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Is Android or iPhone the Platform for Innovation in Imaging Informatics

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It is clear that ubiquitous mobile computing platforms will be a disruptive technology in the delivery of healthcare in the near future. While radiologists are fairly sedentary, their customers, the referring physicians, and the patients are not. The need for closer collaboration and interaction with referring physicians is seen as a key to maintaining relationships and integrating tightly with the patient management team. While today, patients have to settle for their images on a CD, in short time, they will be taking them home on their cell phone. As PACS vendors are moving ever outward in the enterprise, they are already actively developing clients on mobile platforms. Two major contenders are the Apple's iPhone and the Android platform developed by Google. These two designs represent two entirely different architectures and business models.

The iPhone is the future platform of mobile applications in imaging informatics: George Shih, MD

Opening Statement

It is unclear exactly how many iPhones have been sold: four million units announced at MacWorld '08 (January 2008), one million iPhone 3G units on opening weekend (July 14, 2008), and 27 million units in projected sales in 2009 by Morgan Stanley (http://digitaldaily.allthingsd.com/20080618/morgan-stanley-pre-announces-2009-iphone-sales/). Regardless of whether sales will top 5, 10, or 20 million units in 2009, the iPhone along with its phone-less cousin, the iPod Touch, have become the dominant platform for mobile applications (http://apple20.blogs.fortune.cnn.com/2009/01/10/ipod-touch-use-exploded-christmas-day/). Years ahead, which in the IT world is equivalent of light years, of everything except perhaps Android

or RIM, the unabashed enthusiasm of both its users and developers will make iPhone the best platform for mobile radiology applications.

Microsoft Windows has become the dominant platform in radiology desktop applications (e.g., PACS frontends) not because of its superior development platform, but rather because of its sheer penetration into hospitals and on home desktops with upwards of 90% of the world's PC market. It will be similar for the iPhone, the first successful entrant becomes the market dominator. This self selection is a reflection of the war for the hearts and minds of the development and business community. Once the platform passes a tipping point, development snowballs on a platform and innovation blossoms (http://news.cnet.com/8301-13579_3-9811421-37.html, http://apple20.blogs.fortune.cnn.com/2008/06/25/android-vs-iphone-this-is-where-the-pain-happens/). For this reason, whether parts of Android end up being better than iPhone is probably irrelevant, since the iPhone SDK is good enough according to those who have experienced developing on it, and the iPhone has become the smartphone to run real applications (i.e., not just email). A key advantage of the Apple way and the iPhone is its very tightly controlled environ-

ment, it is easier to develop, test, and maintain apps because the screen size, hardware, etc. are all standardized (http://www.telegraph.co.uk/scienceandtechnology/3358612/Google%27s-G1-Android-and-the-Apple-iPhone-how-they-compare.html, http://www.theiphoneblog.com/2008/09/25/iphone-vs-android-top-5-wins-and-losses/). Development in Android will be much more difficult because a developer has to account for all the other requirements and/or limitations by different hardware manufacturers (http://www.macworld.com/article/135274/2008/08/android_appstore.html).

When Apple first launched the iPhone, Steve Jobs announced that all third-party apps on the iPhone would be web-based, in light of the phenomenal mobile Safari browser and vast improvements in web applications using AJAX and CSS which can begin to simulate desktop/native applications. Clearly, this web-only environment did not prove completely sufficient, but a lot of progress was made in developing web apps for the iPhone. One free software bundle called iUI (http://code.google.com/p/iui) makes it easy to turn ordinary HTML into a user interface that resembles a native iPhone app, which can also integrate iUI with other web frameworks. iUI and other tools make it relatively simple to write a web-based application optimized for the iPhone.

Apple requires developers to register, for $99 as part of the Apple Developers Program, and obtain an Apple ID to obtain the iPhone software development kit (http://developer.apple.com/iPhone/program/). For comparison, the Microsoft Visual Studio development suite costs upwards of $600. The iPhone SDK is free to download, uses almost 5G of hard-drive space to install, and requires Leopard 10.5.5 or higher to install the whole bundle. To deploy a program developed requires installing the app on an iPhone via the iTunes application store. XCode 3, the Apple IDE, has been described as the best integrated development environment for mobile devices (http://bc.tech.coop/blog/090429.html). iTunes provides an immense distribution method with users able to find your application and purchase it through the same mechanism. It is easy access to millions of potential users.

The iTunes apps store broke the 10,000 apps mark last December (http://www.ismashphone.com/2008/12/ten-thousand-iphone-apps-lets-make-a-mosaic.html) which is a clear indicator of passing the tipping point of a market dominating

platform. Radiology-related applications are already available in the iTunes apps store including popular ones by MIMvista and Osirix. A list is provided in Table 1. An open-source web-based viewer called Oviyam (http://oviyam.raster.in) is already available which plugs into the open-source PACS called DCM4CHEE and has both a normal web interface and an iPhone-optimized web interface. Inevitably, radiology-related iPhone apps will include many other functions besides viewing DICOM images and will likely include physician-to-physician interactions and physician-to-patient interactions. Other medical, non-radiology-related iPhone apps are also available, which are at this point mostly educational in nature. One good website that tracks iPhone apps is http://www.appshopper.com.

Paras Lakhani, MD
Opening Statement
Android is the Platform of the Future.

The Android is a software platform and operating system for mobile devices or smartphones developed by Google[1] Since the operating system is open-source and based on the Linux kernel, it has received much enthusiasm from the public and development community[2].

Android is the flagship behind the Open Handset Alliance, a major consortium of 48 companies including Motorola, Samsung, T-Mobile, Intel, and Qualcomm that will promote and develop a number of different mobile phones running on the Android operating system[3]. In October 2008, handset manufacturer HTC released the first smartphone using Google's Android platform, HTC Dream or G1. Its successor, HTC Magic or G2, was unveiled at the recent Mobile World Congress in February 2009[4]. Many other mobile devices that will run Android are currently being developed, including those by Motorola, Sony Ericsson, Samsung, and Lenovo, which are scheduled to be released in 2009[5].

Google's Android is designed to compete with other mobile handset platforms, including Apple's iPhone, Windows Mobile, and the Palm OS. However, it is most compared to the iPhone, since it is designed with multimedia capability and a sleek interface in mind.

Like the iPhone, HTC's Android phone offers a robust touchscreen display and portrait/landscape mode. It also functions as a camera phone with an

Table 1. Applications Applicable to Radiology on the iPhone

dsiPhone user interface (web framework)	http://code.google.com/p/iui
Example iUI website	http://beta.gbebe.com
Apple iPhone developer website	http://developer.apple.com/iphone
DICOM viewer iPhone app	http://www.mimvista.com
DICOM viewer iPhone app	http://www.osirix-viewer.com
Web-based iPhone DICOM viewer (open source)	http://oviyam.raster.in
Compilation of iPhone apps	http://www.appshopper.com

easy-to-navigate menu that has text messaging and visual voicemail, an internet client with Wi-Fi and 3G network capability, web-browsing, email, and a portable media player. In addition, the Android has other features, such as full hardware keyboard support, swappable battery, and memory, which are not currently supported by the iPhone[6,7].

Google's entry into the handset arena further supports their revolutionary business model, which is based on generating more traffic onto their popular search engine and users of their web applications. After all, more Android smartphones should translate into more users of their already popular web services. This also serves as a direct threat towards Microsoft (and Apple's) core dominance of selling operating systems and enterprise applications, likely symbolizing a new era in web-centric computing[8] Already, many major PC applications have web counterparts with similar functionality and the added benefit of online collaboration such as Google Documents. There is a growing need for improved collaboration in radiology, and such web applications could be used to enhance communication with referring clinicians and patients. For example, real-time information regarding current wait times for imaging studies could be shared with patients and referrers. In addition, smartphones could enable easy access to results and images, preparation information for patients, directions to imaging centers powered by web-mapping service applications (i.e., Google Maps), and follow-up satisfaction surveys populated by web-based form applications (i.e., Google Docs).

Since the Android is based on the Linux OS and uses the Java programming language (although the core application programming interface (API) and the virtual machine are not entirely consistent with the Java platform), it should be relatively easy to port existing PC applications to the Android. More importantly, a generation of developers trained on the Java can readily develop applications for the Android platform. The iPhone API is a combination of C and Objective-C inherited from the Mac OS X, which will make it more difficult for developers not experienced with the Mac to port PC applications to the iPhone. In addition, Android's resource system, used for defining animations and managing images, layouts, audio, and video, is very flexible, stylish, and straightforward to use, which is important for developing applications that heavily rely on images, as is the case with radiology. With this in mind, the number of Android mobile applications, including medical and radiology apps, should grow as the number of Android devices increase in the future.

I believe that the Android will eventually exceed in the iPhone in sales and will become the major player in the smartphone industry, as it is driven by proven and innovative company in Google, is open source in regard to licensing and accessibility to third-party developers and supported by the large majority of mobile handset manufactures. Likewise, the Android should be well utilized by radiologists, a technological savvy community known to thrive on innovation.

Rebuttal: George Shih, MD

My interaction with the Android-based HTC G1 has been limited to TV commercials and a trip to the T-Mobile store, but for me, it has none of the appeal of the iPhone. The iPhone SDK and Android share some similarities including its UI (multitouch-capable) and browsers (web kit) (http://www.readwriteweb.com/archives/googles_android_how_will_it_compare_to_iphone.php, http://webkit.org/), but iPhone's appeal is all about the Apple design genius. Its intuitive multitouch interface is easy to maneuver. Design and interface are really important as we have discovered with early PACS workstations navigating large datasets in radiology. They affect productivity, discoverability, and frequency of use.

The hardware features often touted to be available on the Android G1 but not including the iPhone keyboard, replaceable battery, and memory card slots. Critics say that they prefer a physical keyboard even though the iPhone does have auto-correction. Keyboards are a human computer interface that is best designed for composition of documents. Most computer access, such as browsing, search, reading, email, etc., does not require a full-size keyboard. Furthermore, well-designed mobile applications and websites whether for iPhone or Android take into consideration the limitations of small input devices and, thus, provide easy access to most readily requested information (http://developer.apple.com/iPhone/library/documentation/UserExperience/Conceptual/MobileHIG/Introduction/Introduction.html).

As for the replaceable battery and memory card slot, these are features that the average user can live without, since these devices have a short lifetime of a couple of years tied mobile phone contracts or new technology upgrades.

The software development platform the iPhone SDK uses Cocoa Touch based on frameworks written in Objective C (an object-oriented cousin and superset of C) does present a slightly higher barrier for non-Mac developers to cross the "proof is in the pudding." Since I started to write this point–counterpoint piece (November 2008), the number of approved iPhone apps in iTunes has doubled from 10,000 to 20,000 (as of mid-February 2009; http://www.macworld.com/article/138753/2009/02/appstore.html) and as of April 2009, over a billion apps have been sold (http://www.readwriteweb.com/archives/1_billion_apps_later_here_are_some_of_our_favorite.php). It is hard to argue with such exponential growth in iPhone apps, in spite of its Objective C "hurdles." There is currently a mad rush for companies and organizations including the ones in radiology to make their websites iPhone compatible and to create iPhone apps.

Rebuttal: Paras Lakhani, MD

The smartphone market is still in its infancy and continues to grow at a blazing pace, achieving 35% growth in 2008[9]. While the iPhone has achieved success with over 10 million units sold in 2008, it only represents a small fraction (1%) of the entire mobile cell phone market[10]. Even in the smartphone arena, Apple lags in global sales compared to Research in Motion (RIM), the manufacturer of the Blackberry, and Nokia, the most popular manufacturer of smartphones globally. Even in smartphones, Apple's iPhone only comprised 8% of smartphone sales globally, compared to 17% for RIM and 44% for Nokia[10]. There is sufficient room for growth in the smartphone industry before the tipping point is reached. Thus, the key question is not what the best device is currently, but which platform will be the most dominant in 10 years, when smartphone sales may replace traditional cell phones entirely. Already, some analysts have predicted that Android-smartphone sales will exceed iPhone sales by 2012[11].

Google and Apple have radically different business models and philosophies. While Google promotes freedom and flexibility with the Android, Apple controls virtually everything regarding the iPhone, embracing a world of operator dominance. For one, the iPhone's operating system is closed source. Second, to join their Developer Program, you first have to pay an annual fee[12]. Third, Apple has an exclusive agreement with AT&T; thus, iPhone users cannot use any other network provider. Not surprisingly, it took over 2 years for the popular VOIP client, Skype, to be available on the iPhone, because it discouraged utilization of AT&T's billion dollar network. Nevertheless, the current iPhone Skype app works only using Wi-Fi and will not work on AT&T's 3G network.

Finally, every application on the iPhone's "App Store" must be approved by Apple first and they can exercise a veto option without giving reason. This has caused a revolt among some developers, because potentially great applications have been nixed by Apple for various reasons. For example, a well-heralded application "Podcaster" was canned by Apple, even though it surpassed Apple's iTunes in functionality by enabling updates of podcast subscriptions directly to the iPhone using Wi-Fi[13]. Apple saw this as a threat to iTunes so the application was never allowed. One influential Apple supporter called this a "disaster for the platform."[14] Confidence in a platform's owner to be a good steward is important to maintain the trust of the developer community.

If Apple continues along this path, how will they ensure that the best applications are available to users? How will they compete with a vast, global development community, as smartphones become

nearly ubiquitous worldwide? Even currently, there are delays in getting important updates accepted by Apple, resulting in buggy software, reduced battery performance, and crashing phones[15].

Not surprisingly, Google has a very different and open business approach, and applications for the Android are only growing. The number of applications supported by a product is a reflection of the number of users for that product. Today, there are more iPhone than Android users, but this will likely change over the next decade, as Google's Android is in a ripe position to grow and surpass the iPhone during that time. Google is sponsoring millions of dollars in prize money to developers who build the best applications for the Android[16]. As such, there is plenty of potential for the development of both medical and radiology applications, including portable 3D image viewers and report-generation systems. Even with the recent release of the first mobile device running the Android, a popular radiology social networking website, Radrounds Mobile (http://www.radrounds.com), has already been programmed to run on the Android platform[17]. In addition, many major medical applications are already available on the Android, including dictionaries, disease management guides, and pharmaceutical and nursing manuals[18]. Several Major PACS applications today are written on the Java platform, and several can be modified to run on Android with minimal refactoring.

I do agree that Microsoft has achieved its dominance due to significant penetration into the market. However, this argument actually favors success of the Android, as Apple is handcuffed by its closed business model[19]. With the support of an established innovative company in Google, and with the support of a large portion of the handset manufacturing community including Motorola, Samsung, LG, and Sony Ericsson[3], the Android is poised to permeate the fledgling smartphone marketplace. Moreover, with many companies supporting the Android, this will lead to competition and innovation among Android devices and eventually lower prices. In fact, one of the reasons why Microsoft and the PC have been so successful compared to the Apple desktop brand is due to much lower prices and greater diversity of companies and manufacturers supporting them.

Finally, one of the major benefits of the Android is its easy and seamless offline integration into Google Applications, such as Google Calendar, Documents, Messaging, Talk, and Gmail. With iPhone, you must connect through Google on the web. While you can sync your offline iPhone calendar to Google's calendar, there is more simplicity with the Android both for Google calendar and Gmail. In other words, if you are already an avid user of Google products, you will better benefit from with the Android than the iPhone.

On an architectural level, the biggest challenge for iPhone is its lack of support for background applications or multitasking[7]. As any practicing radiologist will tell you, multitasking is critical for efficient day-to-day operations, which require the simultaneous activity of interpreting images and dictating reports.

Ultimately, it will be difficult for one company and one operating system to satisfy the needs of a large multicultural and diverse society. More than three billion people across the globe own mobile phones, approximately double the number of television sets in existence[20]. Different users from various societies will have different needs. The Android will be featured on several smartphones, each with potentially different features and functionality and will be easily malleable since it is open source. This potential for diversity is appealing and will facilitate global adoption and adaptation.

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