

Google Android: An Emerging Software Platform For Mobile Devices

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Abstract

Mobile phone usage has been increasing dramatically over the last several years. Globally, if a usage comparison can be carried out between PCs and mobile devices. Mobile devices have approximately 3.5 times more usage than PCs. But cell phone in today's society is not only a tool for making call and writing SMS, but it's a personal item which provides entertainment and information. There should be nothing that users can access on their desktop that they can't access on their cell phone. The increasing importance of mobile devices has triggered intense competition among technology giants, like Symbian, Google, Microsoft, Apple, and Nokia in a bid to capture the bigger market share for mobile platform. So Google launched Android, an open source software platform for mobile devices consisting of an operating system, middleware and key applications. Since its official public release, Android has captured the interest from companies, developers and the general audience.

This paper intends to explore different perspectives, features & suitability of android for mobile devices & comparison between Android, Symbian & Windows mobile OS.

Keywords: Android, Symbian, Windows Mobile, Middleware, Open source software platform.

I. INTRODUCTION

Android is a software stack for mobile devices which includes an operating system, middleware and key applications. Since its official public release, Android has captured the interest from companies, developers and the general audience. From that time up to now, this software platform has been constantly improved either in terms of features or supported hardware and, at the same time, extended to new types of devices different from the originally intended mobile ones. Google entered into the mobile market not as a handset manufacturer, but by launching mobile platform called as "Android" for mobile devices such as Smart phones, PDA and net books on 5th November 2007. Google has a vision that Android based

cell phone will have all the functions available in the latest PC. In order to make this effort possible, Google launched the Open Handset Alliance. Google introduced Android as an OS which runs the powerful applications and gives the users a choice to select their applications and their carriers. The Android platform is made by keeping in mind various sets of users who can use the available capacity within Android at different levels. Android is gaining strength both in the mobile industry and in other industries with different hardware architectures. The increasing interest from the industry arises from two core aspects: its open-source nature and its architectural model. Being an open-source project, Android allows us to fully analyze and understand it, which enables feature comprehension, bug fixing, further improvements regarding new functionalities and finally, porting to new hardware. On the other hand, its Linux kernel-based architecture model also adds the use of Linux to the mobile industry, allowing to take advantage of the knowledge and features offered by Linux. The Android platform consists of several layers which provide a complete software stack. Android applications are Java-based and this factor entails the use of a virtual machine VM environment, with its advantages. Android uses its own VM called Dalvik, which interprets and executes portable Java-style byte code after transforming it, which is optimized to operate on the mobile platform. All of these aspects make Android an appealing target to be used in other type of environments.

The remainder of this paper is organized as follows: Section II briefly describes the Android's background including architecture,

features & programming framework. Section III presents detailed analysis of Android market including comparison with Symbian & Windows Mobile. Finally Section IV concludes this paper.

II. ANDROID BACKGROUND

A. Android Architecture

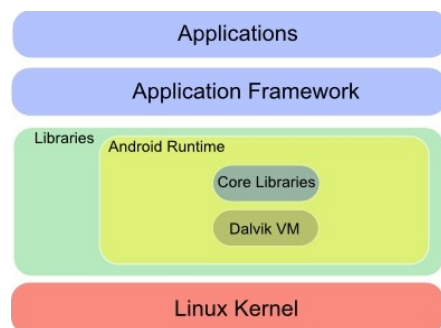


Fig. 1 Android Architecture

Android Architecture is shown in fig1, which consist of number of layers as Applications, Application framework, Libraries, Android runtime & Linux kernel [1]. Application layer is the uppermost layer which provides a set of core applications including an email, SMS program, calendar, maps, browser, contacts, and others. All applications are written using the Java programming language. It should be mentioned that applications can be run simultaneously; it is possible to hear music and read an email at the same time. The Application Framework is a software framework that is used to implement a standard structure of an application for a specific operating system. With the help of managers, content providers and other services programmers it can reassemble functions used by other existing applications. Layer which is present below Application framework consist of two parts as Libraries which are all written in C/C++. They will be called through a Java interface. This includes the Surface Manager, 2D and 3D graphics, Media Codecs like MPEG-4 and MP3, the SQL database SQLite and the web browser engine

WebKit. Second part is Android Runtime which includes a set of core libraries that provides most of the functionality available in the core libraries of the Java programming language. Every Android application runs in its own process, with its own instance of the Dalvik virtual machine. The Dalvik VM executes files in the Dalvik Executable (.dex) format which is optimized for minimal memory footprint. The lowest layer is

Linux Kernel, Android basically relies on Linux version 2.6 for core system services such as security, memory management, process management, network stack, and driver model. The kernel also acts as an abstraction layer between the hardware and the rest of the software stack.

B. Features of Android

Google Android has many features which make it special, but one important feature is Dalvik virtual machine (DVM) [5]. Which is a major component of Android platform. It is optimized for low memory requirements and is designed to allow multiple VM instances to run at the same time. The DVM runs Java applications. However, it is different from standard Java virtual machine in some ways. First, most virtual machines use a stack-based architecture, but Dalvik is a register-based architecture. Second, Dalvik runs Java applications which have been transformed into the Dalvik Executable (.dex) format which is optimized for minimal memory footprint The Dalvik VM relies on the Linux kernel for underlying functionality such as threading and low-level memory management. Java virtual machine tool interface (JVM TI) is a native programming interface on Java virtual machine. The interface provides functionalities to inspect the state of a virtual machine, gather information during run time, and also control the execution of applications running on the Java virtual machine. Android has built in integrated browser based on the open source

WebKit engine & built in powerful SQL database engine called SQLite, use for structured data storage. Android support for common audio, video, and still image formats such as AAC, MPEG4, H.264, MP3, AMR, & contains Rich development environment including a device emulator, tools for debugging, & a plug-in for the Eclipse.

C. Android Programming Framework

The environment requires to develop application for Android consists of the Android SDK, the Eclipse IDE and the Java Development Kit (JDK) which has to be preinstalled for the installation of both, Android SDK and Eclipse. The following versions of the tools mentioned above are used & presented in figure below.

- Android SDK
- JDK: jdk1.6
- Eclipse: eclipse 3.2



Fig. 2 Android Programming Framework

1) *Android Software Development Kit*: The Android SDK includes a comprehensive set of development tools. These include libraries, a handset emulator, documentation, sample code, tutorials & tools such as dx - Dalvik Cross-Assembler, aapt - Android Asset Packaging Tool & adb- Android Debug Bridge. Applications are written using the Java programming language and run on Dalvik, a custom virtual machine designed for embedded use which runs on top of a Linux kernel. The

officially supported integrated development environment (IDE) is Eclipse (3.2 or later)

2) *Android Emulator*: The Android SDK includes a mobile device emulator -- a virtual mobile device that runs on your computer. The emulator lets you prototype, develop, and test Android applications without using a physical device. The Android emulator mimics all of the hardware and software features of a typical mobile device, except that it cannot receive or place actual phone calls. It provides a variety of navigation and control keys, which you can "press" using your mouse or keyboard to generate events for your application. It also provides a screen in which your application is displayed, together with any other Android applications running. To let you model and test your application more easily, the emulator supports Android Virtual Device (AVD) configurations. AVDs let you specify the Android platform that you want to run on the emulator, as well as the hardware options and emulator skin files that you want to use.

III. ANDROID MARKET ANALYSIS

A. Android Market

The Android Market, an online software store, is developed by Google for Android devices. It was made available to users on October 22, 2008. Most of the Android devices come with preinstalled "Market" application which allows users to browse, buy, download, and rate different available applications and other content for mobile phones equipped with the open-source operating system. Unlike with the iPhone App Store, there is no requirement that Android apps should be acquired from Android Market [2]. Android apps may be obtained from any source including a developer's own website. Also, Android developers can create their own application market. Google does not have a strict requirement for the application to show up on the Android Market compared to the process

used by Apple. Lastly, the Android Market follows a 70/30 revenue-sharing model for applications developed by developers. The developers of priced applications receive 70% of the application price and remaining 30% distributes. As of May 04, 2010, Android apps hit around 49,000 applications which were around 12,500 in August 2009 and 20,000 in December 2009. The global smart phone sell in second quarter of 2009 & 2010 are shown below [9].

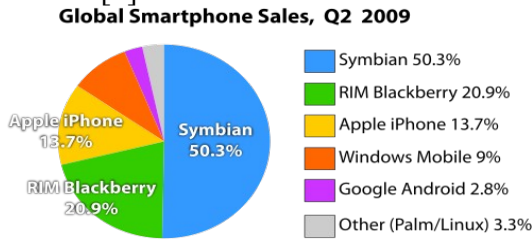


Fig. 3 Global smart phone sell Q2 2009

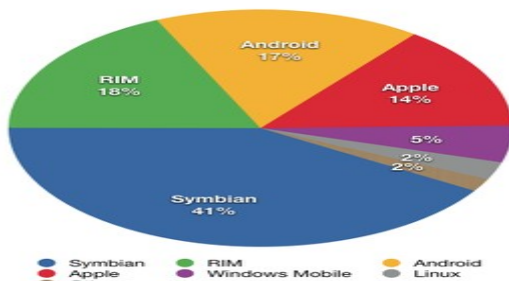


Fig. 4 Global smart phone sell Q2 2010

We saw an increase of approximately 15-20% & 8-10 % growth in the Android & iPhone Applications in App Store as shown below.

TABLE I
COMPARISON BETWEEN GROWTHS OF ANDROID & IPHONE APP

Application Category	05 Mar 2010		05 Apr 2010		05 May 2010	
	iPhone	Android	iPhone	Android	iPhone	Android
Finance	2225	694	2596	919	2781	1021
Health	3353	586	3818	781	4050	901
Lifestyle	9173	2423	10278	3013	10830	3331
Productivity	3583	1196	4028	1454	4251	1677
Sports	5822	825	6585	1142	6966	1404
Social Networking	2627	766	3000	959	3186	1085
Games	25898	4250	31373	4980	34110	6221

Change wave research that has carried out two surveys first for cell phone satisfaction rating by mobile operating system which shows that 72 % people satisfied with android OS as compare to other mobile OS & second for future smart phone buyers with mobile OS shows that people preference to android grown from 30% in June to 37% in September is shown in below figure.

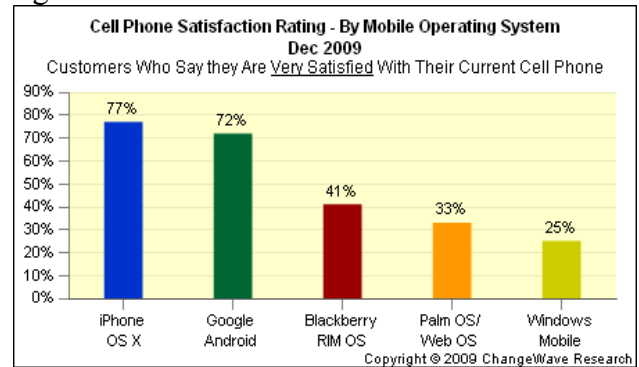


Fig. 5 Cell Phone Satisfaction Rating

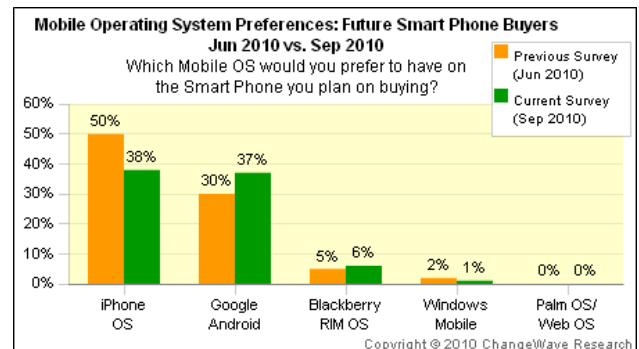


Fig. 6 Mobile Operating Preference

IDC worldwide quarterly mobile phone tracker predicted 50% growth in Android market from 2010 to 2014 as compared leading Mobile OS Symbian whose market may decline from 40 % to 32 % in 2014.

TABLE II
MOBILE OPERATING SYSTEM MARKET SHARE 2010-14

Operating System	2010 Market Share in%	2014 Market Share in %	2014/2010 Change in %
Symbian	40.1	32.9	-18.0
BlackBerry OS	17.9	17.3	-3.5
Android	16.3	24.6	51.2
IOS	14.7	10.9	-25.8
Win Mobile	6.8	9.8	43.3
Others	4.2	4.5	8.3
Total	100	100	

B. Android vs. Symbian vs. Windows Mobile

Comparison is based on main criteria as follows.

1) *Portability*: Portability is a very important assessment criterion. Symbian OS has many references in this area and having standardized architecture and the openness to software. But the fact that Symbian mostly runs on Nokia cell phones and that it is not Java based lets it fall behind Android. Unfortunately Windows Mobile also has several applications that are specific to certain hardware platforms and therefore are not portable. The Android Mobile platform is a Linux & Java based which allow us to use it on many different platforms unlike Symbian & Win Mobile. As a result Android gets one point, Symbian OS gets half a point and Windows Mobile zero points.

Total so far: Symbian OS = 0.5 Windows Mobile = 0 Android = 1

2) *Reliability*: Reliability is very much dependent on user experience. An operating system can be tested extensively, but without having experience of several years in “the real world” it is very hard to give a good estimate. Because of many years of user experience and the amount cell phones working with each of the systems it is possible to say that both, Symbian OS and Windows Mobile, are reliable enough for all kinds of users and applications which are available at the moment. It doesn't mean that both systems run perfectly well but problems with the systems will not result in major difficulties. The Linux kernel used by Android has existed for long period which has proven that it is stable and fail-proof. Therefore it is useful for mobile applications. Because Symbian OS and Windows Mobile control the biggest part of the market and Android is Linux based so we will give every operating system one point.

Total so far: Symbian OS = 1.5 Windows Mobile = 1 Android = 2

3) *Connectivity*: The mobility of a cell phone generally makes a wireless connection preferable. Symbian OS & Windows Mobile features GSM telephony, Bluetooth, Infrared and WI-FI. & their APIs enables a development that targets all of these features and categories. Android also features GSM telephony, Bluetooth, EDGE and WI-FI. All developers have the same access to the framework APIs used by the core applications. All of them support the common and mainly used connectivity standards. Therefore we will give each operating system one point.

Total so far: Symbian OS = 2.5 Windows Mobile = 2 Android = 3

4) *Open Platform*: An “open mobile platform” is a software stack, including an operating system, middleware and key applications, which can be used on every mobile device. It allows users to develop additional software and change or replace functionality without limitations. The most common standards for communication and connectivity are used. All these functionalities have to be free of charge. The only operating system which really fits to these criteria is the Android mobile platform. Which is based on a free available operating system? Another fact is that publishing your own developed applications is free which not the case for Symbian OS and Windows Mobile. This is the reason why Android gets one point and the other operating systems half a point. **Total so far: Symbian OS = 3 Windows Mobile = 2.5 Android = 4**

5) *Kernel Size*: An often used assessment factor for comparing the kernel size is the “Memory footprint” which is the amount of memory used by the operating system. For a significant classification we need to find the operating system with the lowest “Memory Footprint” which in turn maximizes the performance of the operating system. Symbian OS require 200 Kb. The Windows Mobile platform requires 300Kb for a typical installation. The Android OS which is using Linux kernel will need about 250 kb of

memory. All the data above apply to an installation with the basic and minimal functionalities. As a result Symbian OS needs less memory than Android which needs less memory than Windows Mobile. So Symbian gets one point, Android gets half a point and Windows Mobile zero points.

Total so far: Symbian OS = 4 Windows Mobile = 2.5 Android = 4.5

6) *Standards*: Standards in general make the platform more open and attractive for developers. If standards exist it is easier for everyone and especially for developers, to get to know the new system. Every operating system uses the most common standards concerning networking, e-mails, messaging and communication, but only Android is based on the standardized programming language Java. This is also the programming language generally used to develop applications. The advantage of Java is that its programs can run on any platform without having to be rewrite. As a result Android gets one point, Symbian OS and Windows Mobile each half a point.

Total so far: Symbian OS = 4.5 Windows Mobile = 3 Android = 5.5

7) *Special Features*: This section deals with features or applications which are designed to make the system unique. The Android mobile platform has significant advantages in this case. The new integrated browser based on the open source WebKit engine, the virtual machine Dalvik optimized for mobile devices, is a feature which enables every application runs in its own process. Windows Mobile has, due to its outstanding position in the computer market, the advantage that the synchronization between the PC and the cell phone is very easy. Symbian OS however has no special features which must be mentioned. Android gets one point, Windows Mobil half point and Symbian OS zero points.

Total so far: Symbian OS = 4.5 Windows Mobile = 3.5 Android = 6.5

From below table we can say that winner is Android.

TABLE III
RESULT TABLE FOR OS FEATURE COMPARISON

Feature	Android	Symbian	Win Mobile
Portability	1	0.5	0
Reliability	1	1	1
Connectivity	1	1	1
Open system	1	0.5	0.5
Kernel size	0.5	1	0
Standards	1	0.5	0.5
Special features	1	0	0.5
Total	6.5	4.5	3.5

IV CONCLUSION

In this work we have reviewed details of Android, & studied features as well as suitability of android for mobile devices. We have also compared Android with Symbian & Windows Mobile. Findings of this review are that Android is superior compare to its competitive systems & acts as an Emerging Software Platform for Mobile Devices. Android will become a leader in mobile Platform.

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