On Emerging Ecosystems in the Mobile Phone Industry
An evaluation of current and emerging mobile phone ecosystems

by

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Executive Summary

"The battle of devices has now become a war of ecosystems..."

- Stephen Elop, CEO, Nokia[1]

The mobile phone industry has changed dramatically in recent years. What used to be a closed, vertically integrated, device-centric industry has become more open, modular and oriented around software platforms and the ecosystems of complementors they enable.

There are currently two dominant ecosystems in the US mobile phone market, built around the two most successful smartphone OS(s). More OS developers are launching competitive versions of their smartphone OS, looking to build equally strong ecosystems around their platform, making this "war of ecosystems" more intense.

In order to win this war, the organizations have to anticipate the shifts in value flow and be ready to respond in order to create maximum value and capture it. They also have to understand the ecosystem dynamics and various roles within an ecosystem available to them, to help create, grow and sustain thriving ecosystems of component manufacturers, device manufacturers, accessory manufacturers, software application developers and service providers for their platforms.

Shifting Value: Over the last few years, the mobile phone solution stack – hardware components, OS, services and content available to the users, has grown increasingly complex. It has evolved to include a number of hardware components and an increasing number of software features and services – either through features in the OS or through applications developed for the OS.

At the same time, the emergence of a dominant design for mobile phone hardware has resulted in standardization and modularization of some hardware components

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[1] Stephen Elop's "burning platform" memo to Nokia's employees in 2011. http://www.engadget.com/2011/02/08/nokia-ceo-stephen-elop-rallies-troops-in-brutally-honest-burnin/. Retrieved May 15, 13

and forced the device manufacturers to look to complementors for ways to differentiate their mobile phones through software.

According to the law of conservation of modularity, as the mobile phone hardware becomes further modularized, the value will move away from phone hardware to other points in the value flow or the solution stack that are not yet "good enough" like software components like OS, applications and services, and to the components that are bottlenecks for device performance like display and memory. (Christensen, 2003)

The mobile phone market has already moved from categorizing phones based on their hardware capabilities to categorizing based on the software operating system (OS) the phones run on, revealing the increasing value of software platforms in mobile phones.

Ecosystem Dynamics: As some applications and services become more valuable, the OS platform will expand to integrate those features and services into the platform, making the applications obsolete.

However, the growing ecosystem of complementors is what makes a mobile phone attractive to the users and no organization alone can develop the variety of applications and services on its own. Thus, organizations looking to be successful in this market have to be ecosystem leaders and balance the needs of different stakeholders to create and sustain the mindshare amongst the complementors.

The iOS ecosystem is the dominant ecosystem in the mobile phone market and it needs to keep innovating on its hardware and software platform to attract new complementors and create new waves of innovation.

The Android ecosystem is the second most dominant ecosystem. Google and Samsung, the two key organizations have a symbiotic relationship that works now as they have very different business models to capture value. In order to make the ecosystem more successful, the ecosystem needs a keystone or keystones that can create a vision and set a direction for ecosystem growth that balances the device

manufacturers' need for openness, which has caused fragmentation with the need for a stable, secure platform, of the users and application developers.

The Windows Phone platform, from Microsoft (with Nokia mobile phones), is a new entrant based on the modular structure of the Android ecosystem. However, the software and hardware platforms are very integrated and need to become modular enough to support the incremental innovations needed to keep the platform competitive. And Microsoft and Nokia have to develop the skill set needed to create an ecosystem where the value is created and some of it is also captured by the complementors.

Blackberry has a strong mobile focus and has created an ecosystem of application developers for its old platform. It has to leverage the experience it has with creating ecosystems and services and solutions to make its platform more attractive to the users and complementors.

Thus, to win this war of ecosystems, both Google and Samsung, and Apple have to be at the forefront of hardware and software platform innovation to attract new types of complementors, while growing their mindshare amongst the current groups of complementors.

While, to be a contender in this war of ecosystems, both Microsoft (and Nokia), and Blackberry need to rapidly increase the adoption of their hardware and software platforms to be able to create a compelling value proposition to attract the complementors to innovate on their platforms and create a successful third ecosystem in the mobile phone market.

Motivation

I joined Motorola right after school and through a stroke of luck, ended up working on software for Motorola cell phones. I remember when we switched from 8 MB ROM phones to 16 MB ROM phones and how we waited eagerly for the new phone prototypes so we could finally fit our software on them.

I remember working on the first color display phones and seeing web pages displayed in true color, the first camera phones wondering who in the world would want such a low-resolution camera when you could have an amazing digital camera and browsing over the first 3G phones in Europe obsessing over every detail to get it just right - from how long it took to establish a connection to the time needed to display it on the tiny screen.

I also remember when iPhone was launched and the general reaction within the industry was that the phone would never succeed, as it did not have a physical keyboard. I lived through the time when Motorola went from having the second largest market share to practically nothing as we struggled to function in the new, "ecosystem oriented" era ushered by the iPhone.

To say that the introduction of iPhone changed the mobile industry would be an understatement. It disrupted the industry and changed the entire landscape in a way that has left the then market leaders like Nokia and Motorola struggling to adapt and survive for the next few years.

Ever since, the question "how do you create a successful mobile ecosystems?" has been on my mind and I hope this thesis is a step towards answering the question.

Chapter 1: Introduction

In the last six years or so, the mobile phone industry has undergone a lot of changes. What used to be a device-centric, tightly integrated industry has become more open and software-centric, with software innovations improving the user experience and software platforms allowing independent developers to create applications and services that enhance the overall functionality of the mobile phone.

This shift in value from hardware to software started with the introduction of iPhone and continued with the rapid adoption of Android devices.

Pre-iPhone, mobile phones were categorized based on their hardware capabilities from "low-end" basic phones to "value" feature phones to "high-end" smartphones. The network operators tightly controlled the user experience on the phones they approved to give their customers a consistent look and feel across devices available on their network. As a result, the device manufacturers like Nokia, Motorola and Samsung had to innovate on form factor and hardware capabilities to differentiate themselves from other device manufacturers.

The iPhone, right from its introduction, shifted the focus from hardware capabilities to software with its intuitive, easy to use (software) user interface. Device manufacturers' initial response to the iPhone was to copy its form factor – a large screen with minimal, sleek design, and failed to compete against the iPhone in terms of user experience as they were still using pre-iPhone software OS and interfaces.

Not too long after, Google along with device manufacturers and other mobile companies formed the Open Handset Alliance (OHA) and unveiled an open-source operating system (OS) as an alternative to iPhone OS called Android, which was free for anyone to license and use.

There was a rush to adopt this OS as it provided the device manufacturers with an alternative that they hoped would help them compete against the iPhone. The device manufacturers worked with the component manufacturers and Google to

create competitive mobile phones, creating an open ecosystem of device manufacturers and component manufacturers for the Android OS.

Apart from the great user experience, Apple (and Android) also released Software Development Kits (SDKs) that allowed individuals and 3rd party application developers to create applications that run on iOS and Android devices, creating a large ecosystem of software application and services.

Since, the mobile phone has evolved, getting more complex in terms of hardware and software capabilities, requiring all the industry leaders to grow and rely on an ecosystem of partners to deliver a complete solution to its users.

Because of the tight integration needed between the smartphone OS and the mobile phone hardware, these ecosystems are currently built around the software platforms or the smartphone OS(s) increasing the value of software in the mobile phone solution stack.

Currently, iOS and Android dominate the US market with other contenders like Blackberry and Windows Phone slowly getting more competitive (Figure 1 below).

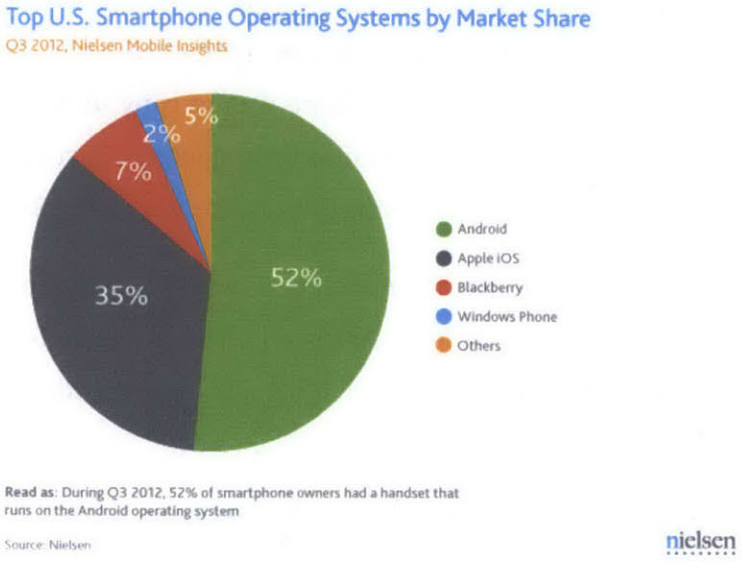

Figure 1: Top US Smartphone Operating Systems by Market Share

However, not all the organizations in the mobile phone market are making money. In Q3 2011, Apple and Samsung grabbed 81% of the 2011 operating profits in the mobile phone market, leaving very little for the other players.[2]

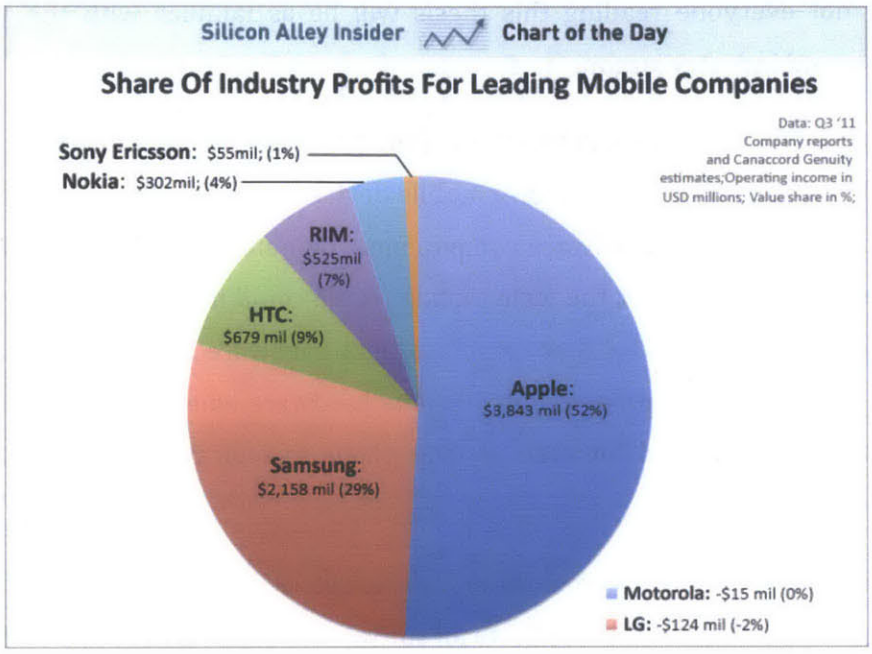

Figure 2: Percentage Share of Profits 2011

So the big question is, where will the value and money in the mobile phone industry be next? And how can you create or position ecosystems to capture that value?

In this thesis, I hypothesize that the next wave of innovation will be in software OS, applications and services, with features and services getting absorbed into the OS to make the next generation of mobile phones more capable than ever.

As the mobile phone hardware components get standardized, the value and money will move downstream from the device, where it resides now, to those components that are the bottleneck for device performance and not yet "good enough". The value will also move upstream to mobile phone software – the OS, applications and services, as these have now become the means of differentiation for mobile phones.

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[2] http://www.businessinsider.com/chart-of-the-day-apple-smartphone-profits-2011-11 retrieved May 3, 13

Explanation of Terms Used

This section contains the most frequently used terms and concepts used in this thesis to help improve its readability as I realize that I use a lot of jargon in this thesis and not everyone reading this thesis will be as familiar with the mobile technologies and industry jargon.

The most commonly used term in this thesis (and perhaps the most confusing too) is a mobile phone, sometimes also called a mobile device or just the device. The mobile phone consists of internal hardware components, the outer shell and the software that runs on the phone. Thus, the term mobile phone could mean either the mobile phone hardware or the device that combines both hardware and software. I have tried to be specific and mentioned mobile phone hardware when I am talking about just the hardware and used the term mobile phone to indicate that it consists of both hardware and software.

The next most frequently used term is the "solution stack". A solution stack is a very software-centric concept used to indicate all software subsystems needed to deliver a fully functional solution.[3] In this thesis, I use this term to mean the entire set of subsystems (both hardware and software) needed to deliver a fully functional mobile phone.

The iPhone changed the course of mobile phone market so drastically because of its success and innovative design that I use it to denote the different eras in mobile phone industry. I use the term pre-iPhone to denote the period in mobile phone market before the introduction of iPhone in 2007 and post-iPhone to denote the time period post the launch of iPhone.

The operators mentioned in this thesis are the network operators or cellular service providers like AT&T, T-Mobile, Sprint, Verizon and such, who provide the cellular services needed for a mobile phone to work.

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[3] http://en.wikipedia.org/wiki/Solution_stack retrieved May 8, 13

Operating System or the OS is a piece of software that runs directly on the mobile phone hardware, manages the hardware components and provides a layer of abstraction for the applications to run on a device. In the mobile phone market, the OS developers have opened up the OS to allow external applications to be developed and run on its mobile phones, making it the platform that enables innovation and I use the terms "software platform" and "OS platform" synonymously.

Application Programming Interfaces or API(s) are a set of interfaces used for communication and data transfer between two software components. In the mobile phone space, these are the interfaces provided by the smartphone OS that external applications running on the mobile phone can use to access certain phone and OS functionality. These API(s) form the basis of the set of tools available for developing applications on mobile phones described below.

Software Development Kit or a SDK is a set of tools that helps the developers to create applications for a particular platform. In this case, we are talking about SDKs for developing mobile phone applications and services on the smartphone OS platforms.[4]

Graphics Processing Unit or GPU is a hardware component used to accelerate the processing and creation of images shown on the display screen.[5] GPUs were initially used only in PCs, workstations and gaming consoles, but as the screen sizes and screen resolution of mobile phones grew, GPUs were introduced in mobile phones to speed up the processing of graphics and reduce the processing load on the applications microprocessor.

Near Field Communications or NFC is a set of standards that can be used by devices in close physical proximity to establish radio communication with each other.[6] The technology has found many uses in smartphones including contactless transactions and data transfer.

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[4] http://en.wikipedia.org/wiki/Software_development_kit retrieved May 8, 13
[5] http://en.wikipedia.org/wiki/GPU retrieved May 8, 13
[6] http://www.nfc-forum.org/aboutnfc/ retrieved May 8, 13

Java 2 Micro Edition or J2ME was a version of Java platform, widely available on pre-iPhone mobile phones, which provided a set of API(s) for developing applications that could run on these mobile phones. J2ME API(s) were used extensively for developing games for pre-iPhone mobile phones that the users could download and install.

Organization

In order to predict the next wave of innovation in the mobile phone market, it is necessary to look at the evolution of the market, the solution stack and its components. Before we start the analysis, Chapter 2 introduces the academic theories and concepts used for the analyses presented in this thesis.

With the theoretical foundation in place, Chapter 3, shows the evolution of the mobile phone solution stack, showing the increasing pace of software-centric innovations in the solution stack in the last several years.

Chapter 4 charts the evolution of mobile phone hardware over a similar time frame to understand how the mobile phone hardware design has evolved. The detailed analysis of mobile phone hardware teardowns also helps us identify industry trends and predict any shifts in value in the solution stack seen in the last chapter.

Chapter 5 describes the importance of software platforms in the mobile phone market and the changes in software platforms by looking at the merger and acquisition activities of five key players and their impact on the platform.

Chapter 6 analyzes the current ecosystems in the mobile phone market, exploring the effects of their structure and value flow to understand its implications on an organization's strategy.

Chapter 7 uses the analyses from previous chapters to compare the characteristics and skill sets of the leaders of the top four ecosystems and provides recommendations for each of the ecosystem leaders for creating or sustaining a successful ecosystem in the mobile phone market.

Chapter 2: Theoretical Foundation

This chapter briefly describes the concepts and theories that form the academic and theoretic foundation for the analyses presented in this thesis.

Dominant Design

"**Dominant design**", a term coined by Abernathy and Utterback, is used to signify the emergence of a product design or a combination of elements that has become the de facto standard in the market due to its widespread adoption. (Utterback, 1994).

For example, the dominant design for PC(s), adopted by all PC manufacturers, was the standard combination of components like a Central Processing Unit (CPU), display, keyboard and mouse. The dominant design for CPUs, in turn, consisted of having a motherboard, a microprocessor, graphics processor, RAM, hard drive, a network card and other external connectors like USB.

In order to gain widespread adoption, a dominant design usually satisfies the requirements of a large base of users spanning multiple customer segments. This means that once a dominant design has been established, any new product design significantly different from the dominant design will find it extremely hard to gain market share and the adoption of this new product design will be limited to some particular niche market whose requirement it satisfies.

For example, once the QWERTY keyboard emerged as the dominant design or layout for keyboards, no significant improvements to the keyboard design have become mainstream. First becoming popular in 1878 with the success of Remington No. 2 typewriters, keyboards with QWERTY design still remain the most commonly available modern-day keyboards, 135 years later.

According to Utterback (1994), for assembled products, a dominant design also leads to standardization of components to allow the firms to capitalize on economies of scale and reducing overall component costs.

Product and Process Innovation

One model that describes the dynamics of product and process innovation within an industry is the Abernathy-Utterback model. (Abernathy and Utterback, 1978)

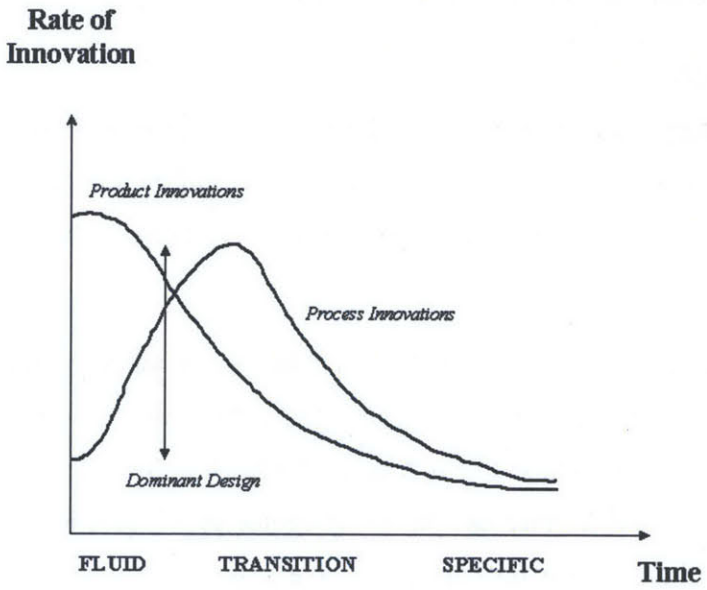

Figure 3: Abernathy-Utterback Product Process Innovation Model[7]

The model categorizes the creation of a new industry into three phases – fluid, transitional and specific (Figure 3).

In the fluid phase of an industry, everything is changing rapidly as a new market is being created. The technology is evolving, customers are being identified and customer needs are being explored. As the customer expectations are still not well understood, the market is filled with disparate product designs. Organizations in the market are focused on product innovation to find a design that is acceptable to the customer and competing on the basis of functionality and product performance.

The emergence of a dominant design marks the shift to the transition phase from the fluid phase. The organizations have a blue print of what the market needs – the design for a successful basic product. The focus in this phase shifts to creating

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[7] Image source: http://siliconangle.com/blog/2009/09/15/cloud-collision-operational-models-and-cultural-change/ retrieved May 16, 13

customized products for niche users to understand the needs of a wider audience. As the market grows, the organizations also start ramping up their manufacturing processes to make large quantities of the product to meet market demand.

As the industry enters the specific phase, all the products in the market are now very similar, based on the dominant design that has emerged and with very little differentiation. The focus of the organizations now is on process innovation and operational efficiencies to reduce the cost of the product while maintaining the quality of the product.

Fast Followers And Fast Seconds

"**Fast followers**", also called second movers, are organizations that employ a strategy of waiting till a dominant design has emerged and become established to enter the market with a me-too product that uses the dominant design.[8]

In contrast, **first movers** are the organizations that enter a market while it is still undefined and help create the market with the hope that its product design will gain widespread adoption and emerge as the dominant design, giving it a significant advantage over its competitors.

Markides and Geroski (2005) further divide the second movers into two categories – fast second and slow second. "*Fast second*" organizations are those who enter the market just as a dominant design seems to be emerging and then create or solidify the market and help increase the adoption of the dominant design. While "*slow second*" organizations are imitative entrants whose strategy is to compete on price, offering a lower cost me-too product.

They state that in markets created by radical innovations, it is better for large, established organizations to employ a "fast second" strategy as this helps the organizations avoid the cost of initial experimentation and mistakes while still having an advantage over the second mover organizations, as they help create the

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[8] http://blogs.hbr.org/hmu/2008/02/fast-second.html retrieved May 5, 13

market. Of course, timing and the ability to anticipate changes and move fast, is crucial to be successful in a fast second strategy. IBM's entry in the PC market, Amazon's creation of an online bookstore and Microsoft's evolution of Windows are all examples of when the organizations have followed a fast second strategy. We will see examples of fast second organizations in the mobile phone industry as well.

Business Ecosystems

Moore (1996) defined a business ecosystem, using the metaphor of a biological ecosystem, as:

"An economic community supported by a foundation of interacting organizations and individuals - the organisms of the business world. This economic community produces goods and services of value to customers, who are also members of the ecosystem. The member organisms also include suppliers, lead producers, competitors, and other stakeholders."

Thus, it is not just a network of organizations or a tight-knit supply chain, but the expectation is that members of a business ecosystem co-evolve their capabilities and roles over time to move towards a shared vision. More often than not, business ecosystems are built around platforms that allow the ecosystem participants to contribute to or innovate upon it.

Ecosystem Phases

In his book, Moore (1996) also outlines the various phases of evolution of business ecosystems, using the evolution of a biological ecosystem as its basis.

In the **Pioneering** phase, the organizations are attempting to learn and explore the options available to them for an initial product/solution offering with high value-add to create maximum value.

The next phase, **Expansion** is where the ecosystem focuses on gaining critical mass in order to survive in a competitive market, by attracting customers with is products/solutions offering and ecosystem partners by offering them a platform to leverage and innovate on.

In the **Authority** phase, as the ecosystem has the required critical mass, the ecosystem members compete internally to gain authority and leverage to influence the direction of growth of the ecosystem.

The last phase, **Renewal or Death**, is where the ecosystem battles for survival again against changing markets, new ecosystems and needs to renew it or face obsolescence.

Roles of Ecosystem Participants

Iansiti and Levien (2004) describe the different roles available to the organizations participating in an ecosystem - keystones, dominators and niche players.

"Keystones" are the members who enhance the productivity of the ecosystem by providing a platform that the members of the ecosystem can leverage, limiting the activities of members who try to dominate the ecosystem and increasing ecosystem diversity.

Business ecosystems have two different types of **"dominators".** There are the *"hub landlords"* who are only focused on extracting maximum value out of the ecosystem and there are true *"dominators"* who are members of the ecosystem who try to control all aspects of value creation in order to capture all the value created, leaving no room for any other members to flourish in the ecosystem.

"Niche players" are the third type of ecosystem participants, who are specialized members of the ecosystem offering products and services that leverage the platform provided by the keystones. They form the mass of the ecosystem and are responsible for the diversity present in the ecosystem.

Law of Conservation of Attractive Profits

Clayton Christensen and Michael Raynor, in their book "The Innovator's Solution", describe a phenomenon called the Law of Conservation of Attractive Profits (or the Law of Conservation of Modularity), inspired by the law of conservation of energy in physics.

"The law states that in the value chain there is a requisite juxtaposition of modular and interdependent architectures, and of reciprocal processes of commoditization and de-commoditization, that exists in order to optimize the performance of what is not good enough.

... When modularity and commoditization cause attractive profits to disappear at one stage in the value chain, the opportunity to earn attractive profits with proprietary products will usually emerge at an adjacent stage." (Christensen and Raynor, 2003)

They talk about a process of commoditization and de-commoditization that occurs simultaneously with the process of modularization and integration. As parts of the value chain overshoot the performance requirements needed by the mainstream customers, they become vulnerable to disruptions and are forced to lower their prices as the customers refuse to pay premium price for performance they don't need – forcing modularization and commoditization. At the same, the parts of the value chain that are adjacent to the modularized components will not be "good enough" as they have to support the modularization and still be able to deliver optimum performance, making them more valuable and forcing integration and de-commoditization.

User Centered Innovation

Von Hippel (2005) describes about a phenomenon called "**user centered innovation**" occurring in certain industries, wherein the product innovation is moving from the manufacturers of products to the users of products. This is true for software products as a lot of the manufacturers have now started offering SDK(s) to enable their users to innovate and extend the functionality of their product, but this phenomenon has been observed in physical products as well.

This phenomenon is understandable as no single product can satisfy the requirements of all the customers. The manufacturers have to prioritize what features they can include in their product and usually release a product that matches the needs of a large population but not all. At this point, the users whose

requirements haven't been satisfied end up modifying the product to suit their needs.

It may be difficult to modify physical products, but given the right skills and tools, modifying software is easier. In case of software, this phenomenon has given rise to a new a business model and developers of software platforms are releasing tools and other infrastructure to help its users develop the additional features they need to satisfy their requirements. This ability to customize increases the adoption of a software platform, while also serving as a pipeline for requirements for the platform's next release.

Chapter 3: From Hardware-Centric To Software-Centric

The mobile phone industry has come a long way since the introduction of iPhone. Pre iPhone, the mobile phone industry was hardware-centric and the mobile phone market had three distinct market segments – "low-end" basic phones, "value" feature phones and "high end" smartphones, based on device's technical capabilities and the technical capabilities increasing in each category.

Low-end phones had just the basic features like a small phonebook, call list, message center available that allowed the users to make calls and send messages.

Feature phones were the "value phones", with features like camera to take pictures and record video, web browser for surfing the web, email support, Java games and even color displays to support richer UI. They formed the bulk of the mobile phone market at the time and both operators and device manufacturers were constantly trying to make the devices more attractive by offering innovative features and hardware capabilities.

Smart phones were the high-end phones primarily for the enterprise customers with integrated connectivity and productivity applications like email, messaging and document viewers. Most featured full-QWERTY keyboards to allow for easy typing, proprietary solutions to enable the users to stay "always connected" and allowed additional software applications for data processing and connectivity to be installed by the users.

Apple launched the iPhone in 2007, and at the time of its launch there was some question if it could be called a "smartphone" as it did not allow additional software to be installed on its platform at that time.[9] However, Apple announced its intention to launch a Software Development Kit (SDK) for 3rd party developers in 2008 to satisfy that requirement and thus introduced "smartphones" to a totally new category of users – the average, non-tech savvy users. Its full-touch user interface

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[9] http://www.engadget.com/2007/01/09/the-iphone-is-not-a-smartphone/ retrieved on May 1, 13

was so intuitive and easy to use that it drew in the non-tech savvy users who were thus far vary of "hi-tech" smartphones as they found them unusable.

In late 2007, the Open Handset Alliance, an alliance that included technology and mobile companies like Google, HTC, Samsung, Sprint Nextel, T-Mobile, Qualcomm and Texas Instruments, was formed and they announced their plans to release an open source smartphone operating system called Android. The announcement described the OS platform as consisting of an integrated mobile software stack – the operating system, middle-ware, user interface and applications and also announced the release of an SDK to provide developers with the tools necessary for developing applications on Android. [10]

Along with launching SDKs for developers, iOS and Android launched services like an application store, which was a virtual market where the users could buy applications and content as well as a monetization framework for the developers to charge the users for their applications, thus creating revenue potential for the developers.

Prior to this, the smartphone OS(s) allowed independent developers to develop applications for mobile phones, but the development process was tedious and not easy to use. For the feature phones, the only option available to the application developers was to create Java applications using a limited J2ME API set. As a result, the only applications available for feature phones were Java games developed by large gaming houses that could afford to spend time and money needed.

The smartphones had more applications available, but there wasn't a clear channel for the users to buy them. There wasn't one dedicated application store; there were dozens of them making it all confusing for the users.

The availability of SDK(s) and an easy channel to sell applications helped motivate individual hobbyists along with the large 3rd party application developers to develop

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[10] http://www.openhandsetalliance.com/press_110507.html retrieved May 8, 13

applications for iOS and Android platforms. The users were enticed by the cool applications available to buy devices running these OS(s) increasing the monetization potential for the developers; creating a virtuous cycle that made the number of applications available on these platforms grow by leaps and bounds.

Soon, the applications were not limited to just games and productivity tools, but seeing the increasing reach of mobile phones, the developers started developing a wide variety of services like cloud storage, location based services like local deals, local information and navigation on top of the OS platform.

Evolution of the Solution Stack

The solution stack has evolved along with the market and has grown progressively more complex with the addition of services, OS features and content. Taking a look at this evolution will help us understand the direction of growth in the solution stack.

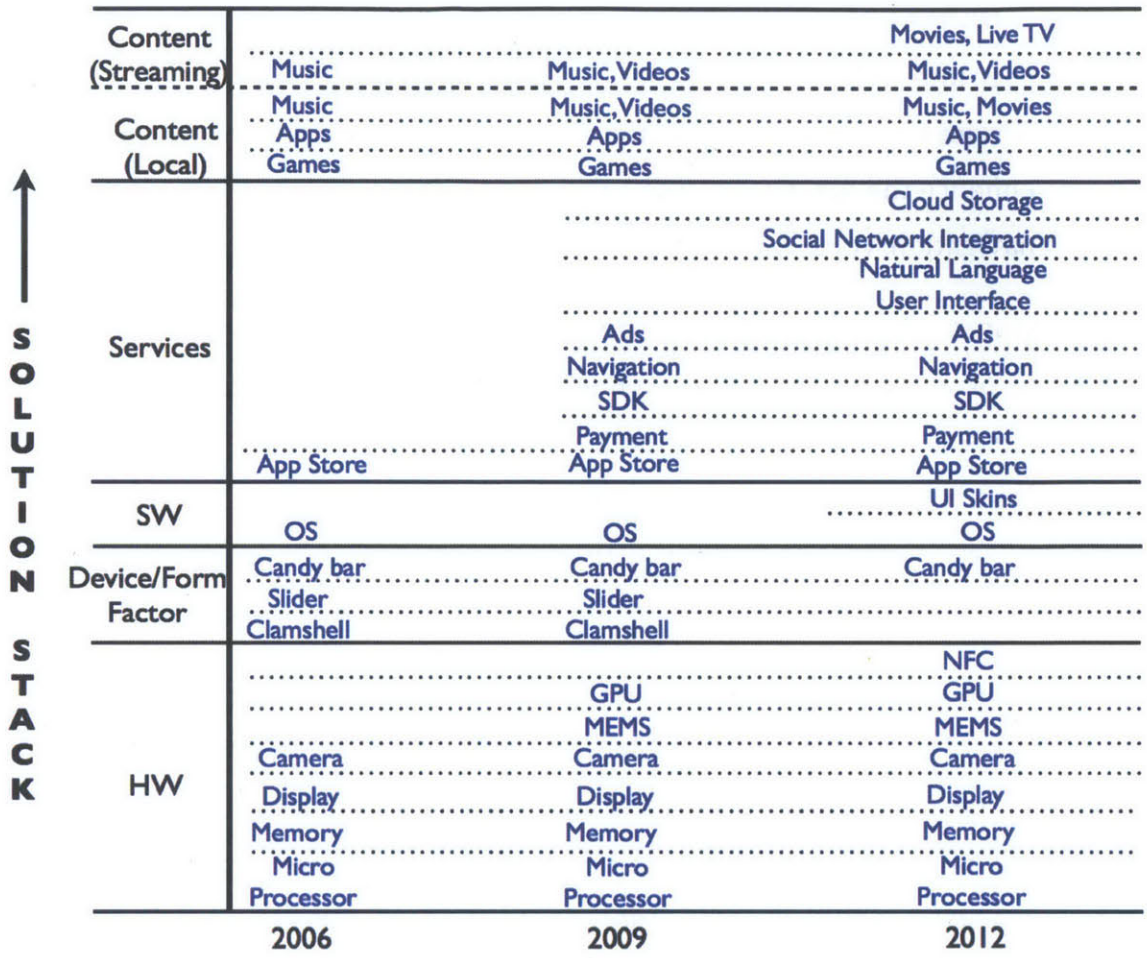

Figure 4: Simplified Solution Stack Evolution

Figure 4 above shows a simplified version of the evolution of the solution stack over the last six years. The image only shows some of the hardware components and services that have been introduced into the solution stack in order to give an idea about the growth and increase in complexity. The actual mobile phone "solution" involves more hardware components and services than the ones shown above.

The mobile phone solution stack has been divided into five components, which we shall see again when we analyze the evolution of mobile phone landscape.

- Hardware, which includes the sub-components that go into a mobile phone like display, camera, memory, microprocessors and GPU.
- Device is the actual phone, which integrates the hardware components and the software components like the OS and applications.

- Software includes the OS and other capabilities that form the OS like the user interface.
- Services component includes the services available to the users that enhance the functionality of a mobile phone like cloud storage and backup, navigation, voice commands or natural language input and so on.

The solution stack in 2006, pre iPhone, was comparatively simple with the device consisting of a few hardware components like a camera, display, memory and microprocessor, the OS and some applications. In terms of content, the users could download and install games on their phones. In case of smartphones, there were 3rd party application stores that allowed the users to buy and download applications that can be installed on the device for additional functionality.

By 2009, the solution stack had grown to include services like payment mechanism, SDKs for application developers, advertisement framework and navigation. The creators of the OS provided most of these services and they were integrated into the OS. The mobile phone hardware included a Graphics Processing Unit (GPU) for processing high quality images and videos and sensors like gyroscope and accelerometers to improve device responsiveness. The content available for the users also grew to include more applications, games music and videos, due to the availability of SDKs, monetization potential and easy mechanisms available to the developers to sell their applications.

The solution stack now is highly complex, with the devices integrating more hardware components like faster microprocessors, NFC chips and the OS evolving to accommodate them. In addition, the services have now grown to include sophisticated payment mechanisms like NFC, cloud backup and storage, social network integration, natural language user interface and mobile advertisements. The OS vendors created some of these services and included them as a part of the platform, while others services were launched as applications but were later absorbed into the platform.

The content similarly has evolved from just local content available on the phone like music, games and applications to include streaming of a variety of content like videos, movies and even television content.

From Figure 4, we can see that there are more features and services becoming available to the users over time, which can be explained by the ease with which anyone can create and publish applications and services on the OS platforms as well as large application developer ecosystem that has risen around the software platforms.

As the number of software services and applications has grown, we can see that the smartphone OS has become a critical piece as it forms the basis for the availability of services and applications for the users as well as the basis of a rich ecosystem of partners that provided pieces of the solution stack.

In a couple of years, as the software becomes "good enough", there will be a wave of hardware innovation that will cause the value to flow back into the hardware. And the industry, thus, shifts back and forth between software-centric and hardware-centric innovation. The theory of value chain dynamics by Charles Fine (Fine, 1998) describes this cyclical nature of the process of integration and modularization and the shifts in the value chain.

Chapter 4: Dominant Design for Mobile Phone Hardware

To analyze and understand the evolution of mobile phone hardware device, we will use a data set of the best phones and smartphones in the US as ranked by CNET and ZDNET every year from 2007 to 2012. A list of the phone models used for each year is included in the appendix. Figure 5 below shows the compilation of the mobile phone form factor for each year to give an idea about the evolution of mobile phone hardware.

As we can see in Figure 5, from 2007 to 2010 the phones are classified in two categories – regular or feature phones and smartphones. That is because, from 2007 to 2010, CNET published two different lists of "best" phones of the year – one for feature phones and one for the smartphones. For 2011 and 2012, they only published the list of top smartphones for the two years, getting rid of the "feature phone" categorization altogether.

As we can see in Figure 5 below, the "best" phones from 2007 to 2010 had many different form factors – sliders where you slide the display to reveal a keyboard, flip-phones or clamshells where there are two or more sections connected by a hinge and candy bar or just a "bar" where the phone is just one piece and resembles a candy bar. [11, 12] But, there was only one form factor – the bar or candy bar amongst the phones chosen as the best of 2011 and 2012.

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[11] http://en.wikipedia.org/wiki/Flip_%28form%29 retrieved May 3, 13
[12] http://en.wikipedia.org/wiki/Mobile_phone_form_factor retrieved May 3, 13

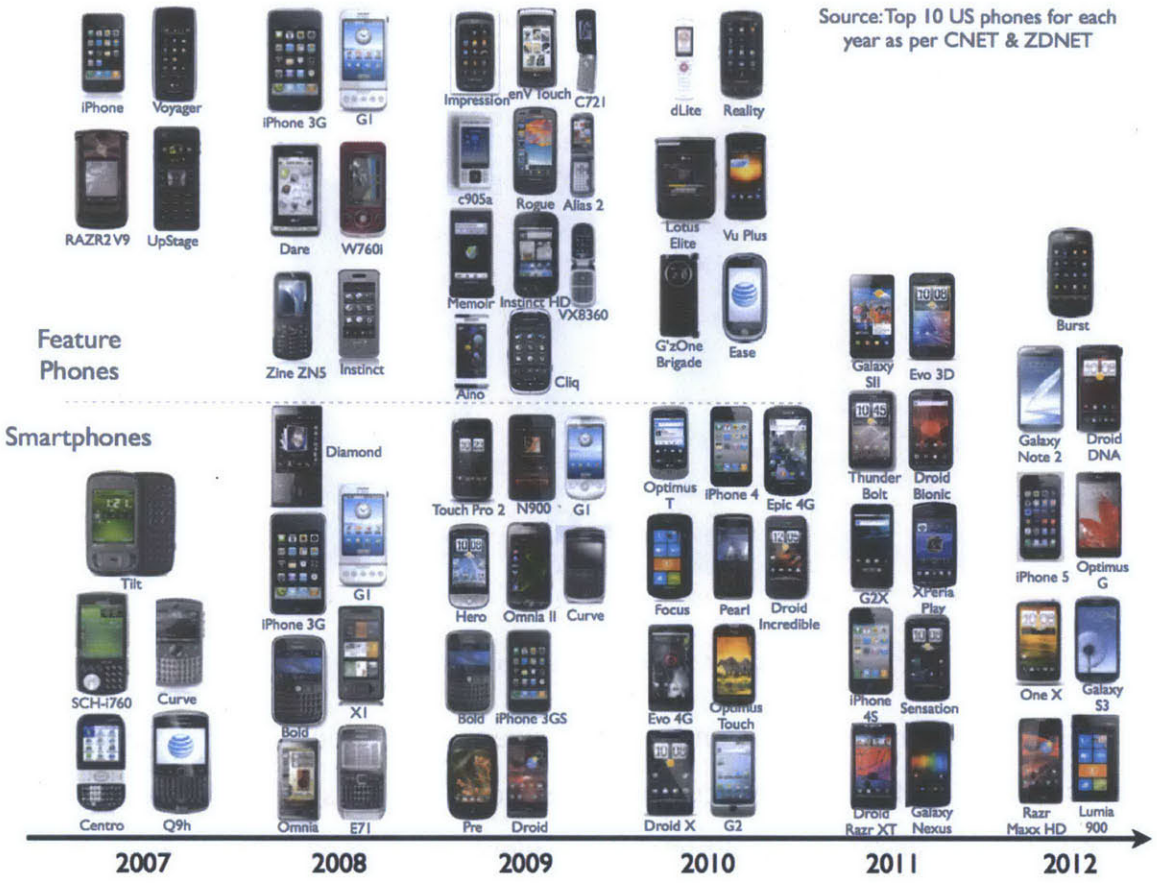

Figure 5: Mobile Phone Hardware Evolution

Similarly, most of the smartphones from 2007 to 2009 had a physical QWERTY keyboard to allow the enterprise users to type out long emails. 2010 had just one smartphone with a physical keyboard. By 2011, all the phones had done away with physical keyboards and had virtual, touch keyboards as all of them sported a large, high-resolution touch screen. Figure 6 shows the number of touch versus non-touch phones in the best phones list for each year.

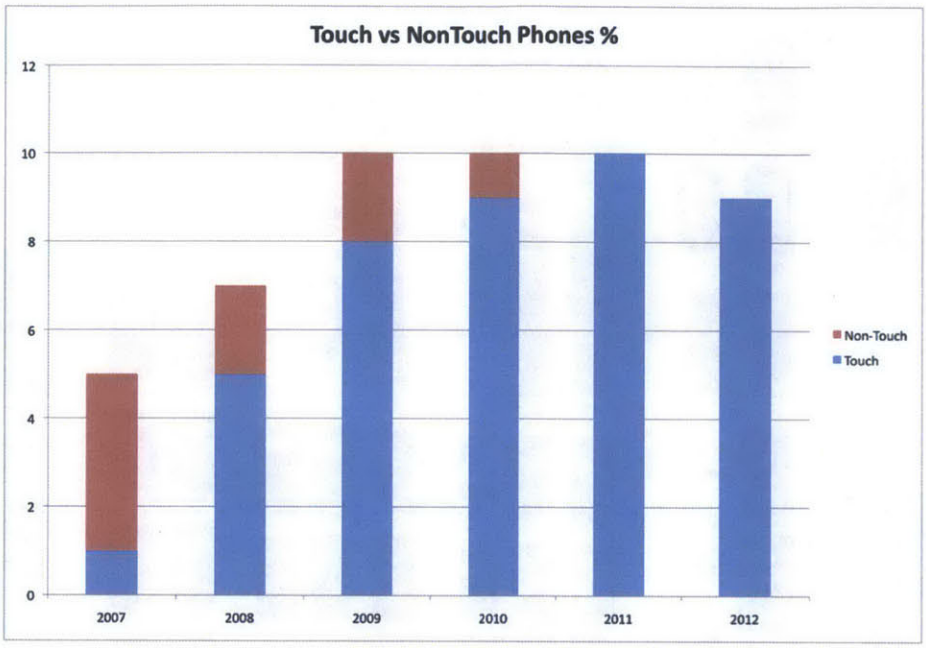

Figure 6: Touch vs. Non Touch Phones

Figure 5 also shows the variation in screen sizes of the phones over the years. The phones from 2007 had smaller screen size to allow for a physical keyboard. By 2008, looking at the success of the iPhone, there were some "look-alikes" phones being introduced up with larger displays. In 2010, the Blackberry Pearl was the only phone on the top 10 for that year with a small (<3") screen size and a physical keyboard. By 2011, all phones had large screens and no physical keyboards.

The fact that all the phones in 2011 and 2012 used the touch screen technology, had no physical keyboards and were all the same candy bar form factor is a strong indicator that the industry is moving towards a "best selling" or a dominant design.

Dominant design is a design that becomes the de facto standard in the market due to its widespread adoption. (Utterback, 1994). For example, the PC(s) after a dominant design was established had very similar hardware configurations – a CPU, a display, a keyboard and mouse. The CPUs from different vendors too had similar configuration – a motherboard, a microprocessor, graphics processor, RAM, hard drive, a network card and other external connectors like USB.

Implications of Dominant Design

Standardization & Modularization

The establishment of a dominant design for mobile phones allows the hardware components that are "good enough" to be standardized and hence modularized.

Standardization means that the requirements for these components are now well-understood, prompting more vendors to enter this space as "fast followers" and leveling the playing field for the existing vendors. This creates competition amongst the vendors and it leads to lower component cost for the device manufacturers.

We can see this in the number of GPU vendors over the years. GPU(s) were only introduced in the mobile phones in 2008, because of the increase in the screen size and the need for high-resolution displays and graphics. Since then, the number of GPU vendors has been steadily increasing. There were only two GPU vendors for the phones in the data set from 2008 to 2010, while there were four GPU vendors in 2011, coinciding with the time when a dominant design for mobile phones emerged (Figure 7).

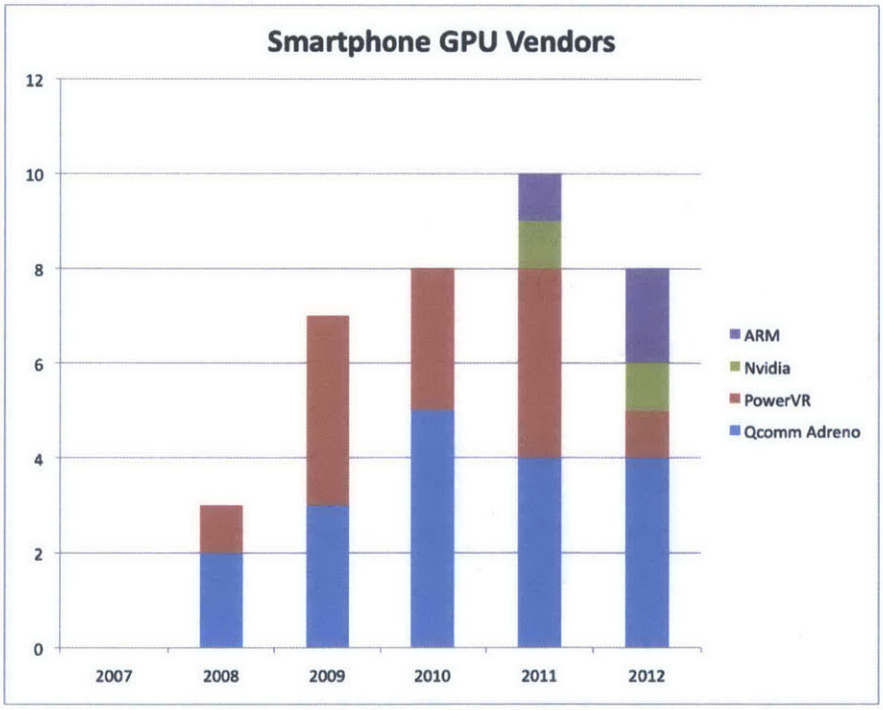

Figure 7: Smartphone GPU Vendors

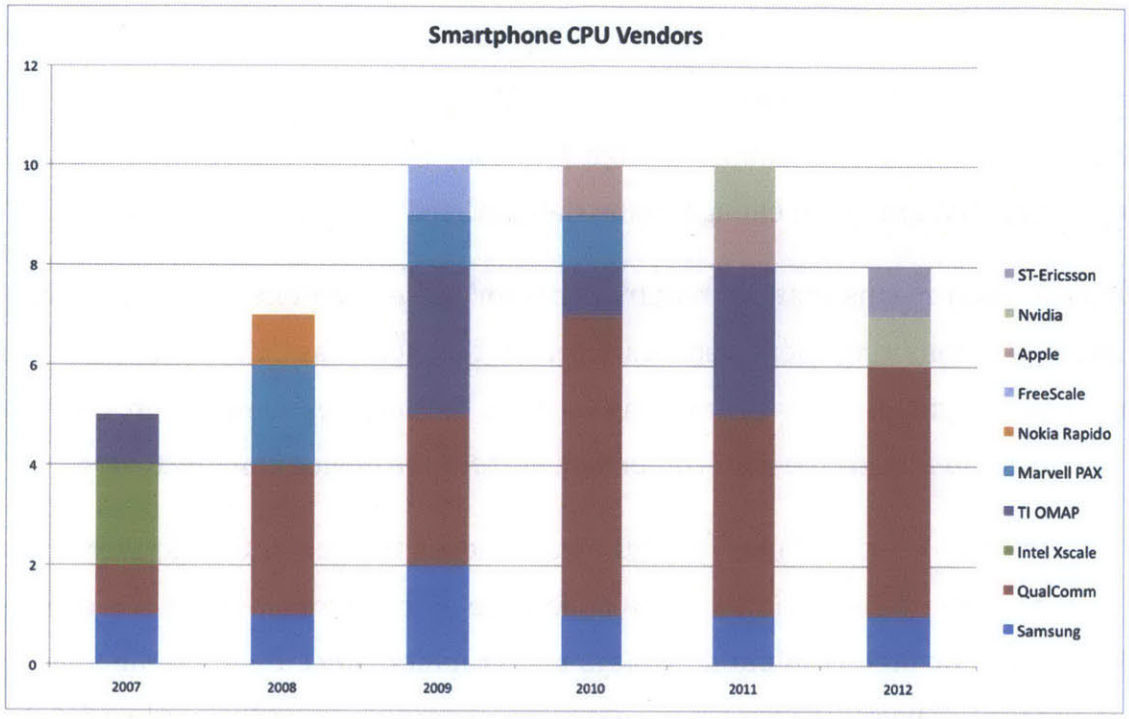

Figure 8: Smartphone Microprocessor Vendors

In contrast, there are a number of microprocessor (CPU) vendors in the mobile phone market operating from 2007 to 2012, with new entrants entering this space and old organizations dropping off, making this a crowded space. We can see microprocessors from two new vendors - Nvidia and ST-Microelectronics in the top phones from 2011 and 2012 (Figure 8).

When we look at the range of screen sizes across the phones (Figure 9), in 2010 there are phones with four different screen sizes in the top phones list. This changes to just two major screen sizes in 2011, with just one phone (Blackberry Pearl) sporting a smaller screen than the rest.

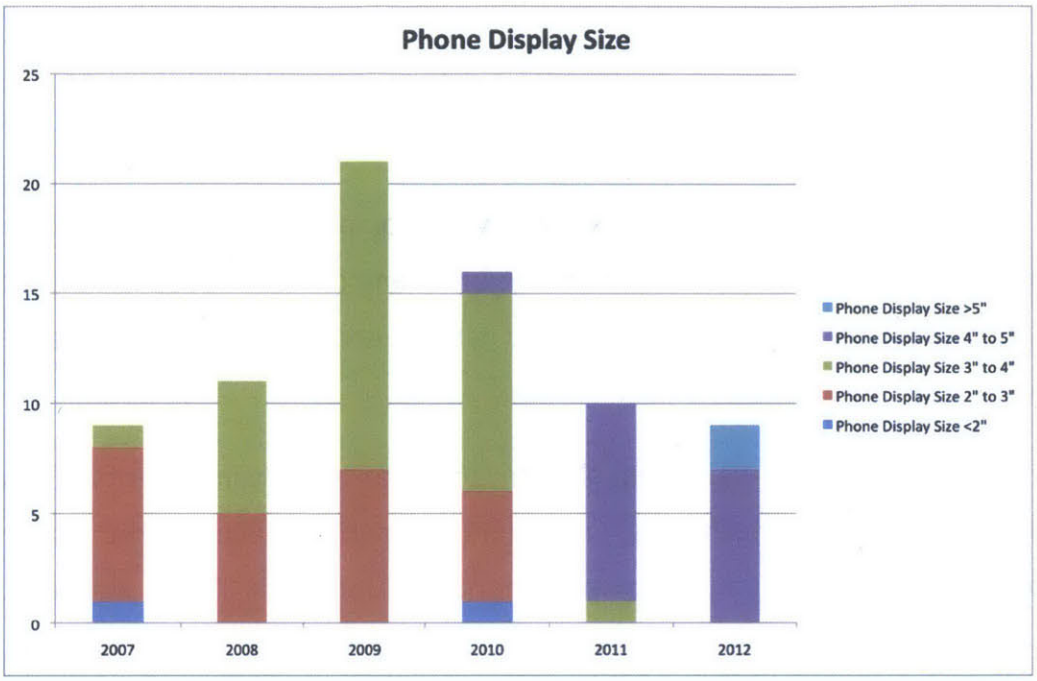

Figure 9: Phone Display Size

Increasing Competition

Another implication of the emergence of a dominant design is that there will now be more devices in the market with the dominant design. Now that the recipe for "best selling" mobile phone hardware is known, more manufacturers will want to enter the space to capture some market share. While their phones may not be at the best in the market, they will still be good enough to provide the users with alternative options for the high priced devices and thus switching the basis of competition from functionality to price. This phenomenon is also explained by the Abernathy-Utterback model for product and process innovation, which states that the innovation moves from product innovation (features, capabilities) to process innovation (operational improvements to reduce cost) after the emergence of a dominant design. (Abernathy and Utterback, 1978)

The number of device manufacturers will keep increasing till a market consolidation happens, as only a few manufacturers can achieve the economies of scale needed to keep the device prices low. Meanwhile, the increase in the number of good enough

devices means the shifting of power and control from the sellers (device manufacturers) to the buyers (network operators and end users).

Shifting of Value

As the dominant design emerges, hardware components get standardized, the number of hardware component manufacturers and device manufacturers increase, and the components as well as the device get cheaper; will there be any value in the hardware?

The answer is yes. The value will shift to those hardware components that are the bottleneck in terms of technology, suppliers and performance like the displays and memory chips currently in the mobile phone solution stack. This is similar to what happened in the PC industry as the PC and its components overshot the performance expected by its customers. (Christensen, Raynor and Verlinden, 2001)

We can already see this reflected in the estimated Bill of Material (BOM) costs for some of the mobile phones, based on the cost estimates published by IHS iSuppli Research in 2011, 2012 and 2013. (Figure 10, Figure 11, Figure 12 below)

Preliminary Samsung Galaxy S4 Virtual Teardown BOM Estimates (Pricing in U.S. Dollars)

	Samsung Galaxy S4 (HSPA Version)		Samsung Galaxy S4 (LTE Version)		Samsung Galaxy S3 (HSPA Version)	
Total BOM Cost	**$236**		**$233**		**$205**	
Manufacturing Cost	**$8.50**		**$8.50**		**$8.00**	
BOM + Manufacturing	**$244**		**$241**		**$213**	
Major Cost Drivers						
Memory (NAND Flash + DRAM)	16GB eMMC + 2GB LPDDR3	$28.00	16GB eMMC + 2GB LPDDR3	$28.00	16GB eMMC + 1GB LPDDR2	$29.00
Display & Touchscreen	5" 1920x1080 Super AMOLED (441ppi), w/ Gorilla®Glass3 by Corning	$75.00	5" 1920x1080 Super AMOLED (441ppi), w/ Gorilla®Glass3 by Corning	$75.00	4.8" 1280x720 Super AMOLED, w/ Gorilla®Glass2 by Corning	$65.00
Processor	Samsung Exynos 5 Octa (5410)	$30.00	Qualcomm Snapdragon 600 (APQ8064T) - Quad-Core	$20.00	Samsung Exynos 4 Quad	$17.50
Camera(s)	13MP + 2MP	$20.00	13MP + 2MP	$20.00	8MP + 1.9MP	$19.00
Wireless Section - BB/RF/PA	Possibly contains Intel PMB9820 + PMB5745 + Front End	$16.00	Possibly contains MDM9615 + WTR1605L + Front End	$25.00	Contains Intel PMB9811 + PMB5712 + Front End	$14.50
User Interface & Sensors	Contains accelerometer, RGB Light, e-compass, Gyro, Barometer, Temperature & Humidity, IR Gesture	$16.00	Contains accelerometer, RGB Light, e-compass, Gyro, Barometer, Temperature & Humidity, IR Gesture	$16.00	Contains Capella CM3663 ALS / Proximity, ST LSM330DLC Accelerometer / Gyro, AKM AK8975C e-Compass, & ST LP331AP Barometer Sensors	$12.70
WLAN / BT / FM / GPS	Possibly contains Broadcom BCM4335 + BCM47521	$9.00	Possibly contains Qualcomm Atheros WCN3680	$5.75	Contains Broadcom BCM4334 + BCM47511	$8.20
Power Management	Samsung PMIC (TBD)	$8.00	Qualcomm PMICs	$9.50	Contains Maxim PMIC	$7.00
Battery	3.8V, 2600mAh w/ NFC Antenna (TBD)	$5.60	3.8V, 2600mAh w/ NFC Antenna (TBD)	$5.60	3.8V, 2100mAh w/ NFC Antenna	$4.90
Mechanical / Electro-Mechanical		$22.00		$22.00		$21.40
Box Contents		$6.00		$6.00		$6.00

Source: IHS iSuppli Research, March 2013

Figure 10: Samsung S4 estimated BOM Costs

Preliminary Analysis - And Comparison With Samsung Galaxy SII Skyrocket

Components / Hardware Elements	Nokia Lumia 900	Samsung SII Skyrocket
Retail Pricing (As of April 2012)	$449.99	$549.99
Total BOM Cost	$209.00	$235.50
Manufacturing Cost	$8.00	$8.00
BOM + Manufacturing	$217.00	$243.50
Major Cost Drivers		
Memory	$27.00	$32.00
Display & Touchscreen	$58.00	$64.00
Processor	$11.00	$22.00
Camera(s)	$18.00	$20.00
Wireless Section - BB/RF/PA	$38.00	$37.00
User Interface & Sensors & Combo Module (WLAN/BT/FM)	$14.00	$16.50
Power Management	$9.00	$11.00
Battery	$4.50	$5.00
Mechanical / Electro-Mechanical / Other	$18.00	$22.00
Box Contents	$5.50	$6.00

Source: IHS iSuppli Research, April 2012

Figure 11: Nokia Lumia 900 and Samsung SII Skyrocket estimated BOM Cost Comparison

Preliminary Bill of Materials (BOM) Estimate for the Major Subsystems in the iPhone 4S (in U.S. Dollars)

	4S		
	16GB	32GB	64GB
Retail Price w/Contract	$199	$299	$399
Total BOM Cost	$188	$207	$245
Manufacturing Cost	$8	$8	$8
BOM + Manufacturing	$196	$215	$254
Major Cost Drivers			
Memory			
NAND Flash	$19.20	$38.40	$76.80
DRAM (DDR / DDR2)	$9.10	$9.10	$9.10
Display & Touch Screen			
Display	$23.00	$23.00	$23.00
Touch screen	$14.00	$14.00	$14.00
Processor	$15.00	$15.00	$15.00
Camera(s)	$17.60	$17.60	$17.60
Wireless Section - BB/RF/PA	$23.54	$23.54	$23.54
User Interface & Sensors	$6.85	$6.85	$6.85
WLAN / BT / FM / GPS	$6.50	$6.50	$6.50
Power Management	$7.20	$7.20	$7.20
Battery	$5.90	$5.90	$5.90
Mechanical / Electro-Mechanical	$33.00	$33.00	$33.00
Box Contents	$7.00	$7.00	$7.00

Source: IHS iSuppli October 2011

Figure 12: iPhone 4S estimated BOM costs

In fact, the estimated cost of the display and memory has been increasing over the years because of the increase in screen sizes and memory capacity, as well as the high demand for those components.

Chapter 5: Software Platform Evolution

We saw the evolution of mobile phone hardware in the last chapter and saw the increase in the number of features and services available on OS platform.

In this chapter we take a look at the mobile phone software platform. We start by understanding why a smartphone platform is important for ecosystems creation and growth. We then take a look at the growth of the SW platform functionality, by looking at the inorganic growth activities like mergers and acquisitions (M&A) of the OS developers in the last 4 years.

Understanding smartphone OS platforms

The smartphone OS has grown more important over the last few years with the rapid increase in the types of functionality and services available for mobile phones over the years, shown in Figure 4.

A lot of this growth can be attributed to the extremely important developer ecosystem that has evolved around the smartphone OS(s), helped by the introduction and availability of tools (like SDKs) and distribution frameworks (application stores). These tools made it easy for individuals and 3rd party application developers to develop and sell their applications and services, promoting user-centered innovation on the smartphone OS platforms. (Von Hippel, 2005)

This application ecosystem is critical for the evolution of the software platform. As the application ecosystem grows to include applications that appeal to niche users, the platform itself becomes more valuable as it now appeals to a wider audience than it would have without these applications.

The best-selling applications also help the platform leaders identify the functionality that the users want most. Not to mention that it is impossible for any organization to match the cumulative development resources and creativity of the developers that form the application ecosystem of a smartphone OS.

A lot of the services added to the solution stack over the years, started as applications or services developed by external developers. Once these applications and services grew popular, they were integrated into the platform – either by developing the same functionality in-house or through acquisitions.

Mergers & Acquisitions

M&A: Apple

Table 1 lists the 15 companies Apple acquired from 2008 to this date.[13] We can see that all the acquisitions were for technology that was used to enhance either the iPhone device or the iOS platform.

It is also interesting to note that out of 15 companies, only three (including AuthenTec) were hardware companies. The rest of the companies acquired are all software or services companies, indicating the importance of software in Apple's mobile strategy.

Table 1: Apple Mergers & Acquisitions List

#	Company Name	Company Business	Date of Acquisition	Derived Products
1	P.A. Semi	Semiconductors	April 2008	Apple A4, A5 (SoC)
2	Placebase	Maps	July 2009	Maps
3	Lala.com	Music Streaming	December 2009	iCloud, iTunes Match
4	Quattro Wireless	Mobile Advertising	January 2010	iAds
5	Intrinsity	Semiconductors	April 2010	Apple A5 (SoC)
6	Siri	Voice Control Software	April 2010	Siri
7	Poly9	Web-based Mapping	July 2010	Maps
8	Polar Rose	Face-Recognition	September 2010	iPhone Software (Camera)
9	IMSense	High Dynamic Range Photography	September 2010	iPhone Software (Camera)
10	C3 Technologies	3D Mapping	August 2011	Maps
11	Anobit	Flash Memory	December 2011	iPhones and iPads
12	Chomp	App Search Engine	February 2012	iPhones and iPads
13	AuthenTec	Security HW and SW for PCs and mobile devices	July 2012	iPhones and iPads
14	Particle	HTML5 Web App Firm	September 2012	Web

[13] https://en.wikipedia.org/wiki/List_of_mergers_and_acquisitions_by_Apple retrieved May 5, 13

15	WiFiSlam	Indoor Location	March 2013	Maps

M&A: Google

Google has acquired 76 companies from the beginning of 2008 to this date.

Table 2 below lists the 29 companies whose technology was used for something on the mobile phone solution stack we saw in the previous chapter.[14] The full list of companies can be found in the Appendix at the end of this thesis.

From the table below, we can see that all of the companies acquired are software companies, which is not surprising since Google primarily is a software company.

Out of the 29 companies it acquired, technology from six of them went to improve YouTube – Google's video platform, technology from 11 helped improve its services offering for the Android solution stack and technology from 12 was used for the Android platform.

It is interesting to note that only 12 out of the total 76 companies acquired were acquired to improve the Android platform and 10 (or 16, if we include the ones for YouTube) were acquired for improving the Android solution stack (services and content available for Android), showing equal focus on improving the OS and the solution stack.

[14] https://en.wikipedia.org/wiki/List_of_mergers_and_acquisitions_by_Google retrieved May 5, 13

Table 2: Google Mergers & Acquisition List For Android

#	Company Name	Company Business	Date of Acquisition	Derived Products
1	Omnisio	Online Video	July 2008	YouTube
2	On2	Video Compression	August 2009	WebM, YouTube
3	AdMob	Mobile Advertising	November 2009	DoubleClick, Invite Media
4	Teracent	Online Advertising	November 2009	AdSense
5	Agnilux	Server Technology start-up	April 2010	Android
6	LabPixies	Gadgets	April 2010	iGoogle, Android
7	BumpTop	Desktop Environment	April 2010	Android
8	Simplify Media	Music Syncing	May 2010	Android
9	Zetawire	Mobile Payment, NFC	August 2010	Android, Google Wallet
10	Instantiations	Java/Eclipse/AJAX Tools	August 2010	Google Web Toolkit
11	Quiksee	Online video	September 2010	Google Maps
12	BlindType	Touch Typing	October 2010	Android
13	Phonetic Arts	Speech Synthesis	December 2010	Google Voice, Google Translate
14	SayNow	Voice Recognition	January 2011	Google Voice
15	Fflick	Social Networking Service	January 2011	YouTube
16	Next New Networks	Online Video	March 2011	YouTube
17	Green Parrot Pictures	Digital Video	March 2011	YouTube
18	TalkBin	Mobile Software	April 2011	Android
19	AdMeld	Online Advertising	June 2011	DoubleClick, Invite Media
20	PittPatt	Facial Recognition System	July 2011	Android
21	Motorola Mobility	Mobile Device Manufacturer	August 2011	Android, Google TV, Patent Portfolio
22	Zagat	Restaurant Reviews	September 2011	Google Places, Google Maps
23	RightsFlow	Music Rights Management	December 2011	YouTube
24	Clever Sense	Mobile Apps	December 2011	Android
25	TxVia	Online Payment	April 2012	Google Wallet
26	Nik Software Inc.	Photography	September 2012	Android
27	Viewdle	Facial Recognition	October 2012	Android
28	BufferBox	Package Delivery	November 2012	Android
29	Web Application Server Talaria	Cloud Computing	March 2013	Google Cloud

M&A: Blackberry

Table 3 below shows the list of 16 acquisitions made by Blackberry over the last 5 years.[15] Of the 16 acquisitions, most of them were for software and only two were hardware companies.

All the software companies acquired by Blackberry were to improve its OS, its application store and other services needed to make it a competitive alternative to iOS and Android. The most important of them all, I believe, is the acquisition of QNX Software System, whose technology has formed the basis of its new Blackberry 10 OS, the reason for getting a Blackberry mobile phone back on the list of top phones for 2012.

Table 3: Blackberry Mergers & Acquisitions List

#	Company Name	Company Business	Date of Acquisition	Derived Products
1	Certicom	Cryptography	January 2009	Hardware
2	Chalk Media	Software	January 2009	Software
3	Dash Navigation	Car Navigation Systems	June 2009	Software
4	Torch Mobile	WebKit Mobile Browser	August 2009	Software
5	QNX Software Systems	Unix like OS	April 2010	Software
6	Cellmania	App Store Software Maker	August 2010	Software
7	Documents To Go and other assets	Office Suite	September 2010	Software
8	The Astonishing Tribe	Interface Wizards	December 2010	Software
9	Gist	Professional Contact Manager	February 2011	Software
10	tinyHippos	Mobile Web Development	March 2011	Software
11	Tungle.me	Social Calendaring	April 2011	Software
12	Scoreloop	Social Gaming	June 2011	Software
13	Ubitexx	Mobile Device Management	May 2011	Software
14	Jaycut	Video Editing	July 2011	Software
15	NewBay	Content Provider	October 2011	Software
16	Paratek	RF multi-band handsets	March 2012	Hardware

[15] https://en.wikipedia.org/wiki/List_of_mergers_and_acquisitions_by_BlackBerry retrieved May 5, 13

M&A: Microsoft

Table 4 below gives the list of 35 companies Microsoft acquired from 2008 to this date.[16] Out of the 35 acquisitions, 13 acquisitions had technology that could have been used for Microsoft's mobile platform – Windows Mobile, Windows Phone or for services on top of the OS, which is more than a third of its acquisitions.

This high number of acquisitions of companies with technologies useful for mobile phones can be an indicator of Microsoft's focus on improving its presence in the mobile phone market.

Another interesting observation is that there is a four-year gap between its acquisitions for mobile technology. In 2008, Microsoft bought Danger and Mobicomp – companies that created a mobile Internet software and mobile applications. The next acquisition that could be related to mobile came in 2012, with the acquisition of Perceptive Pixel.

At the same time, the total number of acquisitions reduced drastically from 2009 – 2011, 11 for the three years as compared to 16 just in 2008 alone. This could be to reduce risk during the economic downturn that prevailed in the US at that time and focus on the safe enterprise market.

However, from 2009 to 2011 was also when the mobile phone platform was undergoing massive changes in its solution stacks, technology platform and value flows and its lack of attention on mobile in those years could be the reason why Microsoft has fallen behind most of other organizations in this space.

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[16] http://en.wikipedia.org/wiki/List_of_mergers_and_acquisitions_by_Microsoft retrieved May 5, 13

Table 4: Microsoft Mergers & Acquisitions List

#	Company Name	Company Business	Date of Acquisition	Assumed Derived Products
1	Calista Technologies	Software	January 2008	
2	Caligari Corporation	Software	February 2008	
3	YaData	Software	February 2008	Analytics
4	Rapt	Advertising Yield Management Software	March 2008	Ads
5	Komoku	Rootkit Security Software	March 2008	Security
6	90 Degree Software	Business Intelligence SW	March 2008	Enterprise
7	Farecast	Online Search Software	April 2008	Bing
8	Danger	Mobile Internet Software	April 2008	Mobile
9	Fast Search & Transfer	Enterprise Search	April 2008	Bing
10	Kidaro	Software	May 2008	Enterprise
11	Quadreon	Software	June 2008	Enterprise
12	Navic Networks	Management Software	June 2008	Ads
13	Mobicomp	Mobile Applications	June 2008	Mobile
14	Powerset	Semantic Search	August 2008	Bing
15	DATAllegro	Data Software	September 2008	
16	Greenfield Online	Search and e-commerce services	September 2008	Bing
17	3DV Systems	Developer of ZCam, a time-of-flight camera	March 2009	Xbox
18	BigPark	Interactive Online Gaming	May 2009	Games
19	Rosetta Biosoftware	Bioinformatics solutions	June 2009	
20	Interactive Supercomputing	Software	September 2009	Servers
21	Opalis Software	Software	December 2009	Enterprise
22	Sentillion Inc.	Identity & Access Mgmt SW for Healthcare	December 2009	
23	AVIcode Inc.	.Net Monitoring Technology	October 2010	
24	Canesta Inc.	3-D Sensing Technology	October 2010	Xbox
25	Skype Communications	Telecommunications	May 2011	
26	Prodiance	Software	June 2011	Enterprise
27	Videosurf	Video Search	November 2011	Bing
28	Yammer	Social Networking	June 2012	
29	Perceptive Pixel	Multi touch hardware	July 2012	Mobile
30	PhoneFactor	Two-factor authentication system	October 2012	Mobile
31	StorSimple	Cloud-storage appliance vendor	October 2012	Office
32	MarketingPilot	Marketing Automation	October 2012	IT
33	Id8 Group R2 Studios	Home Automation	January 2013	
34	MetricsHub	Cloud Monitoring	March 2013	Cloud
35	Netbreeze	Social Analytics	March 2013	IT

M&A: Samsung

Table 5 below gives us the list of six acquisitions by Samsung from 2008 to this date.[17]

Out of the six, there are three companies that have technologies related to the mobile solution stack. Grandis Inc. and NVELO Inc. both had technologies to improve Samsung's memory chips – an important and one of the costliest components of the mobile phone. The third company, mSpot Inc. developed a cloud based music player, and its acquisition marks Samsung's foray into the world of software and maybe its hopes of moving up the solution stack to software and services, where I hypothesize the value is going to be.

Table 5: Samsung Mergers & Acquisitions List

#	Company Name	Company Business	Date of Acquisition	Derived Products
1	MEDISON Co. Ltd.	Medical Equipment Company	December 2010	
2	Grandis Inc.	Memory Developer	July 2011	
3	Samsung and Sony Joint Venture	LCD Display	December 2011	
4	mSpot Inc.	Music Service	May 2012	
5	NVELO Inc.	Cache Software Developer	December 2012	
6	NeuroLogica	Portable CT Scanner	January 2013	

[17] http://en.wikipedia.org/wiki/Samsung#Acquisitions_and_attempted_acquisitions retrieved May 5, 13

Chapter 6: Ecosystems in Mobile Phone Market

Having understood the evolution of mobile phone hardware and software platforms over the last couple of years, lets look at the mobile phone market through an ecosystem lens to understand the structure and value flows that exist in the market.

The growing complexity of the mobile solution stack and increasing importance of applications, services and content in the solution stack has forced the market leaders to create ecosystems of partners and content that provide pieces of the solution stack. This shift in the market is important to understand, as it requires the organizations to adopt a very different business strategy to succeed.

A business ecosystem is defined as "an economic community of organizations and individuals that interact to produce goods and services of value to customers, where members co-evolve their capabilities and roles over time to move towards a shared vision". (Moore, 1996)

One could argue that the concept of "networked business" has been present in the market for a long time with the strength of "network connections" ranging from a transactional buyer-supplier relationship to a joint-venture/long-term partnership.

However, as the offerings to consumers grow from products to services to solutions, an organization has to increasingly rely on its partners to provide a lot of the complementary pieces. Quite often the success of the offering depends on how strategic an organization has been in creating a platform that draws in a community of partners (its ecosystem) to create more value for its customers.

For example, in the personal computers market, Intel and Microsoft helped create and grow the PC ecosystem by leading various initiatives for improved I/O and graphic standards and providing a platform (and supporting infrastructure) for its hardware and software partners to innovate on.

In return, the availability of hardware peripherals like mice, joysticks, keyboards, cameras, modems as well as the software applications like productivity suites,

games, graphics software, desktop publishing software created tremendous value for the PC, making it usable by millions of users, leading to higher PC and ultimately higher Intel microprocessor and Microsoft software sales.

More recently, an iPod without the iTunes ecosystem of music, videos, movies, books, games, applications and such, would just be a great MP3 player with great user experience. It is the availability of the content on iTunes as well as the ability for users to develop applications for the device that makes the iPod an enormously successful product.

Apple's strategic move in bringing music, video, and movie content into iTunes along with creating a superior device is what created value in this ecosystem. And its business model of keeping the platform just open enough to enable innovation while controlling all aspects of its hardware enables it to capture most of this value.

In both the examples above, ecosystems were built on technology platforms that were owned or controlled by the ecosystem leaders. The mobile phone ecosystems are also based on two platforms that the ecosystem participants can innovate with – the hardware or the actual device and the software or the OS.

Ecosystems And Mobile Phone Landscape

The existing ecosystems in mobile phone market are built on top of smartphone OS platform, as it provides the capability to run applications and services for the ecosystem participants. Also, the OS developers provide the supporting infrastructure like SDKs, application stores, support forums and payment mechanisms, needed for development of these application and services.

Along with the makers of the OS(s), there are numerous other organizations, involved at every level of the solution stack and participating in different OS-based ecosystems, looking to succeed in this market; making this a very crowded space.

Figure 13 below shows the organizations involved in creating a simplified solution stack based upon the four OS(s) – iOS, Android, Blackberry and Windows phone,

highlighting pieces of the stack owned by Apple, Google, Blackberry, Microsoft and Samsung.

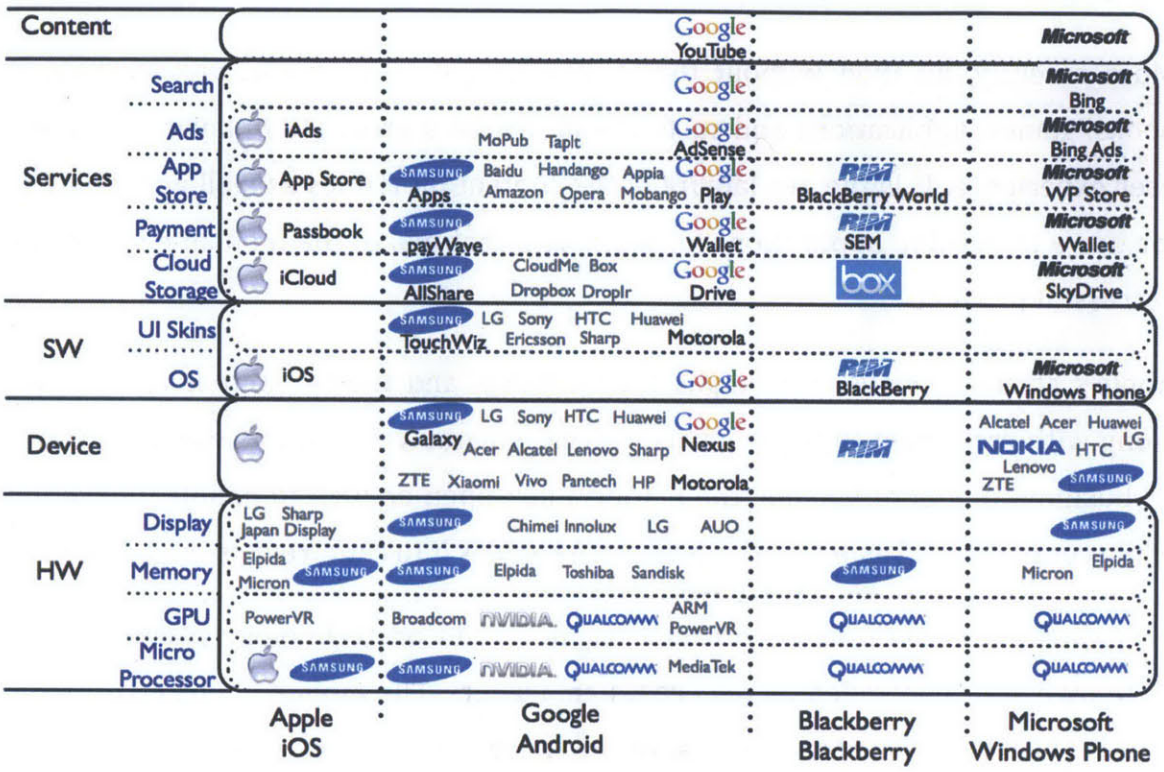

Figure 13: Current Mobile Landscape by OS

As we can see, the organizations have a choice of either doing everything themselves to be able to control the entire stack – creating a closed, integrated solution stack or relying on an ecosystem of partners to provide some pieces of the solution to allow them to focus on their core competencies – making the solution stack modular and open for other organizations to participate and innovate upon.

Looking at the landscape, we can see that Apple and Blackberry, by virtue of not licensing their OS to other device manufacturers and creating their own device, have a partially open ecosystem. They have a limited set of component manufacturers that supply components for their device, keeping that part of the solution stack closed and integrated. But they have opened their software platform to application developers that develop applications and services for their platform as well as content providers.

Google, on the other hand, has kept its ecosystem open, making the OS free and open for all device manufacturers to use. As a result, as shown in Figure 13, it has been widely adopted by a number of component manufacturers, device manufacturers as well as software and service providers.

While Google has a solution stack that is integrated from OS upwards, the OS also allows other device manufacturers to create their own solution stack on top of Android – as Samsung is doing. What is also interesting is the User Interface (UI) skin layer that has emerged on top of Android. Almost every major device manufacturer has its own UI skin, possibly in order to differentiate their devices from all other devices running Android – proving our observations from the previous chapter about the means of differentiation shifting from hardware to software.

Microsoft is following a hybrid strategy by opening up its ecosystem by licensing its OS to various device manufacturers while indirectly controlling the device as the OS has been optimized for only a few hardware configurations. Similar to the other OS vendors, it seems to have integrated the rest of the solution stack on top of the OS.

Microsoft is the only one of the five players highlighted, who does not have its own branded mobile phone. Instead, it relies on its partners to provide the devices allowing it to focus on creating an OS platform competitive with iOS and Android.

Samsung has a unique ecosystem strategy as it participates in all four ecosystems by providing components to the solution stacks for all four OS(s) while also building its own vertical solution stack.

The value flows within an ecosystem shows the relationships between the different members of the ecosystem and gives us another way of understanding the landscape shown in Figure 13.

We shall first look at the value flow in the mobile phone market before the launch of iPhone, and then look at the value flows within each of the ecosystem.

Even though, it may look like all the ecosystems are similar, none of the four ecosystems have exactly similar ecosystem structure and value flow. Apple and Blackberry might be closest to each other, but as we see from Figure 13, Blackberry has yet to integrate a lot of the services already available on other platforms.

Mobile Phone Value Flows

Pre-iPhone Ecosystem Structure and Value Flow

The value flow prior to the introduction of iPhone is easy to understand and depict, as it was the same across different device manufacturers and network operators because they all had similar business models. Figure 14 shows this simplified value chain in place till the introduction of the iPhone.

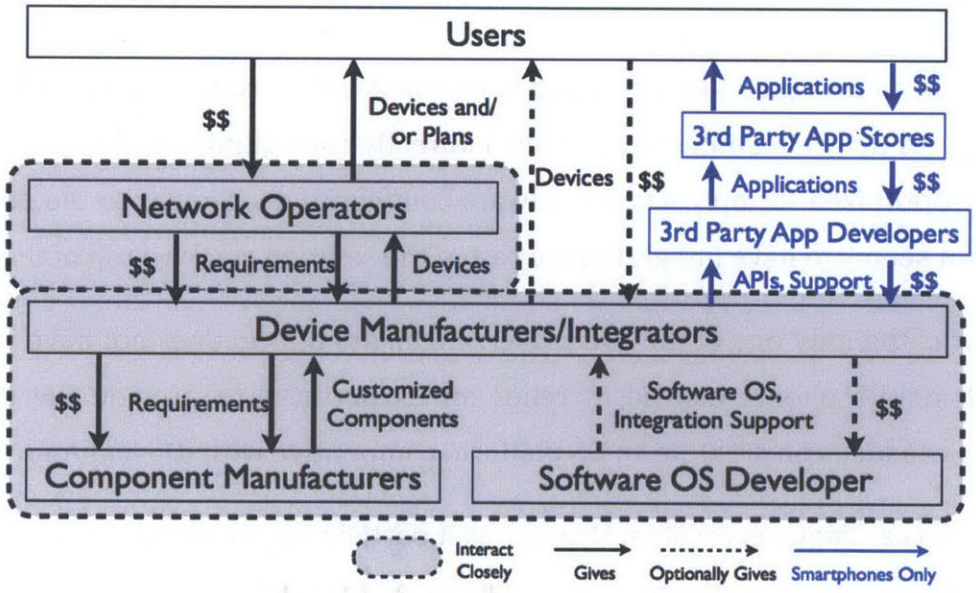

Figure 14: Pre-iPhone Value Flow (Simplified)

In the pre-iPhone era, the network operators were kings. They created device portfolio roadmaps outlining the capabilities of the portfolio of devices they planned to carry for the next 5-10 years.

They shared their planned portfolio with the device manufacturers and also gave them detailed feature (and sometimes even the user interface) requirements that the devices were expected to fulfill. They would also perform extensive laboratory

and acceptance tests prior to agreeing to carry any device, to ensure their requirements were met and the device performed as per their expectation.

The device manufacturers understood that the network operators were their channels to the users. They relied on the network operators to promote and sell their devices, only making minimal effort to advertise and sell directly to public. Hence, they worked hard to ensure that their devices were complaint to the network operators' requirements - even sending out teams of engineers to support the laboratory and acceptance tests.

The device manufacturers worked with the component manufacturers to get customized hardware components (SoCs) as well as help during integration. Most of the device manufacturers had their own proprietary software operating systems (OS), at least for low-end and feature phones and they licensed third party OS like Symbian or Windows Mobile for their smartphones.

Pre-iPhone, there were only a limited set of device API(s) available for the application developers. Given the limited API support, the application ecosystem was small and fragmented with multiple app stores, making it very confusing for the users to find and download applications.

iPhone Ecosystem Value Flow

The introduction of iPhone, not only changed the mobile phone design; it created a new ecosystem structure and changed the flow of value. Figure 15 shows a simplified value flow for the iPhone ecosystem.

The first big change was how the iPhone reached its customers. Instead of letting the network operators be the sole channel to deliver the iPhone to the users, Apple created a second channel to its users by selling the iPhone directly on its website and its retail stores. As Apple had already created a very effective sales channel for the sale of its iPods and Mac OS based machines, it was easy (and logical) for it to re-use the same channel to sell the iPhone.

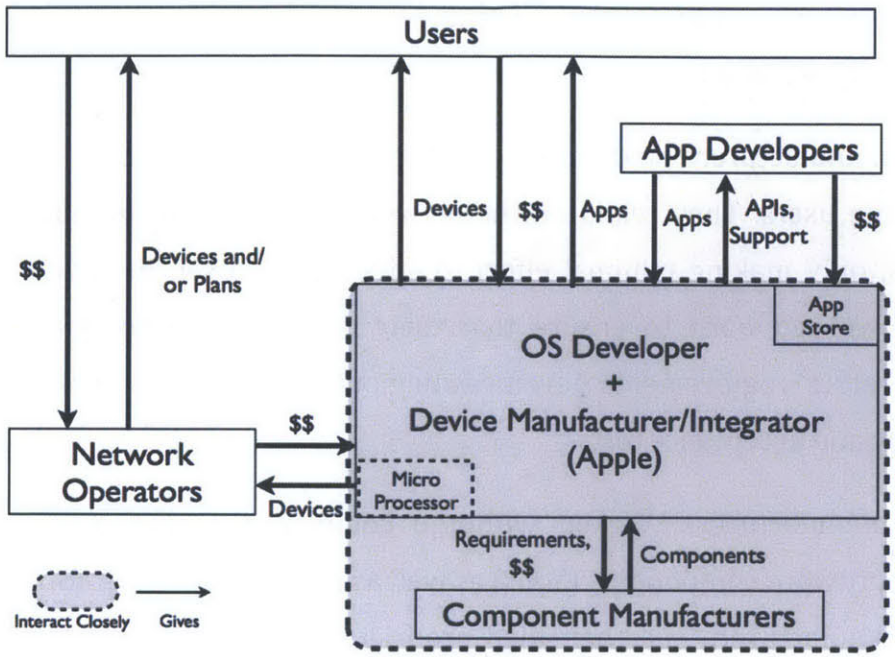

Figure 15: iPhone Ecosystem Value Flow (Simplified)

Second, as Apple was using its own operating system (iOS) and designing its own device, the iPhone was designed and developed in close integration with the component manufacturers but without any input from any network operators.

These two steps effectively removed any leverage the network operators might have had over Apple, as there was now a second channel to the end users that the network operators did not control and they had no control over or even input into iPhone's design and development.

When Apple launched the SDK for the application developers to use, it also provided the support infrastructure needed for easy application development – like support forums and user interface guides to help the application developers create great looking, high quality applications easily.

Instead of relying on third parties to create application stores, Apple launched and mandated the use of its own application store and monetization mechanism becoming the only channel and platform that let the developers and the end users discover, buy and sell iOS applications. This allowed Apple to control the quality of

the applications that the users could download and run on its devices, and enabled the application developers to make some revenue by selling their applications.

As iPhone's market share numbers show, this ecosystem strategy of a mix between a keystone (for application and content ecosystem) and dominator (for trying to capture most of the value created) has proved to be very successful for Apple while leaving very little value for other ecosystem participants to capture.

Still, there are other OS vendors that have tried to copy the structure in hopes of achieving similar success.

Android Ecosystem Value Flow

Even though it was announced only a couple of months after the iPhone, the Android ecosystem has a different structure and value flow, as is seen in Figure 16,

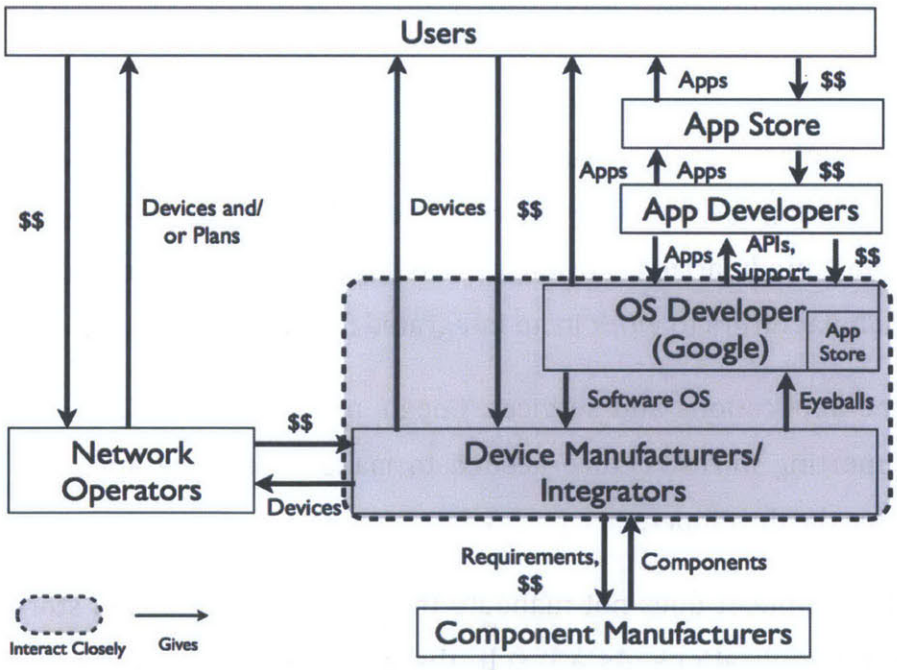

Figure 16: Android Ecosystem Value Flow (Simplified)

Android is an open-source, free smartphone OS for any device manufacturer to license and use, and for that reason has attracted a lot of device manufacturers into its ecosystem. While Google does not own Android, it leads the Open Handset

Alliance (OHA) that is responsible for releasing and maintaining Android OS. It also oversees the development of core Android open-source platform, strikes the necessary business deals and works to create development and user communities, acting as a keystone for this ecosystem. [18]

In return, wider adoption of Android gives Google data to enhance and improve its search and advertisement framework – the main sources of Google's revenues.

In order to keep the integrity of the OS and so that it does not get fragmented into separate OS versions for each device manufacturer, the device manufacturers work closely with Android engineering as they integrate the OS on their hardware platform.

When Android was first launched, there wasn't a clear dominant design in the market and the device manufacturers were innovating with different form factors and hardware capabilities. Consequently, the device manufacturers worked closely with component manufacturers along with Google in order to make devices with the best performance.

But now, as a dominant design emerged, the hardware components have become standardized allowing the interface between the device and the components to be standardized and modularized, no longer needing the device manufacturers and component manufacturers to work in an integrated fashion.

In terms of the applications and services, Google provides an SDK, an application store and supporting infrastructure needed to make developing applications and services easy for the developers.

However, unlike Apple, it does not mandate the use of its application store to buy and sell Android applications. As a result, there are several 3rd party application stores that have been created to sell Android applications including the one from Amazon, Opera and Samsung – as shown in Figure 13.

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[18] http://source.android.com/source/faqs.html retrieved May 8, 13

Also seen in Figure 13 is the fact that Google also manufactures its own devices and it has recently completed the acquisition of Motorola Mobility Inc., one of its licensees, giving it control over two brands of Android devices. However, as Google makes more money when it has more users on its OS platform (and hence more eyeballs), it still needs all the other device manufacturers and so, presumably it is following the same guidelines for working with Android that it has given to the other device manufacturers.

Blackberry Ecosystem Value Flow

As shown in Figure 17, the Blackberry ecosystem structure and value flow is very similar to that of Apple's. Blackberry also manufactures its own devices, uses the OS it has developed for its devices and with its new Blackberry 10 OS mandates the use of its application store (Blackberry World) for buying and selling applications that run on Blackberry 10.

Looking at the small list of component manufacturers that provide components to the Blackberry devices in Figure 13, it seems that the OS has been only optimized to work with hardware components from certain manufacturers, indicating that the solution stack for the hardware is still very integrated.

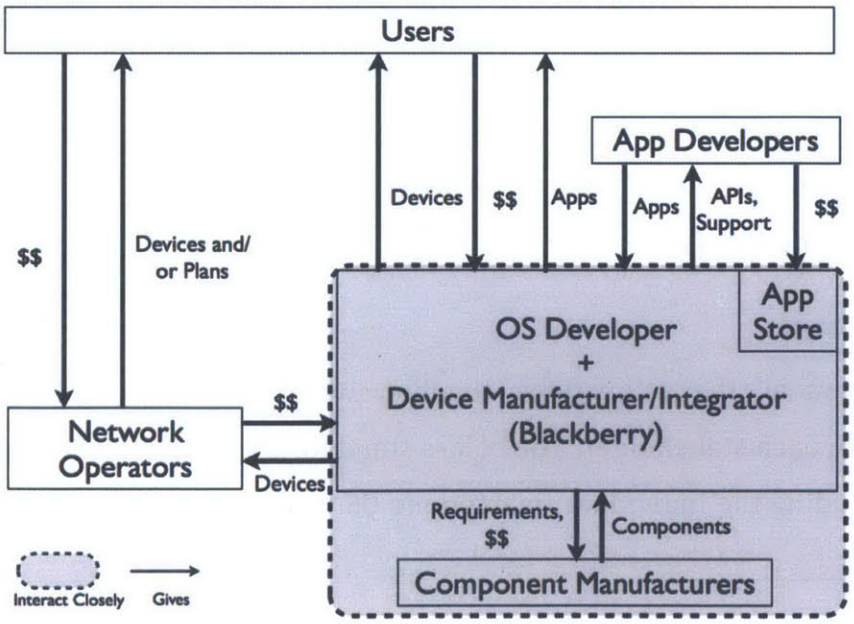

Figure 17: Blackberry Ecosystem Value Flow (Simplified)

Windows Phone Ecosystem Value Flow

The Windows Phone ecosystem value flow, shown in Figure 18, more resembles Android's value flow, as both the OS(s) allow other device manufacturers to license and use the OS.

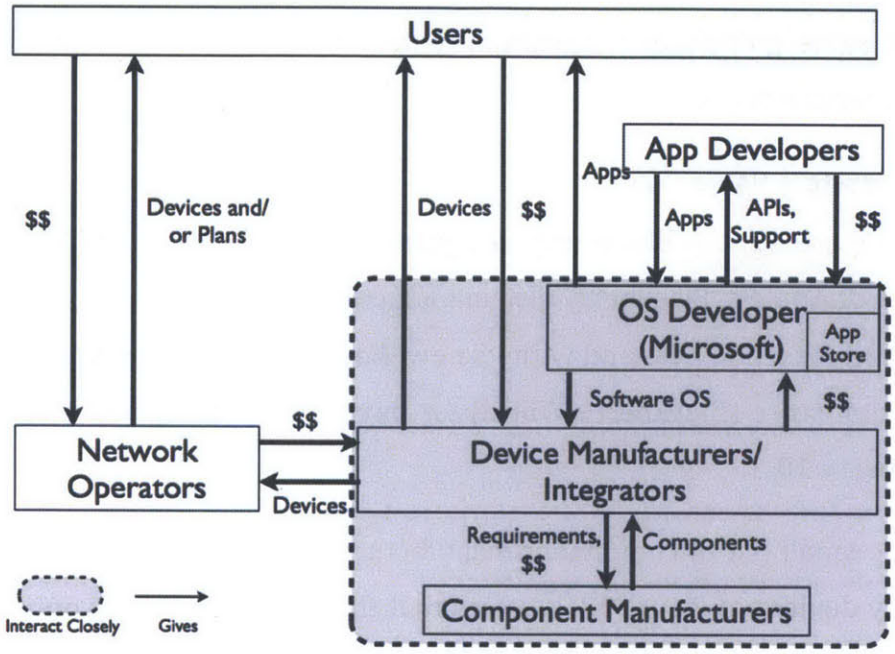

Figure 18: Windows Phone Ecosystem Value Flow (Simplified)

However unlike Android value flow, the OS is integrated and optimized to only work with hardware components from certain vendors. For example, a slide from Windows Phone 8 announcement listed Qualcomm as its key hardware partner, similar to its "Wintel" alliance with Intel for the PC market.[19] The teardown analyses of Windows Phone devices do show that all the devices use Qualcomm microprocessor and GPU(s).

Value Flow Analysis

Figure 19 shows all the value flows together while also showing the level of integration with each stakeholder. The colors stand for different stakeholders in the value flow including the individual smartphone OS vendors. The space between the

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[19] http://www.engadget.com/2012/06/20/windows-phone-8-to-start-on-htc-huawei-nokia-and-samsung/ retrieved May 5, 13

chevrons indicates whether the interface between the stakeholders is integrated or modular.

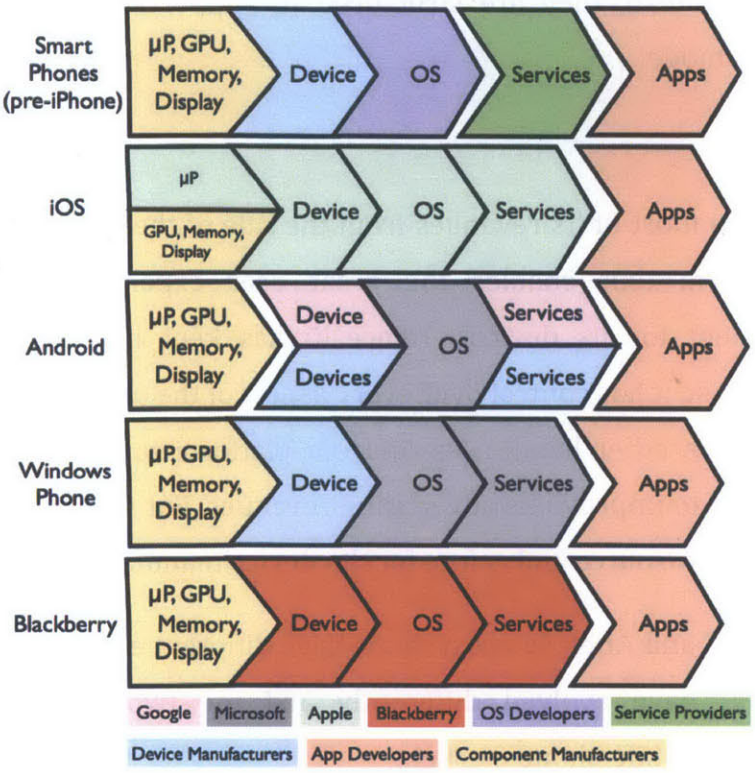

Figure 19: Value Flows Synthesized

One of the changes from the pre-iPhone value flow is the fact that the services like application store and SDK(s) are now integrated in all four ecosystems.

The second change is that the component manufacturers are becoming more modular and hence not as integrated with the device manufacturer in the Android ecosystem. The rest of the ecosystems still have the component manufacturers and device manufacturers interacting closely.

However the Android ecosystem owns 52% of the mobile phone market share, showing that more than half the hardware components being sold are standardized and modularized. Hence, if Blackberry and Windows Phone ecosystem would like to have a chance of competing against iOS and Android ecosystems, they will have to compete on price and rethink their strategy of needing close integration between component manufacturers and device manufacturers.

Business Model Considerations

We saw that the two dominant ecosystems in the mobile phone market are not exactly similar. Instead, they are structured to support the ecosystem leader's specific business model.

For example,

- Apple makes most of its revenues from the sale of the devices, with iOS being the platform that enables the great user experience and application development for its devices. Hence, it has kept its ecosystem structure integrated, so it has control over every aspect of the user experience.
- Google, on the other hand, uses Android platform to get more eyeballs and collect data to improve its advertising revenues. For that reason, it has made Android open-source and is free for the device manufacturers to use.

As a result, the iOS and Android ecosystems have different ecosystem structure and value flows that have evolved differently and the two ecosystems do exist successfully in the mobile phone market.

The two new ecosystems, on the other hand, seem to be following one of the two successful ecosystem structures but the structure may not necessarily support their business models.

While business models are important and should be considered when thinking about business ecosystems, for this thesis, we only look at hardware and software platform evolution as well as ecosystem and value flow analyses to support the hypothesis. The topic of business models in mobile phone ecosystems is deep enough to merit a thesis of its own.

Chapter 7: Recommendations

We have seen and analyzed the changes that the mobile phone market has undergone in the recent years including the changes in hardware platform, the evolution of the solution stack as well as the various ecosystem structures and value flows that existing in the mobile phone market. Having seen the different analyses, this chapter focuses on what this means for the organizations trying to succeed in this market and what are the aspects that need to be considered for a new or existing ecosystem to be successful.

These conclusions are for the near-term (3 to 4 years), only based on the data presented in this thesis. Given how fast the mobile phone landscape has been changing, anything longer term is hard to pinpoint.

Where Will The Money Be?

Currently, it looks like the money within the ecosystems is with the device manufacturers. Apple and Samsung, who took the largest shares of profits, are the top two device manufacturers.[20]

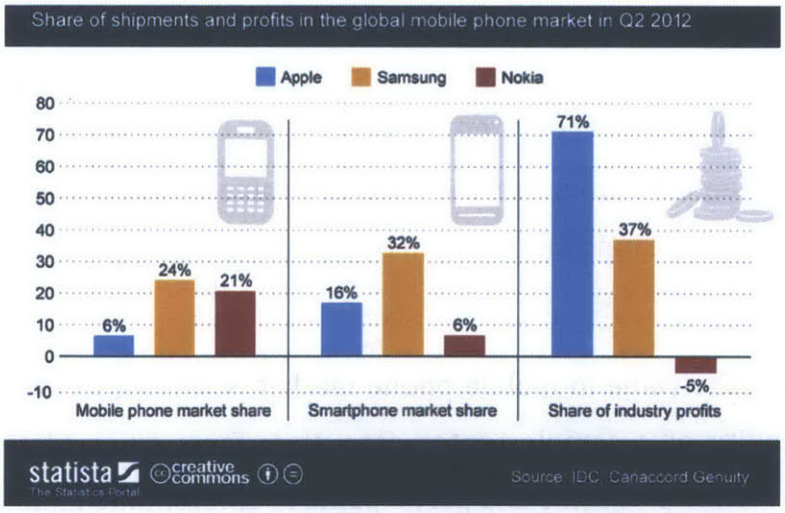

Figure 20: Shipments and Profits in 2012

[20] http://www.statista.com/topics/840/smartphones/chart/528/apple-claims-71-percent-of-the-mobile-phone-industrys-profits/, retrieved May 20, 13

However, there are two phenomena happening in the mobile phone market that help us understand where the money will be in the solution stack.

First, we have seen a dominant design emerge in mobile phone hardware (Chapter 4). Meaning that the "recipe" for best-selling phone hardware is now public and a lot more device manufacturers can make a phone based on this recipe.

Second, we have also seen the software component of the solution stack grow faster than the hardware or the device (Chapter 3). The OS developers are continuously improving OS capabilities and even the device manufacturers, when possible, are looking to use software to differentiate themselves, by creating custom UI skins for their devices for example.

The differentiation will now have to be in the complements. Applications, services, solutions and accessories, which were already important factors in mobile phone sales, will now become more valuable, with money moving towards them.

Also, as the device has become good enough, the value will be in the components that are not yet good enough or not readily available like displays and memory. And some money will also move down the solution stack into those hardware components.

Recommendations for the Ecosystem Leaders

We know that complementors can increase the value of a platform and can also form a pipeline of future innovation for an organization for its platform (Von Hippel, 2005).

We also saw that the value in mobile phone market is moving to the complements and the availability of a complementor ecosystem for a given platform, as they provide a basis for the platforms and participants to differentiate themselves.

To frame the recommendations, we can classify the ecosystems in the mobile phone market as being integrated (like Apple & Blackberry) or modular (like Google & Microsoft).

For the modular ecosystems, there are some key device manufacturers that help the OS developers expand the ecosystem – Samsung in case of Google and Nokia in case of Microsoft.

Figure 21 below shows the four ecosystems classified based on the ecosystem structure (modular vs. integrated), their current status as an incumbent or a new entrant, as well as their options for becoming more successful.

For the two modular ecosystems, we will consider Google and Samsung as well as Microsoft and Nokia together as these combinations represent both hardware and software components of a mobile phone. Also, both Samsung and Nokia account for the bulk of Android and Windows Phone devices in the ecosystem. [21, 22]

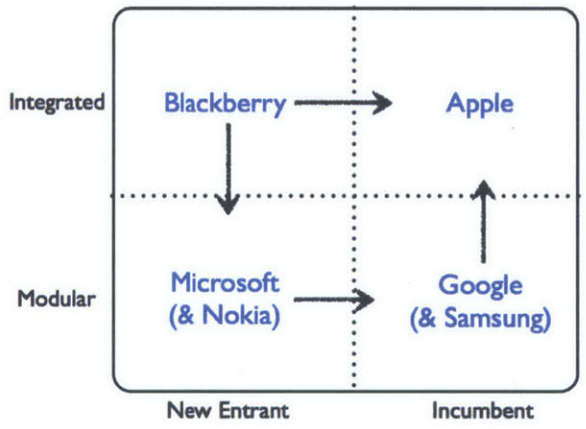

Figure 21: Classification of Current Mobile Phone Ecosystems

Microsoft & Nokia, with similar modular strategy as Google & Samsung, are trying to catch up to them. Blackberry has the option to go modular and compete against Microsoft & Nokia combination or keep its current strategy and follow Apple's trajectory. Google & Samsung, with a modular structure different from Apple's, are also attacking Apple to capture more value. Apple is the top ecosystem currently,

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[21] http://finance.yahoo.com/news/strategy-analytics-samsung-captures-95-162500181.html, retrieved May 20, 13

[22] http://www.idc.com/getdoc.jsp?containerId=prUS24108913, retrieved May 20, 13

based on the value created and value captured (Figure 20, Figure 24), and has to create its own path to grow and remain at the top.

Figure 22 shows a comparison of the four ecosystems in the mobile phone market. We compare them on three capabilities - hardware platform innovation, software platform innovation and ecosystem development capabilities. It also shows ecosystem phase they are currently in as it will help frame the recommendations.

Hardware platform innovation and software platform innovation capabilities are important because ecosystems and platforms go hand in hand. The ecosystem structure is highly dependent on the structure of the platform and this ecosystem structure can be the reason for an ecosystem's success or failure.

For example, one way of increasing the number of ecosystem participants and its chances of success is to make it open. However, for the ecosystem to be open, the platform it is built on has to be designed and developed in a way that it can provide the necessary interfaces and supporting infrastructure for the complementors to innovate. Which is why some of the recommendations for creating or sustaining successful ecosystems have a waterfall effect of needing changes to the platforms on which these ecosystems are built.

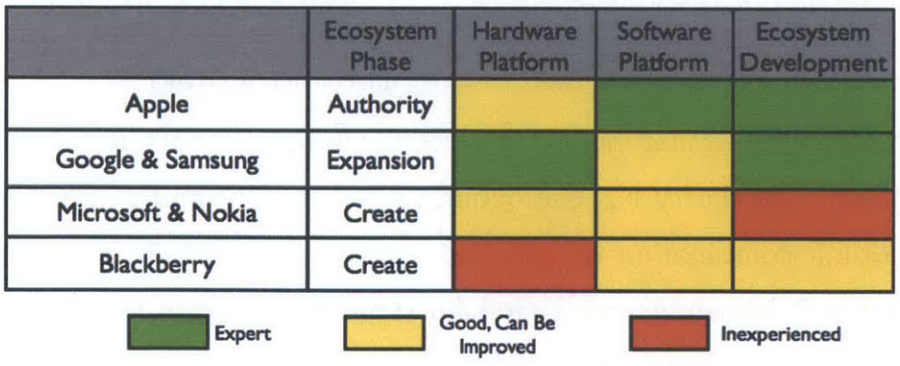

Figure 22: Ecosystems Capabilities Comparison

Moore (1996) outlines the phases of ecosystem evolution assuming that the ecosystems are created at the same time as the market. However, we can also use

these phases for ecosystem development for new entrants in a market. For doing that, we have to remember during the "create" and "expansion" phases for new entrants, the market has already been defined up to a point.

The challenge in these phases is not the lack of understanding the needs of the market. The challenge is of providing a compelling value proposition for the existing complementors and ecosystem participants, to make them willing to adopt the new entrant into its multi-home strategy, with the hope that this investment will generate returns in the future.

Multi-homing means the adoption of more than one platform in a market by an agent (Armstrong, 2006). In a mobile market, most of the application developers choose to develop applications for both iOS and Android platforms, thus adopting a multi-home strategy.

Both the new entrants – Microsoft & Nokia and Blackberry are in the create phase as they are trying to build their ecosystem of complementors. Google and Samsung are in expansion phase, where they have the critical mass needed to keep the ecosystem growing and Apple is in the authority phase – where it is setting the vision and the direction for its ecosystem participants.

In terms of organizational capabilities, Apple has been great at innovating on the software platform as well as ecosystem development by providing the right tools, support and frameworks for the complementors to use. It is good at hardware innovation, but it has lagged Android mobile phones in integrating high-resolution cameras, launching phones with 4G LTE capabilities and most recently NFC chips.

Google and Samsung are great at innovating on the hardware platform as well as ecosystem creation. They could improve their software platform innovation skills as they are usually behind iOS in introducing new software functionality (Table 6).

Table 6: Timeline of Feature Releases on iOS and Android

Feature/Service	Introduced on iOS	Introduced on Android
Maps	June 2007	October 2008
Software Development Kit	March 2008	September 2008
Application Store	July 2008	October 2008
Navigation	July 2008	November 2009
Advertisement Framework	July 2010	January 2009
Natural Language User Interface	October 2011	July 2012
Cloud Storage	October 2011	April 2012
NFC	Not Available	September 2011

Microsoft and Nokia as the new entrants are inexperienced in creating ecosystems. Microsoft is used to being the dominant player in a market, not requiring a compelling value proposition to attract complementors. Nokia was a leader in the pre-iPhone era, when a great device was enough to create and capture value. The organizations together are good at hardware (Nokia) and software platform (Microsoft) innovations, but they need more experience with post-iPhone hardware and software platforms.

Blackberry is good at creating services and solutions and also developing an ecosystem – something it did for its previous mobile phones platform. But it has little experience developing phone hardware and software platform with the current dominant design and hence has a learning curve ahead of it.

Now, lets look at the recommendations for these leaders to be able to create or sustain a successful ecosystem, with the goal of capturing maximum value.

Recommendations for Apple

At this time, Apple has a robust, self-sustaining and steadily growing ecosystem of complementors it can rely upon. One evidence of this is the steadily increase in the number of applications available on iOS platform (Figure 23).

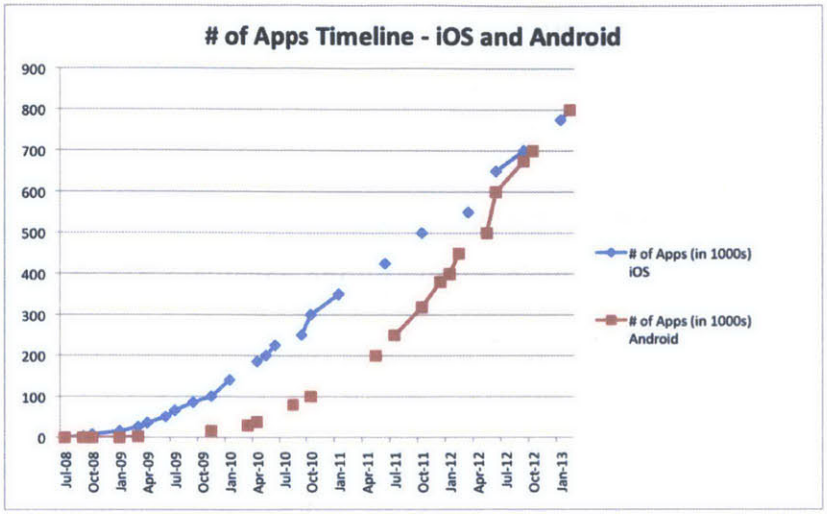

Figure 23: Number of Apps Available for iOS and Android

This ecosystem has created a lot of value for Apple in terms of making iOS devices attractive to the users as well as providing a pipeline of innovative features and services it could integrate into its platform.

Software Platform Innovation: Apple is at the forefront of OS platform innovation, as it integrates applications and services into the platform and offers them to the complementors to innovate upon. For example, it was the first platform to offer cloud back-up and storage services as well as natural language user interface (Siri), as can be seen from Table 6.

As the value of software applications and services increases, it should continue improving the platform by integrating features into the platform and making them available to other complementors to innovate upon. It should also look into offering more paid services to make up for any loss in revenue due to lower mobile phone hardware prices.

At the same time, it should maintain its emphasis on providing the user with an intuitive user experience for all features, unlike the incident with Apple Maps.[23]

[23] http://www.apple.com/letter-from-tim-cook-on-maps/, retrieved May 23, 13

Hardware Platform Innovation: While it is not at the forefront of hardware innovation, Apple has to keep up with the incremental hardware innovations in order to stay competitive.

As the competition within mobile phone hardware increases, the phone hardware will become cheaper. And Apple's mobile phone hardware has to be at least at par with other devices in order to command premium prices.

If absolutely necessary, it can also consider creating second and third source suppliers as well as creating multiple hardware configurations to lower its device cost and give it an option to launch a low end smartphone to capture that growing segment.

Ecosystem Development: Even with the lag in integration of hardware features, the application developers value Apple's ecosystem higher than Google and Samsung's, showing that Apple has managed to share enough value with the application developers to earn their mindshare.[24]

Platform KPIs	Android	iOS
User reach[1]	688 million	254 million
Developer mindshare[2]	72%	56%
Total apps[3]	> 800 thousand	846 thousand
App quality[4]	5505.1	6680.8
Revenue per million users[5]	$ 2.11	$ 7.4
App downloads6	20 billion	20 billion

Sources:
[1] User reach expressed as installed base of devices as of end-2012 (Ahonen)
[2] Developer Economics 2013
[3] iOS: 148apps April 2013,
[4] Applause Index
[5] Developer Economics 2013, based on average revenue per app per month, excluding top 5% of revenue
[6] VisionMobile est. for 2012

Figure 24: Platform KPIs Comparison - iOS and Android

[24] http://www.visionmobile.com/blog/2013/05/a-game-of-ecosystems-measuring-ecosystem-performance/, retrieved May 22, 13

The challenge for Apple is to sustain if not increase the level of innovation in its ecosystem and keep its innovation pipeline full, by attracting more complementors. For that, it has to keep leading with its best-in-class software platform while keeping up with the incremental hardware innovations in order to allow innovative applications and services to be built on top of its platform and increase developer mindshare.

Recommendations for Google and Samsung

Google and Samsung, like Apple, also have a large ecosystem of complementors and have the necessary critical mass to continue the innovation, as seen by the dramatic increase in the number of applications available on its platform (Figure 23).

So far, Google and Samsung have a symbiotic relationship, even though Samsung is capturing most of the value created in the mobile phone market because Google's main revenue source is advertising and Android is just a means to increasing those revenues.

Software Platform Innovation: Surprisingly, Google (and Android) are not at the forefront of software OS innovation. As shown in Table 6, Apple has been the first to introduce most of the functionality in iOS, quickly followed by Google. In order to capture more value, Google (or the Android ecosystem) has to get ahead of Apple in terms of integrating and introducing innovative software features.

Also the openness of the platform and the lack of single point of control have created fragmentation with various device manufacturers creating their own UI skins. It has also increased the number of harmful applications available on the platform, creating security concerns within the users and could be one of the factors causing lower revenues per million users for the application developers (Figure 24).

Fixing these issues may or may not be on Google's priority list, because of its business model, but it has to be one of Samsung's top priorities to be able to attack Apple's hold over the mobile phone market. And Samsung has to figure out a strategy to make it happen – either by working closely with Google to resolve these

issues or finding another way to provide a stable, simpler, superior "version" of the platform to increase the value of the platform and attract more complementors.

It may be difficult for Samsung, on its own; to lead the software platform innovation as it is primarily a hardware (components + mobile phone hardware) company. But, considering that the value is going to move to complementors including software applications and services, it may be in its best interests to quickly get up to speed on the business aspects of software development and become a keystone for the Android ecosystem.

Hardware Platform Innovation: The Android ecosystem, thanks to Samsung, has done pretty well in leading the charge with incremental hardware innovations. It should continue its efforts in hardware innovation – even if they are only incremental changes, as each change brings with it a new set of complementors that can innovate on top of the platform and thus, create more value for the platform.

Ecosystem Development: The Android ecosystem is by far, the most diverse and most populated of all mobile phone ecosystems. This is partially because of how open the ecosystem is and partially because it offers a competitive, low-cost alternative to OS.

This openness has allowed the many device manufacturers to adopt and even modify the platform, which has caused the ecosystem to be fragmented and weakened its attractiveness to a different set of complementors – the application developers.

For Google and Samsung to move the expansion to authority phase, one or both of them need to step up and become a keystone or a leader that can balance the needs of the different stakeholders or complementors and set a direction for the ecosystem.

Together or separately, they have to take steps towards providing exceptional user experience to all stakeholders in all aspects of the mobile device, like Apple does.

Recommendations for Microsoft and Nokia

Microsoft and Nokia are still trying to create an ecosystem of complementors around the Windows Phone platform.

Software Platform Innovation: Microsoft has to figure out a way (modularize?) its OS to run on multiple hardware configurations. Currently, the OS is optimized to run only on certain hardware configurations, limiting the price and availability of devices as well as reducing its attractiveness to complementors.

Also, the OS seems to have been developed with the tablet market in mind with the assumption that the OS can be reused on a mobile phone with reduced performance, which would have worked if not for the availability of two better software platforms for the users and complementors to use.

To be able to attack Google and Samsung, Microsoft has to focus on the mobile phone market, creating a platform that works optimally on multiple hardware configurations, allowing device manufacturers to create a portfolio of devices at all price segments.

Hardware Platform Innovation: The mobile phone hardware for Windows Phone is limited to the small set of hardware configurations that the OS has been optimized for. To keep its mobile phones competitive, Nokia has to integrate and keep up with the incremental hardware, while working closely with Microsoft to ensure the OS supports these changes.

Ecosystem Development: Microsoft and Nokia have attracted some complementors to develop complements for their platform, by forming alliances or paying them. However, they need to attract the 3rd party application developers to grow the ecosystem and get the critical mass required to have a robust and self-sustaining ecosystem.

Figure 25 shows that the two most important factors for 3rd party developers are the install base and cost of development.[25] Hence, the most important thing for Microsoft and Nokia is to flood the market with Windows Phone devices at all price segments as well as provide development tools and frameworks that make it easy for 3rd party developers to adopt the platform.

As the ecosystem is not as open as Android, Microsoft and Nokia also have the opportunity to offer a better application discovery process and higher quality applications, assuming that they get the necessary critical mass of complementors.

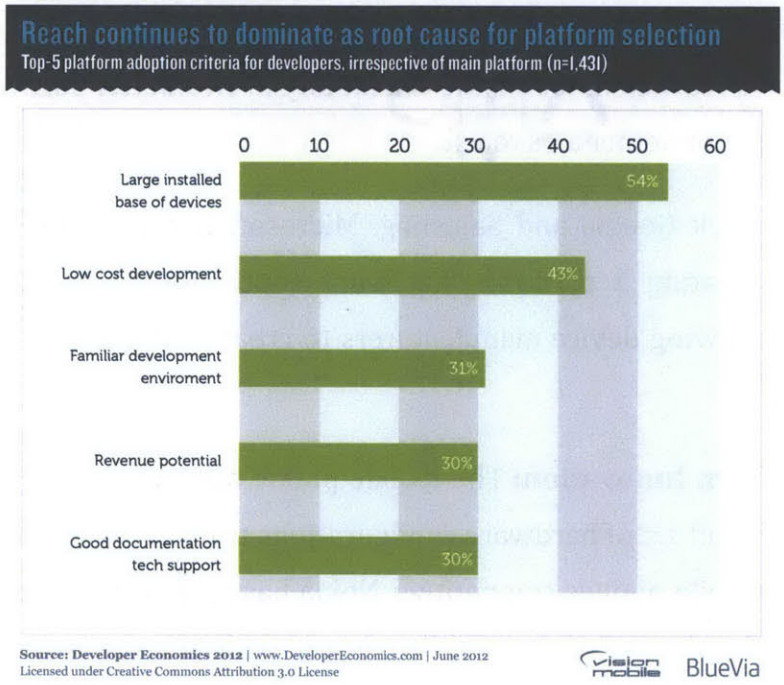

Figure 25: Developer Economics for Platform Selection

Microsoft also has to stop creating an integrated software solution stack by developing all the required features on its own. This may make the software platform competitive, but it hampers ecosystem development as it reduces the opportunities for complementors to innovate and reduces the willingness of complementors to adopt this new platform because of the risk of being made obsolete pretty quickly by platform functionality.

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[25] http://www.visionmobile.com/product/developer-economics-2012/, retrieved May 22, 13

Recommendations for Blackberry

Similar to Microsoft and Nokia, Blackberry is also trying to create an ecosystem of complementors around its new platform, as the old platform will quickly lose its popularity in face of the new dominant design. Blackberry has the option to remain integrated like Apple or become modular like Google.

Software Platform Innovation: Blackberry offered enterprise services and solutions on its old platform. It needs to create a similar portfolio of services for enterprise or similar niche market segment on its new platform. The enterprise space is changing with organizations shifting to the Bring Your Own Device policies, allowing Apple and Google + Samsung to enter the space in terms of mobile phone hardware, but the software services for mobile phones in enterprise is still an option for Blackberry.

Blackberry can also provide support for its corporate applications platform on Apple and Android devices, leveraging the current install base of these ecosystems.

Hardware Platform Innovation: Blackberry is currently creating its own devices. With the emergence of a dominant design, the value of mobile phone hardware will go down and the value of complementors will increase.

First, it has to create a device based on the dominant design that is competitive with the iOS and Android devices in the market, which it has yet to do.

Then, unless Blackberry can offer some level of differentiation, maybe by being the first to integrate the incremental hardware innovations, it has to create modular and hence lower cost hardware configurations, to quickly be able to create an install base to leverage for its ecosystem.

Ecosystem Development: Blackberry has created an ecosystem of application developers for its previous platforms, but the platform the ecosystem was based on was old and very different from the current mobile phone hardware and software platforms.

That said, Blackberry has a strong mobile focus as most of its revenues come from mobile and that is a plus. It also understands how to create mobile phone ecosystems and needs to use that experience to jump-start the creation of ecosystems around its new platforms. It has already taken steps like launching the Blackberry 10K Developer Commitment program by guaranteeing the developers of marketable apps at least 10K USD in revenue.[26]

But, Blackberry has to focus on other complementors apart from 3rd party application developers like service providers and hardware accessory manufacturers to create differentiation for its mobile phones and increase the value of the platform in the eyes of the users.

[26] https://developer.blackberry.com/builtforblackberry/commitment/, retrieved May 22, 13

Chapter 8: Conclusion

We have seen how the mobile phone landscape has evolved these last few years. The mobile phone solution stack has grown more complex with the increasing importance of smartphone OS because of the applications and services it enables (Figure 4). Phone manufacturers and smartphone OS developers influence the value flow that was once controlled by the network operators.

The emergence of a dominant design for mobile phone hardware, however, has leveled the playing field amongst phone manufacturers (Figure 5). The differentiation is now expected to come from complementors – accessories, the OS, applications and services.

The increasing mobile phone user base, availability of SDK(s), virtual application stores and monetization potential has given rise to strong ecosystems of complementors, including applications and services developed on smartphone OS platforms, making the OS developers the leaders of those ecosystems.

It may seem as if all the ecosystems in mobile phone market have similar structure, but a deeper analysis of the value flow and the level of integration and modularization in the platform revealed differences that help or hinder their ecosystem strategies.

All four of the top smartphone ecosystems – Apple, Google (and Samsung), Microsoft (and Nokia) and Blackberry, need complementors to create more value for the platform, to create differentiation as well as to be a pipeline for future innovations.

The two top platforms – iOS and Android have robust, self-sustaining and growing ecosystem of complements, while the two new entrants have to create an ecosystem and develop a compelling value proposition to attract the critical mass needed to make them self-sustaining.

Both new entrant and incumbent ecosystems need to keep improving the hardware and software platform to create new opportunities for complementors to innovate and increase their mindshare amongst the complementors. They also have to balance the needs of multiple groups of complementors while improving the platform to increase its attractiveness to all the complementors.

The process of creating a successful ecosystem is a delicate dance between the complementors and ecosystem leaders as they work together to create more value for everyone while also trying to capture as much value as possible without stifling the ecosystem.

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Glossary

API	Application Programming Interface
CPU	Central Processing Unit
GPU	Graphics Processing Unit
MEMS	Micro-Electro-Mechanical Systems
NFC	Near Field Communication
OHA	Open Handset Alliance
SoC	System on Chip
SDK	Software Development Kit
UI	User Interface

Appendix A: Best Phones List (2007 – 2012)

	Best Phones	Best Smartphones
2007[27, 28]	Apple iPhone LG Voyager Motorola Razr2 V9 Samsung UpStage	AT&T Tilt Samsung SCH-i760 Blackberry Curve Palm Centro Motorola Q9h
2008[29, 30]	Apple iPhone 3G T-Mobile G1 LG Dare Sony Ericsson W760i Motorola Zine ZN5 Samsung Instinct	Apple iPhone 3G T-Mobile G1 HTC Diamond Blackberry Bold Sony Xperia X1 Samsung Omnia Nokia E71
2009[31, 32]	Samsung Impression Sony Ericsson C905a Samsung Memoir Sony Ericsson Aino LG enV Touch Samsung Rogue Samsung Instinct HD Motorola Cliq Casio Exilim C721 Samsung Alias 2 LG VX8360	HTC Touch Pro 2 HTC Hero Blackberry Bold Palm Pre Nokia N800 Samsung Omnia II Apple iPhone 3GS Motorola Droid T-Mobile G1 Blackberry Curve
2010[33, 34]	LG dLite LG Lotus Elite Casio G'zOne Brigade Samsung Reality LG Vu Plus Pantech Ease	LG Optimus T Samsung Focus HTC Evo 4G Motorola Droid X Blackberry Pearl Optimus Touch Apple iPhone 4 T-Mobile G2 Samsung Epic 4G Motorola Droid

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[27] http://reviews.cnet.com/4321-6454_7-6600122.html retrieved May 3, 13
[28] http://reviews.cnet.com/4321-6452_7-6600061.html retrieved May 3, 13
[29] http://reviews.cnet.com/best-cell-phones-2008/ retrieved May 3, 13
[30] http://reviews.cnet.com/2300-6452_7-10000055.html retrieved May 3, 13
[31] http://www.cnet.com/8301-17918_1-10418079-85.html retrieved May 3, 13
[32] http://www.cnet.com/8301-17918_1-10416044-85.html retrieved May 3, 13
[33] http://www.cnet.com/8301-17918_1-20024457-85.html retrieved May 3, 13
[34] http://reviews.cnet.com/2300-6452_7-10005785.html retrieved May 3, 13

Best Phones	Best Smartphones
2011[35, 36]	Samsung Galaxy SII Thunderbolt T-Mobile G2X Apple iPhone 4S Motorola Droid Razr XT HTC Evo 3D Motorola Droid Bionic Sony Xperia Play HTC Sensation Samsung Galaxy Nexus
2012[37]	Samsung Galaxy Note 2 Apple iPhone 5 Pantech Burst HTC OneX Motorola Razr Maxx HD Motorola Droid DNA LG Optimus G Samsung Galaxy S3 Nokia Lumia 900

[35] http://reviews.cnet.com/2300-6454_7-10010647.html retrieved May 3, 13
[36] http://www.zdnet.com/blog/cell-phones/top-10-smartphones-of-2011-for-now/5683 retrieved May 3, 13
[37] http://reviews.cnet.com/2300-6452_7-10014830-1.html retrieved May 3, 13

Appendix B: All Mergers & Acquisitions by Google since 2008

Company Name	Company Business	Date of Acquisition	Derived Products
Omnisio	Online Video	July 2008	YouTube
TNC	Weblog Software	September 2008	Blogger
On2	Video Compression	August 2009	WebM, YouTube
reCAPTCHA	Security	September 2009	Google Books
AdMob	Mobile Advertising	November 2009	DoubleClick, Invite Media
Gizmo5	Voice over IP	November 2009	Google Talk
Teracent	Online Advertising	November 2009	AdSense
AppJet	Collaborative real-time editor	December 2009	Google Wave, Google Docs
Aardvark	Social Search	February 2010	Aardvark
reMail	Email Search	February 2010	Gmail
Picnik	Photo Editing	March 2010	Picasa
DocVerse	Microsoft Office files sharing site	March 2010	Google Docs
Episodic	Online video platform start-up	April 2010	YouTube
PlinkArt	Visual search engine, Mobile start-up,	April 2010	Google Goggles
Agnilux	Server Technology start-up	April 2010	Android
LabPixies	Gadgets	April 2010	iGoogle, Android
BumpTop	Desktop Environment	April 2010	Android
Global IP Solutions	Video and Audio compression	May 2010	WebRTC
Simplify Media	Music Syncing	May 2010	Android
Ruba.com	Travel	May 2010	Google
Invite Media	Advertising	June 2010	DoubleClick
ITA Software	Travel Technology	July 2010	Google Flights
Metaweb	Semantic Search	July 2010	Google Search
Zetawire	Mobile Payment, NFC	August 2010	Android, Google Wallet
Instantiations	Java/Eclipse/AJAX Tools	August 2010	Google Web Toolkit
Slide.com	Social Gaming	August 2010	Google+, orkut
Jambool	Social Gold Payment	August 2010	Google+, orkut
Like.com	Visual Search Engine	August 2010	Google Offers
Angstro	Social Networking Service	August 2010	Google, Google Alert
SocialDeck Inc.	Social Gaming	August 2010	Google, Google+
Quiksee	Online video	September 2010	Google Maps
Plannr	Schedule Management	September 2010	Google+
BlindType	Touch Typing	October 2010	Android
Phonetic Arts	Speech Synthesis	December 2010	Google Voice, Google Translate

WideVine Technologies	DRM	December 2010	Google TV
eBook Technologies	eBook	January 2011	Google Books
SayNow	Voice Recognition	January 2011	Google Voice
Fflick	Social Networking Service	January 2011	YouTube
Zynamics	Security	March 2011	Google
BeatThatQuote.com	Price Comparison Service	March 2011	Google Advisor
Next New Networks	Online Video	March 2011	YouTube
Green Parrot Pictures	Digital Video	March 2011	YouTube
PushLife	Service Provider	April 2011	Google
TalkBin	Mobile Software	April 2011	Android
Sparkbuy	Product Search	May 2011	Google Shopping
PostRank	Social Media Analytics Service	June 2011	Google
AdMeld	Online Advertising	June 2011	DoubleClick, Invite Media
SageTV	Media Center	June 2011	Google TV
Punchd	Loyalty Program	July 2011	Google Offers
Fridge	Social Groups	July 2011	Google+
PittPatt	Facial Recognition System	July 2011	Android
Dealmap	One deal a day service	August 2011	Google Offers
Motorola Mobility	Mobile Device Manufacturer	August 2011	Android, Google TV, Patent Portfolio
Zave Networks	Digital Coupons	September 2011	Google Offers
Zagat	Restaurant Reviews	September 2011	Google Places, Google Maps
DailyDeal	One deal a day service	September 2011	Google Offers
SocialGrapple	Social Media Analytics Service	October 2011	Google+
Apture	Instantaneous Search	November 2011	Google Search
Katango	Social Circle Organization	November 2011	Google+
RightsFlow	Music Rights Management	December 2011	YouTube
Clever Sense	Mobile Apps	December 2011	Android
Milk Inc.	Social Network	March 2012	Google+
TxVia	Online Payment	April 2012	Google Wallet
Meebo	Instant Messaging	June 2012	Google+
Quickoffice	Productivity Suite	June 2012	Google Docs
Sparrow	Mobile Apps	July 2012	Gmail
WildFire Interactive	Social Media Marketing	August 2012	Google, Google+

VirusTotal.com	Security	September 2012	Google
Nik Software Inc.	Photography	September 2012	Android
Viewdle	Facial Recognition	October 2012	Android
Incentive Targeting Inc.	Digital Coupons	November 2012	Google Offers
BufferBox	Package Delivery	November 2012	Android
Channel Intelligence	Product ecommerce	February 2013	Google Shopping
DNNresearch Inc.	Deep Neural Networks	March 2013	Google, Google X Lab
Web Application Server Talaria	Cloud Computing	March 2013	Google Cloud
Behavio	Social Prediction	April 2013	Google Now
Wavii	Natural Language Processing	April 2013	Google Knowledge Graph