Android OS: Mobile Computing
Leads to an Open Source Movement

Chuck Scott
University of Washington, M.S. Technology Innovation
TECHIN 522: History and Future of Technology
Dr. David Ribes
Winter 2020
Abstract

Mobile phones and devices have become ubiquitous in our everyday lives and can be seen from large-scale manufacturing and increasing development of capabilities and integration with our environment. The rapid adoption of smart phones after 2008 is a well-studied phenomenon, which often highlights Apple’s iPhone as a catalyst and key driver. However, prior to the development of the famed iPhone, one company was already developing the foundations and frameworks that mobile phones would be built on for connecting to the internet. The most notable player throughout this phase of rapid mobile software development and adoption was Android operating system.

Owned by Google, Android Operating System (OS), is the most widely used mobile operating system in the world. Android has a long history in this industry, along with its major rival, Apple. Since 2003, the company has been a key innovator in the mobile phone market by creating a robust and reliable cloud platform which nearly all modern phones operate on. As of 2020, they have expanded to be the market leader of mobile OS platforms and are a well-established firm in the industry.

Android is a true Silicon Valley startup story which tells of a company that was well positioned to accelerate the development of an emerging technology, mobile computing. While this is a relatively known tech story, often what is not told is the influence of Android on the open source development community.

This paper will examine the mobile OS platform that is Android. It will briefly overview the technological components in which Android is built on but focusing on the high-level architectural overview. This background helps to illustrate the many efforts of the company to push toward open source development, a critical part of their growth. This study will also explore some common criticisms of Android from the developer community, and the arguments for, and against, open source principles. A brief history of Android is provided, with specific focus on their first ten years (2003 -2013). This time period was selected to highlight key strategic decisions of the company, specifically around open-source development, and some of the key innovations they brought to customers early in the mobile computing era.

By expanding development through strategic licensing and crowd sourced development, Android and its ecosystem continue to grow to this day. This is a symbiotic relationship which has allowed many people to build on the Android platform, creating their own hardware and software versions, and allowing them nearly limitless manipulation and control over the code that runs it.

Though open source in its purest ideals may be a modern ethical topic in technology, this “un-black boxing” of Android shows how the success of this company had direct impact to the open source community and product development globally. Android is open source to its core, and its strength and future relies on a growing community of developers and devices.
The story of Android Inc starts in 2003 and is your typical dotcom boom Silicon Valley success story. It was founded by four people, Rich Miner, Nick Sears, Chris White, and Andy Rubin. While they originally pitched their software for use in cameras, they soon discovered that the emerging market of mobile phones was the industry to be in. Their mission was to develop "smarter mobile devices that are more aware of its owner's location and preferences" (Android Authority).

In 2005, Android was acquired by Google for $50 million. This would end up being a strategic move for Google to enter the mobile phone industry and position itself as one of the big players. However, the company remained secretive about their development of the OS, even in late 2007 when the iPhone was announced. In 2008, Android 1.0 came to the market with the release of the HTC Dream G1, one of the first direct competitors to the iPhone. Also, in this year, they began naming each version of their OS release using codenames, the first being "Cupcake."

Over the next few years, Android would aggressively release new versions of their software, pioneering major changes to mobile computing. In 2009, Android 1.6 “Donut” was the first to support CDMA network, allowing Android to be used in nearly all carriers around the world. This also provided new features to users including a quick search box, gallery, and power management widget. In the following year, 2.0 “Éclair” was launched with a partnership from Motorola and the Droid phone. Again, beating the iPhone to features, this release offered new to user features on a mobile phone such as text-to-speech, multiple account support, Google Maps, and live wallpapers.

Android continued to be at the forefront of new features and now directly competed with Apple, Nokia’s Symbian, and Blackberry. This market was rapidly growing, and competition was getting stronger among the mobile OS companies. However, Android continued to innovate in areas which would become standard in mobile computing. In 2010, the Google Nexus phone offered wi-fi mobile hotspot, Adobe flash, and NFC capabilities. Additionally, Android expanded development for large phone screens and tablets, as well as partnered with Samsung in creating the Galaxy Nexus. The Galaxy product line continues to grow for Samsung and still runs Android OS as base software in its devices.

In early 2011, Android offered onscreen navigation and was the first with biometric unlock, using the devices front facing camera. “Jellybean”, in 2012, boosted even more features with dramatic increases to speed, Google Now, and drag-to-text input. Finally, in 2013, with the release of the Nexus 5, Android was optimized to run on phones without large RAM requirements. This development allowed Android based phones to be sold by carriers all around the world.

Stepping back from the historical timeline, Android’s first 10 years showed explosive growth which allowed them to compete, and eventually win, the mobile computing market. However, the strategy of the company was not to compete directly in hardware, but
instead into software and fast feature releases. A major proponent of this was the open
source development during this time, which allowed rapid, and simultaneous
development of every layer of their technological stack.

It will be argued that the open-source nature of Android created an opportunity to crowd
source innovation in a developing industry. This will be examined further in the following
sections as this paper looks at how Android’s open source platform allows for rapid
development of mobile capabilities, as well as the growth of third-party software
development.

**What is Android OS?**

Google has historically invested heavily in the continued development of Android OS,
resulting in a current market share of 85% of the total mobile OS industry (Android
Authority). Beyond their investment strategy, however, the secret to Android’s success
over the years lies in the structure of their platform.

Android OS is the open source technology stack that runs on over 400 million devices
worldwide (Krajci-Cummings). It was developed as a modified
version of a Linux Kernel, a free and open-source kernel
commonly used in computer systems. It can be broken into five
primary pieces—applications, application frameworks, native
libraries, Android runtime, and the Linux kernel.

The Linux kernel provides access as close to the hardware as
possible. This allows drivers to operate fast and efficiently by
controlling hardware operations and components. On top of
the Linux kernel is the Hardware Abstraction Layer (HAL), a
software subsystem for UNIX-based operating systems
allowing them to interact with the hardware through
programming interfaces. Next, the backend and runtime
programming, typically a Java or C-based framework which
handles environment and interfacing toward the client side. Lastly, the application
layer of the stack represents software closest to the client, usually how they
interface with the device.

What is unique about this technology stack is that it consists of various components that
allow developers and device manufacturers to work independently. The interface allows
for direct manipulation of inputs through software allowing developers to access and
control nearly all the hardware components.

**APACHE and Open Source Momentum**

The key architectural layer for the Android system is its Linux based kernel. This allows
for a robust level of customization of the system with little restrictions. This is the basic
premise of open-source software: a freely available source code that can be redistributed
and modified under a license. Android was able to license their software using their APACHE License. The Apache license allows freedom to use the Android OS software and to modify and distribute alternative versions.

With the introduction of Android, a single operating system removed the need for re-implementation of phone applications and middleware. Software developers could now release applications to a growing number of devices, building any framework on top of the OS and with access to the lowest kernel layers. Android provides developers with the tools to create new graphical applications to users, allowing for near limitless customization options and use-cases (Krajci-Cummings).

Even in 2006, Android touted, “anybody—even Android competitors—can choose to download, install, modify, and distribute its source code for free”. Not surprisingly, many device companies did not want to absorb the cost of developing their own software from the ground up. Instead, they had access to build onto the existing system, customizing Android to build unique experiences for their customers. Most were happy to pay the fee to license, given that most other operating systems were closed to third-party developers and manufacturers. “In other words, smartphones weren’t for everyone.” At least, not until Android made it that way (Android.com).

Furthering the open source movement, Android established the Open Handset Alliance (OHA) in November 2007. The OHA is a group of 84 firms, whose mission was to promote Android as the platform of choice for open source development. It includes major industry players like HTC, Sony, Dell, Intel, Motorola, Qualcomm, Texas Instruments, Samsung, LG, T-Mobile, and Nvidia. (Wikipedia.org).

The members of the OHA also have an important role in overseeing the Android Open Source Project, led by Google. This large-scale open source project in which all the information and source code repositories are available online. This allows developers to make variants of Android OS and port any device into the platform. Anyone can contribute to the repository and all changes are logged. This has been a huge effort to keep the Android platform and ecosystem constantly evolving. In Google’s release video of Android Open Source Project, they stated, “One of our goals is to get Android all over the place…making it easy for the industry to adopt the whole platform. We’ve made it easier for developers to extend the platform to make sure it stays on the cutting edge of the industry.” (Android Developers).

Device makers were now able to install Android on their devices for free, without licensing or developing a proprietary OS. Additionally, app developers were given access to a global market, with the multinational consortium of tech and telecommunication companies committed to the platform. As a direct result, devices and related services began being produced at higher quality for lower prices. (KRAJI-CUMMINGS)
Criticisms from community

There are some in the open source community that have lashed out against Android, questioning whether it is true to “open source” principles. The arguments against the OS are relatively trivial, but fiercely debated nuances, nonetheless. These criticisms speak to the deep idealism of what open source means and how much control should exist between the developer, community, and the company.

The main criticism involves which elements, and how much of Android’s source code is not available to change. Core applications of Google’s such as Assistant, Gmail, Maps, YouTube, and cloud services remain out of the public source code (King, 2015). As Google’s products become integrated more with Android OS, many developers are pushing back on the “closed source creep” of Google. (Amadeo, 2018). The degree of control and customization seems to always lie on a spectrum with open source on one end and closed source on the other. They are not extremes that any one company or program could live in wholly.

Another common criticism is that the core development of Android OS is not community driven, referring to the crowdsourcing and voting from the larger development community regarding features and expansion. One example of this type of open source development is Red Hat’s GNOME project, where developers from around the world contribute code and influence new releases (King). Since Android is officially a Google product, they determine maintenance and security updates, as well as major releases.

However, the number of products that have been built off the Android platform speaks to the diversity of ideas, and the growth of the mobile development. As of February 2020, there are now 2.9 million apps in Google’s Play Store, where the company monetizes and provides a two-sided marketplace for app development. Furthermore, Android provides several resources via their developer.android.com site, allowing anyone the ability to access tools they would need to start building apps for mobile use. Never has it been easier to get into mobile app development and participate in the growing marketplace.

The Future for Android?

Android is the king of the mobile OS market, despite facing criticism and fierce competition. Acquisition of Google and creating one platform which could be rapidly adopted and customized was the key strategies that resulted in their success.

Android’s biggest competitor, Apple’s iOS, still possesses a large development force, though typically with more control over core code of its system. While only having a fraction of mobile OS market, Apple has proved to be a worthy competitor to Android in their constant battle for technological superiority and sales. The conflict between these two companies is widely known in the tech industry with Steve Jobs stating “I’m going to destroy Android, because it’s a stolen product. I'm willing to go to thermonuclear war on this!” (Barjarin).
With only a small number of competitors developing mobile open source platforms: Ubuntu Touch, Firefox OS, and Sailfish OS, rapid adoption of these are highly unlikely. While the debate of ideals in “open source” development continues, the community itself has helped defined what Android is today.

It could have been otherwise for Android though. If Google had not acquired Android, perhaps the company wouldn’t have survived as a small player in the market. Perhaps they would have continued the open source movement with other OS companies, but could they have sparked a development community? Apple or another mobile OS could have easily captured the growing market to themselves. Any of these events was likely to happen at one point and might have led Android away from success, thereby removing much growth in the industry that did occur because of them. Android remains the most successful mobile OS platform in the world AND has grown the developer communities which continue to advance the ecosystem with their innovations.
Bibliography

Android. (2019). Retrieved from Android.com:
https://www.android.com/everyone/enabling-opportunity/

Callaham, J. (2019, August 18). The history of Android OS: its name, origin and more.
Retrieved 02 24, 2020, from Android Authority.

Cooney, Michael. (2012). Gartner: How big trends in security, mobile, big data and
cloud computing will change IT; A quick roundup of IT trends, from Android

Hsiao, K. (2013). Android smartphone adoption and intention to pay for mobile internet:
Perspectives from software, hardware, design, and value. Library Hi Tech, 31(2),
216.

Makeuseof.com. Retrieved from https://www.makeuseof.com/tag/android-really-
open-source-matter/

Krajci I., Cummings D. (2013) History and Evolution of the Android OS. In: Android on
x86. Apress, Berkeley, CA

https://source.android.com/

competitive innovation products: The case of the Smartphone Operating