

Android Operating Systems Perform the Best in Dynamic Mobile Computing Environments

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Abstract—To meet society’s needs over the years, operating systems have had to become increasingly dynamic. Mobile computing is an example of a situation where an operating system must always be flexible, dynamic and changing. In general, mobile computing refers to any mobile operating system which can also be connected to a computer via a port. However, for the purposes of this paper we will focus on mobile computing in terms of cellular phone devices, or smartphones. Smartphones today are both a computer and a telephone mixed into one. In the sections below, we will introduce the concept and history of mobile computing, before getting into the details of operating system performance related to mobile computing. There an in depth survey of available mobile operating systems is done. Lastly, the information found is summarized in tabular form, and then used to make a conclusion of the operating system that performs best during mobile computing for cellular devices.

I. INTRODUCTION

In modern day society and during recent history, mobile phones have become increasingly common. As a result, operating systems have had to adapt to perform in mobile computing environments while they have become more prevalent. For reference, by the end of the year 2010, more smartphones than computers were being sold worldwide. [1] A mobile computing environment differs from a typical environment because it has to be a dynamic or changing environment. No longer does the operating system just work in conditions where everything stays in the same place, it must be able to work wherever and whenever the mobile phone user needs. Considering this, when adapting or creating new operating systems for mobile computing, there must be multiple different ways in which the operating system is affected. Furthermore, the competition between companies to create and implement the mobile operating system with the best performance has always been very high. This has made it so that today there are multiple options for a consumer to choose from when purchasing a new mobile phone. This raises the question of, which OS has the best performance in terms of mobile computing, and, which mobile phone should consumers be buying solely based on the OS performance? These questions will be examined and answered in the following research related to operating system performance for mobile computing.

A. History of Mobile Computing

To fully understand modern mobile computing performance the past iterations that have resulted in today’s technology must be reviewed quickly. In the beginning (early 1990’s), mobile computing didn’t quite yet exist and there was a difference between cellular phones and personal data assistants(PDAs). [2]. In fact, the first cellular phone ever was highly expensive and released to the public in 1983; the Motorola DynaTAC.

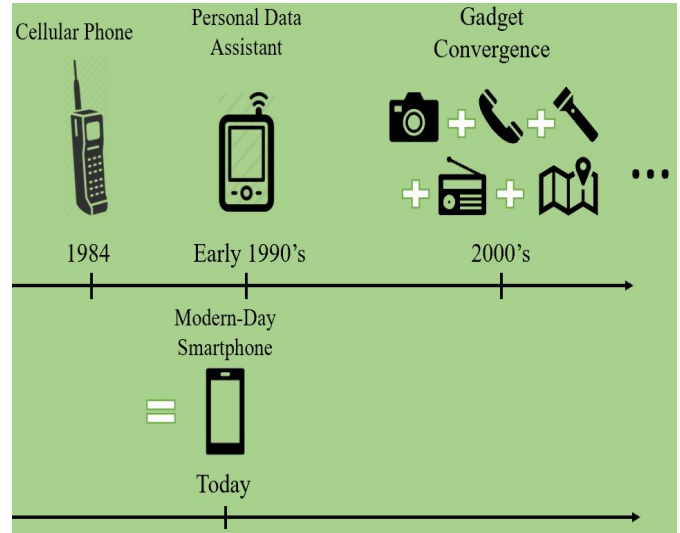


Fig. 1. History of Mobile Devices

[3] PDA’s were devices that could connect to your computer and also work remotely storing simple applications such as calendar and contacts. Convergence of the PDA technology and cellular phones happened around the early 1990’s resulting in the first mobile computing devices, and then large-scale gadget convergence occurred around the 2000’s resulting in more mobile computing devices with more functionalities. [2] This large-scale digital gadget convergence refers to the convergence of multiple hardware devices with cellular phones. Today, almost everyone has their own smartphone that takes pictures, sends text messages, runs applications, has GPS services, downloads music, searches the internet and much more. This would not of been possible without the "gadget convergence" merging together for example, a cell phone and a camera. Above, the timeline of the beginning of mobile computing and digital convergence is shown in 1.

II. DETAILS

In terms of mobile computing, operating systems are affected by changing working environments. As we know, nowadays, technology is dynamic and diverse. Different operating systems have different performance levels to accelerate their work, and new operating systems must interact with multiple devices and have cross-platform functionality. Similarly to in computers, the operating system in a mobile phone serves as an interpreter between the human user and the system working inside the machine. Furthermore, the future of operating systems are systems that are more than just a single unit. Instead, they must sustain a whole ecosystem. The online

service Amazon has a great example in Alexa, a custom-based operating system, which began as a simple speaker and was adapted to become an intelligent, interactive speaker. The operating system is a part of virtualization technology and a type of server virtualization. As market demand increases and the requirement of cross-functionality for various hardware is necessary, operating systems must be changed. Consider the Apple watch or a smart wallet for paying bills and interacting through an app. For these systems to work, they are required to have a particular type of operating system that allows the devices to perform dynamically. As per market demand and concern for working environment flexibility, the operating system has diverse changes it must deal with compared to in the past.

Now, everywhere starting from the restaurant, automobile shop, or any other marketing vendor, uses Tab or mobile phone for their daily services or business. Also, they maintain inventory and stocks throughout the mobile device. Where windows are not compatible to all tabs and various applications, the operating system is not user-friendly. Google's Android mobile operating system is an open and free software stack that includes an operating system, middleware, and main applications for mobile devices such as smartphones. Updates for the open-source Android smartphone operating system have been developed with "dessert-inspired" update names (Cupcake, Donut, Eclair, Gingerbread, Honeycomb, and Ice Cream Sandwich), with each new version coming in alphabetical order with new updates and upgrades. Bada is a Samsung smartphone operating system that was first released in 2010. The Samsung Wave was the first smartphone to run this mobile operating system. Bada offers smartphone applications including multipoint touch, 3D graphics, and, of course, device downloads and installation. [4]

The BlackBerry OS is a proprietary smartphone operating system produced by Research In Motion for its popular BlackBerry handheld smartphones. When combined with the BlackBerry Enterprise Server, the BlackBerry platform is shared among corporate users. It allows compatibility with Microsoft Exchange, Lotus Domino, Novell GroupWise email, and other business applications. [4]

The iPhone OS was initially designed for use on Apple's iPhone smartphones. The smartphone operating system is also known as iOS, and it is powered by a variety of Apple devices such as the iPhone, iPad, iPad 2, and iPod Touch. Since Apple does not licence the iOS smartphone operating system for third-party hardware, it is only available on Apple's own manufactured computers. Apple iOS is based on the Mac OS X operating system.

The Palm OS is a proprietary mobile operating system (PDA operating system) that debuted in 1996 on the Pilot 1000 handheld computer. Support for expansion ports, new processors, removable memory cards, enhanced protection, and support for ARM processors and smartphones have all been included in later versions of the Palm OS. Palm OS 5 was renamed Garnet OS after it was expanded to accommodate a wide variety of screen resolutions, cellular connectivity, and upgraded multimedia capabilities. [4] Symbian is a mobile operating system designed for mobile phones that integrates

connectivity and personal information management (PIM) features. Symbian OS incorporates middleware and wireless communications with an integrated mailbox and Java and PIM capabilities. Nokia has made the Symbian framework accessible in an additional, open, and direct model to partner with some OEMs and a small group of platform development collaborators. Nokia no longer supports Symbian as an open-source programming project.

WebOS is a mobile operating system that uses the Linux kernel as its foundation. Palm initially created WebOS as the successor to its Palm OS mobile operating system. It is a proprietary Mobile OS that was ultimately acquired by HP and is currently referred to in HP literature as webOS. HP uses WebOS in a variety of applications, including some smartphones and HP TouchPads. With the introduction of webOS 3.x, HP has moved the webOS into the enterprise smartphone market by focusing on enhancing security capabilities and management. HP has also announced plans to update a version of webOS inside the Microsoft Windows operating system on both HP desktop and notebook computers in 2012. [4]

Microsoft's mobile operating system, Windows Mobile, is found in laptops and mobile computers without touch screens. The Windows CE 5.2 kernel serves as the foundation for the Mobile OS. Microsoft unveiled a new mobile interface dubbed Windows Phone 7 in 2010. [4]

On the other hand, Android OS is way more flexible to use and more compatible. WEB-OS also supports various devices to use websites. Android OS is more prevalent in the current world because it is an open-source operating system, and it means to build for all android devices. In the development of the android journey, many individuals have contributed, and the developer got the opportunity to make it more functional as peruse. Though Apple devices are more prevalent in Northern America for personal uses, the IOS operating system is a locked source system. It's not compatible with non-apple devices, making it more costly as Apple is the sole developer of their product. In terms of corporate uses, where users need to use a mobile device, their preference is always Android.

Smartphones can run a complete operating system and provide a standardised interface and platform for app developers. The operating system must be able to support things like email and the internet. We tend to take these things for granted on the phone these days, but smartphones today had more processing power than desktop computers ten years ago.

Symbian Operating System was one of the most popular OP. The demand for uses gets changed, and people need more flexible devices and portable devices with more functionality. In some divisions, smartphones and devices took a Desktop and laptop because using a phone for essential functional work is more convenient.

The UBports group developed a smartphone version of the Ubuntu operating system called Ubuntu Touch Phone. Its user interface is written in Qt and is mainly meant for touchscreen mobile devices such as smartphones and tablet computers. The initial aim of convergence was to introduce Ubuntu Touch to notebooks, desktops, IoT devices, TVs, and smartwatches for a completely seamless user experience.

Types of OS	Memory Storage availability and Performance Speed	Privacy of synchronization	Multi-user	Cost for development & License	Market Share	OS family & Programmed in	Contact groups	Multitasking
ANDROID	Not capable of large num of app loading, memory uses high, storage of memory may kill another process.	3rd party software like ownCloud	4.2+, including phones 5+	Free and open-source,	71.90%	Modified Linux kernel-based & C, C++, Java, Kotlin	4+ Or 3rd party software	Yes
BLACKBERRY OS	Not capable of large num of app loading, memory uses high.	BlackBerry Access Third-Party Software		Closed source	N/A	C++	N/A	Yes
iPhone OS / IOS	Not capable of large num of app loading, memory uses low, freeze background process	When synchronizing locally and not using iCloud	9.3+: Education use only on iPad	No -Requires Apple hardware & Proprietary	27.33%	Darwin & C, C++, Objective-C, Swift	Via iCloud or 3rd party software	7+ 4-6: Limited
PALM OS	memory uses low, freeze background process if more task ongoing.	Third-party applications support	No	licensees require	N/A	C++	N/A	No
SYMBIAN OS	Not capable of large num of app loading, memory uses low, freeze.	Only collaborating with the Japanese OEMs	No	Proprietary software. previously Free software	11.7%	C++,Qt	N/A	Yes
Ubuntu Touch	Not capable of large num of app loading, memory uses high, freeze.	N/A	No	Free and open-source, mainly the GPL	N/A	Linux (based on Ubuntu) & HTML5, QML, Go, JavaScript, C++ System: C, C++, QML	N/A	Yes
WINDOWS MOBILE	Not capable of memory loading, memory uses high, uses virtual memory	Third-party applications support	Yes	Proprietary software licensed to OEMs	3.4% or <1%	Visual C++	N/A	Yes

Fig. 2. Comparison of Mobile Operating System Performance

Also, Microsoft corporation came with a unique idea of their operating system, Windows operating system for the phone. But by that time, android Os took over the market because it provides platforms to the developer to use it as per their need and also its operating system is open to all devices, which made it easier to reach.

III. SUMMARY

From the above comparison, Android and IOS operating systems are more flexible in terms of development and have been serving their users with more features. To create this table

information was gathered from the multiple sources: [5], [6], [7], [8]. However, it is clear that in terms of large number of app loading and memory uses that operating system performance is not perfect. Android Operating systems are faster and more efficient in terms of memory management and have been providing services with excellent performance standards for years. This is obviously reflected in the Android market shares, as they are high compared to those of their competition at 71 percent. Also, their development languages are very widely-ranged giving developers and employees have more flexibility in the sector of compatibility and 3rd party software use. Being an open-source operating system, this allows many developers to develop various applications with functionalities in the programming language that they are comfortable with.

Open sourced mobile computing is an advantage since anyone anywhere can make improvements to the software. In this way, new iterations of applications and operating systems can be released and worked on daily by programmers around the world. As a result, many phone developers come with multiple phone models focusing on the android operating system as it is widely used and compatible with many devices. While the iPhone/Apple OS has relatively high market shares and various available coding languages as well, it is not open-sourced and is one of the more expensive types of OS. So, based on it being open-sourced, market shares favouring it, the multiple available coding languages and storage performance we have come to the conclusion that the best operating system in terms of mobile computing today is the Android OS.

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