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Title:

THE FUTURE TRAJECTORY OF GOOGLE ANDROID: A STUDY FROM OPERATING SYSTEM, APPLICATION STORES AND HANDSET MANUFACTURERS

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ABSTRACT

More than four billion mobile phone users is an appealing reason for Google to expand its competitive advantage in the mobile internet advertising with Android. This report addresses a research question "What is the future trajectory of the Google's Android OS?" by identifying the key challenges of Android's future success. Key challenges in term of Android OS, its handset, and the Android Market are discussed that lead to recommendations. The key for the Android OS' success is to be a platform that enables the best user experience. Android OS must have an architecture that eases developers to deliver a high quality of application for consumer's best experience. Any fragmentation in Android OS must also be avoided such that compatibility across various handsets remains. Related to handset, key challenges are to come up with an affordable price, but still comply with the latest network requirements ahead, such as the LTE. Lastly, key challenges for the Android Market Place, it should offer more attractive incentive for developers and provide different pricing scheme, particularly the subscription-based payment. Android Market should also be a single market concept, which does not just provide applications, but also other mobile contents.

CHAPTER I

INTRODUCTION

1.1. GOOGLE INTRODUCTION

Google's mission was (and still is) to organize the world's information and make it universally accessible and useful. Google's founders Larry Page and Sergey Brin developed a new approach to online search that took root in Stanford University. Today, Google is the world's most popular search engine -- an easy-to-use free service that usually returns relevant results in a fraction of a second. According to britannica.com, about 70 percent of all online search requests are handled by Google, placing it at the heart of most Internet users' experience. This not only generated advertising revenues from internet search, which continues to remain its cash cow, but also established the "Google" brand.

Google has been ranked #1 brand in 2009 yet again by Milward Brown, a global market research and consulting company. Google has not only been a brand to reckon with but has become synonymous for online search as well. In order to sustain and increase its relevance in the future Google has moved into the mobile internet market as well.

On 5 November 2007, the Open Handset Alliance (OHA) was formed to promote a free open-source operating system based on Linux for mobile devices and Android code was launched under Free/Open Software license. The Open Handset Alliance is a consortium of dozens of technology and mobile telephone companies, including Intel Corporation, Motorola, Inc., NVIDIA Corporation,

Texas Instruments Incorporated, LG Electronics, Inc., Samsung Electronics, Sprint Nextel Corporation, and T-Mobile (Deutsche Telekom). The first phone to feature the new operating system was the T-Mobile G1, released on Oct. 22, 2008. Android-based phones require the latest third-generation (3G) wireless networks in order to take full advantage of all the system's "smartphone" features, such as one-touch Google searches, Google Docs, Google Earth, and Google Street View.

1.2. RESEARCH OBJECTIVE

The objective of this report is to answer the research question "**What is the future trajectory of Google Android?"** This report is based on publicly available sources such as reports and news articles on Android between October 2008 and July 2009. We will analyze and identify the key challenges of the Android project at three different levels, at the operating system level, the online application store level and finally the handset manufacturers' level. In the final chapter we will identify the key challenges and suggest a few solutions for the overall success of Android community.

CHAPTER 2

RESEARCH BACKGROUND

2.1. GOOGLE'S VISION

Google is a search engine which helps to connect the world together. Its vision is to make a search engine so robust and powerful that it can understand the entire world. Its goal is "to provide much higher level of services to all those who seek information, whether they are at home, office, businesses or in travel". It has continuously focused on innovation so that it can provide fast, accurate and easy-to-access search engine services which can be accessible from anywhere. At the same time they have been constantly improving the user experience as well. Google search is not only limited to the personal computer world but it has also set foot in the mobile internet world with their Android OS.

2.1.1 Mobile Internet

Mobile Internet is the wireless internet services that can be accessed using handheld devices such as mobile phones. Mobile Internet can be classified as limited and unlimited based on the service provider. In limited mobile internet service subscribers have to pay on downloaded packet basis for the internet service whereas in unlimited mobile internet services subscribers will receive unlimited access to news, entertainment, email etc for one month of subscription fee.

Mobile internet is growing rapidly. More than 50% of mobile subscribers use mobile internet these days and according to adMob report, there are 8 billion requests for the mobile ads worldwide at the end of March 2009. In the mobile internet market, iPhone is leading the market share while Android is the next and is rapidly gaining market share. The figure 2 below shows the graph of the market share in mobile internet browsing.

Table 1 Market share in mobile internet browsing as of March 2009

Mobile Browsing by Platform	Total Market Share (%)
iPhone	64.23
Android	8.30
Java ME	8.08
Symbian	7.46
Windows Mobile	5.54
BlackBerry	3.61
Palm	2.22
BREW	0.56

From the above chart we can see that iPhone is leading the market with 64.23 percentage of market share. Google Android is in second place with 8.30 percentage followed by Java ME, Symbian at 8.08 and 7.56 percentage of market shares respectively.

2.1.2 What is Google Android?

"Android is a software stack for mobile device that includes an operating system, middleware and key applications". It is a mobile platform that is complete, open and free. Android Inc. was co-founded by Andy Rubin and was later acquired by Google, the largest search engine corporation, in July 2005. On November 5, 2007, the Open Handset Alliances, a consortium of several technology and mobile companies, was founded to promote and support the open source operating system based on Linux called Android.

The third party developers can create applications, which are written in java programming language based on Linux Kernel, using Android SDK, JDK 5 or 6 and Ellipse IDE version 3.2 or any latest version of Ellipse IDE, with the rich set of Google Android API (Application Programming Interface).

2.1.3. Competitive Features

The current features of Google Android are as follows:

Table 2 Competitive features of Google Android
(Source : wikipidea.org/wiki/Android)

Features	Classification
Handset Layout	The platform is compatible to larger, VGA, 2D and 3D graphics library based on OpenGL ES 1.0 specification, and smartphone layouts
Storage	The Database Software **SQLite** is used for data storage purposes

Connectivity	Android supports connectivity technologies including GSM/EDGE, CDMA, EV-DO, UMTS, Bluetooth and Wi-Fi
Messaging	SMS and MMS are available forms of messaging
Web browser	The web browser available in Android is based on the open-source WebKit application framework
Dalvik virtual machine	Software written in Java can be complied in the Dalvik virtual machine, which is a specialized virtual machine implementation designed for mobile device use
Media support	Android supports the following audio/video/still media formats: MPEG-4,H.264, MP3, AAC, MIDI,OGG,AMR,JPEG,PNG,GIF
Market	Android Market is an open content distribution system that allows consumers to search, purchase, download and install various types of contents. Paid- for apps have been available on the Android Market in the US since 19 February 2009

2.1.4. Android Architecture/Framework

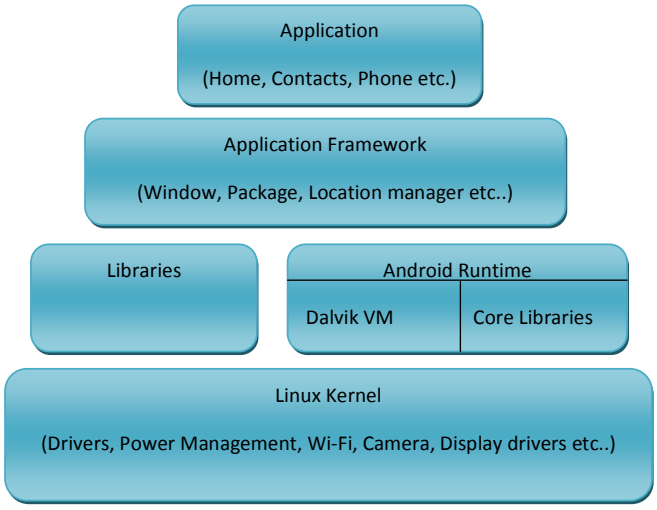


Figure 1 Android architecture/framework

Figure 2 shows the Android architecture or framework which contains the major components of Android operating system. There are four layers in this framework with the Linux Kernel layer at the base and application at the top most layers of the framework. Each section is briefly described below.

Application layer contains a set of core applications such as email client, SMS program, calendar, maps, browser, contacts and others. All these applications are written in Java programming language.

In application framework layer, developers have full rights to access the core application framework. This application framework simplifies the reuse of components; any developer can publish their application capabilities and any other application developer may then make use of those capabilities. This framework layer consists of services including views, content provider, resource manager, notification manager and activity managers.

Libraries and Runtime layer includes a set of C and C++ programming languages and some of the core libraries are system libraries, 3D libraries, SQL, Surface manager etc. Dalvik virtual machine is used to compile (run) the program written in Java languages.

Finally the Linux kernel is the operating system which handles the physical hardware and manages variety of services such as security, networking, memory management, drivers for variety of devices and Power management. The kernel also acts as an abstraction layer between the hardware and rest of the software stack.

2.2. BUSINESS MODEL

2.2.1. The 'Ecosystem'

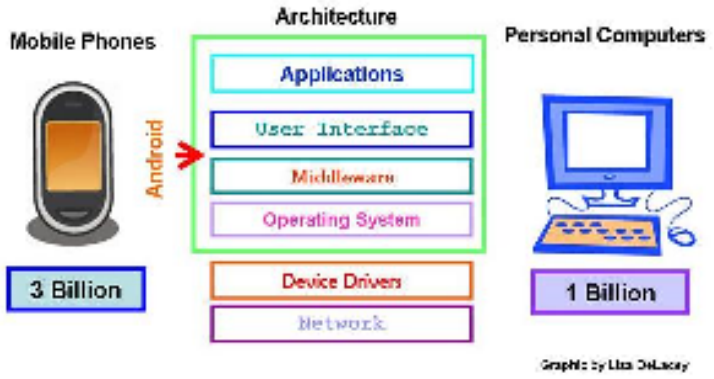
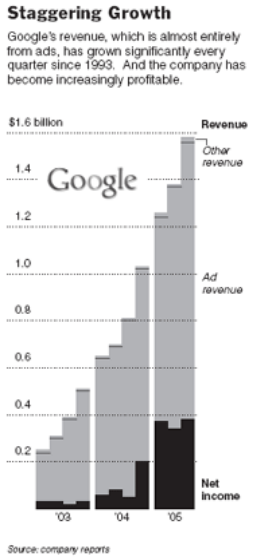


Figure 2 Android ecosystem

(Source: http://www.onlamp.com/pub/a/onlamp/2007/11/12/google-calling-inside-the-gphone-sdk.html)

In order to maintain its relevance and sustain its business which depends mainly on Internet search, Google must formulate novel ideas to gain more advertising income. Unfortunately, as we are now entering a hyper informed society, simple market intensification would not be a compelling story for the advertisers. In other words Google has to find a new market for revenue generation. Fortunately, three billion users on the mobile industry can be an appealing market for those advertisers. The figure 2 above shows us the opportunity for Google to move the competition and future development on customer web experience to mobile internet to increase their business size from their main revenue stream which is advertising as shown on the graph on the next page.



A research shows that in the period between July and September 2007, Google advertising revenue surpasses one of the UK's TV channel revenue for about £ 10 million in the same three-month period

Figure 3 Google's revenue stream

However, as Google is not a main stream player in mobile industry it needs a vehicle to enter the staggering competition in the fast growing industry with a proper business model.

Starting off with analyzing the increasing future trend of the mobile industry and connecting it to a business revenue stream, Google must enter with a platform which can support the customer web experience through a cost competitive, high-tech, and dependable media to face the current mobile industry competition. Google did that in the Q3 2005 with the acquisition of Android Inc by the search engine titan.

However, having this platform is far from sufficient to conquer the mobile industry. Google has to come up with something bigger and better. Google needs something that gets people's attention with real intrinsic long term value for the stakeholders. This belief is what led to the founding of Open Handset Alliance

(OHA) on the 5th November 2007 (less than 1-month after the acquisition of Android Inc)

With the OHA, Google tries to introduce 'openness' to the members which consists of 34 mobile industry players (another 14 new members as of December 9th 2008) as shown below

Figure 4 OHA members

The relationship between the parties involved in the consortium can be drawn similarly as per below

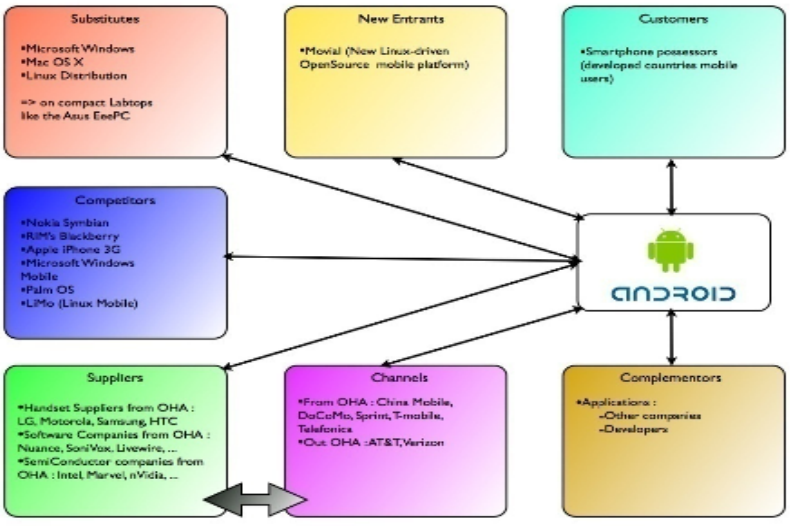


Figure 5 Relationship between Android's stakeholders

2.2.2. Collective Interest of the Stakeholders

With the OHA, Google tries to leverage on the collective interest of all the members in the consortium to make Android successful in the current market of mobile telecommunication. And clearly, this consortium assembles nearly all 2nd-tier players in the mobile communications market who are more than willing to be advocates of 'openness' with their financial rewards. Largely, the collective benefit for OHA members is the nature of Android being an Open source operating system.

Open source which means innovations, new features, bugs fixing happen in scale of weeks not years. Overall, the ecosystem development should be faster than proprietary platforms.

2.2.3. Individual interest of the stakeholders

Customers - four core values that are related directly to customers are cheaper mobile devices, rich portfolio of applications, fast growing innovations, and high tech devices, which can be derived from the 'openness' of the Android platform.

Handset manufacturers (OEMs) - cheaper bill of material which can directly waive 25% of total direct cost on licensing fee, technical development support from the 'open' community and also the support from Google on the virtual java engine called Dalvik Virtual Machine. Furthermore there are no licensing fee from SUN Microsystems's Java Micro Edition (JME), which is used in Java application engine for mobile platforms.

Mobile operators - greater flexibility to customize and differentiate product offerings supported by wider and faster range of innovations which can come from diversified applications and a bigger pool of developers.

Software companies - the open-source platform enables the software companies to streamline their product integration to fully utilize each stack of the Android platform.

Semiconductor companies - for these companies Android opens a bigger market beyond mobile phones, as it has a great potential to penetrate into markets beyond mobile telecommunication like netbooks, set top boxes, VoIP phones, karaoke machines, security and monitoring systems, and digital photo frames)

Commercialization companies - for them, the modern mobile technology provides a platform which will unravel the future potential of mobile industry such as 'Android Market' (Android market for applications).

Google - the aim is still the same, to increase its revenue from advertising as the community grows. In fact, in this scenario Google has better advantage compared to the current mobile telecommunication players, because essentially they are aiming for two different things. Google's aim is to increase its advertising revenue which has no correlation to other mobile telecommunication business model where they aim to sell more mobile phones and also gain a higher market share of the mobile phone users market.

2.2.4. Revenue Stream

As we have explained above the benefit for each stakeholder in the community varies based on their individual interests. The figure below will simplify the scenario explained in the previous section.

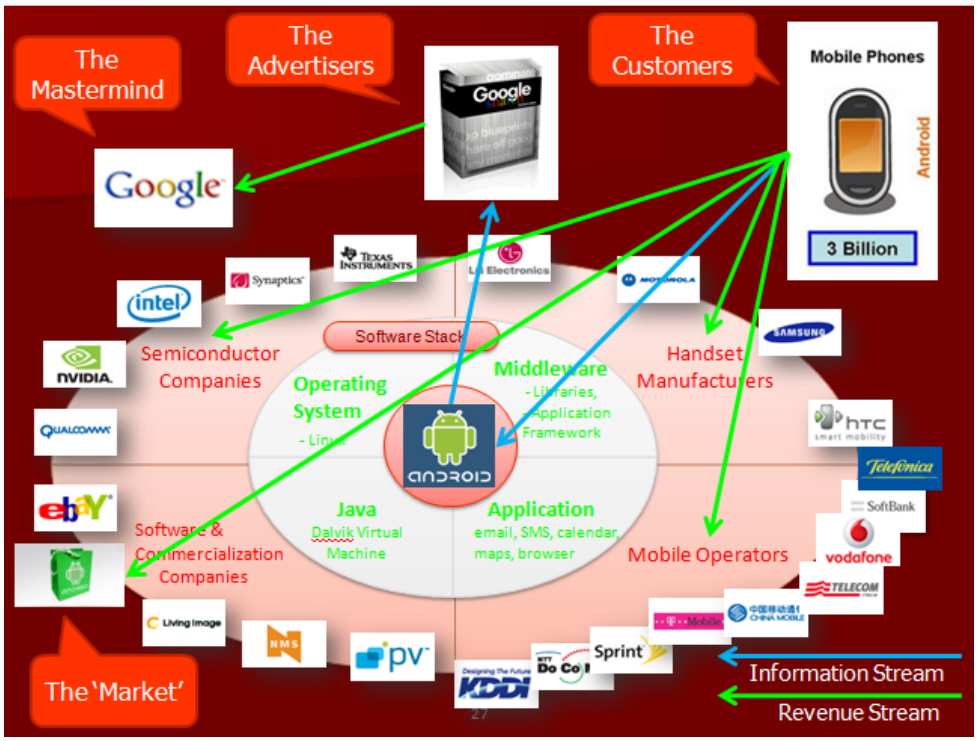


Figure 6 Android's revenue stream

From the image above we can identify two revenue streams for Google and the OHA stakeholders.

(in million USD)

	Google advertising revenue	2007	2008	2009	Objective
CAGR = 14%	with 1-1.5 billion pc based market	16,593.99	21,795.55	24,846.93	
CAGR = ?	added with 3 billion mobile based market			435.91	43,591.10
	total revenue	16,593.99	21,795.55	25,282.84	68,438.03

CAGR (pc based ads)	14.61%
revenue per user / year (based on 2008)	USD 14.53
2009 mobile ads support to revenue	1.75%

* under ceteris paribus condition and forecasted simply on historical growth
** under assumption mobile advertising in 2009 equals to 1% of the total mobile ads market

conclusion
in 2009 alone mobile advertising could support 1.75% growth in total revenue regardless the CAGR

Figure 7 Google Revenue Illustration

(Source : http://www.internetworldstats.com/stats.htm and http://www.google.com/finance?q=goog)

The image above shows the projections of a new market for Google advertising supported by mobile internet experience which could increase their advertising revenue growth rate to nearly 300%.

And secondly, the revenue model for the stakeholders as Google should also consider about the growing concerns of other stakeholders in the OHA ecosystem. The success of the OHA consortium determines the future trajectory of Android development which will significantly impact the future of mobile internet.

The table below shows the stakeholders and their revenue source.

Table 3 Stakeholders of Google Android

Stakeholders	Potential revenue stream
Semi conductor	additional items sold subject to Android platform
Handset manufacturer (OEMs)	additional items sold subject to Android platform
Mobile operators	30% of the Android market revenue
Software developers	70% of the Android market revenue
Commercialization companies	innovations and customization (integrated service to Android stakeholders)

For most of the stakeholders the definite qualitative benefit is the potential to grow faster since Android is an open source platform, which means that innovations can be done much faster than other prevalent proprietary models.

Further, there are also sources mentioned the potential about the mobile AdSense which can be considered as derivative product (Google extension) within mobile ecosystem. With this application in place, the opportunity for advertising revenue sharing is not only limited to mobile operators but also mobile websites owners.

CHAPTER 3

OPERATING SYSTEM

3.1. OPERATING SYSTEM COMPETITION

This section will discuss the major competitors to the Android operating system (OS). A brief introduction to each OS is provided in the Appendix 2.

The figure 9 below depicts the market share figures of OS worldwide in the 4th quarter of 2008. For the past decade, Symbian has had the largest market share in mobile OS worldwide. This matches the success of Nokia in the mobile handset market share worldwide. Based on the figure, Android is part of the 8% Linux market share. Gartner estimated that Android OS accounted for 20% of the total Linux market share, which is around 1.6% of the worldwide market share. The major competitors for Android are Symbian, Research In Motion (RIM), Microsoft Windows Mobile, Mac OS X (iPhone OS), Palm OS, and some Linux-based mobile OSes, such as Mobilinux, LiMo, Maemo, and Openmoko.

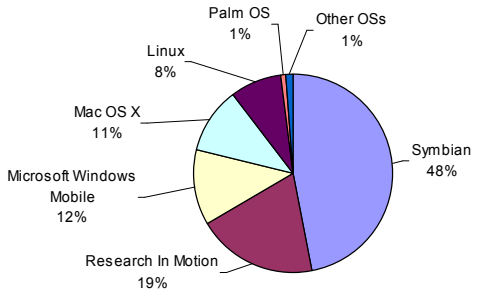


Figure 8 Operating System Market Share, 4Q2008

Analysis based on either open-source or proprietary system will be discussed in this section. The following figure depicts the open/proprietary mapping for the operating system (OS) discussed in this report.

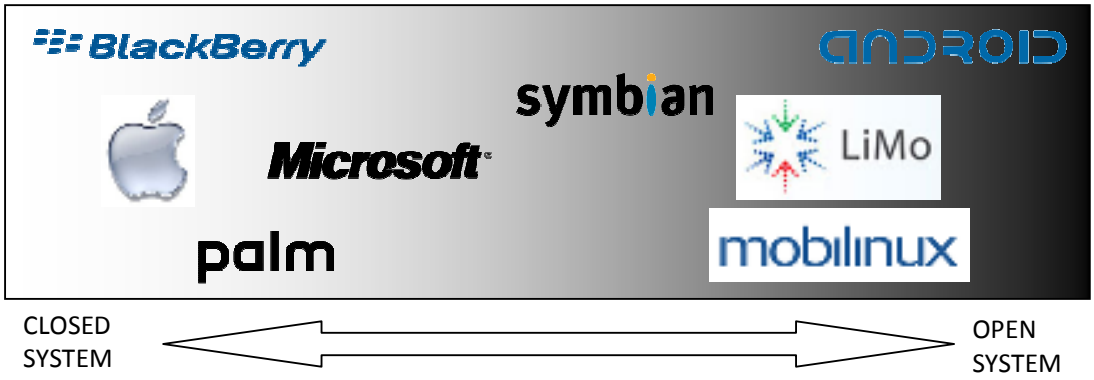


Figure 9 Mobile operating system open/proprietary mapping

The mapping shows a trend that the operating systems are moving towards the two extremes. Palm, which was initially open for some handsets, is now following the iPhone and is in the process of creating a proprietary Linux-based operating system. On the other hand, Symbian OS is going the opposite direction towards the open source OS like Android. In this case, we can see a bi-polar market each trying to accomplish the same thing, which is to make a successful mobile operating system.

3.2. ANDROID AGAINST OTHER OPEN SOURCE OPERATING SYSTEM

Since Android shares the same roots as other Linux-based mobile OS; open source OS is another hurdle that Android should overcome to avoid being yet

another open source mobile OS. The following table summarizes the comparison of Android with the other open source OSes.

Table 4 Comparison of Android and Other Open Source Operating System

	Android	Symbian	LiMo	Mobilinux	Maemo	OpenMoko
Full-stack open source?	Yes	Expected	No	No	No	Yes
Programming language	Java, C/C++	Symbian C++, C/C++, Java, Python	C++	C/C++	Symbian C++, C/C++, Java, Python	Python
Multitasking	Yes	Yes	Yes	Yes	Yes	Yes
Porting redevelopment	Not required	Required, except Java-based apps.	Required	Required	Required	NA
Unique Features	Full-stack free open source	Flexibility of programming language	Royalty-free	Battery-usage maximization	Designed for Mobile Internet Device	High customization
Processing Speed	High	High	High	High	High	Medium-low
Development period	Fast	Medium	Medium	Medium	Medium	Fast
License	Apache 2.0	Eclipse Public License	GNU/GPL	GNU/GPL	GNU/GPL	GNU/GPL

Some advantages of Android compared to other open source OSes is, first, it is the only full-stack free open source OS (access to all levels of the OS) backed by alliance of companies that distinguish itself from OpenMoko. Second, it does not require redevelopment for porting among different handsets since Java is utilized as the programming language. A survey shows that 89% of respondents expressed enthusiasm for Java as it provides an effective handheld platform that can support multiple device types. Third, the development process is relatively

faster than other mobile OS since Java is easier to code compared to others like C/C++. Fourth, Android also provides flexibility for developers to develop native applications (based on C/C++), bypassing the virtual machine where the common java-based application works on top of it. Five, the Apache 2.0 license is more attractive to developers compared to GNU/GPL in terms of revenue generation or viable commercialization opportunities since Apache 2.0 does not oblige developers to release the derived application.

The following sections will further compare between Android and other open source OSes.

3.2.1. Android vs. Symbian

In June 2008, The Symbian Foundation released the biggest evolutionary leap in Symbian OS since its creation, making the platform open source and planning to deliver the full open source in 2 years (June 2010). The foundation started its operations in the first half of 2009, subject to the closing of the acquisition of Symbian Ltd. by Nokia. This OS and some of its source code are currently available under a royalty-free license to the foundation members.

Unlike Android which is a truly open source OS, Symbian is still on its way towards becoming a full-stack open source OS. Symbian Foundation has released the beta version of the security package in July 2009 under the Eclipse Public License (EPL). EPL allows the package to bypass export regulations on cryptographic products from the UK, Symbian's home base, under public licensing rules. However, the current Symbian OS includes a lot of proprietary

codes, which will need to be licensed under the EPL in order for Symbian to be an open source OS. This is still a big challenge for Symbian to be a 'truly' open source OS like Android.

In comparison to Android, Symbian is a multitasking operating system that could execute multiple applications simultaneously. The platform supports several programming languages, notably C/C++ for porting existing UNIX applications, and Java to port Java ME applications. However, the primary programming language for the platform is Symbian C++, a language that makes a steep learning curve for developers. This makes Android more preferable to developers in general. It almost always guarantees a standard application environment across Android devices. The virtual machine provides a layer for programmers so the developers do not have to worry about the underlying hardware on which Android is deployed. Therefore, redevelopment of the applications is not required when porting between Android-based handsets.

The following figure shows the comparison between the two OS stacks. It is clear that all bottom-up Android OS stack can be accessed by developers, while the Symbian is only up to the middleware layer. Developers can create more features by having more access in the Android OS.

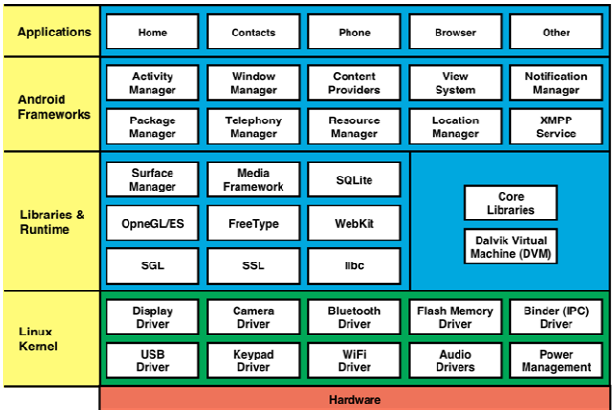


Figure 10 Android OS Stack

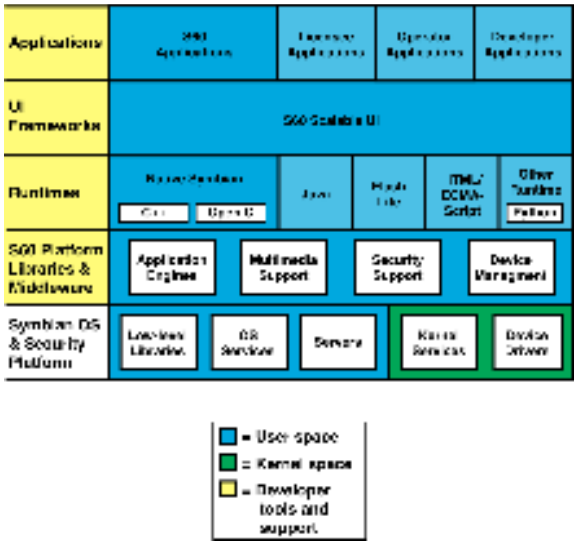


Figure 11 Symbian OS Stack
(Source: http://www.ddj.com/mobile/216300179)

3.2.2. Android vs. LiMo

What distinguishes Android from LiMo is that LiMo is just a middleware where it can run on top of various operating systems, whereas Android is a full operating system (which has its own middleware). Middleware only, meaning LiMo only handles things that are tucked below what the user actually sees. User

experience items, such as the interface, are the responsibility of those developing the device. LiMo aims to ensure compatibility across the industry, without taking away operators' ability to put their own proprietary applications on top. LiMo is a validation of a collaborative-development model that allows proprietary and open-source software to co-exist within a single platform. This could attract developers who want to develop a proprietary application on top of an open source middleware. It is reported that some delegates at Handsets World were generally enthusiastic about the potential of Android rather than LiMo.

In terms of programming languages, comparing LiMo to Android would be similar with the Symbian and Android comparison earlier. Android applications have flexibility to be written in Java or C/C++ while LiMo applications are written in C/C++ only. Development cycle for LiMo would also be longer than Android since development in C/C++ is harder than in Java. LiMo OS based developers will also have to redevelop their applications whenever they want to port into other type of handsets.

3.2.3. Android vs. Mobilinux

One key differentiation of Mobilinux is its advanced power (battery) management. This could be the reason for the success of Mobilinux and be a major player so far. The usage of C/C++ as the programming language would be the main factor to achieve longer battery life. In the case of Android the battery life is relatively shorter. Multi-tasking feature in a Java-based application system is one of the main reasons for this problem. Mobilinux could win over Android in

this point. However, it is the consumers who eventually decide who wins based on their experience. Consumers will most likely make their decision based on the user interface (UI), where Android has superior UI than Mobilinux.

Compared to Symbian and LiMo, MontaVista wants to integrate Android to enhance its Mobilinux portfolio in the mobile OS arena rather than compete directly with Android. MontaVista has announced that it will support its developers who use Mobilinux kernel with Android application. MontaVista wants to have a better UI with Android by maintaining its core kernel with Mobilinux. To show off its Android work, MontaVista has demonstrated the Android OS stack running on top of MontaVista Mobile Linux on a Texas InstrumentsOMAP3 system-on-chip (SoC). This is an evidence of Android bringing the Linux-based mobile OSes to work together in the same platform.

3.2.4. Android vs. Maemo

With the announcement of collaboration with Intel, Nokia could bring Maemo to a higher level. Compared to Android which is supported by an alliance (OHA), Maemo was supported by Nokia only until its collaboration with Intel was announced in June 2009. Maemo is intended more for Mobile Internet Device (MID) usage instead of a typical mobile phone. MID generally has bigger size, needs more power, and thus Maemo was designed specifically to cater to such requirements. The comparison of Maemo and Android in terms of programming language, porting development, processing speed, and development period, it is very similar to the Symbian versus Android comparison in the earlier

section. Based on the comparisons, Maemo would not be a direct competitor for Android at the moment since Maemo is still figuring out its path in mobile computing arena. Until that time when Maemo will also enter the mobile phone OS market, it does not pose a serious challenge to Android.

3.2.5. Android vs. OpenMoko

OpenMoko would be the only OS similar to Android, a full-stack free open source Linux-based OS; however, OpenMoko does not have strong supporters like the OHA for Android. Its unique feature is high customization on the handset applications; even a user can customize it further easily. However, instead of using Java, OpenMoko utilizes Python, a scripting-based programming language. By using such scripting-based language, development cycle period will be much faster than a typical development period of a C or Java-based application.

It is reported that a lot of work is being done to get the Android OS to function properly on a FreeRunner and it is likely that Android will be the distribution most suited for using the FreeRunner as a phone in the near future. Therefore, OpenMoko seems to take the same path similar to Mobilinux, which will collaborate with Android. This is yet another evidence that Android has successfully brought the Linux-based mobile OS community closer and work together in the same platform. Both OpenMoko and Android leverage the power of the Linux kernel and other open-source projects to provide a free software platform for mobile devices.

3.3. ANDROID AGAINST PROPRIETARY OPERATING SYSTEM

Proprietary system is considered a conventional system however compared to the open system, it also has its advantages. Proprietary softwares are usually more stable because it has been tested through several trial and error routines. Furthermore it also carries the goodwill of the OS brand. The documentation of all OS development is strictly enforced and easier to follow however in the case of open source development documentation is still a challenge because there is a sense of volunteerism amongst the open source community. This means they will only contribute to the kind of work they find interesting (like creating specific apps).

However, Android, as an open operating system will cost less than proprietary since developmental cost will be shared between the developers and the company. The company is no longer solely responsible for maintenance. They avail themselves of more developer input than they could ever manage on their own.

However being an open system there is a potential liability in terms of intellectual property infringement because it contains contributions from many contributors and almost impossible to audit the entire code based on violation of previous license. Android community prevents this by using the Digital Millennium Copyright Act so that Android could terminate an application if infringement of any sort is involved.

The proprietary operating systems being used for comparison are RIM, I-phone, Windows Mobile, and Palm

Table 5 Comparison of Android and Proprietary Operating System

	Android	**RIM**	**i-Phone**	**Windows Mobile**	**Palm**
Programming Language	Java & C/C++	Java	C-objective	C++	Java
Multitasking	Yes	Yes	No	Yes	Yes
Porting Redevelopment	No	Not Applicable	Not Applicable	Required	Not Applicable
Unique Feature	Full stack free open source	Push Email, office application	Long battery life	Easy Synchronization	Deck of Cards
		BlackBerry Push API	Integrated entertainment system		Internet Integrated Address book
Security	Permission/ User Authentication, data encryption (developing)	Advanced Encryption Standard, device password	Remote wipe	Exchange Active Sync, device password, remote wipe	Password protection
Processing Speed	Medium-high	Medium	High	High	Medium
Development Period	Fast	Fast	Medium	Medium	Fast

The advantage of Android is the usage of Java programming language, the application in Java has benefits in terms of portability and multitasking. If we compare iPhone and Android, Android certainly has higher value to offer to the consumers in terms of security, as it uses permission/ user authentication. However, iPhone is soon catching up as they are developing encryption based security and high possibility for "Remote Wipe" implementation. In terms of processing speed, Android is considered medium-high due to the use of a virtual machine.

3.3.1. Android vs. Research in Motion

In terms of operating system, although RIM is a proprietary system, the application developer (third party) can write software using application programming interface (API) such as Novell Group Wise, Lotus Notes as well as the proprietary Blackberry APIs. However, the application developed using certain type of restricted functionality have to be digitally signed, so that it can be accounted to a developer account at RIM. This signing guarantees the authorship of an application, but does not guarantee the quality or security of the code.

While for Android, it allows developers to write managed code in the Java language, controlling the device via Google-developed Java libraries. Android offers a full stack of operating system meaning that Android provides more API as opposed to RIM. Based on the below stack comparison, it's clear that the developer could access Android until the Linux Kernel layer whereas in RIM, only until middle layer, the applications and Java classes and frameworks.

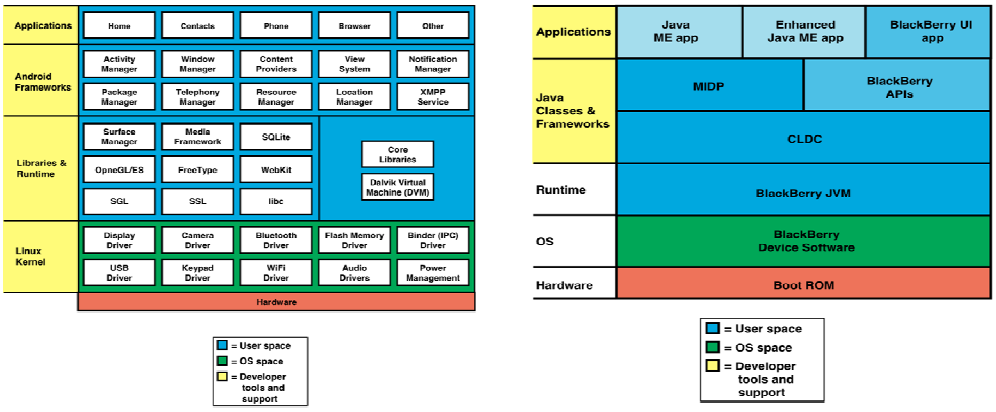


Figure 12 Software stack comparison between Android and RIM
(Source : http://www.ddj.com/mobile/216300179?pgno=4)

In terms of security, the security of RIM OS has been tested by Fraunholer Institute of secure IT. RIM provides high quality security architecture and strong data protection this ensures the security of the pushed content. Blackberry RIM uses Advanced Encryption Standard hence the email and other data remain encrypted at all points between the Blackberry phone and enterprise server. Android's security architecture is based on permission however, encryption based security is being developed currently. This could provide the same or even higher security level than Blackberry RIM.

3.3.1.1. Push API

Push API is programming interface which enables the developer to push an update in the application. This API is gaining more popularity since it could increase the money flow. Some of the benefits of push API are:

- Immediate information: information can directly and time-efficiently be sent to smart phone users.
- Money-saving efficiency: by using Push API, the applications do not need to repeatedly poll servers for new data, although these polling requests are considered small, the costs could add up quickly in the case of multiple applications.
- Reduced Network Latency: this is related to customer satisfaction. Wireless bandwidth is less than wired networks hence transfer rate is also slower. The Push API delivers data to Blackberry without user involvement hence no waiting time from the user's perspectives.

The RIM OS provides robust wireless synchronization which means applications could be pushed easily from PC to handset and vice versa. Although RIM's focus is on the business tool, they are beginning to pay attention to multimedia features starting with the RIM Blackberry Pearl which has built-in media players. This is one of the ways RIM is gaining and expanding their market share.

RIM is releasing the Blackberry Push API (Application Program Interface) to infuse the Java applications from developers. This is done to overcome the application limitation problem. PUSH allows for the delivery of data to a handset without the handset having to submit requests for it. Previously the Push Technology has been used to push emails to users and synchronize calendar information and other enterprise-based solutions. With Blackberry Push API, Push Technology is extended beyond enterprise to all Blackberry users.

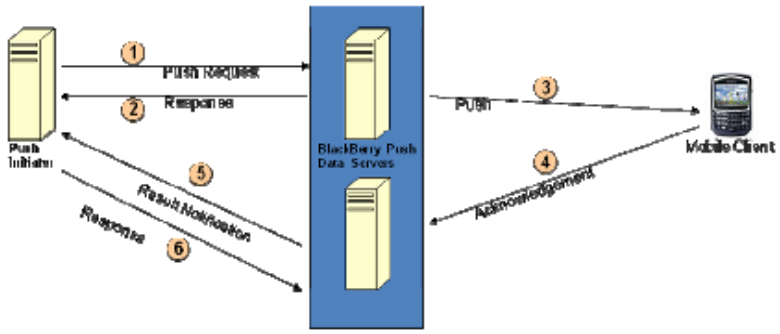


Figure 13. Blackberry push request process flow

Android has the Push technology however it is only limited to push-email and SMS currently. It is not impossible for Android to have Push API like RIM since

both are using Java programming language which enables the developers to develop dynamic applications.

3.3.2. Android vs. iPhone

The major update with the iPhone OS is the release plan for iPhone OS 3.0, which will provide some of the missing features in the iPhone, such as the peer-to-peer file sharing, voice recording, and copy-and-paste. However, video recording and application multi-tasking (background processing) will not yet be provided since there is not much memory to run more than one additional application at a time. Moreover, landscape mode will be supported by more Apple applications. The following figure shows the iPhone OS stack, which depicts parts of the OS that can be accessed by the developer in developing applications.

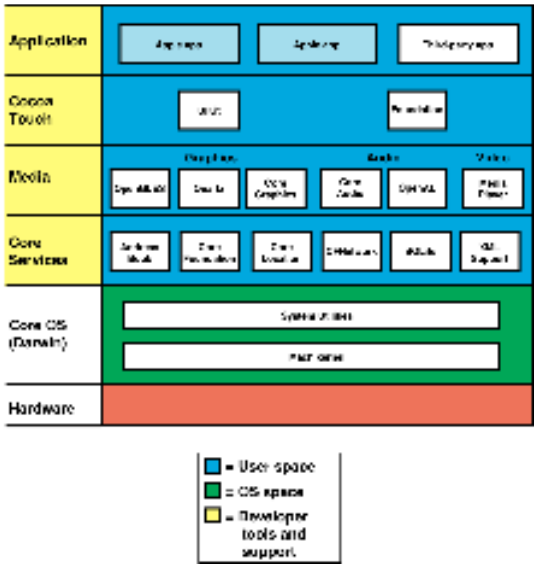


Figure 14 The IPhone OS Stack
(Source : http://www.ddj.com/mobile/216300179)

In terms of the OS licensing, comparing the Android OS with iPhone OS is basically comparing an open source OS with a proprietary one. As a full-stack free open source OS, Android gives freedom to its developers to modify the OS the way they like for any hardware they want to port in. This would lead to more innovations, although such freedom could also increase the risk of fragmentation within the Android OS itself, which the OHA needs to control. As a proprietary OS, iPhone OS is only intended for a certain hardware, i.e. the iPhone or iPod. Compared to Android, there is a greater room for Apple to deliver an integrated user experience, and seamless synergy across its services. As for Android, since it runs on various hardwares with different configurations; that sort of software-to-hardware synergy control will not be as easy as the iPhone.

In terms of the OS features and capabilities, as shown in *table 4*, there are some features that iPhone OS 3.0 does not satisfy when compared to Android, and vice versa. One key difference is that Android supports multi-tasking of applications while the iPhone OS does not. This has enabled Android to have the multi-notification drop down "window shade" that shows all alerts in one place, such as new SMS and new mail, which the iPhone lacks. However, Android uses background processes in this multi-tasking task which drains its battery life. While it is good that Android runs background processes, iPhone has advantage in saving the battery life. Moreover, iPhone has a feature to search phone-wide search as well as direct Bluetooth peer-to-peer file sharing, which Android lacks.

	iPhone 2.2.1	iPhone 3.0	Android
MMS Support	No	Yes	Yes
Copy/Cut and Paste	No	Yes	Yes
Application Notifications	No	Push Notifications	Background Processes
Phone-wide Search	No	Yes (Spotlight)	No
Email Search	No	Yes, but doesn't search message content	Yes (Gmail search box)
Calendar Search	No	Yes	No
3G Tethering	No	Yes (pending carrier signoff)	Yes (3rd-party app)
Voice Over IP	Yes (Wi-Fi only, 3rd-party app)	Available to applications	Yes (3rd-party app)
Multiple Notifications	No (modal popup)	No (modal popup)	Yes (pulldown window shade)
File Sharing	No	Yes	Yes (3rd-party app)
Peer to Peer Bluetooth Connectivity	No	Yes	No
Video recorder	No	No	Coming in Cupcake
Built-in Notepad/Notes app	Yes (but no sync)	Yes	Coming in Cupcake (no sync)
Parental Controls	Yes	Yes	No
Stereo Bluetooth A2DP audio	No	Yes	Coming in Cupcake
Accessory application support	No	Yes	No

Figure 15 IPhone OS vs Android OS feature
(source : http://lifehacker.com/5173441/Android-versus-iphone-30-the-showdown)

In terms of programming language, iPhone OS is based on its own proprietary programming language, the C-Objective language, whereas Android is based on Java, which is a common programming language. With Java, Android will have benefit in terms of ease of developing as well as attract the existing Java developer's community. Moreover, common development tools are used for Android, whereas a dedicated development tool and station (only Apple PC) is used for iPhone. In this case, Android development is more familiar to common developers.

Discussing about the trends, a survey by Strategy Analytics claims that the global shipment of Android OS will grow 900% in 2009, which is mainly due to healthy support from operators, manufacturers, and developers. iPhone is following Android with a 79% growth rate. Android is expanding constantly if this trend continues it could potentially outgrow the iPhone OS, the report says. Moreover, Android's free-licensing model and its open-source structure plays

well in today's tough economic climate in attracting all the parties in the smart-phone ecosystem.

3.3.3. Android vs. Windows Mobile

Windows Mobile (WinMob) is proprietary open technology architecture for a widely used High Level Operating System (HLOS) for smart-phones. Its main target is the individual consumer end user as opposed to RIM's business target. Windows mobile is considered proprietary since its architecture and development is controlled by single company (Microsoft). This proprietary OS is openly and freely licensed to over 20 OEMs which manufacture the WinMob-based mobile devices. Windows mobile is an operating system based on Microsoft Win API that available in Microsoft Windows OS.

From the security point of view, Microsoft and Windows Mobile have cooperated with regard to security management through Exchange Activesync. This enables Windows Mobile users to activate the client-based authentication and use it together with other security features such as device password and remote wipe to erase all data upon user's request if the phone is lost or stolen. Whereas for Android, it uses the security architecture that no application has permission to perform any operation that will severely impact other applications operating system. Android conducts several permission-based functions. In order to perform the function, the permission from user must be obtained. However the open system makes it vulnerable to outside threats since the code is

accessible by everyone in the market. On top of that Android does not have remote wipe capability that would be useful for lost or stolen phone.

3.3.4. Android vs. WebOS (Palm)

In terms of similarities, both platforms are open source based on Linux, and utilize Java as the programming language. However, WebOS is not a full-stack open source OS like Android. Since WebOS came later than Android, WebOS Software Development Kit (SDK), a so called Mojo SDK, has not been released yet. Unlike Android SDK, Mojo SDK will not be released publicly, and thus Mojo SDK will not be available to all developers, which may result in fewer developers for WebOS compared to Android. Moreover, WebOS has multi-touch feature, a feature that Android lacks currently. Although both support multi-tasking, WebOS has a unique multi-tasking feature called “Deck of cards”, which is a multiple programs task bar interface that enables fast switching, and notifications from other apps while maintaining the task at hand. Another unique feature of WebOS is its synergy feature, which merges the phone contacts into a unified address book that integrates with e-mail application to indicate whether a contact is online (like in Gmail or Facebook) at the moment for a chat via instant messaging.

3.4. KEY CHALLENGES

The key for the Android OS' success is to be a platform that enables the best user experience. There are some challenges that the OHA needs to overcome in order to deliver a high level of user experience.

- **Enable developers to deliver a high quality of application for consumer's best experience**

The first key challenge is that Android should keep improving its OS architecture that eases developers to deliver a high quality of application for consumer's best experience. Such OS architecture enables full support at any layer of OS, from the kernel into the application API (application programming interface), such that developers can leverage the full potential of Android OS. With deep flexibility for developers to cultivate the OS, there will be greater possibility of creativity, which will lead to the best application that will deliver the best consumer experience.

- **Prevent Android OS from any fragmentation**

Another crucial challenge is that OHA must avoid Android OS from any fragmentation, a common problem in the Linux world. Fragmentation would lead to incompatibility issues, which will confuse the consumers later on in choosing which applications are compatible and not. Fragmentation commonly occurs when there is lack of support from the open source community in providing a certain feature that is required by a certain party in the community, who will then create another version of the main platform that will fulfill the requirement. It is therefore crucial to provide a very rich, uniform environment and a set of APIs

(application programming interfaces) that are needed to deal with everything by the OHA to the developers.

Instead of further fragmenting the mobile Linux world, the following facts show a trend that Android is most likely unifying them instead. First, MontaVista Linux, which has a significant share in the mobile OS market, was demonstrating the Android applications stacks on top of the MontaVista Linux OS. Previously, the CEO of MontaVista had also shown his confidence in Android and stated that MontaVista will join the OHA, although there is no further confirmation on this matter. The CEO believes that Google's role in delivering a success for Android particularly, and for linux based mobile OS generally, is very positive. Secondly, this wiki for OpenMoko OS stated clearly that Android is likely to be the distribution most suited for the FreeRunner phone.

- **Easy integration with the handset**

Related to handset manufacturers, a key challenge that Android OS is facing is in providing easy integration with the handset. Android OS' value proposition of such easy integration will convince the handset manufacturers more, besides other benefits such as free license, rich features, and full-stack open source. As a result, handset manufacturers will show their loyalty to use Android OS in their handset.

- **Increasing the security protection for the operating system**

Currently Android security is based on the user authentication including the user name and password utilization. Currently Android is developing the security by data encryption as utilized by RIM's Blackberry. However, problem might

occur when the Android phone is stolen, since personal data could be leaked if the phone is hacked.

- **Medium-high processing speed**

Since Android is using Java programming language that requires Virtual Machine, the processing speed is considered medium-high relative to iPhone and Windows mobile. It is even slower if multiple applications are opened at the same time.

CHAPTER 4

MOBILE APPLICATION STORES AND ANDROID MARKET

4.1. NON-ANDROID MOBILE APPLICATION STORES

Mobile Application Stores (MAS) is an online storefront where users can download mobile applications for their handsets, this is in addition to the existing on-device storefront available in most of the mobile phones. This promises to be a very profitable revenue stream ever since the success of Qualcomm's BREW which had "*an average of 80 million applications-downloads per month in 2007 and over $1 billion shared with developers as of early 2007*".

However, all eyes are on Mobile Application Stores after the success of iPhone App Store. Every other major OEM, carrier, mobile OS community and even independent stores want to have a piece of the Mobile Application store market pie. Below is a comparison of some of the operating systems and the features they provide for Mobile Application development.

The three features compared are as follows:

i. **Developer Community and Support** – The developer communities are extensive and are generally from the respective OS however in the case of open source operating systems like Android the communities are extensive and growing. The fundamental advantage of open-source software when it comes to support is that it is always possible to retain a company to provide support. Because the source code is freely available, organizations are not limited to obtaining support from the authors. There is no restriction on other

suppliers learning enough about the software to provide adequate support whenever demand exists.

ii. **Market Penetration** – This is directly proportionate to the market share of their respective handsets. Symbian, Java ME, .Net compact have large market penetration for the above reason. However, in the Smartphone market Apple, Blackberry and Palm are the leaders. If the market penetration is high the community of developers and support may also grow.

iii. **Distribution and Licensing** – Proprietary companies generally have all the distribution and licensing rights. There is an increasing trend of companies making their OS or a part of the OS which pertains to application development open source. Symbian foundation's initiatives are a step towards that ends. In the case of Android, the Apache License vendors are free to add proprietary extensions without submitting those back to the open source community.

Table 6 Mobile Application Stores Comparison

	Symbian	Java ME	Android	Flash Lite	.Net Compact	BREW	Palm OS	iPhone	BlackBerry
Developer Community and Support	Extensive	Extensive	Recent, growing	Extensive	MSDN	Limited at http://brewforums.qualcomm.com	Extensive	Limited	Recent, growing
Market penetration	Deployed on a large number of high end devices.	Extensive	Growing	Average	Average	High in Japan. Average in the U.S., and low in other countries.	Fifth largest player in Smartphone.	One of the largest player in Smartphone market.	One of the largest player in Smartphone market.
Distribution and Licensing	Symbian Signed and limited Open source	None (Java Signed?)	Apache	None	Proprietary	Proprietary	Proprietary	Proprietary	Proprietary

Note: Flash Lite should not be considered a mobile operating system like Symbian OS or iPhone OS: it is a technology for developing applications that run on a mobile operating system.

4.1.1. Mobile Application Stores Features Comparison

Table 7 Features Comparison of Mobile Application Stores
(Source: Vision Mobile Research)

Mobile Application Stores

Fundamentals	App Store	BREW	Download!	Handango	GetJar
Owner	Apple	Qualcomm	Nokia	Handango	GetJar Networks
Distribution model	via iTunes on iPhone and iPod Touch only	via operators on BREW devices only	on S60 devices only	direct and via operator, OEMs and retailers	direct and via operators
Platforms	OSX	BREW	S60	Java, Symbian, RIM WinMo, Palm, Android	Java, Symbian, FL, RIM WinMo, Palm, Android
Installed base of on-device storefront (2008 est.)	12M	500M	200M	N/A	0
Key figures					
Downloads per month as of end of 2008 (est.)	65M (1)	80M on average in 2007	3M (2)	3M (2)	17M (3)
Applications to end of 2008 (est.)	10,000	12,000M	10,000 (S60) 50,000 (Java) (4)	140,000 (4)	10,000
Revenues (2008 est.)	$500M/year (1)	$1B total for developers (March 07)	N/A	N/A	N/A
Revenue model	70% to developer	commission varies	varies	60-70% to developer + rev share to channel	ad-based apps + website promos
Features					
Global marketplace targeting, cert, submission, pricing	✔	✔ (CDMA markets)	partial (case-by-case submission)	✔	partial (targeting only)
Centralised Billing and settlement	✔ (one-shot)	✔ (via operator)	partial (via premium SMS only)	✔ (credit card, in some cases operator billing)	✔ (free or ad-funded apps CC billing coming in 4Q08)
Distribution across MNOs, OEMs and off-deck	✔ (OEM-only)	✔ (via operator)	partial (not available in all regions)	✔ (off-deck and via some OEMs/operators)	✔ (off-deck and via some OEMs/operators)
Provisioning, licensing and software management	✔	✔	partial (no silent install)	partial (mostly licensing)	-
On-device discovery catalogue managmnt & marketing	✔	✔	✔ (shop-in-shop)	✔ (where InHand installed)	partial (via bookmarking app)

(1) Based on publicly reported figures of application downloads and revenues
(2) Based on approximate cumulative figures and a linear growth model
(3) November 2008, stated to be increasing by 1M per month
(4) Handango's total application count includes variants. Nokia applications refer to total # of applications for S60

source: VisionMobile research

Some of the leading and most successful Mobile Application Stores are compared in the above table based on fundamentals, performance and features. At the time of writing of this report a few other Mobile Application Stores were open however, the performance data was not available. A detailed analysis between Android Market place and others is done later.

4.1.1.1. Apple App Store

Apple has an on-device storefront as well as an online storefront. While Apple has stated that they do not expect to profit from the store, it has been

predicted by Piper Jaffray that the App Store could create a profitable marketplace with revenue exceeding US$1 billion annually for the company. As of July 2009, more than 1 Billion apps have been downloaded and 50,000 apps were available.

4.1.1.2. BREW

The on-device storefront is very successful in Japan due to the existing Mobile ecosystem. BREW's download system offers one of the most advanced ranges of billing models, including subscriptions and prepaid credits that can be used for purchasing applications or content. However, their attempts of opening a global marketplace are not a success yet. Currently, Qualcomm is working on releasing Plaza Retail, an online storefront, which gives publishers and developers the ability to make their content available to multiple retailers instantly, regardless of their development platform. This they believe will increase the market opportunity for developers and publishers by offering a much wider range of distribution channels, with new opportunities for both new customers and the BREW community. Most importantly because content is not tied to the device, application retailers can offer consumers the benefit of being able to upgrade or change devices without losing their application investment.

4.1.1.3. Handango

It is one of the first application retailers founded in 1999 that sells mobile software with over 140,000 applications (including variants) in its online stores and over 100 million applications downloaded to date. Handango offers worldwide distribution, support, and e-commerce services to its partners. Company's customers include consumers, software developers, mobile operators, and original equipment manufacturers. Handango supports all mobile devices which include Palm handhelds, Windows Mobile Pocket PCs and smartphones, Symbian OS devices, and BlackBerry devices.

Handango offers InHand that is available since first half 2007, is an on-device application store for finding, installing and buying software for your mobile device. Application download and purchasing are completed directly on the device, so sync with a computer is not necessary. Description, rating and screenshots are available for all applications. Software for using Handango InHand is available for free for PalmOS, Windows Mobile, Symbian UIQ, and Blackberry.

Handango offers application developers three channels of distribution:

- Direct, via handango.com
- Via channel partners such as Verizon Wireless, AT&T, T-Mobile, Alltel, Nokia, RIM, Sony Ericsson, Samsung and AOL. Handango has recently expanded with distribution through physical retail stores, namely BestBuy and Carphone Warehouse.

Via Handango's commerce engine web-shopping infrastructure used by over 1,000 content providers, Handango uses revenue share model with developers and gives 60-70% to developers.

4.1.1.4. GetJar

GetJar is an application distribution and developer community, with over 200,000 developer and beta-tester accounts founded in 2004. GetJar connects mobile consumers, developers, publishers, and advertisers in an interactive environment, and gives users a unique and active role in product development. As of October 2008, GetJar got more than 14 million downloads per month, with 300 million downloads to date. The company is based in the UK, Silicon Valley, and in Lithuania.

- Registered developers: **274,926**
- Registered beta-testers: **35,955**
- Supported Devices: **1,333**
- Total Game/Application Files: **43,843**

GetJar started as a beta-testing community. Due to the large number of new applications that were submitted for testing, GetJar subsequently became popular with the general public as a free application download site. However, GetJar's central goal remains to provide a community where developers can upload their content for free testing, access a broad group of users to download it, and get advice from the community about how to improve their application. GetJar is

similar to Wikipedia: one person uploads an application, and the community helps to improve it.

Despite lacking an on-device storefront, GetJar is a successful and profitable Mobile Application Store. GetJar started as a community site, connecting developers with beta testers, where users can download and test applications. It has since evolved into a distribution channel for application developers including brand-name applications like Opera Mini and Google Maps. GetJar features mostly free and ad-supported applications. Developers can upload applications to GetJar for free, and get downloads for free. Developers monetize through four revenue models:

1. Free applications with no advertising
2. Ad-supported applications, where the developer monetizes through GetJar's in-house ad-injection (CPM) system, or other ad systems (e.g. Greystripe, Smaato) for interstitial ads.
3. Trial applications, where the activation or upgrade takes place via the developer's own website.
4. GetJar plans to add a centralized billing facility via credit card to support paid-for applications, according to Bill Scott, GetJar's SVP.

GetJar also offers application store hosting solutions for operators. The company allows operators to build own-brand or co-branded mobile application stores in what seems like a no-brainer deal: GetJar offers the hosted solution to the operator for free and is also willing to share part of the ad revenue. GetJar

operates custom portals for 11 operators and OEMs, including Three, MAXIS Malaysia and Optimus Portugal.

One downside of GetJar is that it does not offer an on-device storefront, where we may see the company partner with on-device portal providers.

4.1.1.5. Nokia –Download Store

Nokia Download Store is a Web shop for trying and buying content for your Nokia device. From Nokia Download Store you can find, preview and buy a wide variety of content, applications and services from a range of different providers. Previewing and downloading applications doesn't cost you anything, but if you want to buy something, you may have to pay for that item. Currently they only support Nokia handsets: N-Series and higher.

Ovi is the name for Nokia's "umbrella concept" Internet services. Centered on ovi.com, it will market as "personal dashboard" where users can share photos with friends, buy music and access third-party services like Yahoo's Flickr photo site. It has some significance in that Nokia is moving deeper into the world of Internet services, where head-on competition with Microsoft, Google and Apple Inc. is inevitable. During his keynote speech to the 2009 Mobile World Congress in Barcelona, Nokia Executive Vice President Tero Ojanperä announced that the Ovi application store would be launched in May 2009.

Nokia says it will give 70 percent of all download revenue to developers, just like Apple, if consumers pay by credit card. But developers will earn less per transaction if consumers opt to pay through their operators, an option that will

initially be available in nine countries. "*Because of geographic coverage, credit cards will probably remain the main payment method*" said Marco Argenti, vice president of media at Nokia. "*It's going to be the default payment system across the world. (But) in nine countries developers can activate operator payments*." Thus far, in cases where consumers can choose between paying via their operator or using a credit card, more than 80 percent use operator billing, Nokia's own data from the usage of its N-gage gaming service shows.

4.2. ANDROID MARKET

Android market is an open source or an open content distribution system that lets consumers to search, purchase, download and install various types of content such as games, music, news, maps etc. The different contents developed by many developers are connected to users through Google expertise in infrastructure, search and relevance. Developers are able to make their content available in this open source platform that has similar features of feedback and rating system as of YouTube. There are three simple steps to present the content in the Android market place. They are:

- Register online as a merchant
- Upload and describe the uploaded content in detail
- And then finally publish it for the end users

As shown in table 1, there are 3817 applications available in the Google Android market today and 38648 i-phone applications store in counterpart. These

applications include communication, location based tools, travel guide, games, barcode scanner etc.

Table 8 List of Google Android Applications as of May 8, 2009

Communication	199	Shopping	61
Entertainment	727	Social	99
Finance	110	Tools	785
Lifestyle	284	Travel	138
Multimedia	171	Demo	61
News and weather	86	Software libraries	16
Productivity	206	Games	695
Reference	179		

As more developers are getting attracted in the Google android market, these numbers of applications are increasing per month.

The recent updates in the android market includes access for developers to target new countries for free applications, local language support improvement for additional countries and every published applications are required to indicate a minimum SDK version in the manifest file.

4.3. MOBILE APPLICATION MARKET PLACE COMPARISON

In order to compare the market place of each operating system, four criteria are being used i.e. revenue sharing model; payment and billing; mobile ad web and handset sales market share; internet market browsing market share.

Table 9 Mobile application market place comparison

		Android	**RIM**	**i-Phone**	**Windows Mobile**	**Palm**	**Symbian (Nokia)**	**others**
Revenue Model	Developers	0.70	0.80	0.70	0.70	0.70	.70	-
	Company		0.20	0.30	0.30	0.30	.30	-

Share	Carrier	0.30						
Payment and Billing		> $ 25 one time subscription fee	>$ 99 with maximum of 5 free application listing per year	>$99 >$299 for companies with 500 employees	>$ 99 with maximum of 5 free application listing per year > $ 99 additional app in excess of 5			
Mobile Ad Web and App Usage		0.03	0.09	0.43	0.05	0.02	0.36	0.02
Handset sales		<.01	0.17	0.08	0.12	0.02	0.52	0.09
Internet Browsing Market Share	Current Market (US based)	0.0842	0.0347	0.6481	0.0552		0.0739	
	Lunch Month Market Share	0.0000	n/a	0.0017	n/a	n/a	n/a	n/a
	Month 2	0.0348	-	0.0410	-	-	-	-
	Month 3	0.0453	-	0.0496	-	-	-	-
	Month 4	0.0665	-	0.0654	-	-	-	-
	Month 5	0.0728	-	0.0729	-	-	-	-

4.3.1. Revenue Sharing Model

In the revenue sharing of Google Android, the developers gets 70 percentage of the revenue from each purchase of the application and the remaining 30 percentage will go to the respective carriers. Google itself does not get any share from this revenue model. Whereas its big competitors such as iPhone, Window Mobile, Symbian and Palm takes 30 percentage of revenue share for every application that is sold by the company itself and remaining 70 percentage goes to the developers . Research in Motion (RIM) revenue model is slightly different from the Android and other players in the market. In RIM's revenue model, the developers will get 80 percentage of the revenue from each application that is sold and the remaining 20 percentage goes to the company itself. From the

revenue models of i-phone, RIM, Windows Mobile and Palm we can clearly see that the operators are out of the model and have no control in it but Android has given some place to the operator in their revenue sharing model.

4.3.2. Payment and Billing

In the payment and billing system, Android's developers have to pay $ 25 for one time subscription fee. This application fee is online registration fee in order to confirm that each developer is responsible for their applications. In contrast, i-Phone developers have to pay $99 per year and for the companies with 500 or more employees who are creating proprietary in-house applications have to pay $299. Besides, developers for other players like Windows Mobile and RIM have to pay $ 99 per year to list their item in the store and they can save the money by submitting 5 applications by the end of the year. In Window Mobile developers have to pay additional $ 99 for each program listed in the Window Mobile market place store.

4.3.3. Mobile Ad Web and Handset Sales Market Share

- **Global Market Share**

The world wide Smartphone market share by operating system, which was released by AdMob in April 2009, shows that i-Phone is leading with market share of 43% and the second leader Symbian with 36%. While Android only has 3% and the other operating system such as RIM and Windows Mobile have 9%

and 5%. Android can still capture 3% of market share world-wide during 5 months period biting Palm which has only 2 % of market share.

i-Phone comprised 8% of Smartphone market shares but generated 43% of mobile ad request. The market leader in terms of handset sales is Symbian with 52% of market share. RIM, Windows Mobile, Palm and other has 17 %, 12%, 2% and 9% market share respectively. In comparison to these players in the market, Android has less than 1 percentage of market shares worldwide. This means that Android had still challenges ahead in the market in order to increase its market in the handset sales.

- **US Based Market share**

Google Android ad market share is 6 percentages and it has caught Palm in US market as well. Window Mobile OS has decreased from 13% to 11 % while the RIM OS has maintained the growth of 22%. I-Phone is still dominating the market with 50 percentages of ad market shares. The Pie-chart below shows the percentage of the mobile Ad market share in US operating system.

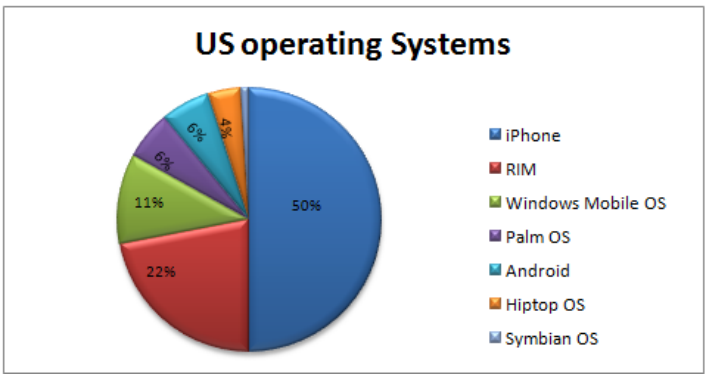


Figure 16 Mobile ad Market share in US operating system as in March 2009

4.3.4. Internet Browsing Market Share

The major competitor of Google android in the market is iPhone and it has tough battle ahead of itself against the iPhone. Although Google Android has been recently launched last year, T-Mobile G1, the only Android device that is being sold, had crossed the million devices in the first quarter as on April 23rd 2009. This number is one-third of the number of Apple Inc. iPhones that sold in the first two quarters.

The graph below shows the neck to neck internet browsing market share of Google Android and iPhone. Android has the same web browsing market share as iPhone and also being in the same stage of life cycle. This report shows a comparison of the overall browsing share for the first months of the iPhone and Android's lunch.

Table 10 Android Vs i-phone market share during the 1st quarter

Months After Launch	i-Phone Share%	Android Share %
Launch Month	.0017	.0000
Month 2	.0410	0.0348
Month 3	0.0496	0.0453
Month 4	0.0654	0.0665
Month 5	0.0729	0.0728

From here we can see that the android phone users are using their internet browser as much as possible. In the internet browser market share, Android market share is almost the same as i-phone during the first 5 months of the launch. This shows that Android is doing well in the internet browser market share and has future ahead in the upcoming months in the market. Since the Android

operating systems are also used in devices other than mobile, like netbooks, we can predict that the number of internet browser users might have increased in the Android market share than its competitors.

Based on the internet browser, the mobile Ad market share also fluctuates in the market. The AdMob , the largest mobile advertising market place measured 72 million ad request for Android in March 2009 while the i-phone ad request was 607 million in the US in the same month.

CHAPTER 5

HANDSET MANUFACTURER

5.1. HANDSET COMPETITION

When analyzing the current 'smart-phone' market we must take the handset capability into competition. Thus we will show and compare the following handsets that dominates the global market since 2004 to 2008 accordingly

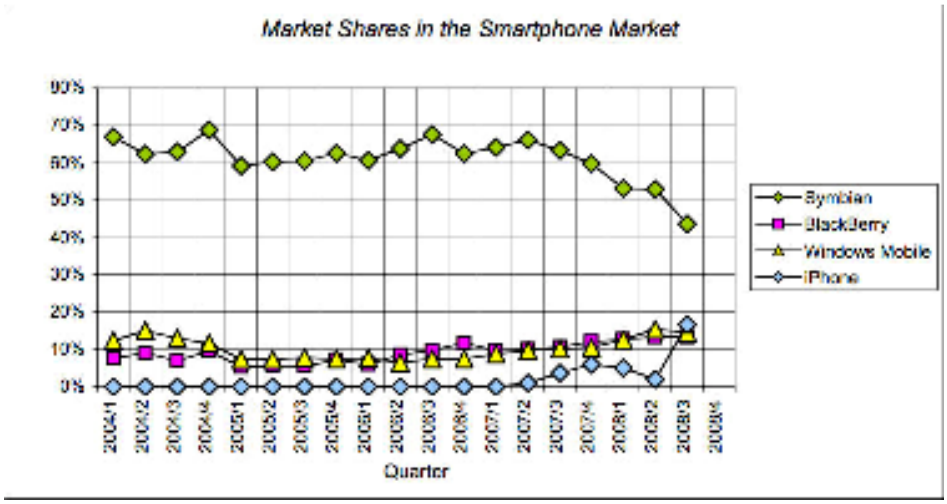


Figure 17 Smartphone Market Share 2004-2008
(Source: http://gizmodo.com/5101114/iphone-conquers-166-percent-of-world-smartphone-market)

From the graph above we can clearly see that Symbian (or interchangeably with Nokia) who has been ruling the smart-phone market since quarter one 2004 decline in market share starting in the 4th quarter of 2007 from roughly 60% out of the Smartphone world population to less than 45% in the quarter three 2008. Meanwhile the 'middle-class' competition we can see that generally Blackberry and Windows Mobile were hold on together taking about 10% each of the world

market share from 2004 to 2008. So basically, nothing changed in the 'middle class' competition. However an interesting phenomenon happened with Apple. They launch their first iPhone on June 3rd 2007 (Q2 2007) and quickly after the phone hits the market it became the most favored Smartphone of choice which reflected in the next quarter Apple report (as they can embrace roughly 5% of the world Smartphone population in a smooth quarter movement). And after this, their Smartphone sales are going up (and reported 18% of the world population on 2008 3rd quarter). From these series of events we can analyze that part of the reason why Symbian sales is going down is actually because of iPhone who's entering and winning the Smartphone competition using their market disruptive strategy

Table 11 Worldwide: Smartphone Sales to End Users by Vendor, 2008 ('000 units)

Company	2008 Sales	Market Share 2008 (%)	2007 Sales	Market Share 2007 (%)	Growth 2007-2008 (%)
Nokia	60,920.5	43.7	60,465.0	49.4	0.8
Research In Motion	23,149.0	16.6	11,767.7	9.6	96.7
Apple	11,417.5	8.2	3,302.6	2.7	245.7
HTC	5,895.4	4.2	3,718.5	3.0	58.5
Sharp	5,234.2	3.8	6,885.3	5.6	-24.0
Others	32,671.4	23.5	36,176.6	29.6	-9.7
Total	**139,287.9**	**100.0**	**122,315.6**	**100.0**	**13.9**

(Source: http://www.ibtimes.com/blogs/articles/1863/20090312/iphone-sales-soar-245-in-2008-nokia-still-dominates-smartphone-market.htm)

And in 2008, Apple 'market disruptive' strategy pays off handsomely with a 245.7% growth rate since 2007, followed by Research in Motion (RIM, who act

on behalf of Blackberry as their proprietary platform as discussed earlier) with 96.7% growth rate, and the new 'Open-source' player with its HTC Dream (Google Android) with 58.5% growth on the third place

Meanwhile others are still struggling to maintain their year-to-year growth. These three main players are already entering a new form of competition with the upper market giant (Nokia). However, in order to compete with this well-known handset player, the other three major players has to prepare a solid, value and content rich handsets to enter the head to head competition in the near future.

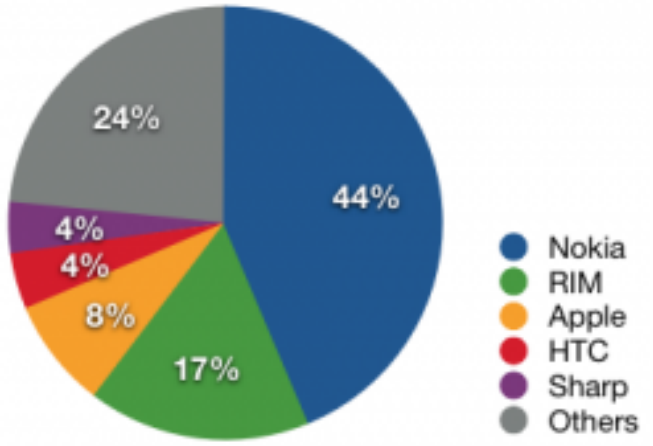


Figure 18 Worldwide Smartphone Market Share 2008
(Source : http://www.ibtimes.com/blogs/articles/1863/20090312/iphone-sales-soar-245-in-2008-nokia-still-dominates-smartphone-market.htm)

While as for 2008, the winner is still Nokia (can be seen on the graph above). Maybe this scenario will changed should these powerful new players think and develop their handset carefully. Thus, we will give a brief analysis of each player's handset capabilities in correlation to Android and the Google business model

Firstly, as this moment we understand that the competitive advantage the Android has for OEMs (original equipment manufacturers) is basically the waiver of their licensing fees. Thus we will try to compare the licensing fees for each handset above

Secondly, we use mobile internet usability of each handset as if we cross-reference this to the business model. Mobile internet would be the objective of Google. We have some underlying assumptions that mobile internet might be the next step for mobile development, for instance from the chart below we can see the year-on-year growth of mobile internet usage

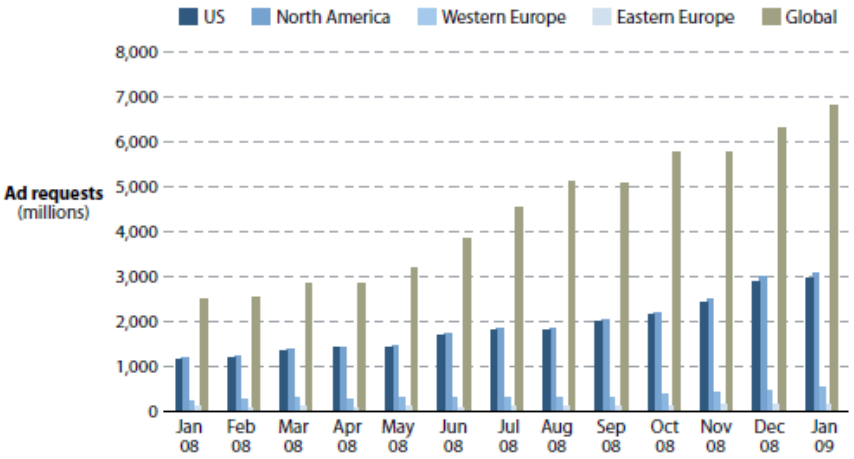


Figure 19 Growth of Mobile Internet Usage (Jan 08 – Jan 09)
(Source: AdMob Mobile Metrics Reports http://metrics.admob.com)

Using this criterion we are assuming that the user experience is relatively important to the continuity of the business model therefore we will measure the supportive function for internet experience and the accessibility to the internet of each handset. Additionally we also analyze whether each handset offers widget to

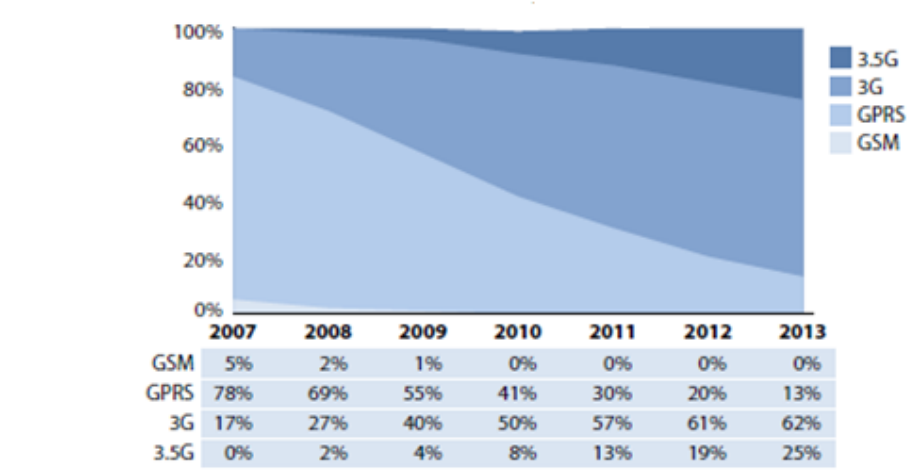
support the internet accessibility as we also find that widget can improve customer browsing experience quite significantly as mentioned on the next table

Table 12 Customer Internet Browsing Experience
(Source: Widget Improve the Convenience of the Mobile Internet, Pete Nuthall, December 2008, Forrester Research)

	Mobile browsing	Mobile widgets	Mobile widgets on the IPhone	Browsing on laptop
Overall convenience score	**-0.12**	**0.21**	**0.61**	**0.13**
Benefits score	**0.57**	**0.89**	**0.86**	**0.57**
Content-based benefits				
Relevance	◔	◕	◕	◐
Speed	◔	●	●	◕
Accessibility	◔	◕	●	◕
Device-based benefits				
Availability of host device	●	●	◐	◔
Proximity	●	●	●	◐
Portability	●	●	●	◔
Ease of input	◔	◕	◕	●
Barriers score	**-0.69**	**-0.69**	**-0.25**	**-0.44**
Consumer education	◐	◕	◐	◔
Discovery/distribution	◐	◕	◔	◔
Costs	●	●	○	●
Complexity	◕	◔	◔	◔

And to support the development of the mobile internet it may opens the door to many other opportunities such as mobile advertising which commercialized by Admob, mobile social networking (in Japan they have mixi or mobage-town). Even though there are concerns like the usability of the current worldwide web HTML based websites to be comfortably browsed from handset with limited browsing feature as in desktop or laptop

And lastly, we will compare the hardware capability to offer high speed data transmission, as we believe that upon developed environment this function will become necessary. As some research mentioned trends towards this speed connection will be the interest for many parties for European market starting 2010 as shown on the graph below



	2007	2008	2009	2010	2011	2012	2013
GSM	5%	2%	1%	0%	0%	0%	0%
GPRS	78%	69%	55%	41%	30%	20%	13%
3G	17%	27%	40%	50%	57%	61%	62%
3.5G	0%	2%	4%	8%	13%	19%	25%

Base: European mobile phones in use
(numbers have been rounded)

*All figures are at year-end.

Figure 20 Penetration of Mobile Phone Technologies in Western Europe (Source: European mobile forecast: 2008 to 2013, Pete Nuthall, March 2008, Forrester Research)

Based on the above, the comparison table for handset manufacturer is as follows. Five criteria are being used to compare: hardware that support internet experience; software that utilize the internet Google resources; network connectivity; price; and market share.

Table 13 Comparison of Android and Non-Android Handset

platforms	handsets	* to support user internet experience	* make use of internet resources	* connectivity	** OS license pricing for each handset	*** worldwide smartphone type brand marketshare
Android	htc dream (T mobile G1)	3.2-inch TFT-LCD flat touch-sensitive screen with 320 x 480 (HVGA) resolution, Home screen widgets (analog clock, calendar, music player, picture frame and search), track ball. WebKit-based browser, ROM: 256 MB. RAM: 192 MB Rechargeable Lithium-ion battery Capacity: 1150 mAh	Email, SMS and MMS notifications Android application market	HSDPA/WCDMA Quad-band GSM/GPRS/EDGE Bluetooth® 2.0 with Enhanced Data Rate Wi-Fi®: IEEE 802.11b/g HTC ExtUSB™ (11-pin mini-USB 2.0 and audio jack in one)	USD -	4%
	htc magic (Android G2)	3.2 inch HVGA touch screen. Home screen widgets (analog clock, calendar, music player, picture frame and search), Trackball with Enter button, Capacitive touchscreen with on-screen keyboard (both portrait and landscape Latest Webkit and Squirrelfish JavaScript engines + magnifier vitual keyboard, ROM: 512 MB, RAM: 288 MB Rechargeable Lithium-ion battery Capacity: 1340 mAh	Gmail, SMS and MMS notifications Android application market Picassa, Youtube text seach, voice search GPS: Google Map,my location, Google Latitude	HSDPA/WCDMA Quad-band GSM/GPRS/EDGE Bluetooth® 2.0 with Enhanced Data Rate Wi-Fi®: IEEE 802.11b/g HTC ExtUSB™ (11-pin mini-USB 2.0 and audio jack in one)	USD -	
	samsung i7500	3.2 inch capacitive OLED touchscreen, HVGA resolution (320 x 480 pixels) Home screen widgets (analog clock, calendar, music player, picture frame and search), virtual key board, Chrome browser 8GB, hot-swappable microSD card slot (up to 16GB) Battery: 1440 mAh battery	Gmail, SMS and MMS notifications Android application market, Picassa, Youtube, text seach, voice search GPS: Google Map,my location, Google Latitude	GSM 850/900/1800/1900 MHz, HSDPA 7.2Mbps, HSUPA 5.76Mbps Wi-Fi, GPS, Bluetooth 2.1 with A2DP, microUSB v.2.0, 3.5mm audio jack	USD -	0%
	motorola	coming in the 2nd quarter of 2009	coming in the 2nd quarter of 2009	coming in the 2nd quarter of 2009	USD -	0%
non-Android	nokia (n95)	Symbian web browser, however it has compatibility to IE, Firefox, or even Opera browser, GPS with downloadable maps for free for more than 100 countries, battery life concern when GPS is running, 330 Mhz processor	all HTML based websites accesibility, SMS, MMS, OVI store for nokia applications	HSDPA, Wi-Fi, quadband GSM, WCDMA, EDGE	USD 7.50	44%
	blackberry (8800)	Trackball, faster processor, increased memory, AJAX support, connection to SAP erp system, push to talk function and GPS, 312 Mhz processor	all HTML based websites accesibility, SMS, MMS, push email functionality	no integrated Wi-Fi, no 3G	undisclosed	17%
	apple (iphone)	Cut, copy and paste function, battery short life concerns, 600 Mhz processor	all HTML based websites accesibility, SMS, MMS, push email functionality, AppStore for various applications	Wi-Fi and 3G availability	undisclosed	8%
	sharp (willcom d4)	QWERTY pad keyboard, 1GB RAM, Run on windows vista SP1 which offer quite similar to desktop browsing experience, 5 inch screen size; 1330 Mhz processor	all HTML based websites accesibility, SMS, MMS	Wi-Fi , however no HSDPA or 3G support	USD 15.00	4%
* under assumption that mobile internet as part of google mission to make information accessible and useful is the objective of android						
** price of handset that provides internet accesibility						
*** as per 2008						

5.2 ANDROID HANDSET

According to PC-mag stating from Roiters that sales of Android phone will be 10 folds compared to 2008. Google's Android was introduced in the United States in the second half of 2008, and now all top cell phone vendors except Nokia have said they would use Android. Experts from Strategy Analytics have good opinion about Android, he said that Android has good position to become a top-tier player in Smartphones over incoming years.

Mawston - Director of Strategy Analytics said that handset vendors and operators like T-Mobile and Vodafone are attracted to Android's relatively low-

cost licensing model, its semi-open-source structure and Google's support for services. That explains why T-Mobile and Vodafone have been the main carriers of a number of Andoid handsets which mushrooming presently and in coming time.

5.2.1. T-Mobile G1/HTC Dream

a) Home screen

Figure 21 T-Mobile G1 Home Screen

One of Android's most valuable qualities -- and perhaps the first thing new users will pay attention -- is the home screen. First off, the users can add shortcuts to applications, web bookmarks, individual contacts, music playlists, and pretty much anything else an app developer wants to expose. These all look just like the icons on PC, and the users can position them wherever they like.

The second part of this one-two punch would be the widget support, and this is where the home screen's true value lies. It reminds us a little of TouchWiz concept from Samsung, but by the nature of Android's extensibility, it'll be far

more useful. Although developers cannot build their own widgets in version 1.0 of the SDK, but Google says support is on the way.

The widgets will turn the home screen into a destination. The users will come to the home screen to check the weather, news, sports scores, the RSS feeds, run a couple web searches, and do pretty much anything else the legion of Android developers can dream of cramming into a pretty little space.

b) Trackball

The trackball of T-Mobile G1 is nearly identical to those found on BlackBerry devices. For many users, with a touch-screen and a full keyboard, they did not think that they would be going to use the ball very often, but it's actually a great help moving around pages with a lot of links, or while editing text. The users can use the rubbery nub for navigation, and it's also clickable for making selections.

c) Browsing

Although not support flash, the G1's WebKit-based browser does bang-up job of rendering sites as faithfully as Mobile Safari. First, the issue of how G1 does not support the multi-touch - the G1 doesn't support it at this point. The G1 offers best single-touch experience for browsing. Flick gestures work exactly; continuing to move the page after the users' fingers have left the screen and slowing to a stop. Panning brings up zoom buttons which located at the bottom of the screen, but the key instrument might actually be the magnifying box, which is called up by pressing an icon in the lower right of the app. The box automatically zooms out the page, offers a small and magnified box that the users can drag

around and zoom into that area – but many experts say that it became hard to control on large pages because even a small movement of the user's finger translates to a significant amount of scroll on the zoomed-out preview.

The page load times is behind the iPhone 3G when both devices were in 3G coverage, but once the pages were loaded, scrolling was smoother on the G1. Actually, both devices scroll pages smoothly - but the G1 was able to do so without resorting to temporarily filling your screen with a checkerboard pattern until it could get around to re-rendering your view. The users can zoom in on pages by tapping an icon on the screen; it usually takes a tap or two to get to the point where you can accurately hit links with their fingers (though they can always use the trackball). While pages show in portrait or landscape mode, the users need to switch to landscape mode and pop out the keyboard if you want to enter text.

d) Make use of all Android OS and Google Support

Networks connects

Despite the shortcomings, Google has still managed to completely eliminate one of the biggest pain points in the wireless world: changing phones. Even with ActiveSync, iSync, Intellisync, WhateverSync, the process of bringing a new phone online has usually been hairy at best, largely because you're moving across heterogeneous platforms. Sometimes the sync goes the wrong way and wipes out data on PC, sometimes data just flat-out refuses to transfer, and quite often, you've got to physically connect the device to your computer to make it all happen.

Email and SMS

Android's Gmail client is considered amazing. It offers push that is actually assertive to be called "push" -- in some cases, the user actually received new emails on the G1 before the web client. It is also created to mimic all of the web version's most important Gmail-specific features, for example conversation threading, archiving. Naturally, this facility knows how to integrate with your contacts, and like almost everything else here, it makes best use of the notification system.

In terms of instant messaging, G1 offers AIM, Google Talk, Windows Live, and Yahoo! Messenger. The AIM client, unlike many mobile clients, accesses their entire buddy list. The customer can log in to one account per service and leave each running in the background.

Notifications

It might seem like a minor point to make, but it is surprised to know that how quickly it became a huge part of the G1 experience: The first piece of the puzzle is a totally average-looking status bar that appears at the top of basically every screen. Next, the users get the standard information every self-respecting phone is going to provide: time, battery charge, signal strength, data network status, WiFi, and silent mode. On the other hand, any app can place an icon to indicate that something interesting has happened -- instant messages, emails, voicemails, schedule reminders, and so on -- and optionally scroll a brief message (say, a snippet of a received SMS). Perhaps the most attractive feature here, though, is the security warning for each app the users download. Android can determine

what potentially sensitive features of the phone the app will have access to. It gets really in-depth, too - it doesn't just tell the users that the app has accessed to their personal information, for example; it notifies that it can read contacts and calendar entries.

5.2.2. Android G2 – HTC Magic

Figure 22 Android G2 Phone

Android G2 would be launched with T-mobile and Vodafone. On T-Mobile it would be called HTC G2/Magic or T-Mobile G2, this will be sell in US market. On Vodafone it would be called HTC Magic. Its initial markets will be in UK, Spain, Germany, France and Italy and the phone will be a timed exclusive with Vodafone.

a) Home screen and Navigation ball

Similar to HTC G2 with Android 1.5, the Trackball is with Enter button, capacitive touch-screen with on-screen keyboard (both portrait and landscape)

b) Browsing

Thanks to the Cupcake OS, the HTC Magic has a very useable and smooth browser. Scrolling is as fast and smooth as the Safari browser but Google, being the Internet giant, added a very useful add-on aside from the circular scroll wheel for zooming in and out of webpage: a magnifier. With Android browser, users can scroll through the zoomed out view of the webpage and magnify the contents of the page they are scrolling so they don't have to guess where is the about me link or contact link of the website.

c) Make use of Android OS and Google support

HCT Magic make use of the update of Android 1.5, however, there are several changes.

According to HTC, the Magic which runs on a 528-MHz Qualcomm processor has 3G and Wi-Fi, and its 3G radio absolutely positively does not work at all in North America. The phone also has a 3.2-megapixel camera, a built-in compass and GPS.

The Magic runs an upcoming version of Android 1.5 with the biggest new feature of soft keyboard, which lets user to enter Web addresses, e-mails and other text without a physical keyboard. The soft keyboard works in both portrait and landscape modes. When the user touches a key, a bigger version of the letter that was typed will pop up on the screen in order to confirm user's choice.

The Magic's photo gallery app has built-in video playback. Users can record videos with the phone, as well, at two quality settings - "low" and "high." The video player plays movies from a microSD card in full-screen mode. In the

Magic's Gmail app, users can check off multiple messages to archive, label or delete them.

5.2.3. Samsung i7500

The Samsung I7500 is the first Android mobile phone provided by a leading brand manufacturer and will be exclusively available from O2 as of June 2009 in all O2 Shops, the specialized trade on the internet from June 2009. The device can be combined with all tariffs and data packages.

Also Samsung just sent out its press release without giving any further information except that the Samsung I7500 will be available in major European countries from June, 2009. No word yet about a possible North American launch, even if the I7500 supports T-Mobile U.S. UMTS frequency

a) Home screen and Navigation ball (track ball)

Home screen with size and feel same as HTC- G1 and HTC G1 version 2; and no track ball.

b) Browsing

The i7500 will come with usual Google application set including Gmail and Chrome browser. The handset will also support Android Market for downloading applications.

c) Make use of Android OS and Google support

Similar to HTC G1 version 2 and HTC Magic, I7500 mobile phone is expected to be the running version 1.5 Android. The phone offers users access to the full suite of Google services, including Google Search™, Google Maps™,

Gmail™, YouTube™, Google Calendar™, and Google Talk™. The integrated GPS receiver enables the comprehensive use of Google Maps features, such as My Location, Google Latitude, Street View, local search and detailed route description.

To sum up, the value of Android phones does not lie in the handset itself. Android has an expanding application market, so that the handset is always leveraged and it has left rooms for developers to create applicable and useful applications.

5.2.4. Motorola

Verizon is reported to offer a Motorola device similar to the T-Mobile G1 with a touch screen and a slide-out keyboard. The first alleged spy-pics of Motorola's long-rumored Android phone, the T-Mobile-branded "Morrison," have filtered their way online, and hinted that the company could be taking Google's mobile OS in a new, decidedly mainstream direction.

The Morisson is a QWERTY slider in the tradition of the G1, though judging by the bright styling, generously-size d-pad and smooth lines; it seems to be oriented toward a broader audience than its blocky T-Mobile stable mate. In fact, the Morrison would sooner pass as a messaging-centric feature phone than a full-fledged smart phone.

5.3. NON-ANDROID HANDSET

5.3.1. Nokia

Nokia N95. Receive a tagline as the 'anti iPhone' mobile cellular from Nokia
Presumably this series predetermined to fight with the new emerging high tech mobile phones (i.e. Apple iPhone, Google Android, Blackberries)
Supported by the solid functionalities presented below, this can be considered a very powerful handset for heavy user, despite of its high price on the trade off

Figure 23
(Source : http://www.pcmag.com/article2/0,2817,2113507,00.asp)

Some news shows that Nokia will assign N95 (to be followed by N96 and N97 – upcoming model) to directly compete with these emerging Smart phones. Priced at USD 749, this handset will enhance the user social networking on mobile experience through its wide screen size (2.6 inches), 5 mega pixel camera, high tech multimedia converter and GPRS support. For connectivity to support the mobile internet, it offers email messaging, web browsing (with downloadable browser), and local Wi-Fi even though unfortunately it doesn't support 3G. Additionally these handsets also support the GPS function aside from its built-in map function (only worked in U.S and Canada). However, some concerns on the non-expandable memory and battery lifetime are still on debate subject to those features which drains the battery.

And operationally, these handsets are still supporting a keypad typing model (to some extent, preferable in some countries).

5.3.2. Apple

"The Market Disruptor"
Apple iPhone 3G. The latest handset from Apple computer that successfully taking away some of the Nokia market shares percentage in the early 2008
Also called as the pioneer for the new breed of 'computing platform'

Figure 24 Apple iPhone 3G
(source : http://www.pcmag.com/article2/0,2817,2319438,00.asp)

With a relatively low priced (USD 299 – when initially launched) and supported by a set of powerful applications (related to browsing and multimedia application in particular), this handset successfully grabs the market from Nokia as the main player on the world handset manufacturer.

It has a slightly larger screen size compared to Nokia N95 (3.5 inches) and has a lower specification on the camera with only 2 mega pixels to support the user social networking on mobile experience.

On the flip side, other than concern about the non-removable battery, the handset also doesn't support for additional memory stick. However, as Apple might have anticipated this, the battery lifetime actually can stay up relatively longer than most Smart phones. Apple also use this handset to grow the iTunes

store, yet according to some reviews Blackberry Curve audio device is still slightly better than Apple.

It has the built-in GPS intact to facilitate the user mobility experience. In addition to that, web browsing is also one of the measures to facilitate the mobile internet experience.

On the hardware side, the touch screen keypad offers a new stream of mobile messaging as the built-in slide typing function which saves users time to write and deliver messages.

Yet overall, the number of buggy unit that represent low quality control from Apple manufacturing are still on the main cons area for this new age hand.

5.3.3. Blackberry

The main strengths of this handset are the QWERTY keyboard, music player, and trackball. It also offers built-in GPS function within. So far, this handset manufacturer focusing themselves on the middle handset market, as they positioned themselves in a very niche and selective positioning.

Known as the most widely used handset type for internet browsing from Blackberry (Research in Motion)

Figure 25. Blackberry Curve 8800
(Source: http://www.nielsenmobile.com/documents/CriticalMass.pdf)

This product sample of Blackberry compete directly in the similar market position with Apple iPhone, Nokia N95, or even Google Android as they are all sold at the relatively similar price range. The high tech model from this manufacturer called Blackberry Storm was released last November 2008.

With a relatively similar screen size to Nokia N95 and its 2.5 mega pixels camera, it offers the customer a social networking handset capability. And supported with a proprietary web browser and quad band functions complete the offers for mobile internet experience as part of their direct competition strategy with Apple iPhone.

Yet overall, it doesn't offer the 3G connectivity but on the trade-off it offers a removable memory by providing a memory card slot under the battery stock. Additionally, it is also using a QWERTY keypad instead of touch screen pad as those of Apple iPhone. This handset sold for USD 299.

5.3.4. Sharp

Sold at USD 1500, it positioned itself a little bit above the market players for this handset segment. And as mentioned above, this handset design is focusing for mobile internet customer, as the super-high-resolution large screen size plus 2 megapixels camera will enhance the customer mobile internet experience, especially for social networking.

The first Windows Vista powered mobile handset released by Sharp (made exclusively for Japan market)

Figure 26. Sharp Willcom D4
(Source: http://gizmodo.com/379297/sharp+willcom-d4-umpc-first-with-intel-atom-centrino-windows-vista-too)

And to ensure the delivery of such convenience 1GB RAM is added to its memory to ensure the hardware capability matches the requirement. On top of that as it runs on Windows Vista platform, users can opt to remove Windows Aero functionality to increase the CPU speed (1300 Mhz). However for this type the RAM is not upgradeable.

The cons for this social networker handset are the design is still very large, the add-in for 'grab and drag' browsing function is not as smooth as other platforms and lastly HSDPA or 3.5G technology is not a built-in feature.

5.3.5. Competitor Responses towards Android

Steve Balmer (Microsoft) is questioning Google's ability to make money with Android. While, Nigel Clifford (Symbian) also saying that Android is merely another Linux platform. Eric Schmidt (Google CEO and Apple Board) commented on his dualism position as normal, he responded "From my perspective, I don't think Google sees Apple as a primary competitor" .

Mr. Schmidt said that if there were areas of competition between the two, he would withdraw from discussions. He added that it was well known that he typically withdraw himself from Apple board discussions related to the iPhone.

5.4. ANALYSIS ON ANDROID HANDSET

By looking at the Android handsets we came up with those common features as compared above. We saw the trend of Android smart-phone is very much Mobile -Internet - oriented. The Android phone's value proposition lies in the "package" of internet access convenience (network and connectivity), internet browsing experience, storage capacity and the Google's resources. As Android is open source, so handset manufacturers or network operators are free to create their own versions of the platform. Also, it is free of charge, providing a potential saving on the mobile OS license fees charged by Symbian (currently about USD 4.80 per handset), Microsoft and other providers. The idea of cutting out the license fee from the bill of materials and being able to create a tailored version of an OS without having to share those innovations with their competitors will definitely appeal to handset manufacturers. It will also be attractive to network

operators who want to specify a particular platform for use on certain devices but don't have the resources to build it themselves.

However, there is a little benefit of using an open source platform like Android if a handset manufacturer makes on the license fee are going to be outweighed by the additional costs of training staff on new tools, a bigger bill of materials and reduced time-to-market. There's also the issue of fragmentation. Google's licensing approach carries a fundamental danger of increasing fragmentation within the industry by spawning a wide range of Android variants, each adding to the costs of the manufacturer, operator or Chipset Company which developed them. Even if integral support for open web standards makes it possible for third party developers to write applications across these different OS builds, handset manufacturer has still got costs being duplicated throughout the supply chain, making the devices themselves less economic to build. As the result, Google has a lot of questions to answer in this area.

Dr. Won-Pyo Hong from Samsung to present the handset manufacture point of view on Android strategy once said: "Our commitment is more to the Android phone than the Google Experience device," Hong said. This means Samsung is straight forward on customizing the handset on top of the Android platform to make it well connectable with operators and satisfied by the users.

As we know, in any circumstances, Google still benefit as its revenue lies in the internet advertising. The competition therefore, is: among Android phones manufacturers and between Android and non-Android phone manufacturers. The customization and privatization of each handset is highly required. This questions

a handset manufacturer to consider carefully before joining the game of producing Android smart phones. If handset manufacturers make sure that they can produce types of Android phone which have friendly user interfaces, fast and convenient internet access, durability, support the current carrier business model and AFFORDABILITY, they can think of joining the competition.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1. OPERATING SYSTEMS

Based on the analysis in chapter 3, the following recommendations could be concluded.

Google's continuous role in the Android OS development - Although Google makes Android as a fully open source OS, it is crucial for Google to continuously support the OS development. The fact that developers decided to jump ship from other Linux based OS for Android development is because of the brand Google behind it.

Increasing the security protection for the operating system – As mentioned in chapter 3, the Android security is based on the user authentication including the user name and password utilization. Problem might occur when the Android phone being stolen since personal data could be leaked if the phone is hacked. In view of this, it is possible for Android to adopt the "Remote Wipe" feature as utilized in Windows Mobile and iPhone. Hence the user could remotely delete the data available in the handset.

Medium-high processing speed – As mentioned in chapter 3, Android is using Java programming language that requires Virtual Machine which make it slower if multiple applications are opened at the same time. Android must find a method to trade-off this minus point. One method is to improve the user experience since based on the Director of Symbian Foundation, Lee Williams, the

most important items for customer are the "*User Experience then followed by security and power*".

6.2. APPLICATION STORES AND ANDROID MARKET

The following 5 features are the key for the success of any Mobile Application Store:

Single Marketplace – They should provide other contents like ringtones, themes, wallpapers not just applications like what BREW does with their on device storefront. The online application publishing process should be simple and transparent with QA process, where the applications are approved within 7days. The testing and certification process should be simple and easy over different OEM, MNO or distributor requirements. The developer should have choice to choose over different pricing scheme like in-app payment, subscription based, per download etc. The marketplace should provide analytics on downloads and estimated revenue, something like Google Analytics which provides web analytics. The marketplace should be open to applications from all major platforms like Java, Symbian etc.

Fair & Ubiquitous Billing – Revenue sharing method which favors developers. A transparent mechanism for processing credit card purchases, a single-click, operator independent mechanism for operator billing, a clearing house which allows quick settlement for developers.

Addressable Market – On-device storefronts are more profitable than Online stores given that most of the mobile users make their application purchase using

their handsets rather than downloading from the Internet. Storefront should be pre-loaded on devices and should also include operator-customized storefronts if necessary. The market should support global distribution where users can downlaod apps from other countries as well.

Provisioning – Licenisng an application to a particular subscriber and device. There has to be features which could prevent fraud against sideloading. Simple and transparent installation process without continual user prompts. Support transparent updates for applications and storefront framework. Automatically restore or transfer purchased applications onto a device.

Storefront – An on-device catalogue located within 1-2 clicks from the idle screen. There should also be WAP and Web based i.e. Online storefronts as an alternative distribution channel which provides multiple channels for app discovery such as user ratings, top 50 apps, location or friend based recommendation. Opportunities for developers to promote or market in on-device storefronts.

6.3. HANDSET MANUFACTURERS

Our final conclusion and recommendation for the OEMs taking the concerns on the identified key challenges to go forward are basically consist of several actions

Firstly, taking into consideration that the market is moving towards faster connectivity proven by the stage of mobile broadband growth stage in the previous tables (penetration of mobile phone technology in Western Europe) and

also the concerns by the mobile operators at the 2008 Mobile World Congress in Barcelona, Spain which shows the movement towards the importance of connectivity to support the ecosystem. LTE (Long term evolution) which is the enhancements of the UMTS system is also working towards the adoption of 4G technology that offers 20 times faster than 3G connectivity to support the growth of user on mobile internet platform as shown below

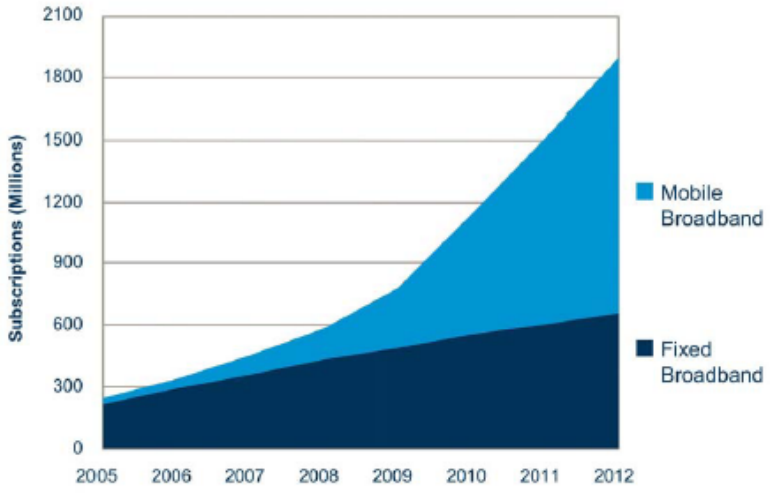


Figure 27 Subscription to Internet Broadband
(Source: http://www.ericsson.com/technology/whitepapers/lte_overview.pdf)

And as we know that the movements toward these technology is still ahead of us, it is going to be better if the OEMs thinking about this functionality implementation as mobile operators (Vodafone, AT&T, and Verizon wireless) are ready to move into this connectivity starting 2010.

Secondly, OEMs also should take a look at their savings on the licensing price. There are certain savings that can be achieved by OEMs using open source platform instead of paying to license to use the proprietary operating systems.

Brief example from the comparison we can see savings per handset made by android users compared to other operating system. However, the concern further is whether the handset manufacturer or OEMs will fully utilize this competitive advantage and use it in the competition, because up until now the open source (Android) based handsets are sold within a relatively similar selling price to end-users. It means that either higher margin at the OEMs or the mobile operators in which the handset being operate it. And certainly the competition will find a way to overcome this hurdle which ultimately moving towards better pricing structure and technology.

Thirdly, we are also concern about the competition within the user interface criteria. As we also know that the most current mobile innovations basically lead by Apple innovations. This innovations is not only limited to open source and close source or proprietary, it is also appear to occur between open source OS providers like Symbian (even though they limit the SDK based on membership) and Android, or even innovation competition within the open source platforms such as Android OEMs themselves. We think that going forward OEMs has to think about their handset capabilities that differentiate themselves than other competitors regardless of operating systems as mentioned above. And ultimately to find better resources to create efficiency not only from the operating system or software level but also the hardware vendors as the market requirements getting higher and any form of efficiency can assist the OEMs to lower their bill of material.

Lastly is the concern on the mobile operator relationship. We think that mobile operators as the pipeline of services to end-users. Meaning that the technology congruence between the handsets being sold and the service being offered should match otherwise there might be much inefficiency of investments, seeing from both handset manufacturers and mobile operators. Underlying this concern is also the fact that currently many mobile operators dedicated to provide better connectivity for better user-experience, thus handset manufacturers could also use this momentum to lead the market by choosing the right mobile operators to partner with and by choosing the right technology to invest in.

However, there is also perspective that shows 'feature phone' which defined as "any phone that is not smartphone or PDA phone" will still be the market leader for mobile telecommunication based on several criteria such as affordability, battery life, usability, customer minimum requirements, and so forth. These are exactly why we think that our concerns above might works to improve the OEMs competitive capability beyond operating systems.

6.4 CONCLUSION

Although at the current early stage of its life, Android has shown a clear trajectory it follows on as the mobile internet platform in the near future. The key for the Android's success is to be a platform that delivers a high level of user experience. To reach its success, firstly, Android OS need to continuously enhance its architecture that will ease developers to deliver a high quality of user

interface for consumer's best experience. Any fragmentation in Android OS must also be avoided such that compatibility across various handsets remains, and Google's continuous support the OS development is crucial in this regard. Related to handset, it is crucial to come up with an affordable price and easy integration between OS and the handsets for a high level of user interface experience. The handset is also required to support faster network connectivity that comply with the latest standard, such as the LTE. As for the Android Market Place, it should offer more attractive incentive for developers and provide different pricing scheme like in-app payment, subscription based, and per download. Moreover, to get broader segment of customers, Android Market should be a single market, which does not just provide applications, but also other contents like ringtones, themes, and wallpapers.

APPENDIX

1. Stakeholders of Android Ecosystem (Open Handset Alliance™)

Open Handset Alliance™ (OHA), is a group of 47 technology and mobile companies who have come together to accelerate innovation in mobile and offer consumers a richer, less expensive, and better mobile experience. They joined together building the first complete, truly open, and free mobile platform called Android™

The idea was started by Google, who initiated the Android™ open-source platform in the first place since acquire the newly startup company in Nov 17th 2005. With aim to build a better phone for customers which roughly consist around 3 billion people around the globe, innovating in the 'open' where all members of OHA are committed to a greater openness in the mobile ecosystem to respond and innovate better to customer demand, and making a vision a reality by fully utilizing this Android™ platform to reach their collective objectives

1.1. Handset Manufacturers

1.1.1. OHA handset manufacturer members

Presently there are nine members under the OHA handsets manufacture category. Together with mobile operators, handset manufacturers join the Alliance to develop handset based on open platform. Being a member of the Alliance, handset manufacturers will get the benefits from lower software bill of material (BOM) cost to faster time to market the handsets. Furthermore, the

handsets offering will be more valuable in customization and differentiation. Following is the brief information about the handsets manufacture members of OHA.

- ASUSTeK Computer Inc. is a leading company in the new digital era for IT and communication products. The company's turnover for 2007 was 6.9 billion U.S. dollars.
- Garmin International, Inc**.** is the global leader in satellite navigation and has built millions of products that serve the automotive, wireless, OEM, fitness, aviation and marine markets.
- HTC Corporation focuses on driving cutting-edge innovation into a wide variety of mobile devices to create the perfect match for individuals. The company is listed on the Taiwan Stock Exchange under ticker 2498.
- Huawei Technologies is a leader in providing next generation telecommunications network solutions for operators around the world.
- LG Electronics, Inc. the brand that is Delightfully Smart; is a global leader and technology innovator in consumer electronics, home appliances and mobile communications. LG's vision is to supply top-of-the-range innovative digital products and services and ensure customer satisfaction.
- Motorola, Inc. is known around the world for innovation and leadership in wireless and broadband communications.
- Samsung Electronics, a leading innovator and provider of mobile phones and telecom systems.

- Sony Ericsson is a top global mobile phone manufacturer with sales of over 100 million phones in 2007. With operations in over 80 countries, Sony Ericsson was established as a 50:50 joint ventures by Sony and Ericsson in October 2001.
- Toshiba Corporation is a world leader and innovator in pioneering high technology, a diversified manufacturer and marketer of advanced electronic and electrical products spanning information & communications equipment and systems.

1.1.2. Android handsets manufacturers

The Android platform is the first open platform that the OHA members work on to developer-friendly open-source licenses, which gives mobile operators and device manufacturers significant freedom and flexibility to design products.

Gadgets include smart phones from HTC, Samsung, Motorola, LG and Huawei and likely notebooks from HP and Eee PC maker Asus. Within the scope of this thesis we would like to focus on analysis of Android mobile only.

So far, the handsets applied for Android OS (operating system) or so called Google Phone on the market is T-mobile G1 and HTC Magic of which in US the network is operated by T-mobile and handset is manufactured by HTC.

HTC

HTC is a Taiwan owned handset manufacturer which has good prestigious trademark in the mobile industry for its cutting-edge innovation into a wide

variety of mobile services to create the perfect match for individuals. By participating in the OHA and being the first handset manufacturer offering Android OS phone, HTC confirmed the benefits of expanding their device portfolio into a new category of connected mobile phones that change the complexion of the mobile industry and re-create user expectations of the mobile phone experience. So far HTC has offered two ranges of Android OS phone: HTC Dream (T-Mobile G1) and HTC Magic. The value of the first Android™-based phone which HTC highlights in their advertising campaign is the smartphone with easy-to- use webmail and chatting applications like Google Talk™ or a cell phone that can guide you to your destination with built in GPS and navigation programs.

Figure 28 HTC handset

The HTC Magic, powered by Android™, is designed stylishly with a number of capabilities. It provides the Google suite of services like Gmail, Search, YouTube and Maps. Accompanied with Outlook® synchronization, Smart Dialer, and an onscreen keyboard with predictive text, the HTC Magic is a "true entertainment and communication powerhouse". Meanwhile the Android™ powered HTC Dream "surpasses all conventional ideas about what a

phone can be" quote from HTC website. HTC Dream leverages the usage of Google Map in HTC Magic to be able to immerse oneself in the location and get to truly experience the destination. Explore fascinating cities like New York, Sydney, London etc and take a virtual walk. With 360º panoramic scenes, Google Maps Street View offered by HTC Dream is the next step in the evolution of maps.

According to DigiTimes, HTC is set to release 10 new handsets in 2009. ALL of these devices will be based on either Windows Mobile or Android. That means there is a pretty good chance that HTC alone launches 2 or 3 new Android devices in 2009.

Samsung

Figure 29 Samsung

The Samsung I7500 is the first Android mobile phone provided by a leading brand manufacturer and will be exclusively available from O2 as of June 2009 in all O2 Shops, the specialized trade on the internet from June 2009. The device can be combined with all tariffs and data packages.

As the first Android mobile phone, the Samsung I7500 offers a 5 megapixel camera with LED Flash. The big 3.2" AMOLED display ensures the brilliant

representation of photos and videos and reduces the battery power due to the energy-saving technology. The battery which has been the limitation of HTC Android phones has been improved in Samsung I7500 with generous dimensions (1500 mah) and ensures that users enjoy long calls and access to the web. The device also includes WLAN (802.11 b/g) and Bluetooth 2.0. Supporting various multimedia codec formats, the I7500 is a multimedia all-rounder. With its memory capacity of up to 40 GB it offers enough space for pictures, music and videos.

Samsung also praises the open platform of the Google Android because of the optimal customized features of the device. A variety of applications and services is available in the Android market. The contact to friends is guaranteed by integrated and freely available Web 2.0 applications like Facebook, Flicker and Instant Messaging. Customers are always up to date anywhere they go due to the automatic synchronization of emails, contacts and appointments of Google accounts. All other popular email accounts can be accessed. The integrated GPS receiver enables the comprehensive use of Google Maps: local positioning, detailed route description and simple navigation. The application Wikitude available in the Android market allows customers to access details of unknown sights via photos on the web. The combination of a camera, GPS and a web browser turns into a personal and interactive guide.

Motorola

Motorola has long been an advocate of open software for mobile platforms. Although the decision has not yet finalized, there is a source of information that by year end, the U.S. handset maker plans to roll out several smartphones based on the Android operating system. According to Motorola co-CEO Sanjay Jha, stated by Business Week, Motorola remains on track to have Android devices in the fourth quarter 2009, for the holiday season. It is said that the new handset's name is Calgary and it will focus on social networking features. This is supposed to be a vital part of a new Motorola smartphone powered by Google Android. Although there's no mention of whether the rest of Good Mobile's offering will be ported to Google Android, we assume Motorola will use this opportunity to spread all its services to the platform.

Figure 30 Motorola's first Android phone

In terms of hardware, the new Motorola Android smartphone is supposed to offer a capacitive touch screen like the Apple iPhone 3G and the recently released Motorola Krave ZN4 - though there are no further details with regards to how it will work exactly. Additionally, the smartphone is said to offer a slide-out QWERTY thumb board. Overall, Business Week suggests that the Motorola

Android smartphone will be a higher-end version of the first Android smartphone, the T-Mobile G1 by HTC. According to Business Week, the Motorola Android smartphone will retail for $150 with a two-year contract and is scheduled to be launched in Q2 2009. It's also supposed to be released in Europe in Q3 2009. There's no word on which bands the Motorola Android smartphone will operate on, but given Motorola's release strategy in the past, we wouldn't be surprised to see both CDMA and GSM versions appear down the road.

LG

Figure 31 LG Handset

According to Reuters Barcelona - LG Electronics plans to start selling a phone model running on Android, the highly anticipated mobile phone operating system, at the start of next year at the latest, a senior official said.

In an interview at the Mobile World Congress trade show, Chang Ma, LG's vice president for marketing strategy told Reuters that they will bring the phone out late in 2008 or early 2009. The new handset is LG KS360 or LG Tribe or LG Neon which will apparently be LG's first Google Android platform mobile phone.

Sony Ericsson

Sony Ericsson was expected to give several new; gorgeous Android based devices in coming time. However, being affected by the global financial crisis which caused Sony Ericsson cut down 2000 jobs worldwide, the company has to delay the time to launch the first Android device. According to Soni Ericsson's Chief Executive Hideki Komiyama, the development of Android based products requires a lot of evaluation, as well as a lot of testing, a lot of acceptance from a consumer viewpoint, and there is still time to go.

However, basing on the source of DigiTimes, citing a report in the Chinese language Commercial Times newspaper, Sony Ericsson is likely out-source the production of its initial Android based smartphones to Taiwan's Foxconn Electronics. In an interview with Reuters, the CEO praised the Android as an important OS, however, the Chinese newspaper, citing an internal document from mobile network operator; Orange indicated that the MNO is working with Sony Ericsson for an Android handset launch around Q3 of this year. Based on typical Sony Ericsson announcement; to launch timelines, it would suggest a product announcement no later than the end of June. The company seems concerned with differentiating its Android products from those of other companies, since all the devices will be running the same base level software.

For Android lovers, this is excellent news. Sony Ericsson did a great job of customizing Windows Mobile for its XPERIA X1 smartphone, so it should do just a good job with the Android OS. Given that the default Android user

interface is already pretty slick, adding a Sony Ericsson custom paint job on top sounds mouth watering.

Huawei

Back in December of last year, Huawei - Chinese phone manufacturer - announced that they planned to release an Android powered handset in the third quarter of 2009. The announcement came shortly after the manufacturer officially joined the Open Handset Alliance.

When unveiling the new device at the Mobile World Congress in Barcelona last week, the company didn't give any details regarding the availability of the handset, nor the carrier that will introduce it to the market. However, a recent article published by the news site DigiTimes states that Huawei already announced its partnership with T-Mobile, and that the manufacturer would start shipping its touchscreen Android-powered smartphone during the third quarter of the ongoing year. In related news, we learn that the new Huawei Android – powered device will also go to South America in the second half of the year 2009.

Also according to an announcement on their official website, Huawei plan to showcase a "Smart mobile phone based on the 'Android' platform" in a section of their booth named "Mobile U-life".

Although Huawei has shown everyone its first Android device at the MWC (Mobile World Congress) without mentioning a lot of important details, so far we know the handset will support a 5-megapixel camera, a 3.5mm-headphone jack and WiFi and a large touchscreen. The phone should arrive in

late 2009 and T-Mobile might be the carrier to sell it in the USA and maybe in other markets too. That's all confirmed by a Huawei spokesman but we're still waiting for the official press release. The phone is rumored to be called the G3 once T-Mobile gets it but that's still long from being absolutely accurate.

1.2. Operators

The Open Handset Alliance (OHA) currently has nine operator members that spread throughout America, Asia, and Europe. Originally there were only five operator members:

NTT DOCOMO

DOCOMO is Japan's largest mobile carrier with more than 54 million subscribers. DOCOMO also is an influential force in the continuing advancement of mobile technologies and standards. In 1999, DOCOMO launched i-mode™, the world's most popular platform for mobile Internet services including e-mail, browsing, downloading and more. Over 48 million DOCOMO subscribers now use i-mode. In 2001, FOMA was introduced by DOCOMO as the world's first 3G commercial mobile service based on W-CDMA. It transformed the mobile system in Japan and also bringing DOCOMO to received global recognition. DOCOMO saw the opportunity of mobile phone as part of "lifestyle tools" as it launched Osaifu-Keitai, a mobile wallet enabling The role of mobile phones as "lifestyle tools" was cemented when DOCOMO launched Osaifu-Keitai™, a mobile wallet platform enabling quick, contactless transactions for cash, credit,

ID, and more. More than 32 million phones equipped for Osaifu-Keitai services are now in use.

KDDI Corporation

KDDI is a telecommunication operator that provides wide-ranging services from mobile to fixed line in Japan. KDDI is a union of 3 different companies DDI, KDD, and IDO which was merged in 1991 with one of the main objective was to compete more effectively to NTT group. KDDI has become the second largest mobile operator in Japan, with 18.1% market share or more than 30 million subscribers, after NTT DOCOMO. The mobile business of KDDI, known as "au", is focusing on young and dynamic market.

Currently au is working with Motorola to develop au box with based on android system which will be launched in fall 2009.

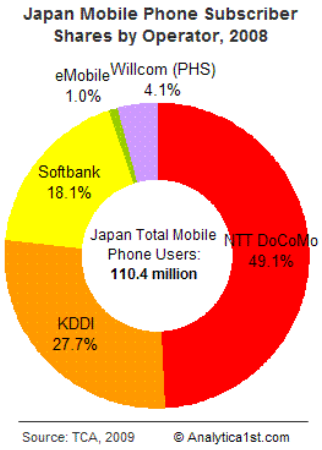


Figure 32 Japan mobile phone subscribers shares by operator

Sprint-Nextel

Sprint-Nextel is a US-based company that focuses its business in mobile communication and internet services. It was formed in 2004 as the result from merger between Sprint and Nextel. It currently offers cellular service under Sprint and Nextel brands. The internet service is under the name SprintLink. The business is not only available in USA but also in several Asian and European countries. Sprint Nextel wholesales capacity on its PCS wireless network to Mobile Virtual Network Operators (MVNO); this means the MVNO uses the Sprint PCS network for cellular services. The MVNOs resell wireless services using their own brand.

Despite of the growing market, Sprint-Nextel business is losing customer. This is one of the reason it joined Google's OHA as one of the founder companies as they view Android is "something exciting to attract new customers"

T-Mobile

T-Mobile, which headquartered in Bonn, Germany, was founded in 1990 as subsidiary of Deutsche Telekom. T-mobile market is available throughout Europe and USA. The main business is mobile telecommunication, home-fixed network, and also enterprise/company solution. In terms of subscriber, T-mobile currently is the eighth operator worldwide with more than 128M subscribers. In United States, T-mobile was the first operator to launched smart-phone with android system (G1-phone developed by HTC). T-mobile is the fourth largest wireless carrier in the US with more than 32M subscribers.

China Mobile

China Mobile Communications Corporation or China Mobile is China's and world's largest mobile phone operator. It has customer based of 415million. China mobile also ranks fifth in global brand equity and first in Asia according to Brand. Its business is only focus on mobile communication; the group's GSM global service cored 219 countries and regions in addition to its GPRS services that covered 138 countries.

Its target market is varied from the customer with high to low level of income with the stratification of its service (Go-tone, M-zone, and easyown)

In December 2008, there were 14 companies entered the OHA; amongst them, four were mobile carriers, which were:

Softbank Mobile Corp

Softbank Mobile Corp is the subsidiary company of Softbank Group that focuses in mobile communication business. Softbank is the third largest mobile carrier in Japan after Docomo and KDDI. Softbank mobile currently operates in PDC (Japanese 2G) and W-CDMA (3G). Softbank mobile was previously known as Vodafone before Vodafone group decided to sell its shareholding of Vodafone Japan to Softbank group in 2006. In order to strengthen its position in Japanese mobile market, Softbank mobile cooperates with Yahoo! Japan to provide mobile as well as fixed-network services.

Telecom Italia

Telecom Italia, with more than 70 million subscribers, is the largest telecommunication company in Italy. The business is available in fixed line, broadband, and mobile. It has market presence in Italy and Brazil. The target market for Telecom Italia is ranging from youth, professionals, and regular based on their available product. Telecom Italia is paying high attention to its stakeholder by creating sustainability strategies which focused in economic, environmental, and social sustainability.

Telefónica

Telefónica is Spanish telecommunication carrier that operates globally and has market presence mostly in Europe and Latin America. After acquiring O2 plc., Movistar and Manx Telecom, it become the third largest fixed-line and mobile telecommunication after China Mobile and Vodafone. The merger with O2 will strengthen Telefónica's position especially in Ireland, UK and Germany. Movistar gave benefit to Telefonica in terms of customer based USA and Latin America. Besides being an OHA member, Telefonica has already launched Apple i-phone and it brought a positive impact in its 2008 results. And Telefonica also planned to launch Android-based mobile phone in 2009.

Vodafone

Vodafone is the second largest mobile operator after China mobile and has market presence in more than 25 countries and partnership in more than 42

countries. Vodafone is divided into two major business units: Vodafone Global that maintain the mobile operation in UK and Vodafone Global Enterprise which handles Vodafone's multinational clients. It is the high end business to business section of Vodafone group, and acts like an operating country. In terms of Android phones, Vodafone is planning to release several series in 2009 namely HTC magic.

1.3. Content Provider

The developers and content providers are the second most important stakeholders in this mobile ecosystem after customers. The developers could be individuals or companies both small and big. The founding members of OHA were 10 companies namely Ascender Corporation, eBay, Esmertec, Google, LivingImage, NMS Communications, Nuance Communications, PacketVideo, SkyPop, SONiVOX. Currently there are 16 companies in the consortium. Apart from these software and content providers there are thousands of individual developers.

The open-community of developers is one of the key drivers in Android's mobile eco-system. Android Market, a software application developed by Google for Android devices, which allows users to browse and download applications published by third-party developers, features content from both big media companies and hobby developers, bridging the gap between premium and user-generated content. Currently, only developers in the US and UK are able to publish priced applications. Below is a brief description of some of the content providers.

Ascender Corp.

Ascender Corp. is a leading provider of advanced font products and innovative applications for mobile devices specializing in type design, font development and licensing.

LivingImage

This company based in Japan consists of renowned engineering, marketing and creative experts in the audio visual arena. By using Android platform, LivingImage will propose tools that give life to a new sphere of visual communication by combining photos, movies and sounds.

Myriad group AG

Myriad is a leading provider of multi-media solutions and end-to-end integration services. They are one of Europe's largest mobile phone software companies, with a global team of 800 software engineers, and a worldwide customer base that includes all major phone manufacturers and 30 mobile network operators.

Nuance Communications, Inc.

Nuance is a leading provider of speech and imaging solutions for businesses and consumers around the world. Their contribution to Android, helps developers begin to build mobile applications with basic voice command functionality in US English. Nuance will offer a complete portfolio of language models, services, applications and advanced technology programs.

OMRON SOFTWARE Co, Ltd.

OMRON SOFTWARE is a leading embedded device software company, provides innovative / universal language and image processing technologies for mobile devices.

Packet Video (PV) (www.pv.com)

PacketVideo (PV) is a multimedia software company whose software powers the world's leading mobile entertainment services, including Verizon Wireless' VCAST music and video services, NTT DoCoMo's 3-G FOMA service and Orange World by Orange. PV provides OpenCORE, the multimedia subsystem to Android.

SkyPop

It provides next generation services for mobile devices.

SONiVOX

SONiVOX is a premier developer of audio technologies and solutions that empower consumers to create “Sound That Rocks”. They are the sole MIDI audio solution in the Google's Open Handset Alliance. MIDI audio are used primarily to create interactive gaming applications.

1.4. Consumers

Mobile consumers are the end user or the mobile subscribers who use the services and benefits from the mobile operators. Mobile consumer can be defined as the consumers who use mobile voice subscriptions, messaging, web access and other mobile data services. These days, mobile consumers are defined by the application they acquire to personalize their mobile experience such as their convenience in shopping, billing and other mobile services. Mobile consumers can be anyone from the public (individual or household) to the business or government end users. Business or government end users are concerned with the

reliability of the communication services they contact for while the public whether individual or household are concerned with any type of technological services.

According to the ABI research, the subscribers of worldwide mobile consumers are expected to reach 4.3 billion at the end of 2009 and this growth continue to be 5.4 billion by the end of 2013.

In the ocean of mobile phone subscribers, Google android has also sailed its boat. There are about 6% of Google Android consumers among the 4.3 billion subscribers in the world.

1.5. Business Commercialization Companies

Commercialization companies are the bridges for all OHA members to realize their Android product development, specifically in hardware and software design, development, and integration. Their roles in the OHA are crucial particularly in supporting operators and handset manufacturers who plan to ship devices and services based on Android. They enable mobile handset manufacturers to have a faster, lower development cost and lower risk. With their assistance, handset manufacturers can offer best Mobile user interfaces design to the consumers. They also help to develop, run, and manage device software faster, better, at lower cost and more reliably. Moreover, they provide technical framework and training for systems integration, test, customization, and management. The current commercialization companies in the OHA are as follow:

Noser Engineering Inc. (www.noser.com/oha) is the core contributor of the Android Platform in the system integration and customization.

Wind River (www.windriver.com/oha) enables companies to develop, run, and manage device software faster, better, at lower cost and more reliably

Aplix Corporation (www.aplixcorp.com) enables mobile handset manufacturers to have a faster, lower development cost and lower risk route to deploy wireless Java solutions.

Borqs (www.borqs.com) provides operator-centric mobile handset operating system (OS) software products and mobile internet service platforms and solutions.

Teleca AB (www.teleca.com) is a global supplier of innovative software and solutions to mobile communications companies. Teleca has about 2,000 employees in Asia, Europe and North America.

TAT - The Astonishing Tribe AB (www.tat.se) is a specialist in mobile user interfaces, recognized for its design capabilities and for its software solutions that enable richer user experiences on any platform, to date embedded in more than 140 million devices.

2. Competition Landscape

2.1. Operating System

2.1.1. Proprietary Operating System

Symbian OS

In June 2008, The Symbian Foundation released the biggest evolutionary leap in Symbian OS since its creation, making the platform open source and planning to deliver the full open source in 2 years (June 2010). The foundation started its operating in the first half of 2009, subject to the closing of the acquisition of Symbian Ltd. by Nokia. This OS and some of its source code is currently available under a royalty-free license to the foundation members. For the past decade, Symbian has the largest share in the mobile OS worldwide. This matches the success of Nokia in the mobile handset market share worldwide. The current version is Symbian 9.0. The APIs are publicly documented and up to Symbian 8.1 anyone could develop software for Symbian OS.

Figure 33 Symbian OS Screenshot

Research In Motion (RIM)

RIM OS is the proprietary OS for the BlackBerry handsets. It is a proprietary OS since it is only available for only the BlackBerry handset. RIM OS mainly focuses with business related features, such as email exchange, calendar and contacts synchronization, and documents servers. However, to compete with other consumer-oriented handset like i-Phone, RIM released the Blackberry Storm in 2008.

Figure 34 RIM OS in BlackBerry Bold Screenshot

Windows Mobile OS

Windows Mobile OS is designed to be somewhat similar to the desktop versions of Windows so that synchronization between devices can be easily carried out. Devices that run Windows Mobile include Pocket PCs, Smartphone, Portable Media Centers, and on-board computers for certain automobiles. The current version of OS is the Windows Mobile 6, which was released on February 12, 2007 at the 3GSM World Congress 2007. It comes in three different versions: Standard, Professional, and Classic.

Figure 35 Windows Mobile 6 OS Screenshot

iPhone OS (Mac X OS)

The iPhone OS is a derivation of the Mac X OS, the Apple computer based OS. Similar to RIM OS, it is a proprietary OS only for the iPhone handset. This OS is the first OS who successfully provide the multi-gesture touch screen feature, which led to richer user experiences with mobile handset. In order to open for more innovations, Apple has release the iPhone SDK on March2008 for the developers to make various applications, as well as test them in an "iPhone simulator". However, loading an application onto the devices is only possible after paying an iPhone Developer Program fee.

Figure 36 iPhone OS Screenshoot

2.1.2. Linux-based OS

Similar to Linux-based OS for desktop, there are fragmentations in the Linux-based OS for mobile handsets. Some major platforms are Mobilinux, LiMo, Maemo, and Openmoko.

Mobilinux OS

Figure 37 Mobilinux OS Screenshot

Mobilinux was announced by MontaVista Software Company in 2005 as a commercial-grade Linux development platform for wireless handsets and other mobile devices such as GPS devices, portable medical devices, and wireless Point of Sales (POS) terminals. It is a proprietary development platform with the customizability and control of an open-source Linux environment. Unlike freely-available source code, Mobilinux is productized and tested by MontaVista's testing facilities. Mobilinux is based on open source and open

standard technology, designed for scalability and maximized battery power usage for single-chip mobile phones. The current version is the new Mobilinux 5.0. Mobilinux 5.0 is the new version of the operating system used in 90% of Linux-based smartphones. More than 35 million phones and other mobile devices run on Mobilinux.

Linux Mobile (LiMo) OS

LiMo OS is developed by LiMo Foundation, an industry consortium dedicated to create the open, hardware-independent, Linux-based operating system for mobile devices. The LiMo Foundation was founded in January 2007. The founder members of the LiMo Foundation are NEC, NTT DOCOMO, Orange, Panasonic, Samsung and Vodafone. The mission of the LiMo Foundation is to create an open, Linux-based software platform for use by the whole global industry to produce mobile devices through a balanced and transparent contribution process enabling a rich ecosystem of differentiated products, applications, and services from device manufacturers, operators, ISVs and integrators. There are currently about 40 types of handsets available, including some handsets by Motorola, Panasonic, NEC, and LG.

Figure 38 LiMo OS Screenshot

Maemo OS

Maemo OS is a Linux-based OS for mobile devices developed by Nokia in collaboration with many open source projects. Maemo OS is mostly based on open source code, thus it is not a fully open source. Currently it is used only by Nokia-based handsets. Maemo Community is a non-profit organization sponsored by Nokia, which has over 16.000 registered members that contribute to more than 700 development projects.

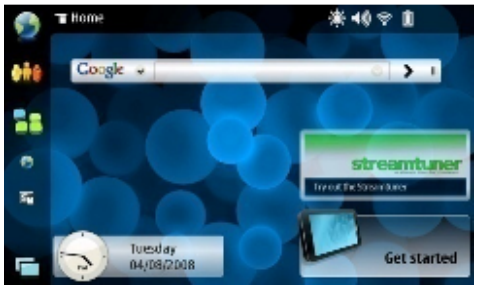


Figure 39: Maemo OS Screenshot

Openmoko Linux OS

Openmoko Linux OS is an open mobile product that empowers developers and consumers to personalize the devices in any way they see fit. Unlike most other mobile phone platforms, these OS are designed to provide end users with the ability to modify the OS and software stack. Almost everything involved in the creation of an Openmoko phone is open source, from the operating system to applications to reference designs. The most recent product is the Neo FreeRunner. This OS is funded by First International Computer, Inc. (FIC) is a Taiwanese computer and components manufacturer.

Figure 40 Openmoko Linux OS

2.2. Mobile Application and Application Stores

Mobile applications are viewed or used on mobile phones, like ringtones, graphics, discount offers, games, movies, and so forth. As mobile phone use has grown since the mid 1990s, the significance of the devices in everyday life has grown accordingly. Owners of mobile phones can now use their devices to make calendar appointments, send and receive text messages (SMS), listen to music, watch videos, shoot videos, redeem coupons for purchases, view Microsoft Word documents, and so forth. The use of mobile applications has grown accordingly.

Many mobile applications, such as SMS/MMS clients, browsers and music players, are pre-installed on mobile phones, whereas others may be provisioned and/or configured post-sales. For example, user can download applications over wireless network and then install them themselves, or they can have them loaded and installed in the mobile operator's store. Mobile applications are a large and continuously growing market and served by an increasing number of mobile

application developers, publishers and providers. The types of mobile applications could be categorized as following.

- Communications: E-mail clients, Mobile Web and Internet Browsers, News/Information Clients, On-Device Portals and Social Network Clients
- Games: This is the biggest and most sought after category by consumers.
- Multimedia: Graphics/Image Viewers and Video/Audio Players
- Productivity: Calendars/Calculators/Diary,Notepad/Memo/Word Processors, Spreadsheets, Banking/Finance, Address Book/Task Managers and Directory services

Mobile Application Stores (MAS) are a new solution market which promises the development of a new revenue stream for operators, handset OEMs and application developers. The success of Apple's App Store has been well documented; more than 5,000 new applications, $30 M revenue in the first 30 days of operation, 200 million downloads in the first 100 days. The facts point to a rediscovered revenue source that the mobile industry is eager to capture.

Since Apple opened its goldmine iPhone App Store, all eyes have been on the upstart mobile provider and its business model. Now that their success is beyond argument for e.g consumers have already downloaded 1 Billion apps by April 2009, every other major provider has either launched a similar application marketplace or announced plans to do so. Let's take a look at the status of the various mobile application stores:

Apple

The iPhone App Store is the original mobile phone application center on the block. With more applications on the iPhone App Store than anywhere else, Apple's application center is the one to beat.

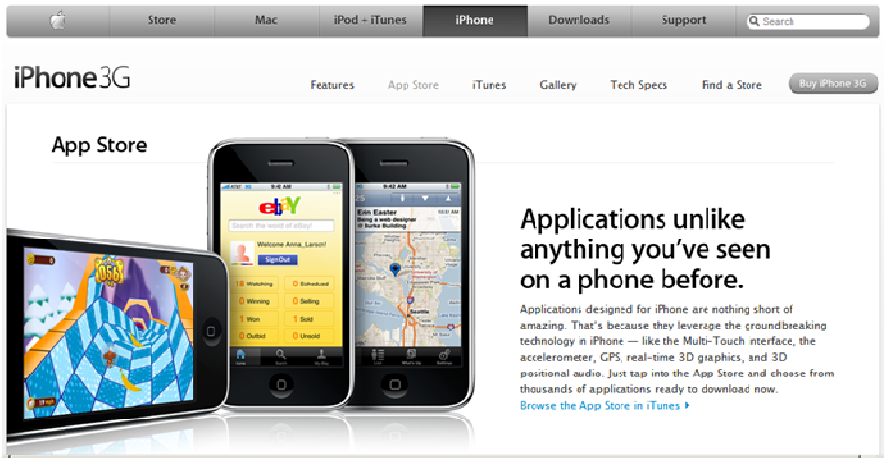


Figure 41 : Apple iPhone App store

Palm

Palm has announced the **Palm App Catalog**, an "on-device application catalog to deliver your apps directly to users" on the new Palm Pre operating system. The Palm Pre's app architecture is already winning praise with analysts for its Palm WebOS, which will run applications written in HTML5, CSS and Javascript - meaning developers won't have to reinvent the wheel to write Palm Pre apps.

BlackBerry

The **BlackBerry World App**, an on-device application catalog is now available through the BlackBerry Storm software version 4.7 and will differ from

the iPhone App Store in that different carriers will have separate marketplaces where they can offer their own, carrier-specific applications.

Figure 42 BlackBerry App World

Google Android Market

The **Android Market** is open for business, and looks to be the most serious of the iPhone competitors. Although it doesn't (yet) have as many applications available as the iPhone store, Google, as always, has their sights set high.

Figure 43 Android Market

Symbian App Store

Both **Nokia** and **Samsung** are developing Symbian app stores. Samsung's is called **Samsung Mobile Applications**, while Nokia's is called the **Ovi Store** and is slated for release in June on the Nokia N97.

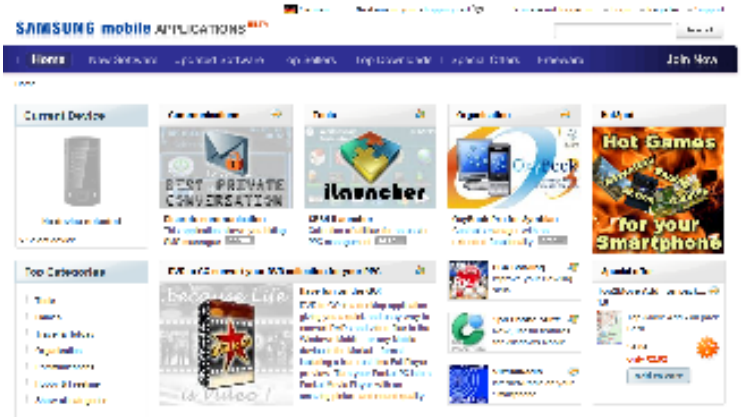


Figure 44: Samsung mobile applications store

Figure 45 : Nokia's Ovi mobile applications store

Microsoft

Microsoft's **SkyMarket** is set to launch with Windows Mobile 7. SkyMarket could turn out to be the IPhone App Store's biggest competitor,

considering that Windows Mobile already sports more than 18,000 applications. Currently, Windows Mobile Catalog provides options to buy mobile applications using Handango or Pocketland.

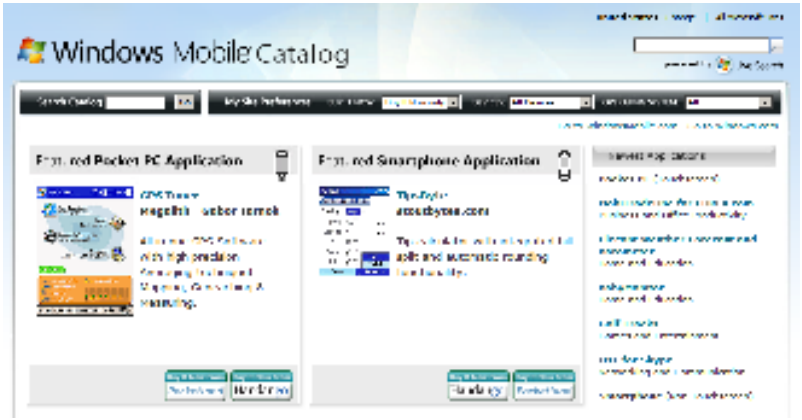


Figure 46 Windows Mobile Catalog

Besides these vendors there are other communities such as -

GetJar

GetJar is application distribution and developer community, with over 200,000 developer and beta-tester accounts founded in 2004. GetJar connects mobile consumers, developers, publishers, and advertisers in an interactive environment, and gives users a unique and active role in product development.

Handango

It is one of the first application retailers founded in 1999 that sells mobile software with over 140,000 applications (including variants) in its online stores and over 100 million applications downloaded to date.

BIBLIOGRAPHY

Andrefski, Jodie (February 17, 2009), Gadget Tell: *Vodafone and HTC make Magic together*. Retrieved on July 09, 2009 from http://www.gadgetell.com/tech/comment/vodafone-and-HTC-make-magic-together/

Android an Open Platform for Mobile Devices. Retrieve on May 01, 2009 from http://www.slideshare.net/ftbalagt/android-an-open-platform-for-mobile-devices

Android Developers: Security and Permissions. Retrieved on June 22, 2009 from http://developer.android.com/guide/topics/security/security.html

Android Market Place Rankings. Retrieved on July 02, 2009 from http://www.androidstats.com/home/categories

Android Open Source Project. Retrieved on February 18, 2009, from http://source.android.com/license

Apple Website Frontpage. (December 05, 2008). Retrieved on June 29, 2009 from www.apple.com

Asay, Matt (December 22, 2008), CNET News: *In Google we trust?* Retrieved on July 10,2009 from http://news.cnet.com/8301-13505_3-10127876-16.html

Babriel, Carolone (April, 15, 2009) *Japan takes Android beyond Phones: Nokia may respond with Maemo*. Retrieve on May 01, 2009 from http://www.rethink-wireless.com/?article_id=1264

BBC Online: *Google Ad Revenue to surpass TV*. Retrieve on April 19, 2009, from http://news.bbc.co.uk/2/hi/business/6108678.stm

Blackberry: Advanced Security Features for Government. Retrieved on June 15, 2009 from http://na.blackberry.com/eng/ataglance/security/government.jsp 1.

Blogulate. (July 3, 2007). *The Sources of All its Riches*. Retrieve on April 15, 2009 from http://blogulate.com/content/the-source-of-all-its-riches/

Brown, Eric (November 19, 2008), *MontaVista touts Android readiness.* Retrieved on June 03, 2009 from http://www.linuxdevices.com/news/NS3442336407.html

Browne, Jonathan, August 2008, Forrester Research: *Japan's Mobile Social Networks Need Some Usability Tweaks*

Business Week. (August 17, 2005). *Google Buys Android for its Mobile Arsenal*. Retrieve on April 19, 2009, from http://www.businessweek.com/technology /content/aug2005/tc20050817_0949_tc024.htm

Business Week Integrated Solution: *RIM Blackberry Case Study*. Retrieved on July 10, 2009 from http://mediakit.businessweek.com/pdf/researchservices/BlkBryCaseStudy.pdf

Canadian Internet Policy and Public Interest Clinic. *About Open Source*. Retrieved on June 15, 2009 from http://www.cippic.ca/open-source

Check Market Online Surveys: *Burn the Brand.* Retrieve on April 15, 2009 from http://www.checkmarket.com/fe/support/articles/brand-survey/

Constantinou, Andreas (November 14, 2008), *The Mobile Application Store Phenomenon*. Retrieved on June 29, 2009 from http://www.visionmobile.com/blog/2008/11/the-mobile-application-store-phenomenon/

Drego, Vidya. L, July 2008, Forrester Research: *Usability and Cost Slow Mobile Internet Adoption*

Eddy, Nathan (February 16, 2009), *MWC: Nokia Announces 'Smart Store' Ovi*. Retrieved on July 02, 2009 from http://www.eweek.com/c/a/Mobile-and-Wireless/MWC-Nokia-Announces-Smart-Store-Ovi/

Eddy, Nathan (March 18, 2009), *Nokia Looks to Challenge Apple App Store*. Retrieved on July 02, 2009 from http://www.eweek.com/c/a/Mobile-and-Wireless/Nokia-Looks-to-Challenge-Apple-App-Store/

Encyclopedia Britannica: *Searching for Business, Google-Inc*. Retrieved on February 18, 2009, from http://www.britannica.com/EBchecked/topic/1017491/Google-Inc

Explain.(May 20, 2008). *Driving Innovation on new Platform: Android and Open Handest Alliance*. Retrieve on April 20, 2009 from http://www.exxplain.com/TrainingDetails.aspx?Ticket=de5d0d74-0f06-4a4f-be8e-ec31f80ff968

Gabreil, Caroline (July 10, 2009), *Symbian releases first fully open package.* Retrieve on May 08, 2009 from http://www.rethink-wireless.com/?article_id=1662

Get Jar Website, *Get Jar Software*. Retrieved on June 29, 2009 from http://www.getjar.com/software

Gilbert, Sarah (May 25, 2007), Blogging Stocks: *iPhone launch date: Everything we know about when the iPhone will be available*. Retrieved on July 09, 2009 from_http://www.bloggingstocks.com/2007/05/25/iphone-launch-date-everything-we-know-about-when-the-iphone-wil/

Gohring, Nancy (November 16, 2007), *Google and Sun May Butt Heads Over Android.* Retrieve from http://www.itworld.com/071116googlesun

Google. *Digital Millenniun Copyright Act-Android*. Retrieve on June 15, 2009 from http://www.google.com/android_dmca.html

Herrman, John (June 22, 2009), Gizmondo: *Is This Motorola's First Android Phone?* Retrieved on July 09, 2009 from http://gizmodo.com/5299453/is-this-motorolas-first-android-phone

Hiner, Jason (June 1, 2009), *Five reasons why the Palm Pre will be a homerun*. Retrieved on July 10, 2009 from http://blogs.techrepublic.com.com/hiner/?p=1706&tag=nl.e101

Intel News Release : *Intel and Nokia Announce Strategic Relationship to shape Next Era of Mobile Computing Innovation*. Retrieved on June 10, 2009 from http://www.intel.com/pressroom/archive/releases/20090623corp_b.htm?iid=pr1_releasepri_20090623rb

June, Laura (May 10, 2009) Engadget Mobile: *Samsung's i7500 Android phone shows up in another, more epic hands-on video*. Retrieved on July 09, 2009 from http://www.engadget.com/2009/05/10/samsungs-i7500-android-phone-shows-up-in-another-more-epic-han/

Kharif, Olga(June 22, 2009), *T-Mobile's New my Touch 3G.* Retrieved on May 21, 2009 from http://www.businessweek.com/technology/content/jun2009/tc20090621_705265.htm?chan=top+news_top+news+index+-+temp_news+%2B+analysis

Kumparak, Greg (May 14, 2008), *Android vs. LIMO: What's the difference.* Retrieve on May 08 2009 from http://www.mobilecrunch.com/2008/05/14/android-vs-limo-whats-the-difference

Lee, Jean K (July 28, 2008), *Willcom D4 UMPC early impressions*. Retrieved on July 10, 2009 from http://www.pocketables.net/2008/07/willcom-d4-umpc.html

Lee, Jean K (August 12, 2008), Review: *Willcom D4 (Sharp WS016SH)*. Retrieved at July 10, 2009 from http://www.pocketables.net/2008/08/review-willcom.html

LinuxDevices, *Monta Vista touts Android Readiness*. Retrieved on June 29, 2009 from http://www.linuxdevices.com/news/NS3442336407.html

Malik, Om (April 9, 2008), *LTE Jumps Ahead in the Race to 4G*. Retrieved on July 10, 2009 from http://gigaom.com/2008/04/09/lte-jumps-ahead-in-the-race-to-4g/

Market Share by Net Applications, *iPhone vs. Android Browsing Share*. Retrieved on July 09, 2009 from http://marketshare.hitslink.com/mobile-phones.aspx?qprid=62&sample=33

McGlaun, Shane (June 23, 2009), PhoneMag: *Verizon and T-Mobile plan to launch Motorola Android phone*. Retrieved on July 10, 2009 from http://www.phonemag.com/verizon-and-t-mobile-plan-to-launch-motorola-android-phone-069242.php

McLean, Prince (October 01, 2007), Apple Insider : *Nokia launches anti-iPhone campaign amid controversy*. Retrieved on July 10, 2009 from http://www.appleinsider.com/articles/07/10/01/nokia_launches_anti_iphone_campaign_amid_controversy.html

Millward Brown Optimor. *100 Most Valuable Global Brands 2009: Mobile Operators*. Retrieved on February 18, 2009, from http://www.millwardbrown.com/Sites/Optimor/Media/Pdfs/en/BrandZ/BrandZ-2009-Report.pdf

Mobile Browser Market Share. Retrieve on April 15, 2009, from http://marketshare.hitslink.com/mobile-phone.aspx

Moris, Simon (December 2004), *Feature Phones Will Continue To Dominate Smart Phones*. Retrieved on July 10, 2009 from http://www.wsdmag.com/Articles/ArticleID/9426/9426.html

MsCracken, Harry (May 06, 2009). *Smartphone OS smackdown: WebOs vs. the world.* Retrieved on June 29, 2009 from http://www.pcworld.idg.com.au/article/306505/smartphone_os_smackdown_webos_vs_world?pp=4&fp=2&fpid=2

Musil, Stevev (April 26, 2009) Report: *First Android Netbook to cost $ 250*. Retrieve on May 01, 2009, from http://news.cnet.com/8301-17938_105-10227770-1.html

Mobilinux article, *New MontaVista Moblinux 5.0: The World's Most Advance Mobile Operating System*. Retrieve on May 15, 2009 from http://www.mobilinux.com/product_detail_mob.php

Open Handset Alliance. Retrieve on April 20, 2009 from http://www.openhandsetalliance.com/press_releases.html

OpenMokoWiki: *Android*. Retrieved on June 15, 2009 from http://wiki.openmoko.org/wiki/Android

Qualcomm Press Release (May 18, 2009), *App Store Pioneer to Take Mobile Retailing to Any Device on Any Network with Plaza Retail*. Retrieved on June 29, 2009 from http://www.qualcomm.com/news/releases/2009/090518_App_Store_Pioneer_to_Take_Mobile.html

Ricker, Thomas (June 30, 2009), Engadget Mobile: *SciPhone Dream G2 Android charger is best ever*. Retrieved on July 09, 2009 from http://www.engadgetmobile.com/tag/G2/

Shankland, Stephen (November 12, 2007). *Google's Android parts ways with JAVA industry group*. Retrieved on June 15, 2009 from http://news.cnet.com/8301-13580_3-9815495-39.html

Siegler, MG (June 11, 2008), *Analyst: There's a great future in iPhone ap*ps. Retrieved on June 29, 2009 from http://digital.venturebeatcom/2008/06/11/analyst-theres-a-great-future-in-iphone-apps/

Segan, Sascha (March 02, 2007) PCMag review: *Blackberry 8800*. Retrieved on July 10, 2009 from http://www.pcmag.com/article2/0,2817,2093340,00.asp

Segan, Sascha (June 22, 2007) PCMag: *The Anti-iPhones*. Retrieved on July 10, 2009 from http://www.pcmag.com/article2/0,2817,2113514,00.asp

StrategyAnalytics, *Android Smartphone Shipments to Grow 900 Percent in 2009*. Retrieved on June 22, 2009 from http://www.strategyanalytics.com/default.aspx?mod=PressReleaseViewer&a0=4728

Symbian's CEO Richard Clifford dismissed Android as just another Linux platform (November 13, 2007). Retrieved on July 10, 2009 from http://www.symbian-freak.com/news/007/11/android_just_another_linux_platform.htm

Symbian Website: *About the Symbian Foundation*. Retrieved on July 10, 2009 from http://www.symbian.org/about/index.php

Times Online. (October 30, 2007). *Google Shows ITV a Vision of the Future*. Retrieve on April 16, 2009 from

http://business.timesonline.co.uk/tol/business/industry_sectors/media/article2767087.ece

Tindal, Suzanne (November 6, 2008), *Ballmer dismisses Google Android*. Retrieved at July 10, 2009 from http://news.cnet.com/8301-1035_3-10083590-94.html

Turner, David (June 25, 2009), *Introducing Android 1.5 NDK, Release 1*. Retrieve on May 05, 2009 from http://android-developers.blogspot.com/2009/06/introducing-android-15-ndk-release-1.html

UMPC Portal Review: *Sharp Willcom D4 WS016SH*. Retrieved on July 10, 2009 from http://www.umpcportal.com/products/Sharp/Willcom%20D4/WS016SH

Weintraub, Seth H (May 8, 2009), *Google's Eric Schmidt doesn't see board conflict with Apple?* Retrieved on July 10, 2009 from http://blogs.computerworld.com/googles_eric_schmidt_see_board_conflict_with_apple

Wikipedia: *3GPP Long Term Evolution*. Retrieved on July 10, 2009 from http://en.wikipedia.org/wiki/Long_Term_Evolution

Wikipedia: *Nokia N95*. Retrieved on July 10, 2009 from http://en.wikipedia.org/wiki/Nokia_N95

Wikipedia: *Open Handset Alliance*. Retrieve on February 18, 2009 from http://en.wikipedia.org/wiki/Open_Handset_Alliance