OPERATING SYSTEMS FOR MOBILE COMPUTING*

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ABSTRACT

The need for specialized operating systems to host mobile computers and provide application development opportunities has risen due to the proliferation of cell phone users. Because phones have become such pervasive and affordable mobile computers, developers and users need a development environment that allows more of its users to create unique and specialized applications that are affordable. This paper provides a comparison of Android, the Symbian Operating System and Apple's Mac Operating System that identifies the role of an operating system in forwarding a successful mobile technology. It also demonstrates the need for operating systems that are open-sourced and that provide an easier way to develop applications.

1. HISTORY OF MOBILE COMPUTING

In the early days of mobile computing, the mid 1990s, a few companies attempted to build and market personal data assistants (PDAs). Even though PDAs are not considered mobile computers, they were in fact, the predecessors to today's smartphones. This is evident by the fact that PDA and phone manufactures have merged into a single market. The early models, like the Palm 1000, and Palm 5000 had very limited functionality. They typically had less than one megabyte of memory, a green screen and very simple applications like a contact database, calendar, note pad, tracking expenses, etc. All had the ability to link to a computer via a serial port [12]. With this link, contacts and calendars could be synchronized.

Around the same time, the cell phone market was building. While cell phones had become fairly common in the late 1980s, most were very simple and were used for

placing calls only. In the early 1990s when cell phone manufacturers began including CPUs, memory, and LCD screens, phones shifted from pure phone to mobile computing device. The first obvious addition was a way to store and access contacts. To do that, manufacturers had to provide some method of writing applications for the small devices and an operating system to run on.

Offering better, more complex applications on phones was a key differentiator for the cell phone market, and applications began to drive the upgrade market. One key application above all others, spawned a new revolution, text messaging.

Around the turn of the century, a gadget convergence movement began. Cell phone manufacturers merged different hardware devices into the cell phone in a race to encourage their customers into upgrading. Today, most cell phones cannot only make phone calls, but can also take pictures, play music, surf the Internet, play video games, and provide driving directions through a GPS receiver. This technology convergence has many people referring to cell phones as mobile devices. In fact, the phones are mobile computers that can place a phone call.

2. THE PRESENT

In 1999, Research In Motion (RIM) introduced the Blackberry which started as a simple two-way pager, but quickly became one of the most widespread of mobile computing devices [3]. As the Blackberry was being introduced to the world, businesses were more concerned with staying in contact with an increasingly mobile workforce. The Blackberry's ability to send and receive email solved some very important problems. The device became so widely adopted, that PC magazine ranked it the 14th most important gadget invented in the past 50 years [17]. The Blackberry stood out from other cell phone devices because of its keyboard. Typing an entire email using a cell phone's standard 12 keys is very difficult for most people (2=ABC, 3=DEF, etc). The Blackberry on the other hand, provided a mini QWERTY keyboard. The market obviously responded, because as of April 2008, the Blackberry boasted over 17% of the worldwide smart- phone market [15]. There is no doubt that the Blackberry helped bridge the gap between gadget-filled cell phones and a true mobile device.

Around the same time the Blackberry was gaining traction, Microsoft released its first operating system targeted at the mobile device market, Pocket PC 2000. This represented the first major push by a software company into the mobile space. Microsoft recognized early that the smartphone may one day rival the laptop as the preferred mobile computing device.

The integration of many disparate hardware devices drove manufacturers to invest more into the cell phone's operating system. Because manufacturers offer many different phones to several different providers, they needed a common operating system. The hardware manufacturers Nokia, Ericsson, Panasonic, and Samsung agreed to collaborate on a single operating system to run their devices, thus the Symbian Operating System was born.

Because of so much collaboration between hardware manufactures, Symbian took a dominant hold on the smartphone industry with a 65% global market share [13]. While Symbian had a vision of a single, collaborative effort, in reality, fragmentation occurred.

In one version alone, four different interfaces evolved: Crystal, Sapphire, Perl and Quartz. Not surprisingly, the different interfaces were targeted at specific hardware devices and companies. Even with all the difficulties involved around hardware providers, all trying to exert control over the direction of the operating system, Symbian accumulated an impressive 100 million subscribers [16]. For many years, Symbian was the leader in the smartphone OS market, even though it provided a notoriously difficult environment in which to develop applications. In June of 2008, Ericson, Sony, Panasonic and Samsung pulled out of the company, selling their interest to Nokia. The focus from the industry was on new and innovative applications.

In January of 2007, Apple unveiled the iPhone at the MacWorld expo in San Francisco. It was the first time a hardware manufacturer was able to dictate the terms of use to a cellular provider, and not the other way around. AT&T landed the lucrative contract and began to sign iPhone users to 2 year contracts. The iPhone was the first smartphone that had mass appeal to the general community. For years, RIM and Symbian controlled the market by primarily marketing to the business community as a productive tool. The iPhone had mass appeal as not only an innovative device, but also a status symbol. It provided a slick touch screen interface that adjusted based on the orientation of the device, replaced the iPod, and offered a convenient mobile gaming platform. Since its unveiling, the iPhone has continued to eat away at Symbian and RIM's market share. In the U.S., the iPhone surpassed Symbian with a significant market share to take the number two spot behind RIM [13].

3. THE FUTURE

In August of 2005, the technology and gadget community was buzzing about Google's acquisition of a company called Android. The Android Company specialized in developing software for mobile devices and was rumored to be building an operating system based on Linux [5]. In late 2006, Google confirmed that they wanted their search technology to have a significant presence in the mobile space [1]. Most people assumed that meant Google was developing a branded smartphone. In reality, their vision extended even farther than that.

Google noticed an interesting trend in their search metrics. The percentage of searches made by mobile devices was on the rise. Just between May and June of 2007, mobile searching traffic increased by 35% [2]. Even though mobile searching only accounts for a fraction of Google's overall volume, it is not hard to speculate what the search industry will resemble in 10 years. By 2012 alone, the market is expected to grow from 35 million annually, to 1.5 billion [6]. That is a market that is growing more than 150% every year.

Prior to Android, Google had very few options for directing mobile users through their site. Many people wanted to use Google but closed, controlled mobile systems did not facilitate easy searching. Verizon Wireless, for example, directs their customers to their own search engine [13], as there is no reason for Verizon to direct them to Google and miss out on the added revenue. To tackle this issue, Google formed a conglomerate of mobile companies called The Open Handset Alliance [11]. The alliance agreed to work together to turn the Android platform into a world-class operating system that was free

to any manufacturer, was based on an open-sourced model, and allowed any application developer to write applications. With a completely open, free platform, handset manufacturers are not burdened with massive software development, and can focus on hardware. Google is able to embed its own search site into the operating system, very similar to the way Internet Explorer is imbedded into Windows. By giving away the operating system for free and focusing revenue on search advertising, Google is able to undercut Microsoft, who still charges $8 to $15 per mobile device [18]. In June 2008, Symbian owner Nokia announced it would also provide its operating system royalty free [16]. One can only assume it is a move to directly compete with Android.

3.1 Difficulties for current users

To understand the success of Android, it is important to understand the difficulties current smartphone customers are having. Most users of mobile devices report dissatisfaction related to the following areas: difficult interface, typing on a small device, network speed, mobile based web browsing, and a lack of applications.

- Difficult Interface: The Android framework allows hardware manufacturers to build user friendly interfaces. As cell phones transformed into smartphones and mobile devices, manufacturers added touch-screens to their devices. The Android operating system was built to take advantage of touch screens.
- Typing on a small device: Since Android is an operating system only, the keyboard provided is based on hardware manufacturers. The very first Android phone, the G1, has a slide-out QWERTY keyboard. The Blackberry proved that QWERTY keyboards were the preferred method. Android has the ability to use a standard phone based keyboard or a touch-screen keyboard.
- Network speed: All existing proposed Android devices will be based on 3G networks. 3G is much faster than the existing network schemas, however it is not quite broadband speed as most users expect. The average download speed from T-Mobile is 1mbit per second. While it is a step in the right direction, consumer's expectations have increased.
- Mobile Web Surfing: Mobile device users want to be able to browse real web pages, not simplified mobile versions. If a device solves the first three issues on this list, real web browsing suddenly becomes possible. Most mobile devices today provide Internet browsing. Website operators build alternate sites just for small screens with limited interfaces. Android provides a built-in full web browser capable of rendering real web pages, not just the small mobile versions.
- Lack of applications: Android is a true open operating system. Users can develop a Java-based application and deploy it on an Android device. This feature has the ability to set Android apart from any other device. Its closest competition is the iPhone. Even with the iPhone, an application must be approved by Apple before it can be offered to its users.

3.2 Android and the iPhone

Android is not the only smartphone that has the potential to solve major causes of dissatisfaction that users have with their phones. According to Pip Coburn, a global technology strategist, "People change habits when the pain of their current situation exceeds their perceived pain of adopting a possible solution." [4] If what he says is true, the technology adoption rate for mobile computing should be phenomenal.

The features described above can be applied to any number of new devices. What makes Android so special? Android has the potential to be a pivotal in the mobile space because of application development. The newest technology, slickest interface and quickest network in the world will not make up for a lack of good applications.

With the assumption that the technology that provides more choices (i.e. more applications) will ultimately be a market leader, then we must compare Android to its largest competitor, the iPhone. Which technology will have more support from the development community? Which technology will offer innovative applications? The areas to compare with respect to developer support are: market base, ease of use, support, and technology.

As a leader in the field, the iPhone clearly has the advantage in the market base. As of June 2008, Apple sold over 9 million iPhones. In comparison, T-mobile expected to sell about 600,000 G1phones by the end of 2008 [7]. Thus, the G1 should be in a good position to compete. If a company is building an application for profit, it makes sense to build it for a large market. The Android operating system can run on many different devices, not just the G1. Users have already installed Android on devices that were built before Android was released. Motorola, for example, has plans to split its devices between Android and Windows Mobile [10]. Currently, there are tens of millions of Motorola devices in use. Ericson, HTC, Samsung and many other hardware manufacturers have plans to release Android devices. Millions of iPhones could be overtaken by an Android platform that is not hardware specific. The critical point is that an application written for the iPhone will work on only one device, the iPhone. An application written for Android has the ability to be deployed on hundreds.

3.3 Ease of development using Android

One of the biggest advantages that Android has over the iPhone is the ease of development. Apple is pushing a closed, proprietary environment, thus none of the inner workings of the iPhone are as exposed for developers [9]. The following list shows a few key areas that make a technology easy for development: enablement, the underlying OS, development tools, and training.

- Enablement: Before developing on any platform, there must be tools. In this case, that is the software development kit (SDK). In order to download the iPhone SDK, one must first register as an Apple Developer Connection Subscriber [8]. Only after agreeing to a strict license agreement can the free SDK be downloaded. Since the SDK runs only on Mac OS, this is a huge determent for iPhone developers. As of August, 2008, Mac OS represented only 8% of the PC market share [14], eliminating 92% of potential developers. Google on the other hand, released

Android's SDK for free in an environment that will run on any PC (Mac or Windows-based).

- The OS: Android is based on an open-sourced Linux operating system. The iPhone is based on Mac OS. Mac OS is a closed, proprietary system owned and controlled by Apple. Linux, on the other hand, is an open-sourced platform that anyone can extend. Thus, an open, free system will normally win against a proprietary, closed one.
- Development Tools: Few developers have experience with iPhone's development language and environment. Android applications, on the other hand, are written exclusively in Java. In addition, Google published an Android plug-in for the Eclipse environment. With millions of Java developers in the world today, this means that there is already a large body of developers who are using the language and the environment needed to create Android applications.
- Training: This is one area where the iPhone beats Android. Google only released the typical online manual for software development. Apple, on the other hand, took it one step further and published a series of recorded training sessions. There is a catch; one can only download the free training sessions through iTunes.

For the average developer to build an application for the iPhone, they would need to 1) buy a fairly recent Macintosh running Mac OS 10x or later, 2) sign up for Apple's developer network, 3) learn a new development language, and 4) learn to develop in a new proprietary environment. If you compare that to Android, the average developer 1) already has a PC that can build Android applications, likely already knows the Java language, and 2) has a 50/50 chance of using the most common development environment, Eclipse.

4. CONCLUSION

Cellular providers continue to promote smartphones as the pinnacle of productive mobile devices. They provide us with a continuously connected device that lets us send and receive email, listen to music, watch videos, play games, surf the Internet, and receive location aware services like turn by turn directions and customizable maps. All of these technologies have come together to transform the smartphone into a truly mobile computer.

Engineers are rapidly working to merge the technologies and bring them to market. One device has the potential to actually make this a reality, the smartphone. Of the smartphone operating systems available, Android is uniquely positioned to be the enabling technology that allows hardware manufacturers, engineers, development companies, and innovative individuals to work together to produce something truly amazing.

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