holding the updates in memory for a short time before sending them to the disk.
* Object manager: Creates, manages, and deletes Windows Executive objects and abstract data types that are used to represent resources such as processes, threads, and synchronization objects. It enforces uniform rules for retaining, naming, and setting the security of objects. The object manager also creates object handles, which consist of access control information and a pointer to the object.
* Plug and play manager: Determines which drivers are required to support a particular device and loads those drivers.
* Power manager: Coordinates power management among various devices and can be configured to reduce power consumption by putting the processor to sleep.
* Security reference monitor: Enforces access-validation and audit-generation rules. The Windows object-oriented model allows for a consistent and uniform view of security, right down to the fundamental entities that make up the Executive. Thus, Windows uses the same routines for access validation and for audit checks for all protected objects, including files, processes, address spaces, and I/O devices.
* Virtual memory manager: Maps virtual addresses in the process's address space to physical pages in the computer's memory.
* Process/thread manager: Creates and deletes objects and tracks process and thread objects.
* Configuration manager: Responsible for implementing and managing the system registry, which is the repository for both systemwide and per-user settings of various parameters.
* Local procedure call (LPC) Facility: Enforces a client/server relationship between applications and executive subsystems within a single system, in a manner similar to a remote procedure call (RPC) facility used for distributed processing.

User-Mode Processes

Four basic types of user-mode processes are supported by Windows:

• Special system support processes: Include services not provided as part of the Windows operating system, such as the logon process and the session manager.

• Service processes: Other Windows services such as the event logger.

• Environment subsystems: Expose the native Windows services to user applications and thus provide an operating system environment or personality. The supported subsystems are Win32, Posix, and OS/2. Each environment subsystem includes dynamic link libraries (DLLs) that convert the user application calls to Windows calls.

• User applications: Can be one of five types: Win32, Posix, OS/2, Windows 3.1, or MS DOS.

**4] RESOURCE MANAGEMENT OF WINDOWS**

Windows System Resource Manager includes five built-in resource management policies that you can use to quickly implement management. In addition, you can create custom resource management policies to meet your specific needs.

### **Built-in resource management policies**

You can enable built-in resource management policies by selecting the type of policy to use. No further configuration is required.

* Equal per process: When the Equal\_Per\_Process resource allocation policy is managing the system, each running process is given equal treatment. For example, if a server that is running ten processes reaches 70 percent processor utilization, Windows System Resource Manager will limit each process to using 10 percent of the processor resources while they are in contention. Note that resources not used by low utilization processes will be allocated to other processes.
* Equal per user: When the Equal\_Per\_User resource allocation policy is managing the system, processes are grouped according to the user account that is running them, and each of these process groups is given equal treatment. For example, if four users are running processes on the server, each user will be allocated 25 percent of the system resources to complete those processes. A user running a single application is allocated the same resources as a user running several applications. This policy is especially useful for application servers.
* Equal per session: When the Equal\_Per\_Session resource allocation policy is managing the system, resources are allocated on an equal basis for each session connected to the system. This policy is for use with RD Session Host servers.
* Equal per IIS application pool: When the Equal\_Per\_IISAppPool resource allocation policy is managing the system, each running IIS application pool is given equal treatment, and applications that are not in an IIS application pool can only use resources that are not being consumed by IIS application pools.
* Weighted Remote Sessions: When the Weighted\_Remote\_Sessions resource allocation policy is managing the system, the processes are grouped according to the priority assigned with the user account. For example, if three users are remotely connected, the user assigned Premium priority will receive highest priority access to the CPU, the user assigned Standard priority will receive second priority to the CPU, and the user assigned Basic priority will receive lowest priority to the CPU. This policy is for use with RD Session Host servers.

### **Custom resource management**

You can use custom resource management methods to identify resource users and allocate resources to them based on your own criteria.

* Process matching criteria: Enable you to select services or applications to be managed by resource allocation policy rules. You can choose by file name or command, or you can specify users or groups. For example, you could create a process matching criterion that applies management to the application iexplore.exe when it is run by the user Administrator.
* Resource allocation policies: Allocate processor and memory resources to processes that are specified by the process matching criteria that you create.
* Exclusion lists: Exclude applications, services, users, or groups from management by Windows System Resource Manager.
* Scheduling: Use a calendar interface to control one-time events or recurring changes to resource allocation. Different resource allocation policies can be active at different times of day, on different days of the week, or according to other scheduling paradigms.
* Conditional policy application: Automatically switch resource allocation policies in response to certain system events (such as installing new memory or additional processors, starting or stopping a node, or changing the availability of a resource group in a cluster).

**5] ADVANTAGES OF WINDOWS PHONE OS:**

* Windows Phone 8 Devices Supports Micro SD Card by which you can directly connect your Memory
* Card to system and transfer Music and Videos.
* The Windows 8 Devices has better Video Codec When Compared With Windows 7.5
* Windows 8 Now Supports Multi Core Processors.
* Windows 8 has new Interface with Small Tiles.
* The 8 Devices can be connected to System by Mass Storage Option where as the Windows 7.5 Devices are connected to System by Zune Support Only.
* Windows 8 Devices Supports HD Displays.
* Apps Available for Windows 8 Devices are better when compared with Windows 7.5 Devices
* Microsoft Office Support is very nice and Document Reading and Editing is Really Very Good.
* XBOX Games add better Gaming Experience.
* Bing Integration and Search is Very Good.
* Has Latest Internet Explorer for better Browsing.
* Social Network Integration is good.
* Has Inbuilt Bar Code Scanner
* Windows 8 Devices Ranks 3rd position in the Mobile Market.
* The Main Advantage I found is The Devices never Struck and no lagging found.

**6] DISADVANTAGES OF WINDOWS PHONE OS:**

* The Devices Available in the Market are Still Using Dual Core Processors Where as Quad Core, Octa Core Processors are Available in the Market.
* The Higher End Devices are only having of 1 GB Ram and 2 GB version Android Devices are Available in the Market.
* The Main Disadvantage is App Catalogue it fails to competite with Android and iOS.
* The Most Games(Temple Run and Many More ) Requires of 1 GB Ram but 1GB Ram is available for only Higher End Devices and the lower End Devices has only 512Mb Ram Support.
* Windows Mainly fails in App Transformation from Android and iOS.
* The Device Supports limited Video Codec and only Plays video files like .3gp, .avi and .mp4 and cannot play any other formats like .mkv and many more.
* The User Interface is another major problem it has only one Interface with live Tiles at the Starting of using this device the Interface is ok but Continuous Use of the same interface may get bored to the User.
* The NFC and Bluetooth is not yet perfect for the Sharing of our Content you can share Photos/Images by Blue tooth but you cannot share Videos.
* One of the Major Problem is There is no System Wide File Manager. We donot have any App also for this, For Access of Files in your Mobile you have to connect it to the System.
* The Other Major thing we have to Consider is Video Player there is no Single Video Player App in the Windows Phone Market. We have to play/Access Video Files in the Music+Videos in your Device. Folder View of Videos is also Not possible and All the Video Files are given as list and you may not Delete All the Videos at a Time and have to select each one by one and Delete them.
* Flash Player: No Flash Player Support in the Browser and by this The Device cannot Display the Flash Content in the Webpage.
* Security Problem: I Think Windows Devices are not that secure because I Did not found a Single Antivirus App in the Market.
* The Devices are little Expensive when compared with the Other Operating System Devices.

**3. SYMBIAN**

**1] WHAT IS SYMBIAN?**

Symbian is a discontinued mobile operating system (os) and computing platform designed for smartphones. symbian was originally developed as a closed-source os for pdas in 1998 by symbian ltd.Symbian Os was a descendant of psion's epoc, and runs exclusively on arm processors, although an unreleased x86 port existed. Symbian was used by many major mobile phone brands, like samsung, motorola, sony ericsson, and above all by nokia. As a pioneer that established the smartphone industry, it was the most popular smartphone os on a worldwide average until the end of 2010 – at a time when smartphones were in limited use, when it was overtaken by android, as google and its partners achieved wide adoption.

Symbian os was (from 2001) essentially a shell system and required an additional user interface (as middleware) to form a complete operating system. Symbian os became prominent from the s60 (formerly series 60) platform built by nokia, first released in 2002 and powering most nokia smartphones. Symbian eventually became the most widely used smart mobile operating system. Uiq was another symbian user interface mostly used by motorola and sony ericsson, whereas in japan there was also the moap platform. Applications of these interfaces were not compatible with each other, despite each being built atop symbian os. Nokia was the majority shareholder in symbian ltd. and purchased the entire share in 2008. the non-profit symbian foundation was then created to make a royalty-free successor to symbian os - seeking to unify the platform, s60 became the foundation's favoured ui and uiq stopped development. Symbian^1 (or s60 5th edition) was created as a result in 2009. Symbian^2 was only used by carrier ntt docomo, one of the members of the foundation, for the japanese market. Symbian^3 was released as in 2010, by which time it became fully open source. Symbian^3 received the anna and belle updates in 2011.

The symbian foundation disintegrated in late 2010 and nokia took back control of the os development. In february 2011, nokia, by now the only remaining company still supporting symbian outside japan, announced that it would use microsoft's windows phone 7 as its primary smartphone platform, whilst symbian would be gradually wound down.Two Months later, nokia moved the os to closed licensing., and later outsourced symbian development to accenture. Although support was promised until 2016, there was little development from accenture, where most symbian developers had already left by 2012. In january 2014, nokia stopped accepting new or changed symbian software from developers.

**2] FEATURES OF SYMBIAN**

1. User Interface:

Symbian has had a native graphics toolkit since its inception, known as avkon (formerly known as series 60). S60 was designed to be manipulated by a keyboard-like interface metaphor, such as the ~15-key augmented telephone keypad, or the mini-qwerty keyboards. Avkon-based software is binary-compatible with symbian versions up to and including symbian^3.

Symbian^3 includes the qt framework, which is now the recommended user interface toolkit for new applications. Qt can also be installed on older symbian devices.

Symbian^4 was planned to introduce a new gui library framework specifically designed for a touch-based interface, known as "ui extensions for mobile" or uiemo (internal project name "orbit"), which was built on top of qt widget; a preview was released in january 2010, however in october 2010 nokia announced that orbit/uiemo had been cancelled.

Symbian^3 on a nokia c6-01

Nokia currently recommends that developers use qt quick with qml, the new high-level declarative ui and scripting framework for creating visually rich touchscreen interfaces that allows development for both symbian and meego; it will be delivered to existing symbian^3 devices as a qt update. When more applications gradually feature a user interface reworked in qt, the legacy s60 framework (avkon) will be deprecated and no longer included with new devices at some point, thus breaking binary compatibility with older s60 applications.

2. Browser:

Symbian^3 and earlier have a built-in webkit based browser. Symbian was the first mobile platform to make use of webkit (in june 2005). Some older symbian models have opera mobile as their default browser.

Nokia released a new browser with the release of symbian anna with improved speed and an improved user interface.

3.Multiple Language Support:

Symbian has strong localization support enabling manufacturers and 3rd party application developers to localize their symbian based products in order to support global distribution. Current symbian release (symbian belle) has support for 48 languages, which nokia makes available on device in language packs (set of languages which cover the languages commonly spoken in the area where the device variant is intended to be sold).

**3] ARCHITECTURE OF SYMBIAN**

1. Technology Domains And Packages:

Symbian's design is subdivided into technology domains each of which comprises a number of software packages. each technology domain has its own roadmap, and the symbian foundation has a team of technology managers who manage these technology domain roadmaps.

Every package is allocated to exactly one technology domain, based on the general functional area to which the package contributes and by which it may be influenced. By grouping related packages by themes, the symbian foundation hopes to encourage a strong community to form around them and to generate discussion and review.

The symbian system model illustrates the scope of each of the technology domains across the platform packages.

Packages are owned and maintained by a package owner, a named individual from an organization member of the symbian foundation, who accepts code contributions from the wider symbian community and is responsible for package.

2. Symbian Kernel:

The symbian kernel (eka2) supports sufficiently fast real-time response to build a single-core phone around it – that is, a phone in which a single processor core executes both the user applications and the signalling stack.the real-time kernel has a microkernel architecture containing only the minimum, most basic primitives and functionality, for maximum robustness, availability and responsiveness. It has been termed a nanokernel, because it needs an extended kernel to implement any other abstractions. It contains a scheduler, memory management and device drivers, with networking, telephony and file system support services in the os services layer or the base services layer. The inclusion of device drivers means the kernel is not a true microkernel.

3. Design

Symbian features pre-emptive multitasking and memory protection, like other operating systems (especially those created for use on desktop computers). Epoc's approach to multitasking was inspired by vms and is based on asynchronous server-based events.

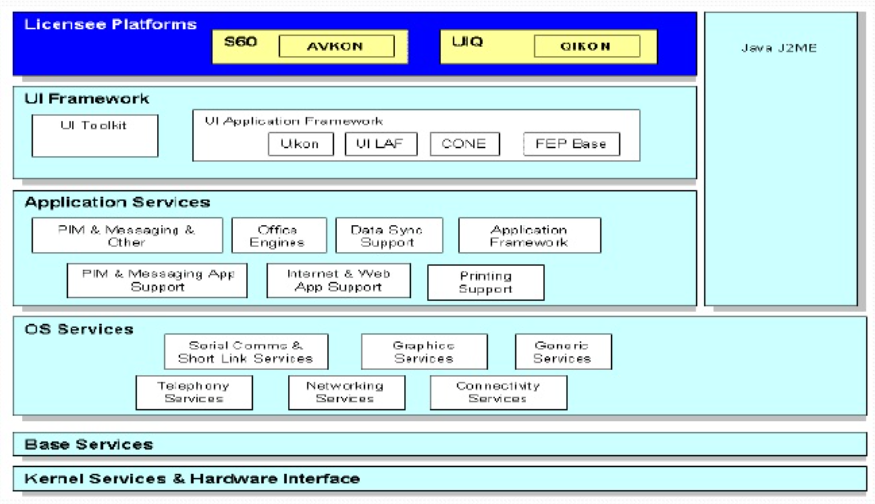
Symbian os was created with three systems design principles in mind:

* The integrity and security of user data is paramount
* User time must not be wasted
* All resources are scarce

To best follow these principles, symbian uses a microkernel, has a request-and-callback approach to services, and maintains separation between user interface and engine. The os is optimised for low-power battery-based devices and for rom-based systems (e.g. features like xip and re-entrancy in shared libraries). Applications, and the os itself, follow an object-oriented design: model-view-controller (mvc).

Later os iterations diluted this approach in response to market demands, notably with the introduction of a real-time kernel and a platform security model in versions 8 and 9.

There is a strong emphasis on conserving resources which is exemplified by symbian-specific programming idioms like descriptors and a cleanup stack. Similar methods exist to conserve storage space. Further, all symbian programming is event-based, and the central processing unit (cpu) is switched into a low power mode when applications are not directly dealing with an event. This is done via a programming idiom called active objects. Similarly the symbian approach to threads and processes is driven by reducing overheads.



4. Operating System:

The all over model contains the following layers, from top to bottom:

Ui framework layer

Application services layer

Java me

Os services layer

Generic os services

Communications services

Multimedia and graphics services

Connectivity services

Base services layer

Kernel services & hardware interface layer

The base services layer is the lowest level reachable by user-side operations; it includes the file server and user library, a plug-in framework which manages all plug-ins, store, central repository, dbms and cryptographic services. It also includes the text window server and the text shell: the two basic services from which a completely functional port can be created without the need for any higher layer services.

Symbian has a microkernel architecture, which means that the minimum necessary is within the kernel to maximise robustness, availability and responsiveness. It contains a scheduler, memory management and device drivers, but other services like networking, telephony and filesystem support are placed in the os services layer or the base services layer. The inclusion of device drivers means the kernel is not a true microkernel. The eka2 real-time kernel, which has been termed a nanokernel, contains only the most basic primitives and requires an extended kernel to implement any other abstractions.

Symbian is designed to emphasise compatibility with other devices, especially removable media file systems. Early development of epoc led to adopting fat as the internal file system, and this remains, but an object-oriented persistence model was placed over the underlying fat to provide a posix-style interface and a streaming model. The internal data formats rely on using the same apis that create the data to run all file manipulations. This has resulted in data-dependence and associated difficulties with changes and data migration.

There is a large networking and communication subsystem, which has three main servers called: etel (epoc telephony), esock (epoc sockets) and c32 (responsible for serial communication). Each of these has a plug-in scheme. For example, esock allows different ".PRT" protocol modules to implement various networking protocol schemes. The subsystem also contains code that supports short-range communication links, such as bluetooth, irda and usb.

There is also a large volume of user interface (ui) code. Only the base classes and substructure were contained in symbian os, while most of the actual user interfaces were maintained by third parties. This is no longer the case. The three major uis – s60, uiq and moap – were contributed to symbian in 2009. Symbian also contains graphics, text layout and font rendering libraries.

All native symbian c++ applications are built up from three framework classes defined by the application architecture: an application class, a document class and an application user interface class. These classes create the fundamental application behaviour. The remaining needed functions, the application view, data model and data interface, are created independently and interact solely through their apis with the other classes.

Many other things do not yet fit into this model – for example, syncml, java me providing another set of apis on top of most of the os and multimedia. Many of these are frameworks, and vendors are expected to supply plug-ins to these frameworks from third parties (for example, helix player for multimedia codecs). This has the advantage that the apis to such areas of functionality are the same on many phone models, and that vendors get a lot of flexibility. But it means that phone vendors needed to do a great deal of integration work to make a symbian os phone.

**4] RESOURCE MANAGEMENT OF SYMBIAN**

Memory management in systems like Linux and Windows employs many of the concepts we have written about to implement management of memory resources. Concepts such as virtual memory pages built from physical memory frames, demand-paged virtual memory, and dynamic page replacement combine to give the illusion of near limitless memory resources, where physical memory is supported and extended by storage such as hard disk space. As an effective general-purpose operating system, Symbian OS must also provide a memory management model. However, since storage on smartphones is usually quite limited, the memory model is restricted and does not use a virtual memory/swap space model for its memory management. It does, however, use most other mechanisms that we have discussed for managing memory, including hardware MMUs.

1. Systems with No Virtual Memory

Many computer systems do not have the facilities to provide full-blown virtual memory with demand paging. The only storage available to the operating system on these platforms is memory; they do not come with a disk drive. Because of this, most smaller systems, from PDAs to smartphones to higher level handheld devices, do not support a demand paged virtual memory.

Consider the memory space used in most small platform devices. Typically, these systems have two types of storage: RAM and flash memory. RAM stores the operating system code (to be used when the system boots); flash memory is used for both operating memory and permanent (file) storage. Often, it is possible to add extra flash memory to a device (such as a Secure Digital card), and this

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memory is used exclusively for permanent storage.

Memory management consists of the following tasks:

Management of application size: The size of an application—both code and data— has a strong effect on how memory is used. It requires skill and discipline to create small software. The push to use object-oriented design can be an obstacle here (more objects means more dynamic memory allocation which means larger heap sizes). Most operating sys- tems for smaller platforms heavily discourage static linking of any modules.

Heap management: The heap—the space for dynamic memory allocation—must be managed very tightly on a smaller platform. Heap space is typically bounded on smaller platforms to force programmers to reclaim and reuse heap space as much as possible. Venturing beyond the boundaries resulting in errors in memory allocation.

Execution in-place: Platforms with no disk drives usually support execu- tion in-place. What this means is that the flash memory is mapped into the virtual address space and programs can be executed directly from flash memory, without copying them into RAM first. Doing so reduces load time to zero, allowing applications to start instantly, and also does not require tying up scarce RAM.

Loading DLLs: The choice of when to load DLLs can affect system the perception of system performance. Loading all DLLs when an application is first loaded into memory, for example, is more acceptable than loading them at sporadic times during execution. Users will better accept lag time in loading an application than delays in execution. Note that DLLs may not need to be loaded. This might be the case if (a) they are already in memory or (b) they are contained on external flash storage (in which case, they can be executed in place).

Offload memory management to hardware: If there is an available MMU, it is used to its fullest extent. In fact, the more functionality that can be put into an MMU, the better off system performance will be.

5] ADVANTAGES OF SYMBIAN

* greater range of applications.
* high quality games.
* better inbuilt web browser.
* connectivity is lot easier and faster.
* real player, smart movie player etc. sort of application are not available with java phones.
* you can install software and applications of any type
* you can download big files through your phone easily with 3g around.
* memory management.
* execution at one place.

6] DISADVANTAGES OF SYMBIAN

* the os is not available for pcs.
* the symbian os can be easily affected by a virus.
* no virtual memory.

**7] APPLICATIONS OF SYMBIAN**

## [Camera Lover Pack](http://www.mediafire.com/?mpxaxfi5ycsx382)

## This is a photographic application for Symbian mobiles and it is released by Scalado. It includes different awesome features like PhotoRama Effect by which you can capture and join 3 pictures and they will be joined automatically as if it was captured in a single shot. Other distinct features include burst capturing, Photo Twister, Photo Fusion e.t.c. It is very handy symbian application for photographers. This is a a paid application available at Nokia store but here you can download it free of cost.

## [Mobi Shield](http://www.mediafire.com/?fbs88uyf43ftle3)

## One of the best Mobile Security application which protects your Symbian Phone from malwares ,viruses and Trojans e.t.c.

## [Smart Office](http://www.mediafire.com/?d8a1q22g82ntdhl)

## Just like Microsoft Office, You can also create,view,edit,share you documents on your symbian mobile phone by using this application. It also supports pdf, txt and all images formats.

## [Maze Lock](http://www.mediafire.com/?jbu6rbuc4ud5kiz)

## Its a security application which locks your mobile phone in a stylish way. Just install this application and set you custom pattern by joining the circular buttons and save the settings. It will lock your phone automatically after the specified time. Draw the same pattern that you set earlier in order to unlock your phone. The Background Images, Font colors, pattern colors e.t.c can also be customized and different other features are included in the paid version of Maze lock symbian application.

## [Viber](http://www.mediafire.com/?icj8t27y7dyq396)

## Its a social application allows you to make free calls,send text SMS and image sharing with other Viber Users. You will just need Internet connection which can be a Wifi or your mobile internet can also be used. Just signup at Viber and after verification of your account using mobile number,it will automatically grab your friends and family accounts from your contact list.

## [Paint Pad](http://www.mediafire.com/?t9vby6t13ynbnxt)

## Its a simple and free paint tool for symbian mobiles. Just link Ms Paint in Windows it also includes all the basic painting and drawing tools. You can also edit existing images and save your drawings in jpeg format.

## [Universal Converter](http://www.mediafire.com/?o1l28d7hcdxjw7d)

## This application allow users to convert different units of length, weight, temperature etc. It includes more than 30 categories and thousands of conversions units. A very helpful application for students who have to do a lot conversions from different units of measurements. It is also a paid application here you can download it free.

## [Nokia Battery Monitor](http://www.mediafire.com/?c2ynr8hvfraich2)

## It shows you all the statistics of your nokia battery life, Estimated Usage, Battery charging time e.t.c. It will also show you Daily and weekly battery usage by different applications installed on your phone. You can also adjust brightness and Turn the power saving feature on or off through simple interface which will increase your battery timing.

***Conclusion:*** Thus the Case Study on Mobile Operating Systems has been successfully done.