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Success Factors of Mobile Business Ecosystems

From Hardware-Centric to Content and Advertising Based Business Models

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ABSTRACT OF LICENTIATE THESIS

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For firms operating in a networked economy or business ecosystems, value creation may be highly dependent on the relationships with other firms, which has added a significant amount of complexity particularly to strategic and product-related decision-making. In systems thinking, a firm is seen as part of a wider economic ecosystem and environment where it influences and is influenced by other firms. Within a business ecosystem, firms coevolve capabilities around innovations, working both cooperatively and competitively to support new products, satisfy customers, and incorporate the following round of innovations. Ecosystems are often formed around platforms on which products and complements are built, and platforms may also facilitate transactions between distinct groups of users in a two or multi-sided market.

In this study, established theoretical concepts have been brought together to analyze the success factors of mobile business ecosystems in a holistic manner. Additionally, the impact of the historical legacy and path-dependent evolution of a firm's previous business activities, capabilities, and assets on decisions the firm has made in its ecosystem and platform strategies is studied, and a novel theoretical concept, 'angle of entry', is recognized. Through a qualitative multiple case study of three leading companies in the smartphone business and their respective business ecosystems, eight common success factors are identified that have contributed to the disruption of the smartphone business by these three new entrants from the IT world, replacing the incumbents. Based on the results, it can be stated that all three leading ecosystems utilize, at least to a certain extent, closed source code to protect their differentiating or otherwise significantly value-adding software components. Similarly, the product platforms of all three ecosystems offer sufficiently open application programming interfaces so that device manufacturers, accessory makers, and developers are able to create products and apps with meaningful differentiation.

Keywords: app store, business ecosystem, mobile, operating system, path dependence, platform, smartphone, strategy, two-sided market, value network

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LISENSIAATINTUTKIMUKSEN TIIVISTELMÄ

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Verkostoituneessa taloudessa tai liiketoimintaekosysteemeissä toimivien yritysten arvonluonti saattaa olla hyvinkin riippuvaista suhteista muihin yrityksiin, mikä on lisännyt erityisesti strategisen ja tuotteisiin liittyvän päätöksenteon kompleksisuutta huomattavasti. Järjestelmäajattelussa yritys nähdään osana laajempaa taloudellista ekosysteemiä ja ympäristöä, jossa se vaikuttaa muihin yrityksiin ja on samalla ympäristönsä vaikutuksen kohteena. Liiketoimintaekosysteemissä yritykset kehittävät yhdessä kyvykkyyksiään innovaatioiden ympärillä tehden yhteistyötä ja kilpaillen samalla tukeakseen uusia tuotteita, tyydyttääkseen asiakkaita ja ottaakseen käyttöön uusia innovaatioita. Ekosysteemeitä muodostuu usein tuotealustojen ympärille, ja lisäksi alustat voivat välittää transaktioita erillisten käyttäjäryhmien välillä nk. kaksi- tai useampipuolisessa markkinassa.

Tässä tutkimuksessa on yhdistetty tunnettuja teoreettisia käsitteitä mobiilialan liiketoimintaekosysteemien menestystekijöiden analysoimiseksi kokonaisvaltaisesti. Lisäksi on tutkittu yrityksen historian ja sen toimintojen, kyvykkyyksien ja resurssien polkuriippuvaisen evoluution vaikutuksia sen päätöksiin ekosysteemi- ja tuotealustastrategioissa. Tämän tuloksena on tunnistettu uusi teoriakäsite, 'tulokulma'. Kolmesta johtavasta älypuhelinliiketoiminnan yrityksestä ja näiden kunkin ekosysteemistä tehdyn kvalitatiivisen monitapaustutkimuksen perusteella työssä tunnistetaan kahdeksan yhteistä menestystekijää, jotka ovat auttaneet näitä IT-maailmasta tulleita tulokasyrityksiä mullistamaan älypuhelinliiketoiminnan syrjäyttäen alan vanhat johtoyritykset. Tulosten perusteella voidaan todeta, että kaikki kolme johtavaa ekosysteemiä hyödyntävät ainakin jossain määrin suljettua lähdekoodia suojatakseen erilaistamista tai muuten merkittävää lisäarvoa tuottavia ohjelmistokomponenttejaan. Samoin kaikkien kolmen ekosysteemin tuotealustat tarjoavat riittävästi avoimia sovellusrajapintoja, jotta laitevalmistajat ja sovelluskehittäjät pystyvät luomaan tarpeeksi erilaistettuja tuotteita ja sovelluksia.

Avainsanat: arvoverkosto, kaksipuolinen markkina, käyttöjärjestelmä, liiketoimintaekosysteemi, mobiili, polkuriippuvuus, sovelluskauppa, strategia, tuotealusta, älypuhelin

Kieli: englanti

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This licentiate thesis is a predoctoral dissertation written as a monograph. All research conducted for it is published here for the first time, not in any other forum. This has been sort of a challenge, given the large number of pages and since the thesis has been written over a relatively long period of time. I had the first concrete ideas about the topic in 2008, when I was finalizing the last remaining parts of the theoretical coursework that was required for a Licentiate's or Doctor's degree at the Helsinki University of Technology (TKK). At that time, I was leading quite a hectic life, working for Nokia Corporation in the strategic competitive intelligence function, later moving to strategic planning and development where many of the topics discussed in this thesis were my bread and butter. I express my gratitude to my superiors at Nokia Siemens Networks and Nokia who were kind enough to support my postgraduate study efforts by allowing me to dedicate a couple of hours each week for my studies.

In the summer of 2009, I met with my advisor Sakari Luukkainen, whom I knew already from the Telecommunications Business major and postgraduate courses at the Department of Computer Science and Engineering. With much enthusiasm and only minor revisions to my old research plan, the work on the thesis was kicked off. I planned the structure of the thesis and started reviewing the key literature that I had already identified earlier, to a large extent at least. As the going got tough and I needed to dedicate more time to my "day job", the thesis progressed only slowly, occasionally even slowing to a halt.

In late 2012, after I decided to take severance from Nokia after almost nine exciting years at the forefront of mobile communications, I finally had more time to work on the thesis, and started revising my earlier writings as well as making some real progress. Then, in early 2013, I got an exciting job opportunity in Germany requiring me to move to the Hanover area in Lower Saxony, an opportunity that I took and have not regretted. The hectic pace of work, all the practicalities of moving to a foreign country, and getting things running smoothly greatly strained my available free time, and so the thesis was unfortunately put on a near-hiatus once again.

From early 2014, I was gradually able to find more time to continue the research and work on the thesis. What you now have in your hands is the result of countless hours of very hard work spanning over a number of years, although the complete thesis has been fully revised and brought up to date during 2014. At last, it is complete.

I express my warmest thanks to Professor Antti Ylä-Jääski of the Aalto University School of Science who acted as the supervisor for the thesis and encouraged me on multiple occasions to push through with my postgraduate studies.

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Helsinki, Finland, Sept. 23, 2014

Juha Winter

Abbreviations and Acronyms

AMD	Advanced Micro Devices, Inc.
AOSP	Android Open Source Project (platform)
API	Application Programming Interface
AR	Augmented Reality
ASL	Apache Software License
ASP	Average Sales Price
ATM	Automated Teller Machine
B2B	Business to Business
BLE	Bluetooth Low Energy
BSD	Berkeley Software Development
BYOD	Bring Your Own Device
CE	Consumer Electronics
CLI	Common Language Infrastructure
CLR	Common Language Runtime (in .NET Framework)
CPC	Cost per Click
CPI	Cost per Impression
CPM	Cost per Mille
CTR	Click-Through Rate
EBIT	Earnings before Interest and Taxes
ETSI	European Telecommunications Standards Insititute
FCL	Framework Class Library (in .NET Framework)
FRAND	Fair, Reasonable, and Nondiscriminatory (licensing terms)
FTC	Federal Trade Commission
FY	Fiscal Year
GMS	Google Mobile Services
GNU	GNU's Not Unix (GNU Project)
GPL	GNU Public License
GSMA	The GSM Association
HD-DVD	High-Definition Digital Video Disc (standard)
ICT	Information and Communications Technology
IDE	Integrated Development Environment

IP	Internet Protocol (alternatively) Intellectual Property
IPO	Initial Public Offering
IPR	Intellectual Property Rights
ISP	Internet Service Provider
ISV	Independent Software Vendor
JIT	Just-in-Time (compiling)
LiMo	Linux Mobile (Foundation)
LTE	Long Term Evolution (4G mobile network technology)
MMS	Multimedia Messaging Service
MNO	Mobile Network Operator
MS-DOS	Microsoft Disk Operating System
MSDN	Microsoft Developer Network
MSP	Multi-Sided Platform
NASDAQ	The NASDAQ Stock Market (National Association of Securities Dealers Automated Quotations)
NFC	Near Field Communications
NYSE	New York Stock Exchange
OAA	Open Automotive Alliance
ODM	Original Design Manufacturer
OEM	Original Equipment Manufacturer
OHA	Open Handset Alliance
OS	Operating System
OTT	Over-the-Top communications
PaaS	Platform as a Service
PCI	Peripheral Component Interconnect (bus)
PDF	Portable Document Format
PIM	Personal Information Management
POS	Point of Sale
R&D	Research and Development
RIM	Research in Motion Limited, now BlackBerry Ltd (Canadian wireless equipment manufacturer)
ROI	Return on Investment
ROIC	Return on Invested Capital
S60	Series 60, a software platform based on the Symbian OS, developed by Nokia
SaaS	Software as a Service
SDK	Software Development Kit
SE	Secure Element
SEC	(United States) Securities and Exchange Commission

SECO	Software Ecosystem
SIM	Subscriber Identity Module
SMB	Small/Medium-sized Business
SMS	Short Message Service
SOA	Service-Oriented Architecture
UI	User Interface
UPS	United Parcel Service of North America, Inc.
USB	Universal Serial Bus
UX	User Experience
VHS	Video Home System (standard)
WAC	Wholesale Applications Community
WP	Windows Phone
XML	Extensible Markup Language

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Chapter 1

Introduction

1.1 Background

In the beginning of the 1990s, few companies or individuals could foresee the vast proliferation of personal wireless communications and the impact it would have on the lives of people in the decades that would follow. Indeed, mobile phones have become so pervasive that the total number of mobile subscriptions globally is expected to hit nearly 7 billion by end of 2014, according to the International Telecommunication Union (ITU, 2014). This would imply an average penetration rate of well over 90%, although there are still significant regional differences with the lowest penetration rates in Africa (69% by end of 2014) and Asia and the Pacific (89% by end of 2014). These regions are also the fastest growing ones, as other regions such as the Commonwealth of Independent States (CIS), Arab States, the Americas, and Europe have reached over 100% penetration, and due to the effects of saturation, are expected to grow at less than 2% during 2014.

While the increase in mobile phone penetration continues to drive growth in Africa and other emerging markets mainly in Asia, most other countries have already reached or are close to reaching saturation levels, which means they have transitioned to replacement sales markets. In developed and developing countries alike, the growth of the mobile handset market is increasingly driven by a major transition and paradigm shift — the transition to *smartphones* or in general terms, mobile devices with advanced computing capabilities, making use of *mobile broadband* subscriptions that enable quick access to Internet-based services and online content. According to ITU (2014), mobile broadband penetration levels are highest in Europe (64%) and the Americas (59%), followed by CIS (49%), with the Arab States (25%), Asia-Pacific (23%), and Africa (19%) trailing significantly. Globally, ITU expects mobile broadband subscriptions to reach 2.3 billion by end of 2014, corresponding to a penetration rate of 32% (ITU, 2014). Clearly, the transition to smartphones will drive revenue both from device replacement sales as well as from subscription upgrades to mobile broadband.

To illustrate the proportions that this relatively new product category has reached, an estimated 988 million smartphones were sold globally in 2013, representing a 44% increase on 2012, according to Canalys (2014). For comparison, only 316 million personal computers (PCs), including laptops, mini-notebooks, and desktops but excluding media tablets (pads) incapable of running Windows 8, were sold in 2013 according to Gartner (2014a), 10% fewer than in 2012. The shrinking of the PC market can be attributed to the rapidly growing popularity of the tablet category, the global sales of which reached 195.4 million units in 2013, marking a 68 percent increase on 2012, according to Gartner (2014b). If we consider the fact that more than 97% of the tablets sold (namely, Apple's iPads and Android-based tablets from Samsung and other manufacturers) actually have more in common with smartphones than traditional PCs due to running operating systems originating from the smartphone world, we can appreciate just how big and rapidly growing the smart device business really is.

In the rest of the section, the history of smartphones from their inception to the present day is briefly reviewed, highlighting key events that have shaped the business landscape. It should be noted that the history piece also reflects the author's personal views and experiences, having worked on the forefront of mobile communications and smartphone development from 2004 onward, except where explicit references are used. Also, in Section 1.1.2, it is discussed why business ecosystems matter in the smartphone business. The interested reader is encouraged to read on, although the objectives of the study at hand, presented in Section 1.2, can well be understood without this background information.

1.1.1 Brief History of Smartphones

How Smartphones Came to Be

Smartphones as a product category and industry branch did not really exist before the year 2000. It was then that the first mobile devices based on the Symbian operating system (OS) were introduced to the market and marketed as "smartphones". One could argue, however, that certain cellular handsets from early to mid '90s (such as the IBM Simon and the Nokia 9000 Communicator) that incorporated PDA functionality could be considered "proto-smartphones", predecessors to proper smartphones as the term is understood today. These early devices were not extensible in terms of their software applications and features, but offered many advanced capabilities out of the box, namely the ability to send and receive emails, and maintain an electronic calendar, address book, and notes. The Nokia 9000 even had rudimentary, text-based web browsing capabilities, which was groundbreaking at the time. Interestingly, many of the early proto-smartphones had a touch screen, often accompanied by a pen-like stylus, as their input method alongside a keyboard that typically conformed to the QWERTY layout.

For the first few years of the new millennium, smartphones remained mostly business and productivity oriented devices that often were quite bulky and had relatively little to offer to ordinary consumers. As a result, they were carried mostly by corporate professionals and technology enthusiasts. It was mainly Nokia (with its 9210(i), 9500, and 9300 communicators), Palm (with its first Treo smartphone circa 2002), and Research in Motion (RIM, who released the first BlackBerry® smartphones in 2003) who pioneered those early days of smartphone business. Sony Ericsson and Motorola also released their first smartphones in 2003, based on Symbian OS and a user interface (UI) and application platform called UIQ[1] (originating from 'User Interface Quartz'), but they failed to gain significant traction despite a number of progressively better products introduced to the market.

By 2006, Symbian had established itself clearly as the market-leading smartphone OS, mainly through the success of Nokia and its popular S60 smartphones, with an overwhelming 67% share of smartphones sold globally running Symbian (Canalys, 2006). It had already previously held more than 50% of the market in 2004 and 2005, but was under pressure from mainly Microsoft's Windows Mobile that was predicted by some to surpass Symbian by 2010 (ZDNet, 2006). Such fears proved unsubstantiated as Symbian dominated two thirds of the market, while Microsoft and RIM held 14% and 7% market shares respectively, for the full year of 2006 (Canalys, 2006).

Microsoft, having expanded into the fledgling smartphone business as an OS provider in late 2001 with its Windows Pocket PC 2002 that included cellular support, was obviously keen to capture a sizable share of the rapidly growing market. This was also viewed as strategically important by the software giant, as the ongoing convergence of personal computing, Internet protocol (IP) based data communications, and mobile telecommunications was recognized already back then. Most devices running the Windows Pocket PC 2002 OS

[1]The UIQ platform was designed for feature-rich phones and optimized for touch screen use from the beginning, but through its many versions and years of existence, it did not manage to attract enough operators, device manufacturers, and ultimately, consumers to remain viable. It was officially disbanded in 2008, when Nokia acquired Symbian Ltd and agreed to pool its assets into the newly established Symbian Foundation. Nokia's popular Series 60 (S60) software platform, also built on Symbian OS, was to be the UI of choice in Symbian Foundation, eliminating the need for alternatives.

were connected PDAs without cellular functionality, but with the first Windows Mobile OS released in June 2003, Microsoft was getting serious about smartphones. Subsequent versions followed approximately on a yearly basis, appearing all the way through to 2009. With Windows Mobile, Microsoft managed to gain a steady, though limited, foothold in the smartphone market, with its global market share fluctuating between roughly 12% and 17% between 2004 and 2008. Various handset manufacturers, from HTC, Motorola, Hewlett-Packard, and Samsung to lesser-known players produced the actual devices with varying success on the market. The devices were favored mostly by professional users, those working in the information and communications technology (ICT) industry, and others requiring mobile office functionality in their handsets.

Nokia, then the largest manufacturer of mobile phones globally, had also established itself as the leader in the smartphone business by 2006. Unlike most other smartphone manufacturers of that era, Nokia had succeeded in making smartphones attractive to many consumer segments, not just business users who were the core audience of both RIM and Microsoft, as proven by the sales success of hit products like the N73 and N95. Nokia's smartphone portfolio at the time was already quite broad and expanding further, seemingly offering "something for everybody" in a multitude of price points, further reinforcing the company's lead. The outlook was bright, as Nokia had a 50% share of the smartphone volumes in Q4 2006. At the same time, its smartphone competitors, RIM, Motorola, Palm, and Sony Ericsson, each had single-digit market shares between 5% and 8%. Samsung did not even make it to the top 5 list, despite having produced Windows Mobile smartphones since 2004. Indeed, the market was tipping in favor of Nokia to the point that one could rightfully ask whether anything could threaten the company's dominance.

Apple's Rise and the Paradigm Change

On January 9, 2007, an announcement was made that would shape the future of smartphone business — the iPhone was announced by Apple, Inc., the Cupertino, California based manufacturer of personal computers (Macs), portable media players (iPods), and related accessories. Apple had returned to prominence from the brink of bankruptcy through the vision and leadership of its CEO and co-founder, Steve Jobs, who had rejoined the company in 1997. The company had basically reinvented its core product offering in the early 2000s, and it benefited greatly from the success of the iPod which commanded as much as three quarters of the portable media player market in 2003-2004, until the music players in smartphones and music oriented feature phones started eating away its market. Before discussing the iPhone, let us briefly review the major transitions that Apple went through before launching its smartphone product. Understanding them will help understand a few particular design decisions that Apple made regarding the iPhone.

In 2001, Apple transitioned to a completely new OS for its computer products called 'Mac OS X' that was partially based on software components from BSD Unix and other open source or mixed source projects such NeXTSTEP, and featuring a proprietary UI and application framework. The underlying core OS was named 'Darwin' by Apple, and it later formed also the basis of the iPhone OS, later abbreviated to iOS. To date, iOS powers Apple's iPhone, iPod Touch, and iPad devices. On the hardware side, Apple announced in 2005 that it would phase out the PowerPC processors that had powered its computers and laptops for more than a decade, transitioning to Intel's x86 processor architecture starting in 2006. This move allowed Apple to better compete with Intel-based PC manufacturers and also to run multiple bodies of software: native Mac OS X, Unix, Java, .NET, as well as Win32, the latter through emulation or virtualization techniques. Dual booting to Microsoft Windows also became possible on Mac computers. This was a shift towards openness in the platform strategy of a vendor that had sworn by proprietary, incompatible solutions for most of its existence.

The iPhone, first sold in June 2007, differed greatly from other smartphones of its time. It had a very large screen for its time, measuring 3.5 inches diagonally and covering nearly the entire front side of the device, much larger than the 2.6-inch screen of the Nokia N95 or other smartphones of the era. Moreover, there was only a single button on the front of the device with no physical keypad or keyboard whatsoever, as the screen was in fact a capacitive touch screen that responded to finger touch. All the functionality of the device was accessible via the touch screen, and a virtual on-screen keypad or keyboard popped up whenever numerical or text input was required. The UI was smooth, responsive, pleasing to the eye, and intuitively easy to learn even for a person that was not "tech savvy". In many ways, the device was remarkably simple to use, yet it accomplished what most users wanted from a mobile handset, and more. Thus, also people who were not familiar with smartphones discovered and loved the new product, and it become a global hit despite its limited geographical availability. For many, the iPhone defined what constituted a smartphone.

All of a sudden, the sophisticated but complex UI of Symbian S60, which relied on deep, layered menu structures, seemed cumbersome and even outdated. It did not help much that it had many times the number of features that the iPhone had when consumers had a hard time finding and using them. At first, the incumbent smartphone manufacturers failed to take the iPhone seriously and argued that with so many features missing (such as 3G cellular access and multimedia messaging service (MMS)), the device is not a real smartphone at all and would only appeal to niche users. Also much of the industry was still dead set on physical keypads and did not believe that touch screens would become widely popular, as the earlier (resistive, stylus-based) touch screen devices had not gained mainstream popularity.

Both assumptions turned out to be wrong — most users did not mind the lack of features in the first iPhone (which were eventually remedied in product software updates and newer iterations of the product), and the finger-sensitive touch screen was not only accepted but loved by consumers, sparking an industry-wide paradigm change to devices with large touch screens as the primary input method. This change was further fueled by the introduction of Android in November 2007, Google's open source mobile software platform that also had adopted a touch UI paradigm similar to the iPhone. It's worth noting that Nokia, too, had earlier developed a touch-based UI for its Symbian Series 90 platform but used it only in a single commercial product, the Nokia 7710. Series 90 was not designed for finger touch, however, but it could have been refined to support that paradigm, had Nokia's leadership not decided to discontinue it in favor of focusing on S60.

App Store as a Platform for Complementary Innovation

A second major shift in the smartphone business landscape occurred when Apple released a software development kit (SDK) for the iPhone on March 6, 2008. This SDK allowed individuals and companies to enroll in the iPhone Developer Program for a modest fee, and develop and publish free or commercial software applications for the iPhone, to be sold in the newly announced iPhone App Store, a consumer-oriented application marketplace run and "curated"[2] by Apple, which would open in July 2008. The business model of the App Store is based on simple revenue sharing scheme: the developer gets 70% of the revenue accrued, and Apple gets the remaining 30%. The app purchases take place conveniently on the device and the billing is handled via the user's iTunes account with credit card details, and as there are no middlemen in the transaction, the developer gets the full 70% of the price paid.

The above proved out to be a wonderful business model, and once open, the app store was bustling with all sorts of creative, fun, and useful applications, capturing the long tail of complementary innovation and really unleashing the power of the iPhone hardware for even the most bizarre purposes one could

[2]The curation basically means that Apple imposes rather strict rules on what kinds of applications can be published, and each application that makes it to the store catalog will have gone through a vetting process. Not only does this improve quality, as poor quality or nonfunctional applications are not accepted, but it also enforces security, as malware, short for malicious software, is typically caught in the vetting process.

think of. While the iPhone did not have all the features out of the box, no matter what the need, there was an app for it. Apple later used a variation of the latter part of the previous phrase in its TV commercials and even obtained a trademark for it.

The iPhone App Store was clearly a differentiator for the iPhone at a time when other smartphones had a much more limited selection of applications available through a number of inconvenient storefronts that not many consumers were even aware of. Furthermore, the fragmentation, perceived high development cost coupled with risky returns, and other barriers that some other development platforms like Symbian suffered from meant that developers flocked to the iPhone App Store where the success stories were abundant. Some lucky individuals who had developed applications that became popular on the iPhone made millions of dollars, though the competition was getting tougher as more and more developers published applications and the catalog was swelling, making discovery (getting one's applications noticed) increasingly an issue.

Android's Rise and Symbian's Fall

Another major, industry-shaping event had taken place on November 5, 2007. It was then that the newly formed Open Handset Alliance, led by Google, announced the launch of Android. Android is a smartphone software platform that was originally developed by the Palo Alto, California based company Android, Inc., founded in October 2003 and later acquired by Google in August 2005. The platform development continued at Google, and an industry consortium of initially 34 organizations was gathered in the form of OHA to prepare for the launch in late 2007. The OHA roster included handset manufacturers, mobile network operators (MNOs), chipset (semiconductor) manufacturers, software integrators, and independent software vendors (ISVs), essentially covering all parts of the value network or ecosystem involved in mobile business. This was to guarantee that Android had enough initial support from the mobile industry to get it off the ground. Google and OHA promoted Android as an "open platform for developers, users, and industry", offering a "cutting-edge mobile user experience" (Google, 2008).

The first Android smartphone, the T-Mobile G1 (also known as the HTC Dream), was manufactured by the Taiwanese handset manufacturer HTC. It began sales in the US and UK in October 2008 and expanded to other markets in early 2009. While not a major commercial success and not quite up to the level of user experience (UX) that the iPhone offered, it did alright and showed what Android was capable of, even at version 1.0. The first Android products were touch & QWERTY sliders with a trackball for navigation, but soon enough, subsequent updates to the OS (starting from v1.5 'Cupcake', released in April 2009) enabled a virtual on-screen keyboard, allowing the creation of touch-only devices in the vein of the iPhone. This accelerated the productization efforts of handset manufacturers, and Samsung, LG, Motorola, Sony Ericsson, and smaller manufacturers soon released their Android debuts during the second half of 2009 and early 2010.

Drastic strategic moves were seen, as for example Motorola, suffering from an outdated portfolio and serious financial troubles, decided to focus its smartphone efforts solely on Android, discontinuing its work on other platforms. Similarly, Sony Ericsson decided to base its future Xperia line of smartphones on Android, giving up on Windows Mobile that had featured in its Xperia X1 device. Also in China, the local handset manufacturers saw Android as a welcome, cost-efficient enabler for producing inexpensive smartphones for the large and fast-growing domestic market as well as for export. The Android ecosystem was rapidly gaining momentum.

Although Nokia's smartphone sales continued strong through 2008 and 2009 despite the global economic downturn, it was clear that the company had two serious challengers in the smartphone space that grew at an alarming rate: Apple with its iPhone and the Android camp. During the period, despite achieving good sales figures, Nokia's Symbian based smartphone portfolio was rapidly losing its competitiveness from consumer perception, UX, and technical performance perspectives. The cumbersome nature and legacy of the Symbian software asset was slowing the much-needed renewal of the platform, and the UX severely lagged behind that of the iPhone but also Android handsets. Furthermore, other device manufacturers such as Samsung and Sony Ericsson had effectively abandoned Symbian as they had focused their efforts on Android, leaving Nokia alone to develop the platform and gather support for the ecosystem, which was very costly but resulted in only limited success. Symbian was perceived exclusively as a Nokia platform which limited the willingness of existing and potential partners to invest in it. Application developers were also increasingly focusing their efforts on iPhone and Android, both of which seemed to offer better returns for their investments through lower development costs, easier monetization and discovery, and a wide audience of consumers that were willing to purchase applications. The ecosystem around Symbian was withering away.

Crumbling Walled Gardens and the Reduced Role of Operators

As a consequence of the success and popularity of the iPhone, MNOs around the world were facing new kinds of dynamics. Even major incumbent operators holding strong bargaining power in large markets such as the US and Western Europe (e.g., UK, Germany, France) had to come to terms with the fact that they no longer could dictate the UX on smartphones or require operator service portals and premium services to be preinstalled in the case of Apple. Apple categorically refused any attempts by operators to alter or customize the experience on its devices.

Exclusivity deals of limited duration were an early tool for Apple to ensure support from key operators in each market area. These operator partners agreed to costly promotion campaigns and device subsidy plans in exchange for the exclusive right to market and sell the iPhone. As a benefit, many of the early operators offering the iPhone (such as AT&T in the US) saw an influx of subscribers, while their rivals suffered from increased levels of churn. Many of these iPhone-less carriers, such as Verizon Wireless and Sprint in the US, turned their attention to Android-based handsets (as evidenced by the Verizon 'Droid' franchise) manufactured mainly by Motorola, Samsung, and HTC, all of whom were still willing to work with operators in terms of customization, co-branding, and so forth. However, even the most stubborn carriers have since given in, and very few operators today would not offer the iPhone given the opportunity.

A second major shift was related to digital content and services, especially applications and their distribution. Traditionally, the major incumbent operators had built 'walled gardens', closed, operator-controlled palettes of content and services for their subscribers that typically restricted the selection of premium content to operator-preferred sources. The content and services were offered through deals and partnerships between the operators and content/service providers, and the operators benefitted from the transactions made by their subscribers. This was not the case with the App Store and iTunes, the marketplaces of choice on the iPhone. As discussed above, Apple had introduced a revenue sharing scheme where it took 30% of application revenue while the developer got 70%, leaving nothing for the operator despite the fact that applications were often downloaded "over the air", using the operator's cellular network. Apple had effectively cut the operators out of the digital content value chain. The allegedly more operator-friendly Android Market (now called Google Play) as well as Nokia's Ovi Store did offer operators a cut in return for operating billing services. Due to the rapidly growing popularity of both iPhone and Android handsets, operators found themselves largely disconnected from application development, distribution, and monetization.

In the past, and as recently as 2012, operators have had several initiatives with the goal of establishing new application development and runtime environments as well as distribution channels that would be more "friendly" to their cause. These include mobile OS and middleware standardization initiatives such as LiMo (Linux Mobile) Foundation as well as web technologies based, cross-platform runtime environments such as the one promoted by the Wholesale Applications Community (WAC). WAC was an operator-led consortium that aimed at creating a unified and open platform to allow mobile application developers to more easily write applications that would work on a variety of devices, OS's, and networks. WAC is defunct as of June 17, 2012, having reached an agreement to integrate its major programs and initiatives into the GSM Association (GSMA).

A third major shift is the proliferation of what is dubbed as 'over-the-top' (OTT) communications. Some applications such as Skype, Fring, and Viber, previously available and popular on PCs, have made their way to smartphones and enable subscribers to circumvent operator tariffs for voice calls, instead paying for data only, often at a flat (or tiered flat) rate. Similarly, text message (SMS) and MMS volumes have declined due to the availability of popular instant messaging and chat applications such as WhatsApp and Snapchat. Many (if not most) operators see this transition as troublesome, as it requires them to come up with new business models that allow them to benefit from increased mobile data usage and neutralize the effects of OTT services gradually eating into voice and SMS revenue. Bundled service pricing is a common solution, combining voice, SMS/MMS, mobile data, and potentially some premium services (e.g., video on demand) into a service plan with a fixed monthly rate. Some carriers still actively fight OTT services by outlawing and blocking them from their networks, but such policies are only likely to frustrate users and increase churn if rivaling carriers have adopted more open policies.

Mobile operators have struggled to maintain their relevance as anything more than data transport service providers, and their past initiatives to assert control in innovation ecosystems have not been very successful. Although their role is crucial in enabling mobile communications, currently they seem to have been increasingly relegated to the role of data transport providers. This development is likely to continue if they cannot innovate and engage their subscribers more. As it stands today, mobile ecosystem leaders and leading handset manufacturers (often but not always the same thing) have captured the minds and hearts of consumers.

War of Ecosystems

Another hurdle for Nokia was its services and solutions strategy, which it had adopted in 2007 and started to implement in 2008. The company launched a plethora of mostly free-of-charge services available on the web and Nokia handsets under the 'Ovi' brand which seemed to offer very little if any benefit over similar, more established services already available. In fact, many of them were actually deemed much worse than the free services from the likes of

Google that were also available for Nokia handsets. Recurring quality issues plagued many of the services despite numerous updates. Additionally, the fragmentation of Nokia's software platforms meant that multiple versions of service clients had to be developed and maintained to support each platform generation and branch. Although Nokia invested huge sums in R&D, more than just about any other company in the industry as a percentage of revenue, the resources were spread across so many platform, product, and service development projects that progress was painfully slow. With the exception of Nokia's complimentary turn-by-turn navigation on its smartphones, free mobile e-mail, and the services targeted for the emerging markets such as Life Tools, the palette of Ovi services and solutions did not, as a whole, meet adoption targets. Many of the services were subsequently ramped down.

Despite these major difficulties, Nokia soldiered on with its in-house platform strategy, focusing on Symbian and Maemo, later renamed MeeGo as a result of Nokia's partnership with Intel. By mid 2010, it was clear that the old strategy was not coming to fruition, and so a drastic change was needed. Android was about to overtake Symbian as the #1 smartphone platform globally (which it accomplished in Q4 2010) and MeeGo was suffering from product delays. Mr. Stephen Elop, joining from Microsoft, became the new CEO of Nokia on September 21, 2010, initiating a strategy assessment and renewal process. The outcome was Nokia's new strategy, announced on Feb 11, 2011, that saw the company enter into a strategic alliance with Microsoft, focusing its smartphone efforts on the Windows Phone platform and ramping down Symbian and MeeGo. Elop claimed that the industry had entered an era where there was a war between ecosystems, not merely a battle between devices. Nokia had not succeeded in building an ecosystem on its own, so it joined forces with Microsoft to create a "third ecosystem" to compete with the ecosystems of Apple and Google (Android). Microsoft stood to gain a lot from the partnership, as it had secured a large-scale handset vendor for its Windows Phone platform which was struggling to gain manufacturer support. While some other manufacturers such as HTC, Samsung, and LG were also Windows Phone licensees, they focused most of their product efforts on Android. Nokia, on the other hand, was "all in" with Windows Phone, in practice having no viable alternatives should things go awry.

Both Microsoft and Nokia had invested heavily in making Windows Phone 8 a booming success, and in many ways, their relevance in the smartphone business was dependent on the success of the products and complements built on that platform. For Nokia, for reasons stated above, it was also very much a question of existence. Even with critically acclaimed products on the market, building a successful, thriving ecosystem is no small feat. Despite huge efforts on Nokia's side to make attractive 'Lumia'-branded smartphone designs on Windows Phone as well as tablets on Windows RT, the devices and their ecosystem failed to generate the kind of momentum that was required to sustain Nokia's smartphone business. Despite healthy sales growth of Lumia smartphones up until Q3 2013, the business was losing money fast, and Nokia had to act. Rumors of a possible takeover of the handset business by Microsoft had circulated already in June 2013, but the news finally came on September 3, 2013: Nokia had signed an agreement to sell its Devices & Services business to Microsoft in an all-cash transaction valued at 5.44 billion Euro. Of the total purchase price of 5.44 billion, 3.79 billion relates to the purchase of substantially all of the Devices & Services business, and the remaining 1.65 billion relates to the mutual patent agreement and "future option" (Nokia, 2013a; Microsoft, 2013).

When the deal was granted approval by Nokia shareholders in the Extraordinary General Meeting on November 19, 2013, the story of Nokia as a handset manufacturer, once largest in the world, was over (Nokia, 2013b). The company would retain its network infrastructure and services business Nokia Solutions and Networks (promptly renamed to Nokia Networks), the location-based services and mapping business HERE, and a third business called Technologies which is said to build on several of Nokia's Chief Technology Officer (CTO) organization and IPR activities, further expanding Nokia's patent portfolio and the licensing activities around it, also exploring new business opportunities through advanced research, development and concept products in areas such as connectivity, sensing and material technologies, as well as web and cloud technologies.

Having given up its once-triumphant handset business, Nokia needs to innovate and find new growth in its remaining businesses which at first look do not have a whole lot of synergy. The location-cloud business of HERE is, however, heavily dependent on connectivity solutions inside vehicles as well as smartphones acting as clients or 'companion devices' to the services, so HERE remains closely linked to the smartphone business even though selling the actual devices is no longer a business for Nokia. Whether HERE will enter the consumer market with some other kinds of devices utilizing location-based services remains to be seen. As for Nokia Networks, the network infrastructure business offers solid revenue for years to come especially due to 4G LTE (Long Term Evolution) network rollouts and upgrades, although the competition remains tough.

While ecosystem building in general takes a lot of time, effort, and money, it is worth noting that the barriers to entry for new smartphone manufacturers are considerably lower than what they used to be about five years ago. This is primarily due to the availability of off-the-shelf, turnkey solutions as a basis for smartphone designs. Many mobile chipset vendors offer reference designs for which they have ported the Android OS and the required device drivers.

This makes it relatively easy even for smaller device vendors with limited mobile specific expertise or software/hardware integration capabilities to make handsets. Also, the free-of-cost and open source nature of Android makes it an attractive, cost-effective platform for building smartphones. This is particularly true in the Far East, especially China, where intellectual property rights (IPR) are not strictly enforced and thus the manufacturers can afford to make handsets even cheaper without fear of litigation. Furthermore, manufacturing assets and scale have also diminished in importance as successful smartphone vendors such as Apple produce their handsets in large volumes through contract manufacturing services such as Foxconn and Pegatron.

The signs of increasingly intense rivalry between mobile business ecosystems are becoming more evident. In June 2012, for example, Apple launched version 6 of its iOS operating system but without the familiar Google Maps application that had been the preinstalled mapping solution ever since the first iPhone in 2007. Instead, Apple had developed its own mapping application with novel features such as 3D flyover and also featuring turn-by-turn navigation free of charge (BBC News, 2012). Interestingly, some much-loved features from Google Maps such as StreetView (the ability to view streets from a full 360 degrees) were absent. Also, usability and map data issues irritated many users and even sparked Apple CEO Tim Cook to apologize, assuring that Apple would fix the shortcomings.

Building a fully functional mapping solution is a demanding task, and Apple had ramped up its mapping capabilities through a series of acquisitions done between 2009 and 2011 (PC Magazine, 2012b). It had gone through all the effort because it wanted to rid its ecosystem of a control point occupied by Google. Owning the mapping platform gives Apple the opportunity to collect more data on user behavior which in turn can be leveraged to improve existing services and monetized via advertisers. In this sense, Apple is increasingly fighting Google in its home arena of advertising, location based services, and cloud-based services in general.

Google is also increasingly leveraging the popularity of its services such as Gmail as a weapon against rivaling ecosystems. On December 14, 2012, Google announced it would be discontinuing some of its mobile synchronization services as part of "winter cleaning" (Google, 2012c). In particular, this meant that after January 30, 2013, non-Android device users would not have push-email or calendar synchronization linked to their Gmail accounts. Phones that rely on the Exchange ActiveSync protocol for synchronization to Gmail as well as Google calendar and contacts would have to revert to periodical, non-push synchronization. This includes all Windows Phone users, so the decision can be seen as a serious blow against the Windows Phone ecosystem, given how popular Gmail accounts are. iPhone users are somewhat less effected as they will likely be able to use a tailored application for accessing their Gmail accounts. Those with paid Google Apps subscriptions would also continue to enjoy Exchange ActiveSync access to their accounts. As a final blow to remaining Symbian/S60 users, Google announced they would stop the support for Google Sync for S60 also on January 30, 2013.

For the consumer and end user, the rivalry and developments described above can be troublesome. For one thing, sharing personal data and content between devices belonging to different ecosystems is not easy. Applications and content purchased on one platform are usually not transferable to another. The notion of ecosystem 'lock-in' is increasingly prominent as, for example, the choice of smartphone is increasingly influential on the purchase decision of tablets, laptops, and media streaming devices and also the choice of services (Apple App Store, iTunes, iCloud vs. Google Play, Google Play Music, Google Drive vs. Microsoft Windows Phone Store, Xbox Music/Video, OneDrive). Due to such strong vertical offerings with limited interoperability and compatibility, the consumer may find him/herself locked into an unsatisfactory solution from which it is costly to break free from, often requiring repurchase of applications and content, and in some cases also hardware peripherals and accessories, adding up to the costs. While creating platform lock-in has always been a central tool for platform proprietors to strengthen network effects and drive revenue, in the world of business ecosystems, lock-in can happen on multiple levels, as also noted by Kenney & Pon (2011).

1.1.2 Why Business Ecosystems Matter

According to Q4 2012 sales figures, Samsung was the leading smartphone manufacturer with a 29.0% global market share, followed by Apple (22.1%), Huawei (5.3%), ZTE (4.7%), and Lenovo (4.4%). The rest of the market, 34.5%, is divided between numerous smaller players (Canalys, 2012b). As of Q4 2012, this group of manufacturers with low single digit market share includes former incumbents such as Nokia and RIM, and niche players such as Sony (formerly Sony Ericsson). Still in the previous quarter, both Sony and RIM made it to the chart with market shares of 5.1% and 4.2%, respectively (Canalys, 2012a). Also, never before have Chinese companies occupied the ranks #3 to #5 in terms of global smartphone market share. What is particularly startling about these figures is that only one and a half year earlier, in Q1 2011, Nokia was still holding on to its position as the #1 smartphone manufacturer with a market share of 24.0%, although Apple and Samsung were close behind already then (Canalys, 2011a). In Q2 2011, Apple overtook Nokia as the largest smartphone manufacturer globally, before Samsung claimed the #1 position later in 2011 (Canalys, 2011b).

The figures above illustrate a rare, if not totally unique phenomenon in recent business history: a leading incumbent in an industry sector suffers an almost complete collapse of its market share and profit in just a couple of years, disappearing into the low-single-digit market share range. Almost simultaneously, two companies that had practically no stake in the smartphone market a few years earlier have taken the lead. Surely such a drastic change in the market structure warrants a study on the factors that contributed to it.

As noted in the previous section, Nokia had failed in creating a thriving business ecosystem and had eventually fallen behind both in product innovation as well as stimulating external, complementary innovation on top of its in-house platforms. The new entrants Apple and Google, despite not previously having a foothold in the mobile business, were able to create and establish mobile business ecosystems around their mobile platforms and software application marketplaces through clever ecosystem and platform strategies and have, at least for the time being, displaced former incumbents such as Nokia and RIM (renamed to BlackBerry in January 2013). Indeed, business ecosystems have become the new basis of competition in the smartphone business, and the dynamics of the industry have changed permanently. Some researchers even go as far as saying that the mobile ecosystem wars are drawing to a close after some six years, with Google's Android and Apple's iOS capturing over 94% of the overall smartphone market, pointing to the marginal role of other players (VisionMobile, 2014). Moreover, according to VisionMobile (2014), the developer mindshare rating was 71% for Android and 55% for iOS. The latter platform commands the highest developer loyalty, however, being the preferred platform for 59% of its developer base.

Based on the above, it would currently seem that the market is very much a duopoly with limited business opportunities for other competing ecosystems. However, both Apple and Google did rise to prominence relatively quickly, through both technical and business model innovation as well as the capability to quickly respond to changes in consumer preferences, disrupting the early incumbents of the smartphone business. Therefore, it is fair to assume that these leading ecosystems, too, are not immune to changes in the technological and business landscape, and their current entrenched positions may be challenged at some point in the future. Understanding the factors that would contribute to such developments is a key motivation for this thesis.

An opportunity is seen to learn from the firms and ecosystems by examining the strategic choices they have made and the results they have achieved over the years. How does one then successfully orchestrate a business ecosystem or manage a platform, particularly in the mobile smartphone industry? The question is of great interest not only in management science and consulting but also in the academia, as an increasing number of research papers and articles published in journals in the last couple of years have examined the competition between mobile software ecosystems and their digital marketplaces for consumers, developers, operators, and other constituents involved in the creation of value.

1.2 Objectives of the Study

1.2.1 Prior Research

The various phenomena and mechanisms related to performance, competition, and cooperation of firms, whether active in mobile business or other industries, have been studied by various authors, though often from a distinctive perspective by each individual author and using different theoretical concepts and frameworks.

Already for some decades, scholars particularly in the strategic management field have studied the sources of competitive advantage in an attempt to explain the differential performance of firms (Rumelt, Schendel, & Teece, 1991). Two prominent views have emerged over time, firstly the influential *industry structure view* of Porter (1980) which suggests that above-average returns primarily stem from a firm's membership in an industry with favorable structural characteristics such as bargaining power relative to suppliers and customers, barriers to entry, rivalry within the industry, and so forth. Thus, many scholars have focused on the industry as the relevant unit of analysis, according to Dyer & Singh (1998).

An alternative view called the *resource-based view*, studied notably by Wernerfelt (1984, 1995) and Barney (1991, 2001), argues that differences in firm performance and returns are fundamentally due to firm heterogeneity and differences in the accumulated tangible or intangible resources and capabilities of firms. When firms possess resources and capabilities that are rare, valuable, non-substitutable, and difficult to imitate, they are able to achieve a competitive advantage over other, competing firms (Dyer & Singh, 1998).

Dyer & Singh (1998) acknowledge the contributions of the industry structure view and resource-based view to understanding factors contributing to above-average returns, but at the same time, argue that these views do not sufficiently consider the fact that the (dis)advantages of a firm are often linked to the (dis)advantages of the *network of relationships* in which the firm is embedded. They also argue that a firm's critical resources may extend beyond its boundaries and that those resources may be embedded in interfirm routines and processes. Thus, firms that make relation-specific investments and combine resources in unique ways may realize an advantage over competing firms unable or unwilling to do so. Hence, *idiosyncratic interfirm linkages* may be a source of *relational rents*[3] and competitive advantage.

Consequently, Dyer & Singh (1998) argue that the *relationship between firms* is an increasingly important unit of analysis for understanding competitive advantage especially in an interorganizational context, hence the term *relational view*. Moreover, they identified four distinct sources that provide competitive advantages when organizations work together, namely 1) *investments in relation-specific assets*, 2) *substantial knowledge exchange*, 3) *complementary resources/capabilities enabling the joint creation of new products, services, or technologies*, and 4) *effective governance mechanisms resulting in lower transaction costs*. As shall be discussed later in Chapter 2, these findings are remarkably similar to those of other theories of interfirm cooperation and competition, laying the theoretical foundation for the research problem of this thesis.

A fundamental concept which many of the theories discussed in this thesis build on is that of *network effects*. The theory of network effects (also called network externalities) and firms and their products forming "virtual networks" was laid out by Katz & Shapiro (1985) and continues to form the foundational basis of much of the more advanced theory that is used to describe and explain modern concepts such as mobile software application stores. The basic notion is that many products have little or no value in isolation, but when combined with other related products, they generate value. In this sense, the products are complementary to each other. Also, positive network effects imply that the more users a product has, the more value it has to each user.

Katz & Shapiro (1985, 1986, 1994) and others recognized that systems markets exhibit complexity in terms of expectations, coordination, and compatibility well beyond that of regular product markets where individual products compete against each other. Here, *expectations* refers to the fact that the components of a system, such as software applications for a computer, may be purchased over a period of time, thus requiring the rational buyer to form expectations about the availability, price, and quality of the components in the future. *Coordination* refers to the issue that a firm's decision to make a certain product, such as a new processor design, depends on other firms' capability and willingness to make their complements, in this case, software, work on it. *Compatibility* refers to the issue of whether a component designed for one particular system also works in another system. Systems that are popular tend to have widely available components and will be even more popular due to the positive feedback (network effects). Indeed, Katz & Shapiro (1994) acknowledge that network effects have proven troublesome to economic theory

[3] Dyer & Singh (1998) define relational rents as supernormal profits jointly generated in an exchange relationship that cannot be generated by either firm in isolation.

as an equilibrium (of supply and demand) may not exist, or multiple equilibria may exist, and also the fundamental theorems of welfare economics may not apply.

Network effects, when generalized to include both *same-side* and *cross-side* effects as described by Eisenmann et al. (2006), are the theoretical foundation for *two-sided markets*, discussed by Parker & Van Alstyne (2000); Rochet & Tirole (2003); Parker & Van Alstyne (2005); Eisenmann et al. (2006) and other authors. Much of the research on the topic has focused on the issue of pricing and subsidization of the two sides of the market whose transactions are facilitated by a platform, but competitive dynamics between several platform providers serving two-sided markets is also an enduring topic of academic interest. Hagiu (2009) and Rysman (2009) discuss multi-sided platforms (MSPs) as a generalization of two-sided markets.

Most of the early examples and case studies of two-sided markets deal with either credit card markets (Rochet & Tirole, 2003), directories of businesses (Rysman, 2004), or computer OS's (Parker & Van Alstyne, 2000, 2005), approaching the demand and pricing relationships of those markets mostly from a theoretical, quantitative perspective. Extensive case studies of qualitative nature on two or multi-sided markets have been a rarity, and until just a few years ago, hardly any had been made specifically on the topic of mobile software platforms and application stores.

The theory of industry platforms and the associated roles of platform leaders and complementors have been studied extensively in particular by Cusumano & Gawer (Gawer & Cusumano, 2002, 2008; Cusumano, 2010). Although building on the theory of network effects as well as two-sided markets, they focus mostly on technical and organizational concepts such as scope of offering, product architecture and modularity, external relationship management, and internal organizational structure. Boudreau (2008) has studied the effects of the number of complementors on the intensity of competition and level of innovation on a platform through quantitative econometric analysis, coming to the conclusion that under specific circumstances, adding too many complementors can detract from a platform's ability to generate new innovation as well as profits for the firms making complements on it, mainly due to crowding-out effects and substitution as opposed to market expansion.

The ecological analogy of *business ecosystem*, as first coined by Moore (1993, 1996) and further refined by Iansiti & Levien (2004a,b), has been widely adopted in management science for describing the modern ICT business landscape, its actors, and the dynamics of cooperation and competition among them. The etymology and characteristics of the term as well as its relationship to other similar concepts such as *value network* (described by, e.g., Christensen (1997), Stabell & Fjeldstad (1998), and Allee (2000)) has been explored by, e.g., Peltoniemi (2004) and Peltoniemi & Vuori (2004). Furthermore, quantitative measures for the health of a business ecosystem have been developed by, e.g., Den Hartigh et al. (2006), building on the concepts developed by Iansiti & Levien (2004a). Also a significant body of research exists on software ecosystems and particularly (open) innovation management in such ecosystems (Chesbrough & Appleyard, 2007; Bosch, 2009; Jansen et al., 2009; Parker et al., 2010).

Extensive case studies on *mobile* software ecosystems have been quite rare, however. Also, when applied to case studies, business ecosystem theory often seems to lead to quite high-level analysis when firm or platform-level analysis would be valuable in adding insight. Many of the firms described as "keystones" in business ecosystem theory act as platform providers for a two-sided market, and therefore it is surprising that ecosystem case studies have not widely considered two-sided market aspects in their analysis.

Interestingly, Eaton et al. (2011) and Tilson et al. (2012) have approached the evolution and dynamics of mobile software ecosystems from a different perspective, studying the paradoxical relationship between control, generativity, and change in the cultivation of innovation in digital ecosystems using mobile application stores as case examples. They note that, for example, control, while reducing generativity through seeking to strengthen control boundaries for emerging innovation, can also feed extensive generativity. In a similar manner, generativity resulting in emerging and unexpected innovations can increase the need for control.

More recent studies, such as those by Tuunainen et al. (2011), Campbell & Ahmed (2011), Idu et al. (2011), Hyrynsalmi et al. (2012), and Bresnahan et al. (2014), have analyzed the software ecosystems and developer marketplaces of Apple, Google, BlackBerry, and Microsoft. As insightful as their studies have been, however, their perspectives have been limited in scope to cover application marketplaces and developer programs without a broader, holistic understanding of the firms' ecosystems of collaborators and competitors, their product platforms, their method of value capture, and the various strategic decisions that they have made over the years to define their 'rules of engagement' in the mobile smartphone business.

An aspect that has received little attention in the existing literature and case studies on mobile business ecosystems is what the author calls *angle of entry* into a business domain. This novel term refers to the historical legacy of a firm mainly in terms of its previous business activities, capabilities, and assets which, as is argued in this study, has had an impact on more recent choices the firm has made in its ecosystem and platform strategies. This seems quite plausible, given that the central argument of the path dependency theory in economics and social sciences, as described by P. David (1985, 1994, 2001), is that the set of options in decision making for any given circumstance is limited by the decisions one has made in the past, even though past circumstances may no longer be valid or have any relevance. Therefore, the author's hypothesis is that the angle of entry of a firm can at least partially be used to explain some of the ecosystem or platform level success factors. This is essentially one of the detailed research questions (#1) that are stated in Section 1.2.3. Given that there are ample historical data and documents available on the mobile industry and its actors, it should be feasible to study to this question.

Finally, it should be noted that at least so far, very few researchers have attempted to bring together the separate but interrelated theories of platforms, two-sided markets, and business ecosystems, despite the fact that these concepts largely describe similar phenomena and underlying mechanisms, even if from somewhat different perspectives. Muegge (2013) makes an attempt in this direction, discussing the platform theory of Cusumano & Gawer (2002) together with the business ecosystem theory of Moore (1993, 1996, 2006) and Iansiti & Levien (2004a,b), arguing that they represent different but complementary layers of analysis in a complex hierarchical system. Herein lies a significant purpose for this thesis from a theoretical perspective: bridging the different theoretical concepts with notable similarities and making sense of them in a holistic way.

1.2.2 Research Target

In designing the framework, practical applicability is an important consideration, as it can be argued that many of the existing frameworks are too abstract or difficult to apply to be of practical value to executives and managers who are responsible for making the strategic decisions that ultimately shape the business landscape and ecosystems. While the goal for this framework is to be *holistic* in the sense that it covers the relevant aspects of the various existing models, no attempt is made to create a unified theoretical framework that would automatically be suitable for any industry setting. The scope of the study is limited strictly to mobile business ecosystems and firms active in the smartphone business.

In the research conducted as part of this thesis, the aim is to *understand the key drivers and strategic choices* that contribute to a firm's ability to successfully create, sustain, and manage a *business ecosystem*[4] of firms producing *value-*

[4]In the context of this study, business ecosystems are typically diverse, not limited to specific geographical regions (as opposed to firm *clusters*), and encompass a wide range of firms that belong to different industries, including (but not limited to) mobile handset vendors, PC and CE vendors, original design manufacturers (ODMs), semiconductor companies, wireless carriers, Internet content & services providers, and ISVs.

adding complementary innovation[5] on top of a product (or industry-wide) *platform* in the smartphone business. An attempt is made to put together an analysis framework that combines the most suitable elements of existing theoretical frameworks known to the scientific community for the specific purpose of analyzing the *success factors* of ecosystems, platforms, and firms active in the smartphone business. In particular, these factors are analyzed from the perspective of a firm's angle of entry into the smartphone business as discussed.

1.2.3 Research Questions

The high-level research question of the study is formulated as follows:

What are the success factors of a business ecosystem in the mobile smartphone industry?

This question can be broken down further to four more specific questions, also illustrated in Figure 1.1:

1. *How do a firm's legacy and angle of entry into the mobile business affect the success factors of its ecosystem?*
2. *How does a leading firm successfully orchestrate an ecosystem to foster value-adding complementary innovation?*
3. *How does a leading firm successfully manage a product/industry platform to enable value-adding complementary innovation?*
4. *What is the interplay between successfully orchestrating an ecosystem and managing a product/industry platform? Are the success drivers similar?*

By the term *angle of entry*, a reference is made to the perception that many large incumbents that currently occupy a major role in mobile smartphone business have an older, more mature business in PC or CE manufacturing, computer operating systems and/or software, or alternatively, in the relatively new business domain of Internet services, content, and online advertising. When these companies have expanded into or refocused their business on the rapidly growing mobile sector, they have made strategic choices regarding which roles in the ecosystem or value network they desire to occupy, and also

[5] Value-adding complementary innovation is defined here somewhat loosely, and can mean anything from commercially available hardware accessories and after-market software applications developed by third parties to specifically tailored business-to-business (B2B) solutions, with the general notion being that it contributes to the overall value and attractiveness of the platform and/or ecosystem through a mechanism known as *positive feedback*, thereby attracting even more complementors.

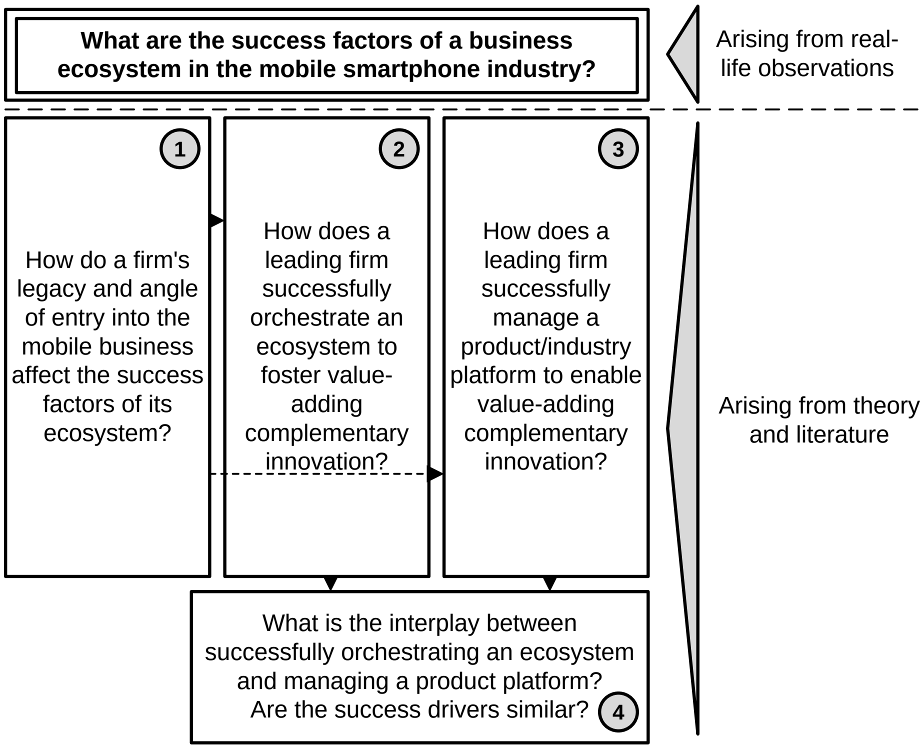

Figure 1.1: Research questions

how they intend to capture value. Based on the legacy of these firms, their existing businesses, and their capabilities and assets, the firms have been and are in somewhat different positions as they have entered the mobile business arena, and thus stand to capture value from their ecosystem in somewhat different ways.

Hence, a topic of research interest in this thesis is to understand how the differing angles of entry affect the success factors of the firms and ecosystems being examined. This concept is illustrated in Figure 1.2. The figure also provides an approximate two-by-two matrix division of the adjacent industries or businesses into hardware and software oriented ones on the horizontal axis, while the vertical axis attempts to separate emphasis on mobility and universal access from personal computing, productivity & entertainment. One should note that this is by no means an absolute division, as there are examples of firms which are equally innovative in both hardware and software development and have a high capability level and significant assets in both areas. Similarly, many companies that have started out as developers and publishers of PC software have since evolved and expanded into Internet and cloud services business often via *Software as a Service* (SaaS) or *Platform*

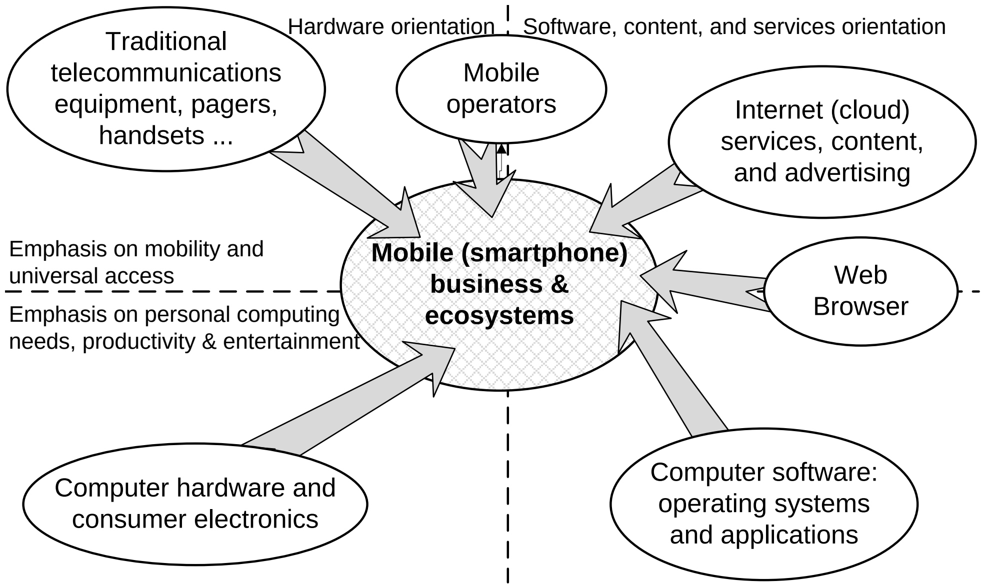

Figure 1.2: Angles of entry into mobile smartphone business

as a Service (PaaS) business models and offerings. As an example, PC software incumbents like Microsoft have taken their productivity software suites and enterprise applications online, Microsoft Office 365 being a good example. Some others firms have become online content providers and/or aggregators. It is common for different software licensing and revenue models to coexist in a single firm, even for the same product range. By this division, the aim is to understand where the firms are coming from in a historical sense, which could explain some of their strategic choices and inclinations.

1.3 Scope of the Study

Stated concisely, the high-level goal of this study is to identify common (and perhaps also some differing) success factors in leading mobile business ecosystems, specifically those led by three companies that are chosen for a multiple case study: Apple, Google, and Microsoft. These companies are chosen for a particular reason: each of them has historically been active in different businesses outside the traditional telecommunications industry before successfully entering, and as of late, dominating the smartphone business, pushing aside long-standing incumbents with roots in the telecommunications equipment industry. Although ‘success’ could be defined in many ways, here it simply refers to the ability of a firm to establish itself in a new business domain previously dominated by incumbents such as Nokia and BlackBerry, and to create a sustainable ecosystem of complementary products and innovation around itself. According to VisionMobile (2014), this is clearly true for at least the Google Android and Apple iOS ecosystems, together accounting for 94% of the overall smartphone market, followed by the Microsoft Windows Phone ecosystem as a distant third with low single-digit market share. In line with their respective market shares in smartphone sales, these ecosystems have captured the mindshare of application developers, ranging from large corporations to individuals, who are largely responsible for the complementary innovation in the ecosystems.

Looking at Figure 1.2, we can see that each of the three relatively new entrants to the smartphone business is coming from a particular angle of entry, Apple from the 'computer hardware and consumer electronics' business, Microsoft from the 'computer software: operating systems and applications' business, and Google from the 'Internet (cloud) services, content, and advertising' business. All of these angles are non-traditional in the sense that they do not represent core elements of the traditional telecommunications value chain but rather adjacent industries (personal computing, Internet search and advertising). The other three angles of entry, 'traditional telecommunications equipment, pagers, handsets', 'mobile operators', and 'web browser' represent the old incumbents (Nokia, BlackBerry) and a number of failed initiatives from operators and various consortia (e.g., WAC, Mozilla Foundation). Since this study focuses on identifying strongly common *success* factors and not *failure* factors of mobile business ecosystems, I choose to limit its scope to the three angles of entry that appear successful as defined above and to the three case companies that represent each of those angles. Further justifications for selecting the case companies are found in Section 1.4.2.

Defining Smartphone Business

This study is limited to a specific business and industry context, the *smartphone business*. As such, it is necessary to note that the word 'smartphone' has no official industry definition, though the following definition is generally agreed to:

> A smartphone is an advanced mobile device with connectivity and functionality well beyond that of a regular, voice-centric phone, most notably with the ability to add and run sophisticated after-market applications on an identifiable operating system. Limited capabilities to run only simple sandboxed applications (e.g., Java-based games) are not considered sufficient for smartphones. The operating system (or platform) of a smartphone must provide sufficiently well defined and documented interfaces as to enable application development, a form of complementary innovation, on the device by parties other than the handset manufacturer itself, although the extent of platform openness in this sense can vary significantly.

In terms of features, most current smartphones support full-featured e-mail and personal information management (PIM) capabilities, including calendar, address books, various notes and tasks lists, alerts and reminders, and other functionality associated with a personal organizer. The ability to synchronize PIM data wirelessly with various online services has also become a norm. Moreover, modern smartphones are expected to natively have corporate email server connectivity and synchronization capabilities, most often associated with Microsoft Exchange support using the ActiveSync protocol. Especially in corporate use, and due to the increasing bring-your-own-device (BYOD) mobile device policy in many firms, standards-based remote device management capabilities are also increasingly becoming a requirement for smartphones.

Messaging oriented smartphones, such as BlackBerry's line of products, commonly include a QWERTY keyboard to facilitate the core use case of the device: writing emails efficiently on the go. However, most smartphone vendors have opted to use a touch screen as the main input mechanism. Many devices, such as Apple's iPhone, use touch as the sole input method with few or no physical buttons, while some others have a hybrid approach, combining the advantages of a physical keyboard with the direct object manipulation of a touch screen. Physical QWERTY keyboards remain available mostly on BlackBerry devices and some older, mid to low tier smartphones as well as some feature phones. The number of such products has diminished, however.

The current trend as of 2014 seems to overwhelmingly favor touch-only devices where a large touch screen is the only input method and physical buttons are used only for volume control, power switch, and other limited purposes. The trend towards bigger touch screens in the range of 4.3 to 5.5 inches has also improved the practical usability of virtual, on-screen QWERTY keyboards. The intermediate device category between smartphones and tablets, often called 'phablets', appears to be gaining popularity and is further validating the consumer acceptance of very large displays (5 inches or more) on pocketable devices. Despite their large physical size, these devices are still used as phones, but also effectively replace the functionality of larger tablets.

The majority of smartphones also double as digital cameras, video recorders, media players, and/or portable navigation devices (PNDs), being true multi-purpose devices. It is fair to say, however, that also modern feature phones have gained much of the functionality and features that were earlier available only on smartphones, leading to terms such as 'pseudo-smartphone' and 'smartphone lite'. Thus, the definition of what really constitutes a smartphone unfortunately continues to remain somewhat blurry. As smartphone OS's, particularly Android, penetrate lower price tiers, the non-smartphone market continues to dwindle and is expected to eventually disappear towards the end of the decade. The year 2013 was expected to be the turning point when smartphones outship feature and basic phones globally (IDC, 2013). Recent statistics seem to confirm this, as smartphones consistently outsold non-smartphones in the first quarter through third quarter of 2013 (VisionMobile, 2014).

It is also important to note that the smartphone business encompasses much more than just the mobile devices and the software running on them. It is increasingly about services, content, and solutions, ranging from quite generic Internet services to highly tailored, integrated solutions for a specific purpose, in both enterprise and consumer settings. The digital content consumed by smartphone users, be it music, videos, applications or whatever, is most often discovered, accessed, and downloaded through the Internet, on the mobile device itself. The smartphones of today are increasingly reliant on the Internet, requiring intermittent connection to the *cloud* at minimum, commonly utilizing at least some form of *cloud storage* (e.g., synchronization of user data to and from server clusters located in the Internet), *cloud computing*, or *cloud-assisted computing* (e.g., real-time speech recognition on smartphones with the help of remote computing resources).

Although most players in the smartphone business rely on device sales as the primary monetization mechanism, it is increasingly evident that stand-alone device sales is becoming a thing of the past and any firm in that business hoping to capture significant revenue growth must be active also on the services, content, and solutions front, either through acting as a proprietor/provider or partnering with other firms who fill that role. Thus, this study will not be limited to mobile devices but will consider services, content, and solutions related aspects where relevant to comprehend the whole picture of this complex and rapidly developing business.

1.4 Research Methodology

1.4.1 Selection of Research Method

Due to the complex nature of the research problem, the empirical research approach is chosen. A further justification is that not all factors impacting the subject of research are known in advance. A foundational set of factors has been identified based on existing bodies of research and literature, but it is assumed that additional, novel factors may be identified during the course of the research.

The main research method is multiple case study due to the real-life context of the research that revolves around several large companies in the mobile communications, computing, and Internet content and services industries. The theoretical framework used in the research is grounded in strategic management and applied economics research, and therefore literature review is used as a supporting method in order to comprehend the current state of research in the context of the multidisciplinary fields involved. The bodies of research most relevant to the research topic pertain to value configurations (such as value networks), network externalities and two-sided markets, business ecosystems as a model of firm populations engaged in mutual cooperation and competition, and management of platforms and complementary innovation.

Unit of Analysis

The primary unit of analysis in this study is a *firm*, more specifically a firm that acts as the orchestrator of an ecosystem and/or as the provider or sponsor/proprietor of a platform (or a two-sided market). Each firm included in the multiple case study is also analyzed in the broader context of its ecosystem and the interorganizational relationships between itself and other firms and organizations, particularly its ecosystem partners. Therefore, also the relationships between firms constitute a secondary unit of analysis, in line with the relational view of Dyer & Singh (1998). A rough division between firm-level and ecosystem-level analysis can be made. This is reflected in the analysis framework described in Chapter 3.

Empirical Data

Mostly qualitative and descriptive data are used for analysis of the case companies' business model, ecosystem and platform approaches, and related strategies for competing and cooperating in the smartphone business, also reflecting on the larger context of the Internet and mobility services and solutions. Qualitative data are used primarily because all the relevant factors having an impact on the analysis framework are not explicitly known *a priori*. It is reasonable to expect that after gathering and analyzing enough empirical evidence, the analysis framework itself could be improved to yield results with even higher relevance with regard to the research questions at hand. That being said, the framework has been built with a preliminary set of analysis dimensions that are well grounded in prior scientific research and literature.

In the case studies of Chapter 4, the investigated data objects are press releases, product information on corporate web sites, trade magazines, industry analyst reports, market research reports, industry expert blogs, and existing scientific publications in the field. Excluding scientific publications which are listed in the References section, these empirical data objects are listed in Appendix A under the section titled 'Chapter 4'.

Research Process

The research process of this study follows roughly the three-layered pyramid model of Christensen et al. (2002) for theory-building, with minor adaptations as shown in Figure 1.3. First, based on the research target and the research questions defined in Sections 1.2.2 and 1.2.3 respectively, relevant bodies of research and existing theory are identified that would support understanding and studying of the research problem, even if they do not readily describe the exact same objects or actors under analysis. A brief overview of this prior research was given in Section 1.2.1, whereas more elaborate review and discussion of the theories takes place in Chapter 2.

Second, the various theories are categorized and grouped together based on perceived similarities of the phenomena that they describe and also based on the cross-citation by their authors who themselves have observed similarities or links between the theories. One basis for the categorization is a similar level of abstraction or analysis. As an example, some theories or concepts relate to the analysis of individual firms or platforms operated by individual firms, whereas others relate to broader communities or ecosystems of firms, describing the complex interplay and relationships between these firms. Based on the categorization of the theories and theoretical concepts, I devise an analysis framework specifically for this study and its research questions. The analysis framework acts as a window of sorts into the data under analysis.

Third, observations, measurements, and descriptions of the phenomena under study are made according to the analysis framework and its categorization, resulting in the formulation of the empirical findings. Eventually, these findings are used to answer the research questions. Already before conducting the analysis, there are certain outcomes or observations that can be expected or even

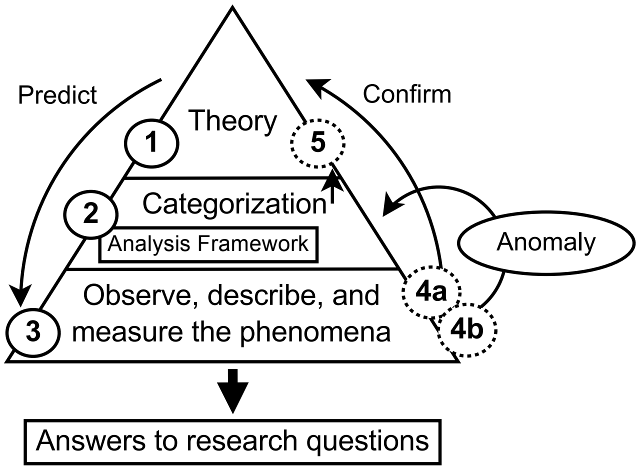

Figure 1.3: Research process

predicted, based on deduction from the theory. While making observations based on the actual empirical data, it can happen that some anomalies are found, i.e., some results seem to clearly contradict the theory and the expected results arising thereof. Most results, however, should confirm the theory (*4a* in Figure 1.3), being in line with the predictions arising from the deductive process.

Christensen et al. (2002) suggest that a secondary, inductive path involving categorization of anomalies (*4b* in Figure 1.3) and formulation of new or revised theory (*5*) be followed as a proper scientific method for building theory. They argue, however, that exceptions should not be mistaken for anomalies, i.e., signs of invalidity of a theory. Instances where the expected outcome did not occur, but for reasons that can be explained by the theory, are not anomalies. Yin (2003) makes a distinction between *literal replications* of a theory, i.e., instances where the outcome matches exactly what the theory predicts, and *theoretical replications* where the predicted outcome did *not* occur, but for reasons that the theory can explain. If a theory can account for an observed phenomenon neither as a literal nor as a theoretical replication, then an anomaly has been identified. (Christensen et al., 2002)

While the nature of the research questions of this study is more practical than theoretical, identifying anomalies or building a new or better theory is not the foremost goal. It may also be that a larger set of data, or a broader set of case studies would be needed in order to be able to create meaningful new theory. Thus, more emphasis is put on getting meaningful answers to the research questions within the scope of this study, and ideally, being able to provide practical guidelines to industry executives on ecosystem management.

1.4.2 Selection of Cases

Three case companies were chosen for the multiple case study in total. The companies, Apple, Google, and Microsoft, were chosen because each of them can be seen as a hub and orchestrator of a business ecosystem in the smartphone business. Each of them is also a platform provider. These three companies compete in the same arena, yet they have very different historical legacies as companies, hence the notion of angle of entry. Each of the companies is representative of one particular angle (arrow) illustrated in Figure 1.2. Apple is the 'computer hardware and consumer electronics' company, whereas Microsoft is the 'computer software: operating systems and applications' firm. Not surprisingly, Google depicts the 'Internet (cloud) services, content, and advertising' player. It is also worth noting that in light of the status quo, two of the case companies are 'winners' in the sense that they occupy the number one and number two positions in the smartphone business as leaders of their respective ecosystems.

In contrast, BlackBerry, although not explicitly covered in the multiple case study, could be considered an example of a 'loser' in the ecosystem game as it has lost much of its former market power due to an unsuccessful ecosystem and platform strategy. The once dominant smartphone manufacturer Nokia could also have warranted its own case study, but given the company's decision to divest its handset business and transfer those assets to Microsoft, Nokia's smartphone business is considered in the context of the Microsoft Windows Phone ecosystem. Microsoft is the big question mark, an unfulfilled promise, which has struggled for years to stay relevant in the smartphone business but has also managed to renew and grow its assets remarkably well. With an all-new generation of operating systems launched for PCs (Windows 8), tablets (Windows RT), and smartphones (Windows Phone 8), it is interesting to consider Microsoft's prospects in the ecosystem game.

These three case studies should provide sufficient data to be able to answer the research questions. As per Figure 1.2, however, the author recognizes two additional angles, namely 'mobile operators' and 'web browser' that could prove out to be interesting study subjects for future research. As noted in Section 1.1.1, large, global MNOs have had a series of unsuccessful attempts in trying to control mobile application distribution, but the last serious effort in this vein, WAC, was abandoned in 2012. Since then, however, advancements in web technologies and standards such as HTML5 have sparked renewed interest in web browser based application environments and even complete operating systems as is the case with the Linux-based Firefox OS, being developed since mid 2011 by the non-profit Mozilla Foundation known for its popular Firefox web browser. Firefox OS saw its initial release in April 2013 and has received significant support particularly from the mobile operator Telefónica, with the first commercial phone launched in Spain in July 2013, followed by certain Latin American countries. In February 2014, launches in another eight countries were announced, including Germany and further Latin American countries (Telefónica, 2014). Also the German multinational operator Deutsche Telekom and its foreign subsidiaries in Poland, Hungary, and Greece launched their first Firefox OS devices during the summer and fall of 2013, with further device launches announced for four additional European markets in 2014 (Deutsche Telekom, 2013, 2014). Nevertheless, the future relevance of Firefox OS as a mobile application platform remains to be seen, but at least for the time being, it is not a serious contender in the smartphone ecosystem game.

1.4.3 Reliability and Validity of the Results

Yin (2003) argues that the quality of case study research should evaluated by certain criteria pertaining to the research framework used, the internal and external validity of the results obtained as well as the reliability of the results. Validity generally refers to the extent to which an account accurately represents the phenomenon to which it refers (Hammersley, 1990). As a consequence, the research framework is valid if it includes the right dimensions of analysis. In the case of interview studies, respondent validation is a viable method for determining the validity of the framework. Other possible methods include the usage of multiple sources of evidence, triangulation, and the establishment of a chain of evidence between the collection of data for each individual case (Yin, 2003). According to Silverman (2005), comprehensive data treatment and use of appropriate tabulations also contributes to an increased validity of the results.

Internal validity is related to causal relationships, i.e., whether certain conditions of the phenomenon under study lead to outcomes of interest. In simple terms, this refers to whether the right things are being studied and analyzed to be able to draw conclusions about a topic of interest.

External validity, on the other hand, refers to the generalizability of the results, i.e., whether or not the identified relationships between the studied phenomenon and certain outcomes can be generalized to a different or possibly broader context, beyond the individual cases studied. According to Yin (2003), it is an important consideration in designing the research framework and selecting the cases.

Reliability means that the observations based on the data collected for the case studies can be reliably repeated over and over with the same results. This requires some rigor in documenting and following the same procedures for each consecutive case, and also managing the empirical data of each case properly, preferably storing it in a database. (Yin, 2003)

For the case studies in Chapter 4, the general quality and quantity (depth and breadth) of the descriptive data used is assessed and the reliability and validity of the results is evaluated in Section 5.2.

1.5 Structure of the Study

This thesis is divided into five chapters. An introduction to the field of study and the research problem at hand is provided in Chapter 1 while also outlining the scope of the study and the research methodology used.

In Chapter 2, the different bodies of research relevant to the research problem are overviewed thoroughly, summarizing the most important theoretical concepts and frameworks on value creation and networks, network effects, business ecosystems, two-sided markets, as well as approaches to managing product/industry platforms and complementary innovation on platforms. To a certain extent, this chapter also attempts to bridge some of these concepts and frameworks which bear many similarities and often describe similar phenomena from a slightly different angle.

In Chapter 3, the author brings forth a new analysis framework that builds upon many of the existing concepts and frameworks introduced in earlier research and described in the previous chapter but also incorporates some novel ideas. This framework is designed especially with the smartphone business context in mind, although its applicability may be wider.

In Chapter 4, the analysis framework developed and explained in the previous chapter is applied to three distinct case studies, each one of them on a major firm that is active in the global smartphone business, albeit with significantly different backgrounds and legacy as well as differing approaches to capturing value and playing the ecosystem game. The latter part of the chapter also synthesizes the results from the case studies in order to identify and discuss commonalities between the case companies and their ecosystems and platforms.

In Chapter 5, the key results obtained from the case studies are summarized in order to be able to formulate answers to the research problem. Reliability and validity of the results are reviewed for the entire study. Practical implications for industry executives and managers are presented, drawing from the answers to the research questions and the case studies. Finally, suggested further research is discussed.

Appendix A contains a list of references to web articles, press releases, news stories, industry analyst reports, expert blogs, and other descriptive material that are used in the case studies of Chapter 4.

Chapter 2

Theoretical Background

In this chapter, the main theoretical concepts relevant to the thesis are presented and discussed. Moreover, the chapter attempts to summarize the bulk of the research articles and other literature that was reviewed in order to comprehend the status quo of the bodies of research related to the thesis. This theoretical background is then used as a basis for developing and formulating the analysis framework described in Chapter 3.

2.1 Path Dependency Theory and Angle of Entry

When outlining the research problem at hand and defining the research questions to be answered in Section 1.2.3, the concept of *angle of entry* was introduced to illustrate the potential impact of the history, capabilities, and assets of different firms on their choices and inclinations evident in their ecosystem and platform strategies as well as performance in the mobile smartphones business. Also presented was the hypothesis that the angle of entry of a firm can at least partially be used to explain some of the ecosystem or platform level success factors.

As noted in Section 1.2.1, the theory of path dependency in economics would seems to support this idea. Let us explore this foundational concept briefly.

2.1.1 Path Dependence

Originally, path dependency theory was conceived by economists, most notably David, Arthur, and Liebowitz & Margolis, to explain technology adoption processes, such as why industries have sometimes settled on supposedly inferior technological standards (consider, e.g., the classic case of the Video Home System (VHS) vs. Betamax standards war which ended in the victory of VHS), but also to understand industry evolution in general. The theory has been strongly influential on the field of evolutionary economics. It also has its counterpart in mathematics and physics where chaos theory includes the notion of *sensitive dependence on initial conditions*. Using a popular example commonly referred to as the *butterfly effect*, *"a hurricane off the coast of Florida may be the fault of a butterfly flapping its wings in the Sahara"* (Liebowitz & Margolis, 1995b).

Arthur (1989, 1994) has studied the dynamics of allocation between two or more competing technologies displaying increasing returns, i.e., the more they are adopted, the more experience is gained with them, and the more they are developed further and improved. He notes that modern, complex technologies often exhibit such characteristics, arising naturally in a market where agents (e.g., consumers) must choose between technologies competing for adoption. He further argues that under such conditions multiple outcomes are possible, as allocation problems with increasing returns tend to exhibit multiple equilibria. Although static analysis can typically locate these multiple equilibria, it usually cannot conclusively tell which one will be "selected", i.e., be the outcome of the adoption process, resulting in a specific market-share structure. Through a dynamic analysis approach, he has studied how the possibility of random events occurring during adoption influences the selection of the outcome. According to the results obtained by Arthur (1989), seemingly small historical events and insignificant circumstances can become magnified by positive feedback loops and may cumulatively "tip" the system into the actual outcome selected.

According to David (2001), the concept of path dependence refers to a property of *"contingent, non-reversible dynamic processes, including a wide array of biological and social processes that can properly be described as evolutionary"*. In probabilistic terms, he states that *"a path dependent stochastic process is one whose asymptotic distribution evolves as a consequence (function of) the process's own history"* and that non-ergodic processes, being unable to shake free of their history, are said to yield path dependent outcomes.

In particular, David (1985) has studied the emergence of the nowadays ubiquitous QWERTY keyboard layout (originating from the 1870s) as the de facto standard on typewriters and later PCs. Some alternative layouts introduced later, such as the Dvorak layout (from the 1930s), offered better ergonomics and less effort in moving fingers, yielding a better typing rate than a standard QWERTY keyboard, but have remained marginal. David (1985) argues that it is possible for a standard that is first-to-market to become entrenched, persisting in the face of superior competitors due to the legacy established by the early standard. This notion of legacy can be seen as analogous to network effects as described by Katz & Shapiro (1985, 1986) — typically, the longer a particular standard has existed, the larger its network of users and the stronger its network effects. The original considerations that led to the adoption of the QWERTY layout — avoiding typewriter hammer-jamming problems — are but a distant memory, but modern society is locked into this arguably inefficient standard by little more than historical accident.

Liebowitz & Margolis (1995a) have studied path dependence from the perspective that economies and markets appear to make errors in the choice of products and standards and may even "lock-in" to these incorrect choices despite readily available information that points out better choices. They argue that possessing even a minor advantage or a seemingly inconsequential lead for some technology, product, or standard can have significant and irreversible influences on the ultimate market allocation of resources. Similarly, Arthur (1989) notes that dynamic allocation under increasing returns can cause the economy gradually to lock itself in to an outcome that is not necessarily superior to alternatives, not easily altered, and not entirely predictable in advance[1]. Thus, it is interesting that such lock-ins and errors do occur even though the business world is characterized by voluntary decisions and individually maximizing behavior.

Three types (or degrees) of path dependence are identified by Liebowitz & Margolis (1995a), each with progressively stronger assertions depending on whether inefficiency is implied and whether it could have been avoided. *First-degree path dependence* merely implies the existence of an intertemporal relationship, i.e., that a past decision (initial conditions) will have an impact on subsequent conditions but this impact need not imply any kind of inefficiency of the outcome. Also, it is possible that the maker of the past decision has fully appreciated the long-term effects of his/her decision and has taken them into account. *Second-degree path dependence* implies that a past decision, seemingly efficient at the time of its making, turns out to be inefficient in retrospect due to better knowledge available. In such a case, sensitive dependence on initial conditions leads to outcomes that are regrettable and costly to change. Since little can be done retroactively to solve the problem of lim-

[1]Arthur (1989) discusses the problem also from the perspective of policy makers, arguing that in the constant and diminishing-returns cases, the usual policy of letting the superior technology emerge as the outcome that dominates is indeed appropriate, whereas in the increasing-returns case, however, a *laissez-faire* policy lacking any regulatory intervention does not guarantee that the superior technology in the long-run sense is actually going to be the one that prevails in the competition for adoption. A possible solution could include an inter-agent market to induce early adopters to explore promising but costly nascent technologies that might prove lucrative for later adopters, or alternatively, a central authority could fund the exploration of promising but less popular technological paths.

ited knowledge, this type of path dependence is not considered meaningfully inefficient even when the outcomes are suboptimal. Finally, *third-degree path dependence* means a situation where sensitive dependence on initial conditions leads to an outcome that is indeed inefficient but also "remediable" (avoidable) in the sense that there either exists or existed some feasible method for recognizing and achieving a preferred outcome but that outcome is not obtained due to that method (erroneously) not being used.

In a manner similar to examining the path dependence of industries and standards, it is possible to examine individual firms in terms of their adoption of technologies, business models, and their strategic choices in general. If we study the legacy of a firm, we are likely to observe that many historical decisions have influenced the firm's current actions and that the firm's legacy continues to have an influence on its present and future.

2.1.2 Angle of Entry and Its Impact on Ecosystem and Platform Strategies

The hypothesis on the angle of entry of firms is supported by the perception that many large incumbents that currently occupy a major role in the mobile smartphone business have an older, more mature business in PC or CE manufacturing, computer operating systems and/or software, or alternatively, in the relatively new business domain of Internet services, content, and online advertising. As these companies have expanded or refocused their business on the rapidly growing mobile sector, they have made strategic choices regarding which roles in the ecosystem or value network they desire to occupy, and also how they intend to capture value. Based on the legacy of these firms, their existing businesses, and their capabilities and assets, the firms have been and are in somewhat different positions as they have entered the mobile business arena, and thus stand to capture value from their ecosystem in somewhat different ways.

Case Example: Apple

Apple, whose legacy is in the design and manufacture of proprietary computer hardware and accompanying software, has based its monetization model mainly on selling hardware: computers, tablets, smartphones, and personal media players. One could argue that because of its legacy as a premium-priced, niche computer manufacturer, Apple is repeating the same scheme in its newer business domains such as smartphones, selling less in absolute volume terms than companies that also produce low-cost, mass-market products but capturing the bulk of industry's revenue and profits by maintaining a very high average sales price (ASP) and gross margin for its products. Apple's closed platform approach for its computers, using proprietary, non-PC-compatible hardware (before the 2005 Intel migration decision), a proprietary OS, and proprietary or otherwise incompatible peripheral interfaces, has been carried over to its portable CE devices, including smartphones.

Still today, there is no standard Universal Serial Bus (USB) connector on the latest iPhone or iPad, although Apple has replaced its familiar, 30-pin dock connector with a new 8-pin 'Lightning' connector. Consumers are required to purchase (costly) adapter cables if they wish to continue using their existing hardware accessories with the new Apple devices. While also a form of monetization for Apple through the charging of license fees from accessory vendors for allowing the use of the proprietary interface and "Made for iPhone" branding, this approach also allows Apple stricter control of the accessory vendors (Wall Street Journal, 2012). In comparison, most other smartphone vendors have adopted an open accessory ecosystem strategy and use the micro-USB interface for which connectors, cables, and accessories are abundant and affordable.

From the perspective of path dependence as described by Liebowitz & Margolis (1995a), it would appear that Apple exhibits the first-degree type, as it has clearly made conscious decisions early on that have influenced the company's technology and product design choices to this day. While these decisions have been quite different from those of other PC/CE manufacturers, they do not imply inefficiency — today, Apple (NASDAQ: AAPL) has the largest market capitalization of all publicly traded companies in the world, having overtaken Exxon Mobil (NYSE: XOM) in the first quarter of 2012. As noted in Section 1.1.1, however, Apple has accomplished several major technology transitions in situations where it could have been described to operate inefficiently due to third-degree path dependence (e.g., relying on PowerPC processors in its computers when the market-dominant Intel processors already had a major lead in performance).

Case Example: Google

Google, the current search giant, started out with search keyword advertising as its sole method of monetization. While the SaaS business model and its applications, e.g., Google Apps for Business, rely on continuous subscription-based monetization models, advertising revenue mostly on a cost-per-click (CPC) basis remains Google's primary source of revenue, i.e., advertisers pay when users click their ads. An alternative pricing scheme is based on cost-per-impression (CPI). In addition to search advertising, Google also provides display advertising services through its DoubleClick advertising technology that includes video, text, images, and other interactive ads. These ads appear on YouTube, Google Finance, and Google Network member websites (BMI-Matters, 2012).

Already before Google acquired the struggling handset maker Motorola (which already used Google's Android OS platform in its smartphones), it was widely speculated whether Google would start making money by selling its own "Googlephone" or, in general, CE devices enabled with Android and Google software. As of January 2014, however, Google has taken a step back from in-house smartphone manufacturing with the decision to divest the former Motorola handset business but has interestingly expanded into new domains such as automotive (e.g., autonomous driving as well as automotive Android platform development through the Open Automotive Alliance (OAA)), robotics, and home automation (MIT Technology Review, 2013; Fast Company, 2014). These developments can be taken as a definitive sign that Google is very serious about the Internet of Things, seeking to further expand its presence in people's daily lives.

To date, Google has mostly relied on its hardware partners to produce Android handsets and 'Chromebooks' (see Google, 2012a), laptops running Google's Linux-based Chrome OS, but it has also directly sold its 'Nexus'-branded Android devices which are intended to showcase the latest "Google experience" on a device, often at a reasonable price. This applies also to Android tablets (see Google, 2012b). Google also introduced a media-streaming entertainment device (set-top box) called 'Nexus Q' in June 2012 but later cancelled it amidst criticism for having too few features for its price. So, even today, while definitely the hub of the largest smartphone ecosystem currently in existence, Google is mostly sticking to its roots in terms of monetization, earning as much as 96% of its revenue from advertising (BMIMatters, 2012).

Google is a relatively new company, having been founded in 1998, but nevertheless, it can be seen to exhibit first-degree path dependence in its innovation process and business model. For example, much like the original Google search engine (circa 1997–1998), almost all of its newer services were first launched as a public "beta", eventually maturing to commercial grade services or ramped down (such as Google Wave) if they did not meet adoption targets. Also, Google has been adamant in keeping its services "free" to the general public — of course, free essentially means ad-funded, and Google is increasingly profiting from mining the "big data" that hundreds of millions of consumers have trusted the company with.

Kenney & Pon (2011), who extensively discuss the OS platform strategies of smartphone players such as Apple and Google, also speculate that the business models of those companies are legacies of the path-dependent evolutions of the firm and the sector within which they were dominant and that this notion can at least partially explain the different business models that firms have adopted as they have entered the mobile smartphone business. Further examples and evidence on the validity of the 'angle of entry' concept are presented in Chapter 4, where it is applied to the analysis of the case companies.

2.2 Concepts for Modeling Value Creation

In this section, a number of popular concepts for modeling the value creation process of firms are reviewed and discussed. In particular, the value chain, the value shop, and the value network are examined, referencing the key literature on each concept.

2.2.1 Value Chain

The value chain is a popular business management concept that was originated by Porter (1985). Porter argues that every firm has a collection of strategically important activities that are performed to design, produce, market, deliver, and support its product, and that those activities can be grouped into a series of sequential, value-adding stages, forming a chain. Products pass through every activity of the chain, gaining some value at each successive activity. The goal of the activities of a firm is to offer the customer a level of value that exceeds or offsets the combined costs of the activities, thus resulting in a profit margin. In essence, the value chain is a tool for identifying and analyzing the sources of firm-level competitive advantage.

Porter asserts that a firm's value chain and the way it performs its individual activities are a reflection of its history, its strategy, its approach to implementing its strategy, and the underlying economics of the activities themselves, and that although firms in the same industry may have similar value chains, the value chains of competitors often differ. Porter uses a generic value chain model as illustrated in Figure 2.1 to describe the common value activities of firms. These value activities can be grouped into five generic categories of *primary activities* which directly contribute to creating and bringing value to the customer, and four generic categories of *support activities* which enable and improve the performance of the primary activities. (Porter, 1985)

The primary activity categories are:

- *Inbound Logistics*: the receiving, warehousing, and disseminating of inputs, and their transportation to manufacturing as required.

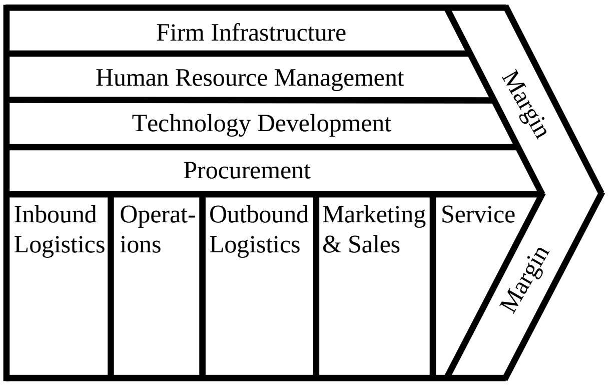

Figure 2.1: Porter's generic value chain model

- *Operations*: transforming inputs into final products: e.g., machining, packaging, assembly, testing, and facility operations.
- *Outbound Logistics*: collecting, warehousing, and distributing the finished goods to buyers.
- *Marketing & Sales*: providing means (sales channels, sales force) by which buyers can purchase the product and inducing them to do so through advertising, promoting, etc.
- *Service*: after-sales support of customers who have purchased the product, covering installation, maintenance, repair, training, part supply, etc.

The support activity categories are:

- *Firm Infrastructure*: general management, planning, finance, accounting, legal, government affairs, quality management, standardization, information systems, etc.
- *Human Resource Management*: recruiting, hiring, training, development, and compensation of all types of personnel for both primary and support activities.
- *Technology Development*: broad range of activities aiming at product or process improvements, or more generically, to improve any technology embodied in the value activities.
- *Procurement*: purchasing inputs such as raw materials, supplies, and other consumable items, as well as assets including machinery, equipment, buildings, etc.

A firm's ability to generate margin or profit is dependent on its effectiveness in performing the activities efficiently, so that the price that the customer is willing to pay for the products more than offsets the costs of the activities. Each activity in the value chain, in principle, provides an opportunity to generate superior value as compared to competitors. Therefore, a competitive advantage may be attained by reconfiguring the value chain to provide either lower cost or better differentiation.

The value chain concept has been extended beyond the boundaries of individual firms. A firm's value chain can be considered part of a larger system that includes the value chains of upstream suppliers, downstream channels, and buyers. Porter has named this series of value chains as the *value system*, illustrated conceptually in Figure 2.2 (Porter, 1985).

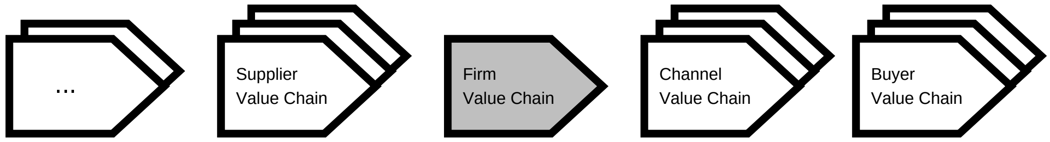

Figure 2.2: Porter's value system

While the activities within a value chain are related through linkages, these linkages exist not only in a firm's value chain, but also between value chains of different firms. Managing linkages often involves trade-offs between optimization and coordination. Although a firm with a high degree of *vertical integration* (i.e., a wide scope of internal activities spanning partially or fully the domains of suppliers, channels, and/or buyers) is better equipped to coordinate upstream and downstream activities, a firm with a lesser degree of vertical integration can nevertheless make agreements with suppliers and channel partners to achieve better coordination, e.g., through geographical co-location or proximity. Thus, the exploitation of vertical linkages does not necessarily require vertical integration, but integration may make it easier to reap the benefits of those linkages. It is clearly evident that a firm's success in developing and sustaining a competitive advantage depends not only on its own value chain, but also its ability to manage the value system it belongs to. (Porter, 1985)

Criticism

Although still widely used as an analysis tool, the value chain framework has been criticized for focusing too much on the unidirectional flow of materials and transformation of inputs into products as a means to create value. Undoubtedly, the primary activity taxonomy of the value chain is well suited to describing and analyzing a traditional manufacturing firm, but less so for many firms operating in the services and knowledge industries, as argued by Stabell & Fjeldstad (1998). Moreover, for industries such as insurance and banking, trying to assign and analyze activities in terms of the five primary activity categories is not only difficult, but can also obscure the value creation logic rather than illuminate it. Although it is possible to describe, e.g., the document flow of an insurance company using the value chain model, such a model hardly captures the essence of the value creation, as the logic of many strategically important activities (reinsurance, risk assessment, customer relationship management, etc.) cannot be effectively described using the logistics and transformation focused approach of the value chain. A similar case can be made for banking, where the value chain is unable to deal explicitly with both lenders and borrowers as bank customers. The model also serves to obscure the value creation logic by putting too much emphasis on transaction processing and its associated unit costs, while all but ignoring interest spread and risk management (Stabell & Fjeldstad, 1998).

Through the identification of alternative means of value creation, Stabell & Fjeldstad (1998) have generalized value chain analysis into what they call *value configuration analysis*. Porter's value chain is seen as one of three alternative value configuration models, the others being the *value shop* and the *value network*. These models are discussed in the following sections.

2.2.2 Value Shop

The generic value chain is arguably suitable for modeling a so called *long-linked* technology, where value is created by transforming inputs into products, and the product acts as the medium for transferring value between the firm and its customers (Stabell & Fjeldstad, 1998). However, this is in stark contrast to a large number of firms whose value creation logic relies on using *knowledge* to solve specific problems for clients. The value shop model introduced by Stabell & Fjeldstad (1998) describes the value creation in these firms as consisting of activities related to the diagnosis of the problem, the development, testing and selection of alternative solutions, as well as the implementation and evaluation of the selected solution. This makes the value shop an ideal model for describing knowledge intensive firms, e.g., consulting companies, engineering companies, law firms, hospitals, and in general, firms that compete in the knowledge economy (Fjeldstad & Andersen, 2003). Nevertheless, often some important functions or parts of a firm can be better understood as a value shop in terms of their value creation logic, even though the primary activities of the firm as a whole would conform to the value chain model. The value shop model is illustrated in Figure 2.3 (Stabell & Fjeldstad, 1998).

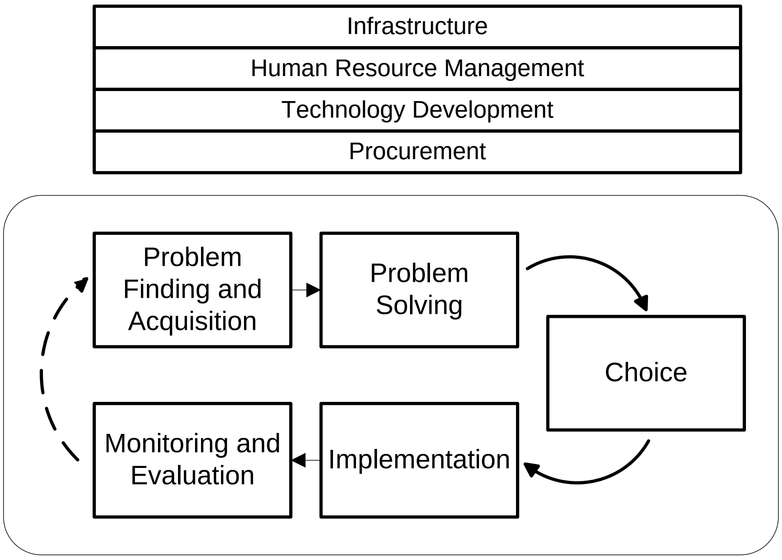

Figure 2.3: Stabell and Fjeldstad's value shop

In a similar fashion to the value chain, the value shop has primary and secondary activities. The five generic categories of primary value shop activities are (Fjeldstad & Andersen, 2003; Stabell & Fjeldstad, 1998):

- *Problem Finding and Acquisition*: identifying, recording, reviewing, and formulating the problem to be solved as well as choosing the overall problem-solving approach
- *Problem Solving*: development and evaluation of alternative solutions to the problem
- *Choice*: selecting one of the alternative solutions to be pursued
- *Implementation*: communicating, organizing, and implementing the chosen solution
- *Monitoring and Evaluation*: measuring and evaluating to what extent the implemented solution has solved the initial problem statement

However, contrary to the value chain, the activities of the value shop are not strictly sequential, but interruptible and recurring in the sense that if the selected approach does not resolve the problem, a new iteration of the activity cycle is started, usually with a different set of resources committed. Using an analogy from healthcare, a doctor will initially try straightforward and inexpensive diagnostic methods and treatments and then scale up both diagnostics and treatments until the patient has recovered. (Fjeldstad & Andersen, 2003; Stabell & Fjeldstad, 1998)

The secondary or support activity categories are the same as those identified by Porter (1985). They are not always explicitly included in value shop diagrams, as Stabell & Fjeldstad (1998) argue that many of them are co-performed with the primary activities. Although the support activities are not distinct, they are deemed as crucial to a firm's competitive advantage.

Stabell & Fjeldstad (1998) emphasize the importance of value drivers over cost drivers in value shops. They argue that clients of knowledge intensive firms are primarily looking for relatively certain solutions to their problems rather than services with the lowest price tag as their main attribute. The canonical value driver in such firms is *success* as it materializes in *reputation* and relationships. A firm's success improves access to the best personnel for hire as well as the best clients and projects. Also Porter (1985) recognized that reputation signals value.

For any value shop, *learning* is an integral and important part of the problem-solving cycle, as is evidenced by the primary activity category Monitoring and Evaluation. It is a means to improve the shop's capabilities to deal with the problem at hand, increasing effectiveness through better problem definition, better solution alternatives, and better implementation. Moreover, learning across projects and problems of different clients is a critical shop-level linkage which is seen as especially important for interrupted problem-solving cycles that appear inconclusive but provide valuable feedback if monitored and evaluated systematically. (Stabell & Fjeldstad, 1998)

2.2.3 Value Network

The *value network*, contrary to the more straightforward value chain and value shop, is a multifaceted concept described by several authors, most notably Christensen (1997) and Stabell & Fjeldstad (1998), although it can be said that the foundation for the concept was laid in the research of Normann & Ramirez (1993) on *value constellations* where they identified the shortcomings of the value chain in the post-industrial economy. Normann & Ramirez (1993) argued that value should be created in any way that is appropriate, without being limited by the organizational boundaries of suppliers and customers as in the value chain model, and that the offering of a firm determines the boundary points where different participants come together to *co-produce* value.

Before going deeper into the theory of value networks, some foundational concepts are discussed briefly.

Network Externalities and Positive Feedback

The concept of a network is familiar to everyone — communications networks such as telephone networks and the Internet as well as transportation networks such as railroad networks and airline networks are well-known examples of real, physical networks. There are, however, other types of networks which are virtual in nature and as such do not require physical interconnections between their nodes. Examples of such networks include, e.g., the users of many high-tech or consumer electronics products, such as Mac users. In this example, the users are in the same network because they share a computing platform that allows them to use the same software and hardware components due to compatibility. (Shapiro & Varian, 1998)

The fundamental economic characteristic of networks, whether real or virtual, is that they exhibit *network effects*, also known as *network externalities* (Katz & Shapiro, 1985). This means that the value of the network for a user is dependent on the number of other people who are connected to (and reachable via) the network. A positive network externality provides incremental value to the entire network for each additional user connected to it. The classic example illustrating the concept is the telephone network: the more users own a telephone and are connected to the network, the more valuable the network is to each of its users. Thus, a user joining the network ends up creating value for the other existing users, although this may have not been the user's original motivation. Negative network externalities, where additional users make a network less valuable to its existing users, are commonly referred to as congestion. Positive network externalities can be likened to *demand-side economies of scale*, as opposed to *supply-side economies of scale*, the latter being the prevalent form in manufacturing industries.

Sustained positive network externalities can lead to a *positive feedback* loop where the network gains increasing value due to new users, which then attracts even more new users to the network. This phenomenon is often referred to as a *virtuous circle* (or cycle), meaning that "the strong get stronger". The flip side of positive feedback is that "the weak get weaker" as well, caught in a *vicious circle*. Shapiro & Varian (1998) argue that positive feedback is a prevalent, potent force in the network economy, especially affecting industries such as consumer electronics and personal computing. When two or more firms compete in a market that exhibits strong positive feedback, only one may emerge as the winner, *tipping* the market in its favor and driving the competition out of business. Such a market is commonly referred to as a *winner-take-all* market.

Stabell and Fjeldstad's Value Networks

Firms that create value by acting as *mediators* to their customers in the exchange of goods, information, or capital can appropriately be modeled as value networks, according to Stabell & Fjeldstad (1998). A value network firm relies on a mediating technology that facilitates the various types of exchange relationships between its customers which are geographically and temporally distributed. Value is created by linking customers through the contract set and infrastructure. The linking can be either direct or indirect, a telephone service being a prime example of the former (a call between two customers), and banking an example of the latter (a group of customers linked through a common pool of funds). Examples of value network firms include telephone companies and Internet service providers (ISPs), banks, insurance companies, stock brokers, credit card companies, airlines, postal services, etc.

It is important to note that the firm itself does not constitute the network but rather provides a networking service by means of its infrastructure. The firm, in its mediating capacity, can be thought of as a club manager of sorts. The mediating firm admits those firms that are perceived to complement the existing member base as members to the network, and excludes (in some cases) those that don't. A value network firm has primary and secondary (support) activity categories, illustrated in Figure 2.4 (Stabell & Fjeldstad, 1998). Once again, the support activity categories are the same as those in the value chain and the value shop, but the primary activities are distinct. In the value network, there is no sequence between the activities as they are performed fully in parallel, setting the model apart from the fully sequential flow of the value chain and iteratively sequential, interruptible flow of the value shop.

Promotion and Contract Management is about marketing the network, inviting and recruiting new members, and managing the contracts that determine the privileges and obligations for each member. The contractual terms governing the service provisioning can define, e.g., the size of credit lines, bandwidth and traffic quotas, and the associated charging. The mediating firm has within its power to establish, monitor, and terminate direct or indirect relationships among the members of the network. From its point of view, all members of the network are its customers, although supplier-customer relationships may exist between members. (Fjeldstad & Andersen, 2003; Stabell & Fjeldstad, 1998)

Service Provisioning equates to assisting the customers in making exchanges (of money, information, goods, etc.) between each other. The mediator's role here is to enable multilateral interactions between the customers through the bilateral interactions between itself and the customers. The activities within this category include those associated with establishing, maintaining,

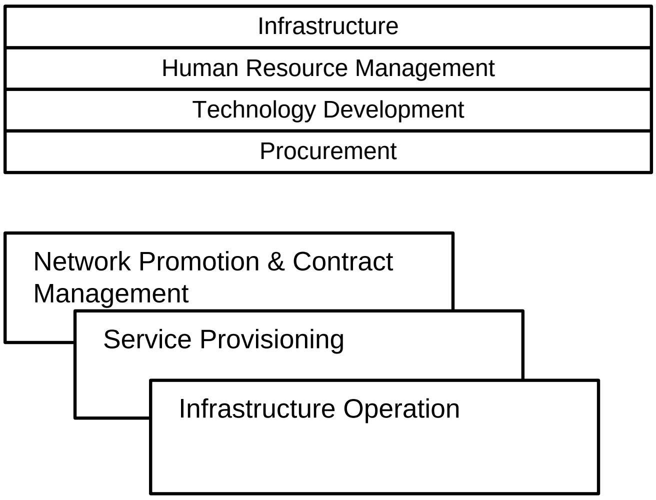

Figure 2.4: Stabell and Fjeldstad's value network

and terminating links between customers, and billing accordingly. (Fjeldstad & Andersen, 2003; Stabell & Fjeldstad, 1998)

Infrastructure Operation includes activities associated with maintaining and running the infrastructure of the network, e.g., maintaining access points to the network and ensuring sufficient capacity is available to serve the customers. (Fjeldstad & Andersen, 2003; Stabell & Fjeldstad, 1998)

Value network firms compete mainly on the basis of three key determinants: 1) the size of network (number of member firms), 2) the degree to which the network members have exchanges with each other, and 3) the types of exchanges that can be organized via the network. These factors involve trade-offs, so the value network firm must maintain the right balance between network scope (reach) and the capacity and range of services provided (richness). This is also instrumental in ensuring network profitability. (Fjeldstad & Andersen, 2003)

The cost side is largely determined by the activities associated with acquiring members for the network as well as operating the infrastructure and providing the services, and the proportion of fixed costs is typically high compared to variable costs, making the attribution of costs to any particular unit of service difficult. Value, on the other hand, is closely linked to network size and composition. Some members and links in the network are more valuable than others, and it is typical of value networks that strategic pricing is applied to individual links, as is the case, e.g., with airlines and their process of yield management. As a general principle, the revenue yield of a value network must be managed on a network basis rather than an individual link basis. Fjeldstad & Andersen (2003) suggest three strategies for this purpose:

1. *Optimizing pricing*: pricing a service for its expected value to customers at a given time rather than marginal cost; this is done as part of yield management as noted above
2. *Increasing the number of exchanges that can be facilitated over a network*: using complementary networks to increase network attractiveness and stimulating good activity in the networks to increase the value of own services
3. *Internalizing transactions*: transactions that occur within a firm's own network are generally cheaper than those that require interconnection with other networks, so internalizing transactions not only helps drive costs down but also increases flexibility to manage the network yield

It is imperative that a value network firm initially recruits the customers that are more connected than others as members, allowing the firm to maximize the value-adding, positive network effects gained through increased connectivity. Moreover, doing so allows them to overcome the barrier that the lack of these network effects presents during the initial roll-out phase of a new service, as the service becomes more valuable earlier. As some firms bring in significantly more value to the network than others due to their unique assets or capabilities, they are to be recruited earlier than others. Yet, while customers value connectivity, especially to their particular nodes of interest, providing that connectivity within your network may not always be the most economically viable option due to the costs involved. In such cases, it may make sense to form alliances with other networks in order to allow interconnections, effectively combining the network effects of the individual networks. (Fjeldstad & Andersen, 2003)

Christensen's Value Networks

Christensen (1997) defines the concept of the value network as the *"context within which a firm identifies and responds to customers' needs, solves problems, procures input, reacts to competitors, and strives for profit"*. He further argues that within a value network, each firm's competitive strategy, and its past choices of markets in particular, determines its perceptions of the economic value of a new technology, and that these perceptions shape the rewards expected through pursuit of sustaining and disruptive innovations. Through the concept, he attempts to understand why large, established incumbents (or so called "great companies") so often fail when new disruptive technologies are ignored for too long due to a lack of market pull from current customers.

This short term customer needs focused optimization of business operations and resources, while a management cornerstone of many successful industry leaders, effectively also inhibits the companies to pursue technological innovations that are seemingly insignificant in terms of business opportunity at first, but later disrupt the incumbent's business as the market shifts in favor of new technology and the new entrants pushing it. In other words, incumbents often pursue continuous, incremental innovations to sustain the value of a key product in the value network, while innovations more disruptive in nature, enabling new products that are not part of the firm's current value network, are often neglected. This is due to the fact that the new products often provide lower margins at first and are not very well suited for existing customers but rather target new segments for which demand is still embryonic.

Christensen (1997) argues that companies form value networks because they provide products or services that together constitute a solution for a particular market. Often, the structure of the value network reflects that of the end product or solution where products and their components are nested hierarchically in a complex manner. Thus, the value network can be described as a nested network of producers and markets through which components at each level are made and sold to integrators in the next higher level, with the computing hardware industry as an example.

Competition between firms exists on the level of each value network component, e.g., a mass memory manufacturer competes against other mass memory manufacturers but they all occupy the same position in the value network, acting as suppliers to computer manufacturers. In different value networks, however, the firms competing for the same component may differ. The specific characteristics of a value network often make it difficult for firms in that particular network to adapt to the requirements of other value networks.

Allee's Value Networks

Allee (2000) argues that virtually any organization can be understood as a value network, including government agencies and non-profit organizations, and value network perspectives can help explain the dynamics of various economic clusters and national economies as well. In her view, however, most approaches to analyzing and reconfiguring value networks have not taken into account the role of knowledge and intangible value exchange as the foundation for these emerging networked enterprises, in spite of widespread research interest in the knowledge economy, intellectual capital, and intangible assets in general. According to her definition, a value network generates economic value through *"complex dynamic exchanges between one or more enterprises, customers, suppliers, strategic partners, and the community"*.

A framework of "the three currencies of value" which defines the bases of value exchange between organizations, not limited merely to transactions around goods, services, and revenue, is presented by Allee (2000) in order to explain the exchange of knowledge and other intangible assets such as sense of community, customer loyalty, and opportunities related to, e.g., branding. They are called currencies of value because they serve as a medium of exchange, this being the basic definition of currency as well. The three currencies of value defined by Allee (2000) are as follows:

1. *Goods, services, and revenue*: Exchanges for services or goods, including all transactions involving contracts and invoices, return receipt of orders, request for proposals, confirmations, or payment. Knowledge products or services that generate revenue or are expected as part of service (such as reports or package inserts) are part of the flow of goods, services, and revenue.

2. *Knowledge*: Exchanges of strategic information, planning knowledge, process knowledge, technical know-how, collaborative design, policy development, etc., which flow around and support the core product and service value chain.

3. *Intangible benefits*: Exchanges of value and benefits that go beyond the actual service and that are not accounted for in traditional financial measures, such as a sense of community, customer loyalty, image enhancement, or co-branding opportunities.

Allee (2000) argues that as an increasing number of products and services depend on the exchange of knowledge and information between organizations, knowledge and intangible assets become mediums of exchange or currencies in their own right. Hence, direct exchanges of revenue, goods, and services are only a part of the overall picture, and knowledge and intangible benefits are of equal importance, and the success of a networked firm indeed depends on building a rich web of trusted relationships. These relationships between firms in a value network may be worthy indicators of present and future capabilities to sustain a competitive advantage.

2.3 Business Ecosystem

2.3.1 Introduction

The concept of *business ecosystem*, first introduced in the Harvard Business Review article *Predators and Prey: A New Ecology of Competition* by Moore (1993) and further elaborated on in a subsequent book (Moore, 1996), is a relatively new but nowadays widely adopted concept in strategic management for describing communities of interacting organizations that cooperate, compete, and coevolve together over time in order to adapt themselves to an ever-changing environment. The business ecosystem is understood as a dynamic or even volatile structure, constantly evolving in response to internal and external stimuli such as competition between firms inside and outside the ecosystem as well as changes in the external conditions and business environment, technology and innovation, etc.

Moore (1993) argues that successful businesses are those that evolve rapidly and effectively, but this cannot be accomplished in a vacuum. Instead, they must draw in resources and capital and attract various partners, suppliers, and customers to create cooperative networks. As a starting point for his biological analogy, Moore refers to anthropologist Gregory Bateson's definition of *coevolution*, a process in which interdependent species evolve in an endless reciprocal cycle, in which *"changes in species A set the stage for the natural selection of changes in species B"* and vice versa. Moreover, citing biologist Stephen Jay Gould, Moore acknowledges that just as natural ecosystems may collapse when environmental conditions change too radically, often resulting in the previously dominant species losing their central role, business ecosystems and their member organizations face similar challenges.

Ecosystem as an Analogy

Moore (1993) was not the first to user the biological ecosystem as an analogy in a business context. Frosch & Gallopoulos (1989) introduced the concept of industrial ecosystem as an ideal state of sorts where all industrial operations and manufacturing processes are optimized in such a way that all material is recycled infinitely and efficiently, with environmental sustainability as the goal. However, this concept is quite far from the one developed by Moore. Rothschild (1990), on the other hand, is much closer with his perception of the economy as an ecosystem, called *"bionomics"*. Rothschild argues that several key phenomena observed in nature, such as competition, specialization, cooperation, exploitation, learning, growth, etc., are also central in the business world, and in fact, the basic mechanisms of economic change are remarkably similar with those found in nature, the main difference being speed which is obviously much greater in economic change.

Rothschild (1990) uses various other biological analogies in describing economic phenomena. He states that an organization is defined by its technology and by its associations with its suppliers, competitors, and customers, just like a living organism is defined by the information in its genes as well as by its relationships to its prey, competitors, and predators. From a bionomics perspective, he argues, organisms and organizations are nodes in networks of relationships. With the passage of time, some nodes are wiped out and new ones emerge, triggering adjustments that ripple across each network. Rothschild likens firms to biological organisms and industries to species. Following the laws of natural selection, efficiency is rewarded by survival whereas inefficiency is punished by extinction.

In his book on complexity theory, Lewin (1999) links biology and the world of business through an explanation that companies, much like biological organisms, operate within a rich network of interactions, both on a local scale and on a global scale. He argues further that biological ecosystems and economic ecosystems are complex adaptive systems in nature and thus follow the same fundamental laws and share some fundamental properties.

It should be noted, however, that there are some pronounced differences between biological and business ecosystems. Iansiti & Levien (2004a) point out that, first of all, the actors in business ecosystems are intelligent and thus capable of planning and envisioning the future with a certain degree of accuracy. Related to the intelligence of the ecosystem actors is also the ability to make conscious decisions, whereas biological ecosystems lack a similar conscious intent (Lewin, 1999). Another difference is that business ecosystems typically compete over potential members although such behavior cannot be observed in nature. Moreover, according to Iansiti & Levien (2004a), business ecosystems aim at delivering innovations, whereas the goal of natural ecosystems is merely survival.

Peltoniemi & Vuori have studied the concept of business ecosystem and its various uses as an analogy extensively. The interested reader should consult their publications (Peltoniemi, 2004; Peltoniemi & Vuori, 2004; Peltoniemi, 2006) for a more thorough overview.

2.3.2 Moore's Business Ecosystem

As a management theorist and consultant, Moore (1996) attempts to understand why so many previously prosperous businesses fail despite having good products and services and well-run processes in place to produce them. Moore attributes this to mainly two types of business problems: the fall of the economic fabric (environment and conditions) around a business, and the invasion of the business's market territory by too many similar contributors, i.e., being commoditized as a result of excessive competition. The failure to respond to either of these problems stems from a conventional view to competition. Traditional models of management, based on product and service competition and process improvement are necessary but no longer sufficient for firms to survive in a modern, rapidly evolving business environment.

Moore argues that a new systematic approach to strategy is needed here, and that traditional responses are of little avail. For example, diversification strategies typically assume the fixedness of industry structure although that condition rarely holds true anymore as industries undergo rapid structural development. Moreover, the traditional notions of vertical and horizontal integration or economies of scale that are so prominent in Porter's school of thought, have reduced significance in the new world of cooperating communities as these capabilities are not necessarily crucial in attaining competitive advantage. According to Moore, however, scale and scope do matter, but only as they contribute to a continuing innovation trajectory, allowing a company to continually lower its costs while increasing its performance.

For a firm to prosper, paying close attention to its economic environment as well as to other firms influencing its evolution is essential. The new paradigm necessitates thinking in terms of entire systems, seeing a business as part of a wider economic ecosystem and environment. This systems thinking is present throughout Moore's work, and is also evident in his many biological analogies and examples which, he argues, are quite simply the most direct way to explain difficult systems concepts. Though biological analogies and concepts, e.g. Darwinian selection, have been applied to the study of business, Moore criticizes many such attempts for their too narrow application and scope. In his view, although firm (species) level improvement is undoubtedly crucial for the success of firms, there are complementary forms of evolution occurring on higher levels of abstraction, playing vital but often grossly underrated roles. These include interactions occurring across an entire ecosystem or between ecosystems. Moreover, it is competition between ecosystems as opposed to individual companies that is largely fueling the transformation of many industries today. (Moore, 1996)

Moore (1993, 1996) suggests that a firm be viewed not as a member of a single industry but as part of a business ecosystem that spans a number of industries. The central idea is a that firms within a business ecosystem coevolve capabilities around a new innovation, working both cooperatively and competitively to support new products, satisfy customers, and incorporate the next round of innovation. Moore also acknowledges the special role that certain firms, so-called keystones, hold as leaders of their respective ecosystems, being valued by the rest of the community and enabling all ecosystem members to invest toward *a shared future in which they anticipate profiting together*. This *shared fate* is a central principle pertaining to business ecosystems as we shall see also in more recent renditions of the concept such as the one provided by Iansiti & Levien (2004a).

Moore (1996) attempts to give out a definition for business ecosystem: *"an economic community supported by a foundation of interacting organizations and* *individuals — the organizations of the business world. This economic community produces goods and services of value to customers, who are themselves members of the ecosystem. The member organisms also include suppliers, lead producers, competitors, and other stakeholders. Over time, they coevolve their capabilities and roles, and tend to align themselves with the directions set by one or more central companies. [...]".* Figure 2.5 illustrates the structure of a typical business ecosystem (Moore, 1996). As we can see, the boundaries of an ecosystem span a wide range of organizations and individuals far beyond the core business (which includes direct supply chain and distribution channel partners) or even the extended enterprise.

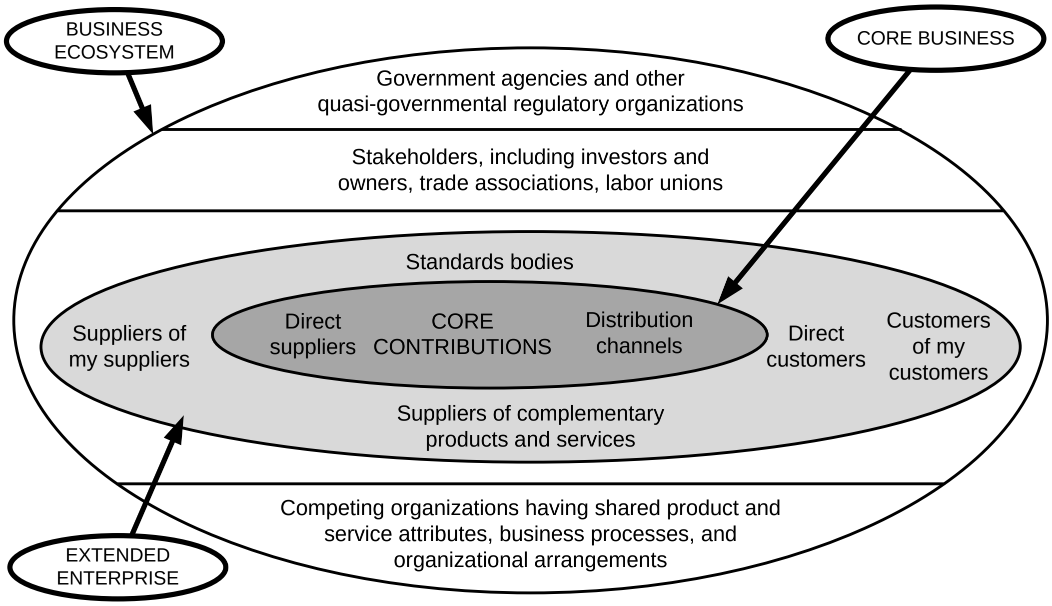

Figure 2.5: Moore's business ecosystem

The economic model on which successful ecosystems are based according to Moore is fairly simple. Firms in the ecosystem possess certain core capabilities which form the basis of value creation and are utilized to produce core products to customers. These core products are further complemented by a variety of complementary products and services that enhance the customer experience, and together they constitute the "total experience" or total offering provided to the customers. Moreover, the profits earned from sales of core products and services are partially invested in further development of the core capabilities and future offering, enabling a sustained innovation trajectory leading to lower costs and enhanced performance. However, part of the returns are also invested in leadership and support for the ecosystem itself which includes activities such as community development (recruiting new members), evangelism, standardization, conflict resolution, etc., which generally benefit all the firms engaged in the ecosystem. (Moore, 1996)

Moore's Four Stages of a Business Ecosystem – A Life Cycle Model

A central hypothesis in Moore's theory of business ecosystems is that much like biological ecosystems, business ecosystems undergo different stages of succession. This succession can be understood as progressive change in composition of a community of organisms (or in business context, firms). This successive series of changes pertains not only to the size and scope of the ecosystem but also to its structure and organization. Moore encourages business leaders to identify and define the "great eras" of change in their business ecosystems, arguing that the sequence and nature of the great eras in the development of a business ecosystem are to some extent predictable. Through a better understanding of where a firm is currently situated in its ecosystem life cycle, its executives can attempt to anticipate important potential changes taking place in the future and take appropriate action to respond to these challenges, whether it means preparing to provide the next key contribution to the community or precautionary actions to protect the firm's position. (Moore, 1996)

From his experience of working with various firms in different industries, Moore has identified a pattern of roughly four distinct, sequential stages in the evolution of a business ecosystem. These stages are: 1) *pioneering* (also called *birth*), when the basic paradigm of the ecosystem is being worked; 2) *expansion*, when the community broadens its scope and consumes resources of all types; 3) *authority* (also called *leadership*), when the community structure becomes stable and competition for leadership and profits within the ecosystem gets brutal; and finally, 4) either *renewal*, when continuing innovation must take place for the community to thrive and remain vibrant, *or death*, if the community stagnates. In reality, however, the evolutionary stages may be difficult to discern from one another as the borders between them are often blurry, and the challenges of one stage may instead appear in another. One thing that does remain consistent, as Moore argues, is the process of coevolution, i.e., the complex interplay between competitive and cooperative business strategies. (Moore, 1993, 1996)

Business Ecosystems and Competition Policy

Moore revisited the concept of business ecosystem in an article for the Antitrust Bulletin (Moore, 2006). He argues that markets and hierarchies have long dominated thinking about economic organization, and that a third concept, the business ecosystem, should rightfully receive equal recognition in both theory and policymaking, as it has become a pervasive form of economic coordination. These three concepts, in his view, should provide the foundation for competition policy, regulation, and antitrust actions. Furthermore, he attempts to educate the judicial system and policymakers about the reality of business ecosystems and the public goods that they create, in part with the goal of countering a tendency in the antitrust courts to attack ecosystems and their mechanisms of coordination. Moore argues that antitrust cases that do not recognize the ecosystem level of organization run the risk of ignoring and potentially damaging important collaborative, innovation-furthering public goods. He does acknowledge, however, that there are some particular ways in which the ecosystem form can be abused, and for which competition policy and antitrust regulation are indeed necessary.

The focus of companies, according to Moore, has progressed from competing on efficiency and effectiveness to competing on the basis of continuous innovation. Moreover, for every advance there are complementary innovations that must be combined for customer benefit. As a single firm rarely possesses all the specialized knowledge required for the whole system, the complementary advances must often coevolve across firms. Moore advocates openness and states that one of the most exiting ideas in business today is that business ecosystems can be "opened up" to the whole world of potential contributions and creative participants (Moore, 2006). In a business ecosystem, if the system modules are properly defined and the interfaces are well documented, and the business contracts are not too restrictive either, then the ecosystem can be said to be open to new entrants in some niches. Ecosystem-reinforcing investments by an incumbent in opening the ecosystem by, e.g., promoting neutral standardization efforts can be both pro-competitive and pro-innovative.

For the coevolution of firms' products and services to succeed, firms need to align their visions. Furthermore, they need to ensure that their R&D and capital investments as well as operating processes are mutually supportive and synergistic. Most importantly, however, they must maintain close dialogue with customers to ensure that the end result matches customer expectations. Mastering the challenges of "distributed creativity" is a key goal for the ecosystem form of organization, whereas a traditional hierarchical firm, according to Moore, is unable to effectively address the breadth and importance of interfirm relationships. The unaided market, without business ecosystems, is not able to achieve such interfirm coordination that would justify firms' aligning their dreams, plans, and product roadmaps. (Moore, 2006)

2.3.3 Iansiti and Levien's Business Ecosystem

Perhaps the most modern rendition of the business ecosystem concept is that of Iansiti & Levien, presented both in their book (Iansiti & Levien, 2004a) and a Harvard Business Review article (Iansiti & Levien, 2004b). Much like Moore, they too have studied numerous firms in various industries and interviewed hundreds of managers, attempting to understand why some companies in today's network economy thrive while others fail. Their approach integrates deep managerial research with a broader understanding of networks drawn from various academic fields. The research problem is viewed from the angle of business networks, the key question being how firms should manage the complex business networks which they are a part of. To an increasing extent, firms rely on assets which they do not own but have access to through a business network. Strategy, according to Iansiti & Levien (2004a), is therefore increasingly about the art of managing these distributed assets in an efficient manner.

Iansiti & Levien (2004a) note that the problems of business networks are by no means unique, and similar networks are found in a wide range of domains. Indeed, the study of networks in fields such as physics, biology, and social psychology has advanced dramatically in recent years. Iansiti & Levien (2004a) argue that perhaps more than any other type of network, a biological ecosystem provides a powerful analogy for understanding a business network. *"Like business networks, biological ecosystems are characterized by a large number of loosely interconnected participants who depend on each other for their mutual effectiveness and survival. And like business network participants, biological species in ecosystems share their fate with each other. If the ecosystem is healthy, individual species thrive. If the ecosystem is unhealthy, individual species suffer deeply. And as with business ecosystems, reversals in overall ecosystem health can happen very quickly."* (Iansiti & Levien, 2004a)

Ecosystems are not homogeneous in structure. The majority of them, according to Iansiti & Levien (2004a), have richly connected *hubs* that have a great influence among the members and thus can have a profound impact on the overall health of the ecosystem based on their behavior. In almost all cases, these hubs appear as active *keystones* whose interests are aligned with those of the overall ecosystem and who have the critical role of regulating its health. Keystones, whether in biological or in business context, *enhance stability, predictability, and other measures of system health* by *regulating connections* and *creating stable and predictable platforms* on which other network members can rely.

Each ecosystem is comprised of several domains which may be shared with other ecosystems. As an example, in the software ecosystem of Microsoft, the largest domains (measured by number of firms) are system integrators, development service companies, and ISVs. A prerequisite to a well-functioning ecosystem is that each domain that is critical in the delivery of a product or service should be healthy. Thus it follows that the fragility of any single domain can undermine the performance and health of the whole ecosystem. In order to assess the health of business ecosystems in the sense that *the ecosystem as a whole is durably creating opportunities for each of its domains*, Iansiti & Levien (2004a) propose three critical measures for a business ecosystem: *productivity*, *robustness*, and *niche creation*.

Productivity

Productivity attempts to capture the effectiveness of an ecosystem converting raw materials and other factors of production into products and services. In traditional economic productivity analysis, *return on invested capital* (ROIC) is one of the most common measures. However, many business ecosystems are constantly subject to new conditions in the form of new technologies, new processes, and new demands. Moreover, measures of productivity should also capture the effectiveness of an ecosystem in converting innovation into lowered costs and new products and functions. Thus, Iansiti & Levien (2004a) suggest at least three types of productivity-related metrics: *factor productivity* (e.g. ROIC), *change in productivity over time*, and *delivery of innovations* (i.e., an ecosystem's inclination to share and promote innovation — one measure of this could be the time lag between the appearance of a technology and its wider dissemination).

Robustness

An ecosystem must persist in the face of environmental changes in order to provide sustained benefits to its participants. Robustness is mainly a measure of resilience against various perturbations and disruptions that could threaten the existence of the ecosystem. The benefits of a robust ecosystem are rather obvious: firms belonging to it are able to operate in a relatively stable and predictable environment, as the impact of external shocks is dampened. The most basic metrics of ecosystem robustness are *survival rates* of participants, i.e., a healthy ecosystem will promote the survival of a diverse set of firms in various niches. Iansiti & Levien (2004a) depict survival rates through the number of firms in a given ecosystem. However, this simplification does not reveal churn — a high number of firm entries coupled with a high number of exits is not revealed when only observing the number of firms at a given time.

The use of additional metrics of robustness is encouraged by Iansiti & Levien

(2004a), and they suggest a few more. *Persistence of ecosystem structure* means most connections between firms or between technologies remain in the event of external shocks, and that firms can rely on certain structural features of the ecosystem. *Predictability* means that change in an ecosystem is not only contained but also predictably localized. Although different parts of the ecosystem are affected by different shocks, a predictable "core" generally remains unaffected. *Limited obsolescence*, on the other hand, means that there is no major abandonment of so-called obsolete capacity in response to an external perturbation, meaning that most of the installed base or investment in technology finds continued use after the dramatic environmental changes have taken place. This emphasizes the adaptability of technology. Finally, *continuity of user experience and use cases* refers to the general expectation of consumers that the user experience of the ecosystem's products evolves consistently and gradually as new technologies are introduced, as opposed to being radically transformed.

Niche Creation

As a third measure of ecosystem health, niche creation is the capacity to create valuable new niches which can also be thought of as the capacity to create *meaningful diversity*. Iansiti & Levien (2004a) emphasize that not just any diversity matters, but rather diversity that creates value. Thus, the new categories of business should provide new functionality, enable new scenarios, or expose new technology or ideas. In short, niche creation is about the ecosystem's capacity to provide valuable opportunities for new and existing firms. Iansiti & Levien (2004a) suggest that this measure can be assessed through two related metrics: *growth in firm variety* (i.e., number of new firms created in the ecosystem in a given period of time) and *growth in product and technical variety* (the number of new product options, technological building blocks, categories, products, or businesses being created within the ecosystem in a given period of time).

Criticism and Complementary Measures of Ecosystem Health

A point of criticism of the ecosystem health metrics outlined by Iansiti & Levien (2004a) is that while they may be fully appropriate for meso (intermediate) level analysis, which can be based on public data available from, e.g., census bureaus (such as number of startups per industry sector, etc.), micro (company) level analysis typically requires more detailed data. Den Hartigh et al. (2006) recognize this problem and present a number of operational measures that are, in their view, better suited for measuring business ecosystem health on the company level and of more practical value and use to managers.

Their stated aim for such metrics is that they be user friendly, measurable with commonly available data and usable over the longer term as well as usable on multiple levels, i.e., for individual companies in ecosystems, for cross-sections of ecosystems, and for ecosystems as a whole. Based on a selection process involving both industry expert interviews and literature review, they arrive at an inventory of measures that is tested and validated against the set criteria.

Table 2.1: Partner and network health measures

Partner Health	**Network Health**
- EBIT/total assets - Total revenue/total assets - Liquidity - Solvency (periods t & t-1) - Retained earnings / total assets - Total asset growth - Working capital / total assets	- Number of partnerships - Visibility in the market - Covariance of partner variety with the market

The validated measures form the basis of their ecosystem health metrics which are broken down into two groups of measures: *partner health* and *network health*. The former reflects the long-term financial well-being of the business ecosystem, whereas the latter reflects its long-term network strength. Together, Den Hartigh et al. (2006) view these two metrics as representative of business ecosystem health, of more practical value to firms and their managers in governing business ecosystems than the higher level determinants of productivity, robustness, and niche creation. The measures which together compose partner health and network health are shown in Table 2.1. For further details on the measures and the justifications for selecting them, the reader is suggested to refer to Den Hartigh et al. (2006).

Ecosystem Roles and Strategies

Iansiti & Levien (2004b) identify three distinct roles in ecosystems that firms may occupy or strive for, each with a corresponding ecosystem strategy. These roles are *keystone*, *physical dominator*, and *niche player*. A fourth role called *value dominator* is identified as well, but it is suggested that such firms are detrimental to an ecosystem's health, leading to starvation and ultimately even the destruction of the ecosystem. Let us discuss each of these roles in detail.

The firms and organizations known as keystones play a crucial role in business ecosystems. What sets them apart from the other roles is that they aim to improve the health of their ecosystem by providing a stable, predictable set of common assets available to other organizations in the ecosystem. Examples of such assets include operating systems, e-commerce and distribution platforms, development tools, etc. As a result, other organizations are able to build their own offerings on these assets, creating value not only for themselves or the keystone, but generally also for the overall ecosystem. In this sense, the keystones often make the creation of new products by third parties more efficient. Keystones can further increase ecosystem productivity by simplifying the complex task of connecting ecosystem participants to one another, as in a network. They can also serve to increase ecosystem robustness through constantly incorporating innovations and by providing a reliable point of reference to other organizations in the face of new and uncertain conditions. Finally, keystones can encourage niche creation by offering innovative technologies for third parties to build on. (Iansiti & Levien, 2004b)

In most cases, removal of a keystone is a severe blow to an ecosystem, often leading to its collapse. While keystones actively promote the health of their ecosystem, they don't do it for altruistic reasons but rather because it serves their own strategy and long-term goals well. It is also worth noting that keystones do not occupy a large number of the nodes in an ecosystem network whereas dominators do. Keystones leave parts of the ecosystem intentionally unoccupied to encourage diversity and niche creation in those areas. This is not the case with dominators, who often become much of the ecosystem by themselves, leaving little room for other players to operate sustainably, thereby reducing diversity and often productivity as well. Diversity, in turn, often directly enhances the stability of an ecosystem by ensuring that the ecosystem has the capacity, in terms of variation in genetics and behavior, to respond and adapt to changes or disruptions in the environment. Thus, keystones often enhance the diversity, and as a consequence, the stability of an ecosystem. However, keystones do often act as "selective predators" and may adversely affect the growth of some players, but this is to keep potential dominators in check. Iansiti & Levien (2004b) suggest that if a firm is at the center of a complex network of asset-sharing relationships and operates in a turbulent environment, a keystone strategy may be the most effective alternative, provided that the firm is willing to share a part of the value generated with others in the ecosystem.

While keystones leverage their position in an ecosystem in a somewhat indirect manner, dominators use their power to take over the network directly or drain value from it. The former type of dominator is called a physical dominator, a firm that aims to integrate vertically or horizontally a large portion of its ecosystem. Once physical dominators become large enough, they are responsible for most of the value creation and capture in the ecosystem, leaving little opportunity for diversity and niche creation. While such a strategy has been successfully applied by, e.g., IBM for a long period of time, the long-term sustainability of the approach is questionable, as keystone strategies tend to allow for more innovation and flexibility in the ecosystem. The latter type of dominator, called a value dominator, has little direct control over its ecosystem but is nevertheless in a position where it can extract value from other members of the ecosystem. Value dominators tend to create little if any value to their ecosystems, instead robbing most of the value created by others. This kind of parasitic behavior is detrimental to the health of the ecosystem, eventually leading to starvation and the collapse of the ecosystem, bringing down the value dominator with it. This makes such an ecosystem strategy fundamentally flawed.

In contrast to the value dominator strategy, Iansiti & Levien (2004b) do argue that the physical dominator strategy can make sense when a firm relies on a complex network of external assets but operates in a mature industry where the innovation that comes with diversity isn't a high priority. In such a setting, the firm can directly take over the assets it needs by acquiring its partners or suppliers or by taking over their functions otherwise. As a physical dominator ultimately becomes its own ecosystem, it is able to extract the maximum value from the assets under its control without the complex relationships that characterize an ecosystem, and so an ecosystem strategy becomes irrelevant — this may, however, change at some point in the future, and the physical dominator may find itself challenged or even disrupted by a firm following a keystone strategy in its ecosystem.

Most of the firms or organizations that populate a business ecosystem follow a niche strategy, relying on specialized capabilities that differentiate them from other members of the ecosystem. Iansiti & Levien (2004a) state that if a firm faces rapid and constant change and can focus on a narrow and clearly defined business segment by leveraging the assets of other firms, then a niche strategy is viable. In other words, niche players are able to focus their efforts and resources on a specific domain of expertise by leveraging the complementary resources of a keystone or other niche players. They not only represent the bulk of the ecosystem but are also responsible for most of the value creation and innovation occurring in the ecosystem — that is, if they are not marginalized or exploited by a powerful dominator. As niche players are very much dependent on relationships within their ecosystem, much more so than the other ecosystem roles, they indeed need to carefully analyze their business environment and ecosystem, assessing the relative strengths of current and potential keystones and dominators. Iansiti & Levien (2004b) argue that even despite the best, highly specialized strategies, niche players usually come into conflict with other niche players, keystones, and especially dominators. Niche players unable to maintain a sufficient pace in differentiation and expansion towards the edges of their ecosystem may find themselves swallowed up by an expanding keystone, e.g., through the incorporation of the niche player's product into the keystone's platform. While such developments can be beneficial for the overall good of the ecosystem, they sometimes come at the expense of individual niche players.

Finally, it's important to note that the roles in an ecosystem aren't static and evolve over time. Also, a company that is a keystone in one business domain may be a dominator or niche player in other domains. Moreover, niche players may be eventually become the keystones of their own ecosystems. (Iansiti & Levien, 2004b)

2.4 Software Ecosystems and Two-Sided Markets

2.4.1 Introduction

For purposes of studying business ecosystems from the perspective of mobile software and applications in particular, the concepts of *software ecosystem* and *two-sided market* are discussed in the following subsections. Software ecosystems extend the basic principles of networked relationships and business ecosystem roles to the specific context of firms operating in the ICT and software industry. The concept of two-sided market, discussed from Section 2.4.3 onwards, can be used to describe and explain the dynamics of mobile application business, particularly from the perspectives of application developers, consumers, and the keystone firms or ecosystem orchestrators that provide and control the platforms that serve the two distinct groups of users and their needs.

2.4.2 Mobile Software Ecosystems

In the computer software industry, no single firm can satisfy the demand for every software product that customers need. There are certainly large-scale software powerhouses such as Microsoft, Oracle, SAP, and Adobe to name but a few, but still the overall software market is very diverse and fragmented. Contrary to more traditional industries where firms have sought vertical integration to establish control over assets as a source of competitive advantage, the relationships between software vendors are more complex and networked in nature. Often, these firms resort to *virtual integration* through alliances to establish networks of influence and interoperability (Iyer et al., 2006). In particular, software firms form relationships with other firms to gain access to different types of resources, and such links form a network of relationships that shape competition and value delivery.

Indeed, these networks of relationships exhibit many characteristics of an ecosystem as described earlier, including cooperation and competition. Often, software vendors need to ensure interoperability with complementors, i.e., other firms that provide complementary software applications, but also competitors to enable a viable ecosystem with stronger network effects. It can be argued that most software vendors no longer function as fully independent units that can deliver separate products, but they have rather become dependent on other software vendors for vital software components, such as operating systems, libraries, component stores, and platforms (Jansen et al., 2009). The rapid pace of technological chance is likely a key factor in explaining why most software firms choose to build on networked relationships in *sofware ecosystems* rather than integrate vertically by acquiring all the assets they need.

Definition

No universally accepted definition exists for what constitutes a software ecosystem or SECO, as some authors like to abbreviate the term. Instead, most scholars who deal with the concept have come up with their own definitions. For example, Bosch (2009) defines a software ecosystem as consisting of a *"set of software solutions that enable, support and automate the activities and transactions by the actors in the associated social or business ecosystem and the organizations that provide these solutions"*. In his taxonomy, he also makes a distinction between commercial and social ecosystems, noting that in a commercial ecosystem, the actors are businesses, suppliers, and customers, the factors are goods and services, and the transactions include financial transactions as well as information and knowledge sharing, inquiries, pre and post-sales contacts, etc. In contrast, social ecosystems consist of users, their social connections, and the exchanges of various forms of information. Bosch (2009) further adds that a software ecosystem is also a commercial ecosystem, and thus it follows that the goods and services are the software solutions and software services that enable, provide support for, or automate activities and transactions.

Software Ecosystem Roles and Strategies

According to Iyer et al. (2006), three roles are important in most software networks: *the hub*, a firm with a disproportionately high number of links, *the broker*, a firm that creates a connection between two sets of firms, and *the bridge*, a link critical to the overall connectedness within the network. Hubs are usually large, established firms who typically act as platform providers to complementors. In line with the ecosystem strategies described by Iansiti & Levien (2004a), hubs may choose between three operating strategies: keystone, dominator, or niche. Brokers often act as arbitrators between two or more firms, attempting to establish a common standard within a standards body. Finally, the bridge role is attributed to firms who promote and enhance software application interoperability through middleware and other software techniques (Iyer et al., 2006).

The keystone role in an ecosystem equates to firms providing a standard or platform technology that provides a foundation for the ecosystem. Despite the central role that keystones play in an ecosystem, they do not typically constitute the bulk of the ecosystem by themselves as measured by generated revenue or profit but leave room for other firms to sustainably operate in the same ecosystem. This is not true for dominators, firms that progressively eliminate other firms in their ecosystem through acquisitions or driving them out of the market, capturing an increasing share of the value generated in the ecosystem and also being increasingly responsible for the innovation (and thus renewal) of the ecosystem, decreasing diversity. While dominators being able to serve the full customer base of the ecosystem may be successful for a period of time, they are bad for the overall health of the ecosystem in the long term. According to Jansen et al. (2009), several examples have shown that strong dominators either destroy the ecosystem or are regulated by external factors such that the ecosystem can survive.

The niche player role corresponds to a firm that is dependent on the standard or platform technology provided by the keystone player for creating business value. Some niche players may also depend on other niche players and vice versa without the presence of a keystone, but usually such roles are unsustainable in the long term. Jansen et al. (2009) notes that eventually, such relationships evolve into a dependency on a keystone, or one of the niche players may itself become a keystone.

Categorization and Success Factors

Bosch (2009) identifies three distinct categories of software ecosystems each with its own characteristics, challenges, and success factors: *operating system centric*, *application-centric*, and *end-user programming* software ecosystems. As software product line companies transition to a software ecosystem approach, the most likely scenario is to introduce an application-centric software ecosystem. This can be done on desktop (e.g., Microsoft Office), on the web (e.g., Salesforce.com, eBay, Amazon), or in a mobile environment. He argues that introducing a new OS and building an ecosystem around it is an extremely difficult challenge, and there is a lengthy history of failed attempts.

The primary cause of difficulty is the need to convince developers to build compelling applications on the OS in order to attract end users as customers. Without a sizable base of customers willing to purchase applications, however, few developers are willing to invest in application development on the OS. This affirms the chicken-and-egg problem observed in nascent two-sided markets by, e.g., Rochet & Tirole (2003) and Parker & Van Alstyne (2005). As can be ascertained from the works of several authors (e.g., Hyrynsalmi et al. (2012), Idu et al. (2011), Tuunainen et al. (2011), Hagiu (2009)), the concept of two-sided market is, in fact, a common way to describe and analyze OS-centric ecosystems, also in the context of mobile business.

The following success factors apply particularly to OS-centric ecosystems, as suggested by Bosch (2009):

- *Minimal effort required by developers* to build applications on top of the OS, thereby enabling both breadth and quality of the application offering.
- *Generic, evolving functionality and set of features provided by the OS* that maintains attractiveness for developers. It is important for an OS to incorporate commoditizing functionality early on without alienating existing developers.
- *The number of customers that use the OS and that are accessible to developers* for monetization.

For the purposes of the research conducted as part of this thesis, we will do well to focus on OS-centric software ecosystems particularly in the mobile smartphone business context. Therefore, further discussion of other types of software ecosystems is omitted.

Mobile Application Stores

Since 2007 when the first large-scale mobile application marketplaces were announced, software ecosystems have become a significant part of the mobile domain. These software ecosystems are largely characterized by their application stores, most often run by the keystone or orchestrator of the ecosystem. Apple's App Store, Google Play (formerly Android Market), Microsoft's Windows Phone Store, and Blackberry App World are the leading mobile application stores, each catering to a specific mobile OS platform, but they are by no means the only ones. For example, there are multiple alternative application stores for the Android platform such as Amazon Appstore for Android, GetJar, Slide ME, AppsLib, Samsung Apps, and F-Droid to name a few (Digital Trends, 2013a). Additionally, there are many regional or operator-specific application stores.

For platform proprietors, mobile application stores are an important part of their overall developer offering, acting as the primary (or only) distribution channel for applications developed by third parties. They help stimulate complementary innovation by offering developers a straightforward way to monetize their work. They create stickiness to the platform, as apps purchased from one app store are usually not transferable to other platforms without repurchase. Also, some apps are only available for a certain platform and when a large enough number of such applications exist, the apps may become a true differentiator for that platform. Nowadays, however, the most popular applications are available on multiple platforms, thus leaving less potential for differentiation.

Mobile application stores are also examples of a theoretical concept called 'two-sided market'. To understand the dynamics of mobile application stores, one needs to first understand this concept thoroughly. In the next subsection, the theory behind this concept is thoroughly explained.

2.4.3 Two-Sided Markets as an Economic Platform

The theoretical foundations for the concept of two-sided market were laid in the research on network externalities by Katz & Shapiro (1985, 1986, 1994) and Shapiro & Varian (1998), but Parker & Van Alstyne (2000, 2005) were the first to put forth a formal model of cross-market externalities that could be used to explain some observed firm strategies such as those of Microsoft, Netscape (AOL), Sun, and Adobe, among others. Moreover, Rysman (2000, 2004) wrote the first known empirical paper on network effects in a two-sided context, studying specifically the market for Yellow Pages.

A key question that Parker & Van Alstyne (2000) attempted to answer was related to free giveaways — how could firms benefit from unpaid goods? As an example, both Microsoft and Netscape went to great lengths to distribute their web browsers for free and through as many channels as possible. Similarly, Adobe distributes its Portable Document Format (PDF) reader software for free. Parker & Van Alstyne (2000) claim that under specific market conditions, firms can increase their profitability and gain other benefits by giving away products for free. Especially in the business domain of information products, they argue, *free strategic complements* can raise a firm's profits while *free strategic substitutes* can lower profits for competitors.

Rochet & Tirole (2003, 2004, 2006) have also pioneered the research on two-sided markets, and they originally approached the topic from the angle of credit card markets, presenting elaborate mathematical modeling for price allocation on the two sides of the market based on a number factors. As the formal definitions, quantitative models, and formulas provided by different authors are not fully compatible, the theory is discussed mainly from a qualitative perspective, from the angle of content providers and end consumers in the information products market (as elaborated by Parker & Van Alstyne (2000, 2005); Eisenmann et al. (2006)) which includes software applications.

As discussed in Section 2.2.1, the most traditional conceptual model of value capture, the value chain, represents value moving from left to right, or upstream to downstream. To the left of the firm is cost, represented by the upstream suppliers, and to the right is revenue, represented by the downstream channels and customers. But what if both sides could include both cost and revenue elements? This is the fundamental idea of two-sided markets. A firm that brings together two distinct groups of users into a network of sorts, facilitates their transactions through some kind of infrastructure or platform (possibly in the form of a service or product), and is able to draw revenue from both groups, is the provider of an economic platform, a two-sided market.

Real world examples of two-sided markets are numerous: the credit card is perhaps one of the most well-known and tangible ones, linking together merchants who accept credit card as payment and consumers who purchase goods using credit cards. In this example, the credit card companies draw revenue from the merchants who typically have to pay a commission as a percentage (known as the *merchant discount rate*) of the transaction value, and the consumers, who typically have to pay at least an annual fee for the credit card. Still, both the merchant and the consumer benefit from the credit card which forms a common platform for everyday financial transactions, facilitating business. Another common example is newspapers which join advertisers and readers together. Beyond physical products, also services like online recruitment databases, bringing together job seekers and employers, count as two-sided markets. (Eisenmann et al., 2006)

As noted in Section 2.2.3, systems that can be described as a network of users exhibit network effects, also called network externalities, that can be either positive or negative. The existence of positive network effects means that the more users a network has, the more valuable it is to each user. Two-sided markets, with their two distinct groups of users, can be thought of as two-sided networks that exhibit *cross-side network effects*. As these two groups are attracted to each other, the value of the network to any given user is largely based on the number of users on the *other* side of the network. The value of the mediating platform grows as it matches demand from both sides of the market.

A two-sided market is often described as manifesting a "chicken-and-egg" problem in the sense that it's crucial to get both sides on board for this matched market to grow and generate profit (Rochet & Tirole, 2003; Parker & Van Alstyne, 2005). This presents a profit optimization problem for the mediating platform provider, and a common and straightforward solution is to discount one market in order to grow both, and to profit more from the other. This model favors an intermediary that straddles both sides of the market and can set the prices more efficiently by internalizing the two-sided network externalities. This advantage is lost when independent firms serve either market separately. (Parker & Van Alstyne, 2005)

Rochet & Tirole (2003) argue that actually many if not most markets with network externalities are two or multiple-sided markets. According to their definition, a market with network externalities is a two-sided market if platforms can effectively cross-subsidize between different categories of end-users that are parties to a transaction. In other words, the volume of transactions on and the profit generated by a platform depend not only on the total price charged to the parties to the transaction, but also on its decomposition. Platforms may be unable perform cross-subsidization due to mainly two reasons:

1. *Both sides of the market coordinate their purchases.* Examples include a debit card platform negotiating with a government for the handling of interagency financial transactions, an Internet service provider (ISP) offering an intranet solution to a company, or a streaming-media platform offering streaming audio and video to a firm primarily for internal use — they all deal with a single party. When the total price of goods or services is not affected by subsidization, there is no impact on the demand for the platform.

2. *Pass-through and neutrality.* Even when the users on each side of the market act independently, monetary transfers between them may undo the redistributive impact and prevent any cross-subsidization. The value-added tax can be considered a classic example of the possibility of neutrality, as it really does not matter whether the seller or the buyer pays the tax. Eventually, prices adjust so that any tax paid by the seller is passed through to the consumer. In the event that such neutrality holds, the market should be treated as one sided. In one-sided markets, only the total per-transaction price charged by the platform matters and not its decomposition between the two distinct groups of users.

Definition

The proposed definition for a two-sided market by Rochet & Tirole (2006) is as follows:

> A market is two-sided if the platform can affect the volume of transactions by charging more to one side of the market and reducing the price paid by the other side by an equal amount; in other words, the price structure matters, and platforms must design it so as to bring both sides on board. The market is one-sided if the end-users negotiate away the actual allocation of the burden (i.e., the Coase[2] theorem applies); it is also one-sided in the presence of asymmetric information between buyer and seller, if the transaction between buyer and seller involves a price determined through bargaining or monopoly price-setting, provided that there are no membership externalities.

Another good example of two-sided markets is video game development. Game developers favor platforms that have a large enough user base, constituting an audience of potential purchasers of their game titles, as they need to offset the substantial upfront development costs for a particular platform. Conversely, players tend to favor platforms with a greater variety of game titles available. Hence, due to positive cross-side network effects, successful platforms enjoy increasing returns to scale and improving margins as users are willing to pay more for access to a bigger network.

It is worth noting, however, that *same-side* network effects do matter also in two-sided markets. As opposed to cross-side effects that are most often positive, same-side effects can be negative when they mean, e.g., increased competition among content publishers or congestion due to a very large number of end-users accessing a service simultaneously. They can be positive just as well though, as in the case of online gaming communities which benefit from a larger pool of players. (Eisenmann et al., 2006)

These types of dynamics also mean that platform leaders, who are able to extract higher margins from their two-sided networks, are also capable of investing more in R&D or lowering prices to drive weaker competitors out of the market. Eisenmann et al. (2006) argue that, as a result, mature two-sided network industries are usually dominated by a handful of large platforms. This is

[2] The Coase theorem states that if property rights are clearly established and tradable, and if there are no transaction costs nor asymmetric information, the outcome of the negotiation between two (or several) parties will be Pareto efficient, even in the presence of externalities. If outcomes are inefficient and nothing hinders bargaining, the parties will negotiate their way to efficiency. (Rochet & Tirole, 2006)

evident in our earlier example of credit card companies, and even more so in the extreme example of the PC operating systems market which is dominated by a single company, namely Microsoft. Even in the face of such *winner-take-all* dynamics, there are examples of platforms that have successfully resisted much stronger rivals by specialization and finding their own niche. Linux, for example, has been steadily growing its market share in the server space at the expense of Windows and Unix based servers, having accounted for 28.5% of all server revenue in the fourth quarter of 2013, up 4.6 percentage points when compared with the fourth quarter of 2012, as reported by the research company IDC (2014). Nevertheless, competition in two-sided markets can be fierce, and companies cannot afford to rest on their laurels even if their immediate rivals have been vanquished. As noted by Eisenmann et al. (2006, 2007), platform providers face a threat of *envelopment* by large companies often operating in adjacent markets that have the ability to offer multi-platform bundles. Platform envelopment is discussed in Section 2.5.4.

Discussion

Two-sided markets (or platforms) have been studied and discussed from a theoretical perspective by quite a few authors over the past decade. Many have come up with quite abstract models and rather complex formulas for demand and price allocation with respect to the different sides of the market. Also, as noted by Evans & Schmalensee (2008), the existing theoretical and empirical research seems to suggest that the functioning of two-sided markets is highly dependent on the specific institutions and technologies of an industry, so one must proceed with care in making any generalizations. Moreover, there has been little rigorous empirical research on two-sided platforms or competition among them. In recent years, however, a number of papers have been published that examine mobile operating systems and application stores as two-sided platforms, as an example, the papers by Hyrynsalmi et al. (2012) and Tuunainen et al. (2011). The case studies conducted as part of this thesis, in part, aim to reduce the gap in empirical research on two-sided markets, especially in the rapidly evolving, dynamic context of mobile smartphone business.

2.4.4 Pricing and Subsidies in Two-Sided Markets

Setting prices and possible discounts with respect to the two sides of a network is no simple affair. Obviously, the choices made by the platform provider can have a huge impact on the growth of the network, both in terms of number of users on each side and derived value. A key contribution of a two-sided network model is determining which side receives a discount. Different firms choose different beneficiaries, depending on the industry in question and the characteristics of the two groups of users involved. Parker & Van Alstyne (2005) argue that this depends on cross-price elasticities as well as the relative sizes of the two-sided network effects. Also Evans & Schmalensee (2008) acknowledge that prices on one side of the market may be below marginal cost and possibly negative in long-run equilibrium. Moreover, they argue that the percent markup of price over marginal cost is *not* inversely related to the elasticity of demand for either customer group, as would be the case in many traditional markets.

Willingness to pay on each side must be considered carefully, as poor choices can lead to stagnation of the network. Often it is the case that there is a “subsidy side” that the platform provider chooses to subsidize in order to attract users to that side in large numbers, the reason being that these users in high volumes are valued by the other side of the network, namely the “money side”. In other words, having a large number of users on the subsidy side is crucial to developing strong positive cross-side network effects to attract users to the money side. To encourage this development, the platform provider charges users on the subsidy side less than they would be charged in the case that they represented an independent market, hence the usage of the term subsidy. Ultimately, these subsidies are paid for by the money side users (e.g., merchants, publishers, developers, etc.), who value the high number of addressable users on the subsidy side so much that they’re willing to pay the platform provider a premium to gain access to them via the platform. (Eisenmann et al., 2006)

For example, in streaming video, portable documents, and advertising, to subsidize content consumers and charge content developers is the industry norm. Operating systems and multiplayer games are an example to the opposite in which content developers receive subsidies and consumers pay to join the network. It is important to recognize that in the case of content providers and end consumers, either market can be a candidate for discounting or free giveaways. Deciding which market to subsidize depends on the relative network externality benefits. At a high level of externality benefit, the market that contributes more to demand for its complement is the market to subsidize. At lower levels of externality benefit, platform providers may charge positive prices in both markets but keep the price on one side artificially low by discounting it (Parker & Van Alstyne, 2005). This is also in line with the research of Armstrong (2006) which identifies three factors that determine the structure of prices offered to the two groups:

- *Relative size of cross-group (cross-side) externalities.* If a member of group 1 exerts a large positive externality on each member of group 2, then platforms will aggressively try to persuade group 1 to join them. In general terms but especially in competitive markets, it is group 1's benefit to the other group that determines group 1's price, not how much group 1 benefits from the presence of group 2. Furthermore, positive cross-group externalities act to intensify competition and reduce platform profit, unless they act to tip the industry to monopoly.

- *Fixed fees or per-transaction charges.* Platforms providers may charge for their services on a fixed, lump-sum basis, so that a user's payment does not explicitly depend the platform's performance on the other side of the market. An alternative scheme is that the payment is an explicit function of the platform's performance on the other side. The major difference between the two charging bases is that cross-group externalities are weaker with per-transaction charges, since the total cost of transactions with users on the other side increases with each new transaction, eroding the total benefit gained from those transactions. Because externalities are lessened with per-transaction charging, it is plausible that platform profit is higher when this form of charging is used, except in the case of monopoly platforms. The distinction between the two forms of tariff only makes a difference when there are competing platforms, not in a monopoly situation.
- *Single-homing or multi-homing.* A user is said to "single-home" when he or she chooses to use only one platform for a specific purpose. In contrast, when the user has joined multiple competing platforms, he or she is "multi-homing". Multi-homing can occur on either side of the market, or on both sides. (Multi-homing is discussed in more detail in Section 2.4.7.)

In a two-sided market, the attraction between the two groups of users typically works both ways, as having a greater number of money-side users (who typically provide the goods, content, or services that subsidy-side users are interested in) indeed attracts even more subsidy-side users to the platform, creating a virtuous circle though a positive feedback loop. The platform provider, exercising pricing power on both sides of the market, has to find the delicate balance between subsiding one side and demanding premium from the other side.

Understanding the *price sensitivity of users* on each side plays a crucial role here. Typically, end users or consumers are much more price sensitive than content publishers, and therefore, the former group of users are subsidized while the latter do not mind paying charges so much. As already noted, however, each case and pair of user groups must be evaluated on an individual basis.

User sensitivity to quality is another point to consider in choosing the side to subsidize. Eisenmann et al. (2006) state that the side that must supply sufficient quality is to be charged, through royalties and/or other kinds of transaction-based or fixed fees, whereas the side that strongly demands quality is to be subsidized. This can also be interpreted as increasing the barriers to entry on the money side, as the suppliers must have good enough sales prospects to be able to offset their fixed costs. For suppliers to have reasonably good sales prospects, they usually have to be serious about quality. Using mobile game development as an example, developers often have to pay a one-time registration fee to gain access to the development tools and/or marketplace. Additionally, they typically have to share a fixed portion of their revenue from titles sold through the marketplace. Moreover, some mobile application marketplaces require that applications be thoroughly tested and vetted by the marketplace owner before they can be admitted to the catalog. The combined cost and effort of developing and bringing applications to the market acts as a deterrent to unscrupulous developers seeking to make quick money through poor quality applications. On the other hand, too stringent, costly, and/or tedious policies set by the platform provider may put off some typically smaller developers and thus limit diversity and innovation in the application catalog. Mobile application stores are examined in more detail later in this section.

Output cost or the incremental cost of each added subsidy-side user to the platform provider needs to be considered when deciding the extent of the subsidies provided. When this cost is negligible, subsidy decisions are more straightforward. This is the case with digital goods such as software applications and downloadable content. Also, when the platform provider has plenty of idle server capacity or storage, adding more users to the network is cheap. In contrast, when the subsidized giveaways take the form of physical goods such as computers, handsets, or other electronic equipment, risks to the platform provider are much higher and can materialize in substantial losses, should the money-side users not provide enough revenue to cover the subsidy costs. (Eisenmann et al., 2006)

As already discussed, two-sided networks often exhibit positive cross-side network effects, and thus adding users on either side positively impacts growth on the opposite side. Sometimes, however, excessive growth of one side can be a negative development for users on that side, in which case the network is said to exhibit *negative same-side network effects*. This is most often due to rivalry either on the supply side (too many sellers may introduce downward pricing pressure) or demand side (too many buyers fighting over a scarce supply of goods). Under such circumstances, Eisenmann et al. (2006) suggest that platform providers consider granting exclusive rights to a single supplier in each transaction category and extracting high rent for this concession. Exclusivity is not without problems though, and the platform provider must therefore ensure that sellers do not abuse their monopoly positions, which in turn would have buyer-side repercussions.

Eisenmann et al. (2006) recognize that *users' brand value* can be an important determinant of growth in two-sided markets. The participation of so called "marquee users" can be crucial for attracting users to the other side of the network. Often these marquee users are high profile suppliers or exceptionally big buyers. For a platform provider, they present an opportunity to accelerate the growth of its network, especially in the case of exclusive arrangements, i.e., agreeing that the marquee users do not join rival platforms. Such arrangements can be quite costly, however, especially so for smaller platform providers that have limited bargaining power. Conflict over the division of value between platform providers and large (marquee) users are common, especially when the large users' role is critical in mobilizing the network in the first place.

Finally, it is important to recognize that two-sided network pricing follows a different set of rules and logic than conventional business. No matter what the merits of the platform, failing to set prices and subsidies accordingly can ruin the business.

2.4.5 Competitive Dynamics of Two-Sided Markets

In developing their growth strategies, platform providers need to consider the dynamics of the competition in their market. In particular, they must determine whether the market is likely to be served by a single platform provider in the long run, or there is room for multiple providers to operate sustainably. In the case of the former, the platform provider must then decide whether it will "fight to the death" or share its platform with rivals. In the case of technical standards related to consumer goods and content distribution, it is often the case that a single standard or solution emerges as the winner after a phase of intense rivalry, as was the case with JVC's VHS vs. Sony's Betamax video cassette standards war, and more recently, the battle between Sony's Blu-ray vs. Toshiba's HD DVD for dominance of the high-definition video disc format which ended in Blu-ray's victory and the dissolution of the HD DVD Promotion Group in March 2008 (RegHardware, 2008).

Eisenmann et al. (2006) argue that fighting it out is often a bet-the-company decision where the winner ultimately takes it all, and there is little value left for those who suffer a defeat. Hence, they identify factors that typically contribute to a market being served by a single platform:

- *Multi-homing costs are high for at least one user side.* Homing costs include all the expenses that network users incur to establish and maintain affiliation with a particular network, including the costs of adoption, operation, and also opportunity cost. Users need a good reason or incentive to affiliate with multiple platforms in the case of high multi-homing costs.

- *Cross-side network effects are positive and strong.* As discussed above, a large user base on one side of the network encourages growth on the other side and (often) vice versa. A small-scale platform will have difficulty attracting users unless it is the only way to reach certain users on the other side.

- *Same-side network are positive.* On top off cross-side network effects, positive same-side network effects increase the likelihood that a single platform will ultimately prevail, as they further encourage user base growth on one or both sides of the network.

- *No strong preference for special features exists on either side of the network.* Homogeneous, non-differentiated user needs tend to lead to convergence on a single platform. On the other hand, if there are unique, specialized needs among users, opportunities are ripe for smaller, differentiated platforms to capture their own niches.

A downside with battles for dominance in two-sided markets is that some users will delay adoption in fear of being stranded with obsolete investments, in the case that the platform they have chosen loses out. To overcome such user uncertainty, the rivaling platform providers often spend vast sums on upfront marketing. If they instead cooperated and enabled a shared platform, they would jointly have access to a larger user base and their marketing spend could be reduced. (Eisenmann et al., 2006)

2.4.6 Expansion Strategies for Two-Sided Markets

Modeling two-sided demand and pricing as well as competition between platforms has been the focus of most research on two-sided markets (Rochet & Tirole, 2003, 2004, 2006; Parker & Van Alstyne, 2000, 2005; Rysman, 2004; Weyl, 2006, 2009; Armstrong, 2006; Armstrong & Wright, 2007). This has led to some criticism that other factors and issues of equal or higher importance for the growth and expansion of two-sided markets have received too little attention. Hagiu (2009), who discusses multi-sided platforms (MSPs) as a generalization of two-sided markets, argues that strategic design defines the relevant space in which the MSP is operating, its multiple constituents and its competitors, both actual and potential, and in short, its relevant ecosystem. This strategic design, in his view, should precede business model decisions such as pricing. He argues, however, that designing and expanding MSPs is a complex, daunting, and most importantly a dynamic process, as the most successful MSPs do not sit still, but rather they are constantly evolving, increasing their depth and/or reach, and in the process, redefining their boundaries and those of entire industries. This is said to be especially true for MSPs in high technology markets, but even very traditional businesses can *"unlock powerful sources of indirect network effects with a little technological help and a good amount of creativity"* (Hagiu, 2009).

Hagiu (2009) approaches the strategic design of MSPs by defining two types of fundamental functions, namely *reducing search costs*, and *reducing shared costs*, arguing that the platform design essentially relies on the choice of its functionalities. Search costs are costs incurred by the various sides before they actually interact, for purposes of determining the best "trading partners", and they can be further divided into two subtypes, two-sided (or multi-sided) and audience making. This classification depends on whether each of the two (or multiple) sides is searching for each other or only one is, or in other words, whether the cross-side network effects are positive in both (all) directions or only one direction. In the former case, reducing search costs generally means reducing two-sided asymmetric information, which makes "sampling" of candidates for transactions easier. Common examples include various online buyer-seller matching services and dating services.

An example of the latter subtype is a platform that joins consumers and advertisers together. Here, the advertisers obviously value a larger audience of consumers, but consumers do not perceive much added value in a greater number of advertisers and may even perceive excess advertisers negatively. In such cases, the platform provider should be extra careful not to compromise the product or service offered to the side of the market that is *indifferent* to the presence of the other side or does not strongly benefit from it. Hagiu (2009) mentions Google having made a conscious decision not to allow pictures or videos in the sponsored ad space of search results, in order not to degrade the consumer search experience, for which relevance is key. As such, audience-making MSPs generally reduce search costs by facilitating one side's provision of information about new products or services to the audience on the other side.

Reducing the costs incurred during the transactions themselves (i.e., after the search is over and the transacting parties have found each other) is the second fundamental function defined by Hagiu (2009). These costs are called shared costs since a portion of them is generally common to all transactions between users on different sides of the MSP. Video game consoles and software operating systems are good examples of MSPs that have lowered shared costs for game and application developers on one side, and end-users of games or PC applications on the other side. If developers had to separately build a console for each game, development would be rather inefficient indeed.

According to Hagiu (2009), well-established one-sided markets (and the firms running them) can often expand in a powerful way to become two-sided markets without facing the "chicken-and-egg" problem that so commonly plagues nascent providers of two-sided platforms. Firms that have, and are able to leverage, a strong existing relationship with either side (e.g., merchants or consumers) are in a much better position to succeed. The key here is to find the most powerful leverage for a firm's established one-sided strength, which implies identifying a new side that could create strong cross-side network effects with the existing one. Hagiu (2009) suggests a simple two-step process to achieve this is by:

1. Identifying the fundamental function a business performs for its customers;
2. Identifying other customer groups with whom the existing customers conduct frequent transactions, for which the existing business can enhance the value or lower the cost.

One prominent example of a one-sided firm having successfully expanded to become two sided is Google, the company that is credited with pioneering the now established Internet business model of associating sponsored links to search results, enabling targeted search advertising. Despite its beginnings as a one-sided search service, Google quickly realized that its technology allowing consumers to search the web could also be used to reduce search costs between advertisers and consumers. It then created AdWord and AdSense, the programs which allow it to offer and charge for search-related advertising. Compared to traditional, non-targeted advertising (such as ads in the Yellow Pages), this was a major improvement in advertising efficiency. (Hagiu, 2009)

Depth vs. Breadth

When expanding a two-sided (or multi-sided) platform, a key strategic trade-off has to be made between deepening the fundamental functions performed for the existing sides of the market and their users, and expanding to distinctively new functions which might bring new sides (and thus new, previously unreached groups of users) on board. However, pursuing new functions and user groups without sufficient depth in the existing functionality risks leaving open opportunities for focused competitors who may occupy a niche in the market. On the other hand, breadth may sometimes be a necessary condition for generating a critical level of cross-side network effects which are required for the platform to thrive or hold its ground against potential competitors, also players from adjacent industries seeking lateral expansion. (Hagiu, 2009)

Depth creates more value for the existing users of the platform and intensifies the cross-side network effects by making transactions between parties more efficient, more frequent, or both. This creates "stickiness" on the existing sides and makes their users less likely to be attracted away to other platforms. In some cases, however, adding too much depth of functionality can be harmful as well, as some additions may not be welcomed by all users and can in fact introduce negative network externalities. As an example, many eBay users were put off by the inclusion of Skype voice communication into the service (Hagiu, 2009).

Breadth is driven by the desire for unlocking new sources of value and creating new cross-side network effects through the addition of new sides to the platform. The need for more breadth can also be driven by competitive dynamics and survival as rival platforms can also expand their functionalities to new domains, potentially attacking an incumbent platform. Besides the difficulties involved in entering new industries, two other important factors can limit MSP breadth. The first factor, *resource constraints*, is not specific to MSPs, it may limit a company's ability to expand by serving new customer groups. The second factor, *conflicts of interest*, is specific to MSPs and may seriously constrain the platform's growth well before it has reached the limits of its resources. Should conflicts of interest arise among the parties involved in an MSP, managers are faced with hard decisions which may involve drastic trade-offs. (Hagiu, 2009)

Openness

Rysman (2009) acknowledges that *openness*, alongside pricing, is one of the two most important strategies that a potential two-sided platform provider needs to choose. He notes that while the pricing decision has been the subject of rigorous research, openness has proven more difficult to analyze. Moreover, in the literature on two-sided markets, openness refers to two strategic choices: the number of sides to pursue (as in one-sided, two-sided, or multi-sided markets) and how to relate to competing platforms (aiming for either incompatibility, compatibility, or some sort of integration).

In the example case of computer operating systems, let us consider Apple and Microsoft. Both companies produce their own operating systems, and both rely on ISVs and third-party developers for most of the available software application offering. A key difference between the two is that Microsoft did not (at least not until the recent Surface line of products, see Microsoft (2012a, 2012b)) produce computer hardware of its own but instead relied on independent PC manufacturers to supply the hardware, whereas Apple has always been a branded computer vendor. Rysman (2009) argues that in this sense, Microsoft is more open than Apple, as Microsoft can be characterized as managing a three-sided market between consumers, software providers, and hardware providers, whereas Apple manages only a two-sided market between consumers and software providers.

The choice of openness as in the number of sides to support in a platform can be likened to the choice over vertical integration, although the relationship between hardware and operating systems is not strictly vertical. The lesser the extent of integration in a platform, the more sides are potentially introduced to the multi-sided market equation. According to Rysman (2009), the special case of being one-sided is an extreme move away from openness where a firm integrates to the degree that two-sided market interaction ceases. Much like Hagiu (2009), Rysman (2009) perceives it as more natural that firms start out with a one-sided model and switch to a two-sided model as they become more established and seek expansion. In this case, the "chicken-and-egg" problem of getting customers on board can be avoided, since one side of the market is already established, and the platform provider can initially provide the needed complements itself.

A case example of the benefits of openness in transforming a single-sided market into a two-sided one and enabling an open innovation ecosystem is described in detail by Raivio & Luukkainen (2011). Their paper discusses Open Telco, a concept referring to open network interfaces and APIs on operators' side of a telecommunications network enabling novel end user services. It allows operators to diversify their single-sided business model mainly based on subscriber revenue by becoming the providers of two-sided platforms, serving also application and service developers, content providers and aggregators, advertisers, and other parties in addition to subscribers, the end users. Multi-sided platforms enable operators to reap the benefits of cross-side network effects in addition to the obvious same-side network effects that already enable their core business in voice telephony, text messages, etc., and enable more versatile business innovations. For the operators, this diversification and expansion of their traditional business model and role in the ecosystem is necessary, should they wish to resist being relegated to pure data transport providers (or "dumb bit pipes", as some industry professionals like to say).

Openness is discussed further in the context of product platforms in Section 2.5.5.

2.4.7 Multi-Homing in Two-Sided Markets

In many two-sided markets, a fraction of the users on either side (or both sides) connect to multiple platforms instead of just one. Using an analogy from Internet terminology, they are said to "multi-home" (Rochet & Tirole, 2003). Common examples of multi-homing include merchants who accept multiple credit cards (e.g., Visa, MasterCard, American Express) and PC users who have more than one web browser installed on their computer (e.g., Microsoft Internet Explorer and Mozilla Firefox). In the former example, multi-homing actually occurs on both sides, as many consumers also carry more than one credit card. In the latter case, many (though not all) web sites are fully compatible with either browser.

Multi-homing has profound implications on the competitive dynamics and pricing of platforms. More specifically, a large proportion of multi-homing users on one side of the market intensifies price competition on the other side from the perspective of platform providers. Therefore, platform providers often need to lower prices to stay competitive and attempt to secure exclusive relationships with users on the other side. As an example, merchants may be inclined to turn down the more costly[3] American Express credit card, if they accept other cards such as Visa and also know that a large percentage of their American Express carrying clientele also have a Visa in their wallet. Such a situation increases price pressure towards the platform provider (American Express in this case) who has to either close the price gap or somehow convince their users that the price premium is justified. As noted by Rochet & Tirole (2003), American Express has afforded to charge higher merchant discount rates because their clientele was perceived as very attractive by merchants. The gap between American Express's and the non-profit associations' merchant discount rates has narrowed in the 1990s as an increasing number of American Express customers also got a Visa or MasterCard, thus lowering the incentive for merchants to accept American Express cards.

In general terms, multi-homing as a phenomenon stems from the users' desire to benefit from network externalities in an environment of incompatible or non-interconnected platforms. Using an analogy from the real estate market, in the absence of common listing, the seller of a house may want to establish multiple, non-exclusive arrangements with real estate agencies in order to reach a wide range of potential buyers. Similarly, potential buyers may also deal with multiple real estate agencies. As a further example, video game developers may port their game to several game platforms. More generally, software developers may multi-home to competing but incompatible software platforms. (Rochet & Tirole, 2006)

[3] in terms of merchant discount rates; as an example, refer to UniBul (2012).

Armstrong (2006) has studied the phenomenon of multi-homing especially in situations where one side of the market is single-homing and the other is multi-homing. Such situations, which he refers to as “competitive bottlenecks”, have special implications on the pricing of the platform with respect to the two sides of the market. In such situations, if users on the multi-homing side wish to interact with a user on the single-homing side, they have no other option but to deal with that particular user’s platform of choice. Hence, platforms have monopoly power over providing access to their single-homing customers for the multi-homing side. This monopoly power, according to Armstrong (2006), leads to high prices being charged to the multi-homing side, limiting the number of users on that side. A notable exception to this is a market that tips to monopoly, in which case an incumbent’s profits typically increase with the importance of network effects, since barriers to entry remain high even when the incumbent sets high prices. The tendency towards high prices for the multi-homing side is, however, tempered when the single-homing side benefits from having many users on the other side of the market (i.e., the cross-side network effects are strong in that direction). In such cases, high prices to the multi-homing side would drive away users on that side and cause an overall disadvantage to the platform as it tries to attract users to the single-homing side. In contrast, platforms do have to compete for the single-homing users, and the profits generated from the multi-homing side are largely used to subsidize the single-homing side. (Armstrong, 2006)

Multi-Homing in Mobile Application Stores

Mobile application marketplaces or stores, examples of which include the Apple App Store, Google Play (formerly Android Marketplace), BlackBerry App Center, and Windows Phone Store, are a common manifestation of two-sided markets in the mobile business domain. They are also a prime example of a two-sided market where multi-homing occurs, to an extent, on both sides of the market. Specifically, either developers or consumers (end users) can multi-home, and there are incentives and deterrents to each. For developers, the primary incentive to multi-home is to expand their addressable market by reaching more consumers than they would reach by targeting only a single platform. Obviously, the smaller the overlap between the user bases of different platforms, the greater the benefit of targeting additional platforms. Conversely, if it’s possible to reach a large enough mass of consumers by developing applications for a single platform, adding support for an additional platform may not be financially attractive enough, considering the additional investments required and the increased risk level. For developers, multi-homing is therefore largely a cost-benefit consideration between *revenue and profit potential as well as market share* and *development costs and risks.*

Consumers, on the other hand, have relative freedom of choice in deciding which devices they purchase, but as most smartphones and tablets have an expected consumer life cycle of roughly two years, there tends to be at least some degree of lock-in to the ecosystem. Some users may opt to purchase devices from different ecosystems (e.g., an Android-based smartphone but an iPad tablet), thus gaining access to two distinct software ecosystems and their application stores. In this way, they satisfy their desire to benefit from network externalities in an environment of incompatible or non-interconnected platforms, as already noted above. Also, while Windows-based PCs still dominate the personal computing market, it is quite safe to assume that a major share of iPhone users use a Windows-based PC instead of a Mac computer, making them multi-homing users. While gaining access to a larger catalog of diverse applications may be a benefit for some users, multi-homing on the consumer side is also discouraged by compatibility issues (e.g., in transferring personal data and content between devices) and increased complexity, as the consumer will often need familiarize him/herself with different user interfaces and application logic.

In the mobile business domain, multi-homing has been studied by, e.g., Hyrynsalmi et al. (2012) across competing mobile application stores, and by Idu et al. (2011) in the specific case of three sub-ecosystems of the Apple ecosystem, each centered around a product line: the iPhone, the iPad, and the Mac. The latter paper analyses the behavior of companies that target more than one Apple sub-ecosystem using statistical analysis and survey methods. Its findings confirm a strong relationship between the number of platforms a company targets and the type of applications it publishes as well as the number of these applications. It also recognizes that the most common trend for developers was that of first targeting the iPhone platform and then the iPad. Idu et al. (2011) argue that multi-homing from a strategic perspective is motivated mainly by a wider customer base and the portability the Apple sub-ecosystems offer. This is well in line with the notion that access to a wider addressable market is the main incentive for multi-homing, and the downside of increased development costs is mitigated by the portability of applications across the sub-ecosystems.

Hyrynsalmi et al. (2012) acknowledge that from the software developer's perspective, the choice of ecosystem (platform) might be a crucial decision and that some developers have chosen to target two or more ecosystems, balancing between a greater potential market share and the costs of porting the product for different platforms. They note that generally speaking, a publishing strategy where content, products, or services are published for multiple ecosystems is not new even in the mobile business domain, but there are relatively few studies and little knowledge on the effects of multi-homing on applications, developers, and ecosystems, or the scale of the phenomenon. They also argue that the level of competition between mobile ecosystems is high, and the application offering can be used as a means of differentiating from the competitors. However, if multi-homing were indeed a common strategy for developers, then the catalogs of rivaling application stores would be very similar and differentiating on that basis would be hard.

Based on a quantitative analysis of three large application stores (Apple App Store, Google Play, and Windows Phone Marketplace) and a total of more than 850,000 applications, it turns out that the number of multi-homing developers is small, constituting only 6.8% of the total number of developers identified (Hyrynsalmi et al., 2012). Considering that the ecosystems analyzed seem to contain lots of hobbyist or semi-professional developers who publish "just for fun" or without a clear monetization plan, the result is less surprising. Also, based on the data, it seems that the content consumption of consumers is mostly focused on a tiny fraction of applications which are usually published by professional developers and which are also often available for several mobile OS platforms. Hyrynsalmi et al. (2012) argue that these professional developers, who often also tend to multi-home, are the crucial ones to bring on board for any ecosystem.

Hyrynsalmi et al. (2012) mention the example of Rovio Entertainment's then-latest mobile game in the Angry Birds franchise called Angry Birds Space which was initially announced for iOS and Android but not for Windows Phone. Later, however, the game and a subsequent title have been made available also for Windows Phone, but it is not publicly known whether Microsoft or its OEM partners (mainly Nokia) had to subsidize the porting of the games. As noted, adding support for a platform requires usually significant additional investments from a developer. If those investments cannot be justified by the expected revenue increase, outside financing in the form of development or marketing subsidies may be required to incentivize multi-homing. Such subsidies could be costly for the ecosystem orchestrators, but they have few viable options available to foster innovation as long as they lack the market share to create enough developer pull by themselves. For an ecosystem, not having the most popular applications available would likely lead to a negative consumer perception which would hinder the growth of said ecosystem. Hence, it is quite reasonable to deduce that the presence of key professional developers and their applications can make or break a mobile software ecosystem.

2.5 Platform Strategy

2.5.1 Introduction

Let us imagine a company that would develop each individual product it offers from scratch, starting from customer requirements and ending up with the final product design ready for manufacturing. This would effectively mean that there are little or no synergies between products developed in parallel or in succession as far as R&D effort is concerned, and the development costs of each product have to be born in their entirety over again. While such an operational model might be viable for companies catering to highly individualized, diverse customer needs where no customer project resembles another, most companies seek to maximize the utility of their R&D investment. This can be done by identifying generic, common components or building blocks that are frequently or always needed across products. These common components form a foundation on which a product line can be designed and built.

The foundation, let us call it a *product platform*, usually needs to be defined and implemented only once, at least for a particular product generation. This implies significant to major cost savings for the individual product programs, as they can directly utilize and build upon the functionality of the platform, not having to implement it themselves. Of course, the platform itself needs development on a regular basis in order to enable the latest product innovations. An outdated platform can be a severe bottleneck to the performance of products built on it. Nevertheless, platforms often evolve in somewhat slower cycles than the products built on them. Eventually, some innovations first introduced in an individual product may also become part of a platform, thus becoming available to a broader range of products.

The rough definition of a product platform as stated above is also aligned with that of Cusumano (2010) who describes a product platform as *"a foundation or base of common components around which a company might build a series of related products"*. However, it is worthwhile to note that platforms are not necessarily restricted to the boundaries of an individual firm. Cusumano (2010) makes a clear conceptual distinction between product and *industry* platforms, the latter being an enduring subject of research for him and his fellow researchers (Cusumano & Gawer, 2002; Cusumano, 2010; Gawer & Cusumano, 2002, 2008). Gawer & Cusumano (2002) argue that two essential differences set industry platforms apart from in-house product platforms. Firstly, while an industry platform provides a common foundation or core technology lending itself to reuse in different product variations as is the case with product platforms, it provides this function as part of a technology "system", the components of which are likely to come from different firms (or perhaps at least different departments of the same firm) called “complementors”. Secondly, an industry platform has limited value to users without the complementary products or services created by these complementors.

Gawer & Cusumano (2008) note that managers sometimes underestimate the importance of deciding early on between pursuing a product or a platform strategy. This decision is highly relevant because the industry conditions and business choices that favor a platform can differ from those that favor a product. As a result, the incentives for owners of industry platforms differ from those of companies that make proprietary products. Owners of industry platforms, in particular, benefit from the wealth of innovation in complementary products as well as from competition at the overall system level that would bring prices down.

According to Gawer & Cusumano (2008), failure to decide early enough between a product or platform strategy can result in dangerous strategic confusion. In order to achieve platform status, firms need to make specific decisions that govern technology evolution, product and system design, and business relationships within the ecosystem, and as noted, they are different decisions than those made when pursuing a product strategy. Another common mistake managers of firms can make is to simply overlook the platform potential of their products, instead clinging on to a product approach.

Not many platform-making firms have the resources and capabilities needed to produce all the useful complements by themselves. In order to allow their technology to become an industrywide platform, firms generally need a strategy to open their platform technology to complementors, coupled with economic incentives for encouraging other firms to join the same ecosystem and adopt the platform. This also helps stimulate innovation and diversity in the firm population, as it enables the founding of new firms dedicated to building products and services on platform assets developed by others while allowing these new firms to focus their R&D effort on building differentiating capability (Muegge, 2013).

Many firms have indeed opened up their platforms, be it a hardware component such as a microprocessor or an operating system, so that other firms may build complements on these platforms. These complements may be complete, standalone products that merely utilize the platform, or they may be add-on applications, accessories or other types of complementary products that serve to enrich the platform itself or other products built on it. In the context of this study, the concept of platform most often refers to an OS platform for which software applications can be developed, either by the platform proprietor or by third parties.

2.5.2 Elements of Platform Leadership

The success of companies today is often dependent not only on internal assets and capabilities or economic forces in the surrounding world, but also the innovations of other companies. Such is the case with, e.g., Intel who acknowledged that it is "tied to innovations by others" to make its innovation valuable (Cusumano & Gawer, 2002). In Intel's case, any innovation done by the company in processor design needs to be matched by a corresponding innovation by the OS vendor, primarily Microsoft, or ISVs. Interestingly, despite Intel's crucial role in the PC ecosystem and the key importance of its microprocessors as a platform for building computers, a spokesperson described Intel's situation as "desperate", as quoted by Cusumano & Gawer (2002). This is because a microprocessor can do little useful by itself — it is a component in a broader platform or system. Therefore, Intel cannot be sure that its own key complementors will continue to produce corresponding innovations as fast as the company innovates itself, creating uncertainty that affects its market expansion. Similarly, it cannot be sure that the target platform, the PC, will evolve in compatible ways.

In a world of complex, interconnected relationships between companies especially in the IT industry, Gawer & Cusumano (2002, 2008) have studied the core elements of *platform leadership*, i.e., the factors that play a major role in determining whether companies successfully become *platform leaders*, or whether they are relegated to other roles, e.g., platform leader *wannabes*, or *complementors*. These roles are not mutually exclusive, and indeed, a company can simultaneously be both a platform leader and a complementor depending on the business context and perspective. Using Intel and Microsoft as examples, both are complementors in the sense that PC manufacturers need them to build products. The two companies are, however, also platform leaders due to their influence over the PC system architecture and interfaces that other companies rely on to produce complements for PCs, whether hardware or software based. (Cusumano & Gawer, 2002)

Platform leaders generally face three types of problems: the first is how to maintain the integrity of the platform, i.e., its compatibility with complementary products vis-à-vis *future* technological innovations. This implies a certain degree of *forward compatibility*, defined as the ability of the platform design to gracefully accept input or complements intended for a future version of itself. The second, related problem is how to let platforms evolve technologically so as to avoid obsolescence while maintaining compatibility with *past* complements (an attribute also known as *backward compatibility*). The third problem is how to *maintain* platform leadership over a longer period of time, a nontrivial task in an environment of constant technological development and rivalry. (Cusumano & Gawer, 2002; Gawer & Cusumano, 2002)

As only few platform leaders have the capabilities or resources to produce all the complements needed to make a complete system by themselves, collaboration with complementors is required. This collaboration, in turn, increases the potential market for all parties involved. Ultimately, platform leadership is the ability of a company to *drive innovation around a particular platform technology at the broad industry level*. Cusumano & Gawer (2002) note the similarities to concepts such as network externalities and positive feedback effects (as discussed in Section 2.2.3) in the sense that the more people use platform products, the more incentives there are for complement producers to make more complementary products for the platform, thereby creating a virtuous cycle. Having analyzed Intel, Microsoft, Cisco, and NTT DoCoMo, Cusumano & Gawer (2002) have identified four distinct but closely related levers of platform leadership that, as they claim, can assist managers in both strategy formulation and implementation. Next, let us discuss each of these levers briefly.

Lever One: Scope of the Firm

Scope determines the amount of innovation that a firm does in-house as opposed to letting external parties do. This is probably the most important and defining decision a firm can make as far as its platform strategy is concerned. Also firms aspiring to become platform leaders must weigh whether to develop extensive internal capabilities to produce complements, let the market produce complements, or follow a middle-of-the-road approach. The first step is to assess how dependent the firm is on complements, followed by determining how to increase demand for the firm's platform. Developing own complements should only be considered if the firm has the technical, financial, and organizational capabilities required to compete in the relevant markets. A well-known example is that of Microsoft introducing its own productivity software suite (Microsoft Office) and web browser (Internet Explorer) to complement its OS, largely displacing former complementors like Novell, WordPerfect, Lotus, and Netscape. Cisco, on the other hand, has been known to make acquisitions to expand its product offering into new areas. (Cusumano & Gawer, 2002)

For a platform leader (or wannabe) deciding to work with outside developers, the choice of incentives for prospective complementors is an important topic of consideration, both to get complementors with the right set of capabilities on board as well as to exert influence or even control over the design and production of complements. This could involve sharing technical information on the platform and its interfaces or own products, or perhaps even providing engineering support services or other staff to help complementors build compatible products. Platform proprietors can develop enabling technologies, such as APIs and other programming interfaces and SDKs and other tools, and provide them to third parties for free or a modest fee. Marketing support is another common type of incentive offered by platform proprietors to complementors. (Cusumano & Gawer, 2002)

Ultimately, the question of scope is not a simple one - firms need to individually weigh whether it makes sense for them the produce complements in-house or not. A good rule of thumb would be to have at least some level of in-house capability not only for producing complements internally but also to provide constructive direction and competition for third-party complementors.

Lever Two: Product Technology

Platform leaders and wannabes must make decisions on product and platform architecture, including the high-level platform design as well as the interfaces that link subsystems together and allow complements to work with the product or the broader platform. Complements aside, these decisions can have a profound impact on the structure of a whole industry as well as on the innovation that follows, e.g., who does what type of innovation and what is the share of investments occurring outside the platform leader.

An important decision related to product and/or platform architecture is how much modularity to allow. Having a modular architecture with easily separable components and well-defined interfaces can reduce innovation costs and encourage the emergence of specialized companies dedicated to producing certain components. Having open interfaces publicly specified by the platform leader further contributes to the effectiveness of a modular architecture, as it allows complementors to directly connect components to the platform. However, disclosing too much information also makes it easier for competitors to spy on the technical implementation of the platform. This is the reason for many firms opening up only certain specific interfaces and keeping others private to safeguard their innovation. Such is the case with, e.g., Intel who openly provides information about peripheral interfaces such as the Peripheral Component Interconnect (PCI) bus and the USB bus, but keeps the microarchitecture of its processors a secret from others.

Similarly, Microsoft is known for publishing a set of detailed APIs for application programming on Windows as well as information for peripheral hardware manufacturers to write device drivers for Windows, but otherwise keeping the source code of the Windows OS closed, i.e., inaccessible to parties outside of Microsoft. Only recently has Microsoft shown signs of openness in this respect — the company joined the Open Compute Project, a consortium created by Facebook to share the designs of servers and other equipment that form the foundation of the Internet's largest data centers. Interestingly, Microsoft said it is open-sourcing the software code it created for the management of hardware operations, such as server diagnostics, power supply, and fan control (Ars Technica, 2014). Also earlier, Microsoft gave .NET developers the opportunity to have a look into its .NET Framework source code for debugging purposes but without the possibility to modify the source code (eWeek, 2007).

Stimulating innovation involves a trade-off between secrecy and disclosure. Secrecy is good for protecting intellectual property and blocking substitute innovation, whereas disclosure is the better approach for enabling complementary innovation. (Cusumano & Gawer, 2002)

Lever Three: Relationships with External Complementors

Platform leaders need to decide the extent of their collaboration or competition with complementors. This involves balancing the need to seek consensus with key complementors and resolve possible conflicts, and the need to assert control over technical specifications and standards relating to the platform and the products complementing it. Pursuing both objectives at the same time is often uneasy, yet essential for a successful platform leader. Consensus-seeking among industry players is usually driven by one firm, and that firm needs to have a certain degree of control over the interfaces between system components, e.g., between a hardware platform and software OS as well as other components. In this capacity, the firm exerts control not over others' specific choices but rather the premises of choice. Cusumano & Gawer (2002) call this *ecological control* and further argue that control presupposes some degree of consensus because leadership is possible only if others agree to follow. For complex systems of interconnected components like the PC, consensus is required in the sense that a critical mass of key players has to agree on common interface specifications. If no such agreement is reached, not enough complementary and compatible products will be produced or the industry will innovate too slowly. (Cusumano & Gawer, 2002)

Generally speaking, platforms leaders should strive to be industry enablers, helping other firms to innovate around them in increasingly better ways. Often this may imply sacrificing short-term interests in favor of the common good, which in practice could mean, e.g., investment in definition of standard interfaces allowing the creation of compatible complements and efforts to promote compliance of products. Moreover, platform producers should build reputations for consistency, not for impulsively "stepping on the toes" of complementors, i.e., expanding into their product domains. In this way, they can also demonstrate to potential complementors that they are acting on behalf of the whole industry and establish credibility in the areas where they want to influence future standards or product designs. (Cusumano & Gawer, 2002)

Lever Four: Internal Organization

As discussed, dealing with external firms both as complementors and as potential competitors requires a tricky balancing act, and this ambiguity of relationships can generate tensions and conflicts of interest that need to be addressed by platform leaders and complementors like. Designing a firm's internal organization appropriately is one way to do this.

In order to manage external relationships with complementors effectively, platform leaders need to create an internal organization that supports this goal. A typical example is that of internal groups within the platform leader competing with complementors, while other groups within the firm depend on those same complementors to adopt the platform and its standards. The conflicting goals of internal sub-organizations therefore pose a challenge. To deal with such situations, the executives and managers of a platform leader need to acknowledge the necessity of pursuing conflicting goals and communicate the multiple goals through the organization. Additionally, a process for conflict resolution should be established, and senior executives should be prepared to arbitrate if and when conflicts arise, while simultaneously fostering an organizational culture that tolerates ambiguity and encourages discussion and debate. Groups with very different, possibly conflicting goals are often kept separate in the organizational structure, either as separate divisions capable of direct business or cooperation with complementors, or separated through an internal "Chinese wall". The latter option typically involves an organization within an organization that is separated both physically from the rest of the firm or the larger organization it is a part of, as well as through restrictions in information handling and sharing practices. Through such an organization, the platform leaders may appear more neutral.

2.5.3 Problematic of Platform Leadership

Cusumano & Gawer (2002) identify also problems and pitfalls associated with platform leadership. Firstly, not all companies can be platform leaders, and there are certainly other ways to compete and other roles to occupy, such as that of a niche player offering superior quality or differentiated products and services. Platform leaders, on the other hand, risk being too platform-centric. Sticking to certain key technologies or architectural design choices may make it hard for platform leaders to evolve their platforms and thus to keep up the pace of innovation. Some firms may also shun policies and movements like open source that could help stimulate external complementary innovation. These are but examples of reasons why platform leaders might eventually find themselves struggling with platform evolution. (Cusumano & Gawer, 2002)

Having Too Many Complementors

Much of the classic literature dealing with systems competition and network effects, whether direct/same-side (Katz & Shapiro, 1994) or indirect/cross-side (Eisenmann et al., 2006), is founded on the premise that the more users a system or platform has, the more valuable the platform is to these users, or in the case of two or multi-sided platforms, to the users on the other side of the platform (e.g., complementors). The assumption has largely been that the more complementors the better, and any increase in the number of complementors drives a virtuous circle to the benefit of the platform proprietor as well as its customers through increased innovation and business opportunities in complementary goods (Cusumano & Gawer, 2002; Gawer & Cusumano, 2002). Based on a substantial body of research (Langlois & Robertson, 1992; Grindley, 1995; Bresnahan & Greenstein, 1999; von Burg, 2001), it would indeed appear that such a virtuous circle exists circle between attracting complementors, stimulating platform adoption, and encouraging complementary innovation.

Boudreau (2008) notes that a consistent message across these studies is that network effects and so-called "bandwagon" dynamics propelled the creation of complementary goods around platforms and that complementor entry tended to drive the entry of even more complementors, in a way "softening" competition. This, as he argues, is a clear indication that adding complementors had a tendency to raise the profit potential for complementors. In contrast, he acknowledges that there are a few formal models that consider the effect of adding complementors to a platform when there are already many complementors on board, indicating that the resulting competition-toughening effects may outweigh market expansion effects. He cites the empirical study of Augereau et al. (2006) on the adoption of 56k modem technologies by ISPs in the United States as rare evidence supporting this idea. The authors of that study find that high levels of adoption of a given technology standard slowed subsequent adoption of the same technology, leading to the inference that increasingly high entry toughened competition, making entry less attractive. Therefore, while initial growth and adoption of a platform may benefit from the competition softening and market expansion as a result of more complementors getting on board, high numbers of complementors may actually lead to market splitting and competition-hardening effects. This, as Boudreau (2008) argues, is primarily because progressively increasing numbers of complementors should lead to complementary products being less and less differentiated, suffering from increasing substitution.

Based on the perceptions above, Boudreau (2008) contends that it is quite possible to have *too many* complementors, and that after a certain point, adding more complementors to a platform serves only to toughen competition, and more specifically, leads to tougher competition between complementors to the extent that they offer undifferentiated products. Toughened competition, in turn, usually means reduced profits, and ultimately in the case of extreme competition, no profit. This is his first hypothesis, the second one being that adding complementors to a platform with already many complementors reduces complementary innovation, and more specifically, reduces complementary innovation to the extent that complementors offer undifferentiated products. At least the latter hypothesis appears to be supported by Parker & Van Alstyne (2008), who develop and discuss a model related to innovation around a platform. Their main finding is that while adding complementors to a platform can indeed increase complementary innovation, this happens only on the premise that doing so does not reduce differentiation among complementors' products — in other words, where differentiation declines, innovation should also decline respectively.

Applying an econometric analysis approach to a large data set of monthly outputs from the online mobile software application marketplace Handango between November 1999 and December 2004, Boudreau (2008) sets out to validate his hypotheses. Handango was one of the first online mobile software stores to sell applications for multiple platforms, mainly Palm, Microsoft, Symbian, RIM (BlackBerry), and Java. Boudreau (2008) notes that roughly 90% of the sample observations relate to the then-market leaders Palm, Microsoft, and Symbian. For quantitative analysis, he uses software title price-setting as a proxy for the intensity of competition and the timing of new versions reflecting discretionary development decisions as a proxy for the amount of complementary innovation.

It can be acknowledged that while the data samples are from a time period preceding the smartphone "revolution" of Apple and Google, it is fair to assume that the mechanisms and effects influencing the level of competition and innovation have remained the same. As for the first hypothesis, the results suggest that adding complementors toughened competition, but only in the case of complementors selling the *same* type of software, e.g., games. This would appear to be consistent with the notion that the more similar products or substitutes are available, the tougher the competition. However, adding complementors selling *different* types of software in fact softened competition, so generally, the effect of adding complementors to a platform is positive, again consistent with usual views of competition softening with network effects. Similarly, adding complementors initially did positively affect overall rates of new software title development, but after a specific point (just below 1000 complementors), the effects became negative, and the crowding-out effect was thus dominant. (Boudreau, 2008)

For managers in high-technology industries, the results obtained by Boudreau (2008) have an important implication: as platforms mature and grow, platform owners may wish to abandon a strategy of attracting many complementors and building a "critical mass" in favor of one of more carefully regulating the number of complementors. Moreover, the discovery of ambivalent effects created by adding complementors further suggests that platform owners may want to evaluate the composition of the complementor population surrounding a platform more carefully, by type. In doing so, they might engineer interactions that best create value around the platform.

2.5.4 Platform Strategy and Governance

Gawer & Cusumano (2008) contend that while the benefits of becoming a platform leader seem clear, not every market has to have a platform leader. Especially in larger markets, such as video game consoles, Web portals, and smartphones, several platform firms can coexist and survive without one clear winner. The prerequisite for this scenario to occur seems to be that the market has enough room for differentiation in user needs, so that multiple firms can persist in specific niches or segments, especially if users can switch among more than one platform without too much difficulty.

While not every product can become a platform, research suggests that a technology or product or service must satisfy two prerequisite conditions in order to have platform potential: 1) *It should perform at least one essential function within what can be described as a "system of use" or solve an essential technological problem within an industry*, and 2) *it should be easy to connect to or to build upon to expand the system of use as well as to allow new and even unintended end-uses.* Unless these conditions are fulfilled, Gawer & Cusumano (2008) argue, the strategic game of platforms cannot begin.

Gawer & Cusumano (2008) have identified two strategic approaches for firms aspiring to become platform leaders. The first strategy, called "coring", is applicable to creating a new platform where one has not existed before. The second strategy, called "tipping", addresses the challenges of winning platform wars by building market momentum.

Coring

Coring comprises the set of activities that a company can use to identify or design an element (typically a technology, a product, or a service) and turn this element into something that is fundamental to a technological system as well as to a market. When an element or component of a system resolves technical problems affecting a major proportion of other parts of the system, it is considered "core". However, inventing platform-like technologies may well be easier than coming up with business strategies that successfully encourage industry partners and customers to adopt a particular technology. Both technical and business aspects do, nevertheless, need to be addressed appropriately for the process of coring to succeed. One of the key questions for an aspiring platform leader is how to create economic incentives for complementors to innovate and allow them to profit sufficiently while protecting its own sources of profit. This requires a delicate balancing act which may well be the greatest challenge to platform leadership. (Gawer & Cusumano, 2008)

Tipping

Competition among technical standards and incompatible technologies is commonplace in platform battles. For an industry standard or platform leader to emerge victorious from standards wars, the markets have to tip in favor of a particular technology standard or platform comprising that standard. Tipping constitutes the complete set of strategic moves or activities that companies can utilize to shape market dynamics in their favor and win a platform war. These moves can include sales, marketing, product development, and coalition building. (Gawer & Cusumano, 2008)

Similar to coring, successful tipping requires actions taken from both the technology and the business sides of the platform. When fighting standards wars to become a platform leader, firms should attempt to gain control over an installed base while licensing their intellectual property in a comprehensive manner and facilitating partner investments in complementary innovation. Investment in building brand equity as well as manufacturing, distribution, or service capabilities should also be a priority for platform-leader wannabes. In doing so, they will signal support of their platform. (Gawer & Cusumano, 2008)

Gawer & Cusumano (2008) consider pricing as another useful strategic weapon in platform wars, but its complexity in platform markets exceeds the significantly simpler product markets. As platforms can be understood as two-sided (or multi-sided) markets, platform leaders and wannabes may need to subsidize one side of the market first in order to bring on the other, paying side. Unfortunately, there is no simple formula to prescribe how much exactly to subsidize one side of the market over the other. Moreover, the decision on pricing and subsidies depends on whether short-term profits or sustainable, longer term ecosystem growth is pursued. Attempting to maximize the outcome with regard to one of these goals will not lead to optimal results with regard to the other goal.

Tipping may also happen effectively in the form of competitors or users banding together in a coalition, defending themselves from the entry of a platform-leader wannabe. In trying to make a market tip toward their platform, firms often encounter common obstacles and make similar mistakes. In particular, established platform leaders with powerful positions in their market must exercise caution not to violate antitrust laws. Sometimes problems occur because tipping strategies dependent on narrow technical standards are effective only as long as platform boundaries remain relatively stable and predictable. Converging technologies often create opportunities for firms to extend their platforms into areas previously occupied by other platforms, which in turn may cause pressure on the providers of these platforms to maintain their position. (Gawer & Cusumano, 2008)

Platform Envelopment

A firm can also accomplish tipping in a powerful way by "tipping across markets", crossing over the boundary of its current market to absorb technical features from an adjacent market and bundling them to extend its platform. This phenomenon has been called *platform envelopment* by, e.g., Eisenmann et al. (2007), who argue that by leveraging common components and shared user relationships, one platform provider may combine its own functionality with that of another provider active in an adjacent market, resulting in a multi-platform bundle. They also note that entrenched incumbents who may be otherwise sheltered from entry by standalone competitors (due to strong network effects and high switching costs) may nevertheless be vulnerable to an adjacent platform provider's envelopment attack.

Eisenmann et al. (2007) identify three types of envelopment attacks by platform providers, depending on the relationship between the platforms of the attacker and the target, the platforms being defined as either functionally unrelated, weak substitutes, or complements. The corresponding types of envelopment attacks are *conglomeration attack*, *intermodal attack*, and *foreclosure attack*. Each type has its own merits and potential with regard to *price discrimination gains*, *efficiency improvements*, and *strategic advantages*.

According to Eisenmann et al. (2007), conglomeration attacks are frequently the mechanism behind *convergence*, a phenomenon that is particularly pervasive in industries that produce, process, and distribute information in digital form. Convergence can be described as the unification of function, or the combining of previously separate, distinct products. Performance improvements of semiconductors and broadband communications networks are among the most notable drivers of convergence.

Digital convergence has taken place prominently in the CE industry, where new device categories such as smartphones haven integrated the functionality of mobile phones, music players, and even computers in their ability to access the Internet and run sophisticated applications catering to various needs. Similarly, gaming consoles have long since become media centers capable of DVD and Blu-ray disc playback as well as Internet browsing. Finally, convergence is also evident in the triple play offerings of cable and telephone network operators who often bundle TV and/or telephone services with broadband Internet access. What is common to these examples of conglomeration attacks is that the bundled platforms are largely functionally unrelated, but they share common users and components, yielding significant economies of scope through bundling (Eisenmann et al., 2007). Also Gawer & Cusumano (2008) argue that tipping across markets, or platform envelopment, appears to be particularly important in the context of technological convergence which is happening among computers, telecommunications equipment, and digital appliances and CE in general.

The second type of envelopment attack, the intermodal attack, can occur when the platforms are weak substitutes for each other, i.e., they serve the same basic purpose but satisfy different sets of user needs. This is typically because they rely on fundamentally different technologies or distinct *modes* for accessing relevant functionality. An intermodal attack may serve to neutralize an emerging competitive threat, and may also help realize efficiency improvements through economies of scope in initial marketing as well as potentially significant reductions in production and operating costs. Furthermore, integrating weak substitutes may yield quality improvements over two platforms offered by different firms. (Eisenmann et al., 2007)

As an example, Eisenmann et al. (2007) note that prior to 1982, Federal Express (FedEx) and United Parcel Service (UPS) broadly speaking fulfilled the same purpose of package shipping, although they served different user needs. The former relied on a network of air freight hubs to ship small, high-value packages overnight or in a very short time, whereas the latter relied exclusively on trucks for transport, being better suited for larger and less time-sensitive shipments. In 1982, however, UPS launched its own overnight air delivery service, constituting an intermodal attack on FedEx. As many customers require both fast delivery services as well as larger, less time-sensitive freight transportation, UPS was able to capture efficiency gains.

Finally, the third type of envelopment attack in the taxonomy discussed above, the foreclosure attack, can occur when the target's platform serves as a complement to the attacker's platform. In such a case, the target is either a nested network user or a nested component of the attacker's platform. By bundling the functionality of the target's platform with its own, the attacker *forecloses* access to its users. From a strategic perspective, a foreclosure attack can also strengthen the attacker's core platform by denying its rivals access to a crucial complement. (Eisenmann et al., 2007)

As a well-known example cited by Eisenmann et al. (2007), Microsoft launched its Windows Media Player in 1998, enveloping RealNetworks' then-dominant streaming media platform. While both RealNetworks and Microsoft provided their player software to consumers for free, Microsoft bundled its streaming media server software with the Windows NT server OS alongside other commonly used server software, at no additional cost. This bundling approach by Microsoft and the consequent platform envelopment caused RealNetworks' solution to rapidly lose market share. Eisenmann et al. (2007) note that in general, foreclosure attacks like those of Microsoft can play a powerful role in the evolution of multi-layer industries like the PC industry. Also in broader terms, platform envelopment provides a mechanism for platform leadership change that does not require breakthrough innovation or Schumpeterian "creative destruction"[4].

Proprietary or Shared Control

A recurring consideration of critical importance that firms developing platform-mediated networks face is the choice between proprietary and shared control of the platform. As noted by Eisenmann (2008), both approaches offer advantages and can be successful, as evidenced by numerous firms such as the proprietary platform providers like Federal Express, Google, Nintendo, Ticketmaster, and Verizon Yellow Pages, and by firms leveraging shared platforms such as Century 21, Maersk, NASDAQ, Red Hat Linux, and Visa. These firms operating in diverse industries orchestrate platform-mediated networks, where the users (individuals or firms) rely on a common platform to interact with each other. The platform, managed by one or more intermediaries often called platform proprietors or sponsors, comprises the infrastructure and rules employed in users' interactions. These interactions, in turn, are subject to network effects as discussed earlier in the context of two-sided markets in Section 2.4.3.

Eisenmann (2008) examines factors that favor proprietary versus shared models when designing new platforms, also looking at the differing management challenges in each case during the life cycle of the platform. He identifies three distinct life-cycle stages that occur in sequential order: 1) *platform design*, 2) *network mobilization*, and 3) *platform maturity*. Let us discuss these stages briefly.

[4] *Creative destruction* as a term was coined by Joseph Schumpeter in his book titled 'Capitalism, Socialism and Democracy' (Schumpeter, 1942) to denote a *"process of industrial mutation that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one"*.

Platform Design

When aspiring platform providers choose between proprietary versus shared models, two attributes in particular are of importance. In the case that launching a new platform requires very substantial investments in centralized infrastructure or user subsidies, proprietary platform providers have an advantage over shared platform providers, as the latter are subject to *free rider problems*. To illustrate the free rider problems, let us consider the following: When significant investments in user subsidization or centralized infrastructure are required to develop a new platform, the party that makes the investment must be able to reap the resulting profits to justify the spending. By definition, this condition holds true for a proprietary platform as there are no free riders. For comparison, when multiple providers share a platform, one provider could be responsible for the bulk of the investments, only to see other providers subsequently exploit these investments as free riders, quite possibly without putting in any investment of their own. Thus, proprietary platform providers have an inherent advantage over their shared platform counterparts.

As mentioned, free rider problems can plague platform providers not only in infrastructure investments but also in, e.g., network user subsidies. Subsidies can take various forms, but a common form is *penetration pricing*, i.e., subsidizing early adopters of a platform in order to fuel its growth and gain a critical mass of users early on. Due to network effects, growth of the user base increases willingness to pay among later adopters. In such a case, users joining later on are typically charged fees that recover the upfront investments and subsidies. This makes economic sense, however, only if the provider of the subsidies is also able to fully capture the payoff of the users, without free riders eating away at the profits. (Eisenmann, 2008)

When the entire market is likely to be served by a single platform in the long run, a shared approach may be more appealing for both users and aspiring platform providers. This may be the case when the market exhibits winner-take-all dynamics (as explained in Section 2.2.3), which in turn are likely to occur at the platform level in the presence of strong network effects, high multi-homing costs, and limited demand for differentiated features, all at the same time. Eisenmann (2008) further notes that winner-take-all dynamics occurring at the platform level are equal to similar dynamics at the individual provider level only for proprietary platforms. In other words, winner take-all-dynamics for a proprietary platform imply a monopoly for a single firm. However, a proprietary platform monopoly as the alternative would expose users to the threat of hold-up in the form of aggressive price hikes due to lack of competition, and also prospective rivaling platform providers would face severe financial risk if they were to lose the winner-take-all battle.

Network Mobilization

In mobilizing new networks, Eisenmann (2008) argues, platform providers and their managers face different challenges depending on whether their platform is proprietary or shared. As already noted, one possibility for proprietary platform providers is to rely on business models that subsidize certain users. There are, however, multiple ways to offer subsidies to users, so finding the right formula for creating value for users is a key challenge for proprietary providers during network mobilization. Penetration pricing is commonly applied to subsidize early adopters and reduce their upfront investment, speeding up early growth of the platform's user base. However, with two-sided platforms, each side of the platform must first have a sufficient number of users before prospective users on the other side are willing to invest and join. To overcome this problem, platform providers often subsidize users on one side permanently, creating an attractive subsidy side whose growing user base boosts users' willingness to pay on the money side due to cross-side network effects as elaborated by Eisenmann et al. (2006); Eisenmann (2008).

For shared platform providers, in contrast, free rider problems often make it economically difficult to offer subsidies. Before being able to attract network users at all, architects of a shared platform need to solve the problem of recruiting peer providers. A key concern for prospective peer providers is the ability to earn enough profit by competing on the shared platform. If peers believe it to be difficult for them to earn a profit, they will be deterred from participating. Thus, disputes over how to divide captured value can destabilize a shared platform. Similarly, standards-setting processes can become stalemated when the contributing partners of shared platform each push their own technologies, hoping to earn license fees or realize time-to-market advantages over others. As a result, the principal challenge for a shared platform during network mobilization is capturing value for peer providers in an adequate manner so as to convince the peer providers of the commercial viability of participation. (Eisenmann, 2008)

Platform Maturity

As platforms grow and become mature, depending on whether they are proprietary or shared, their providers will again face different management challenges. For proprietary platforms, managing scope will be the primary concern, as continuous innovation creates opportunities for diversification. Moreover, proprietary platform providers must decide whether to depend on other parties for essential complements or instead, become vertically integrated.

It can be difficult for shared platform providers to agree on diversification and vertical integration initiatives due to their often conflicting strategic agendas. Eisenmann (2008) suggests that instead, shared platform providers should focus on managing innovation. It is commonplace that firms create proprietary features to differentiate their offerings from those of shared platform partners. When such a development is pushed too far, it can fragment (or fork) the platform and cause incompatibility. In a similar manner, major upgrades to a shared platform are not without problems either and can cause various annoying problems. The desire of incumbents to preserve their dominance often comes at the expense of newcomers with innovative proposals.

Capturing Value from Shared Platforms

Eisenmann (2008) suggests three possible approaches to capturing value specifically for shared platform providers:

- *Restricting membership*: When organizing a shared platform, firms often exclude their closest rivals. If, however, exclusion leads the rivals to sponsor a competing platform, this strategy can backfire.
- *Profiting from intellectual property*: If license fees are set too low, platform providers that possess a lot of IP may flock to a platform that offers a better deal. Conversely, if license fees are set too high, providers with little IP may avoid the platform as they would bear a cost disadvantage. Also, high fees can encourage firms to devote a lot of effort to building their technologies into the shared platform, which can lead to stalemates in standards-setting processes.
- *Profiting from implementation*: It is common for providers of shared platforms to seek to differentiate their offerings through proprietary extensions to a common standard. This strategy has the potential to splinter a shared platform when taken to extremes.

All three approaches should be pursued with moderation, as they run the risk of destabilizing the platform's coalition if taken too far. Managers should carefully consider the tradeoffs between them, especially between profiting from IP versus implementation. Should firms be able to incorporate their own IP into common standards, they are likely to realize time-to-market advantages over shared platform rivals due to their engineering personnel's familiarity with the technologies. Similarly, a firm's engineers may be able to create proprietary extensions that differentiate the firm's offerings if the firm's technologies are at the core of platform standards. Due to these reasons, firms often have an incentive to contribute technology to the shared platform for free, foregoing potential profits from IP licensing. (Eisenmann, 2008)

2.5.5 Open vs. Closed Considerations

How open should a platform be in order to maximize innovation or value creation on it? Choosing the optimal level of openness is a critical decision for firms acting as platform proprietors as noted by a number of authors (Boudreau, 2010; Eisenmann, Parker, & Van Alstyne, 2008; Gawer & Henderson, 2007; Gawer & Cusumano, 2002), involving a tradeoff between growth and appropriation (West, 2003). Parker & Van Alstyne (2008) and Eisenmann et al. (2008) note that opening a platform can spur growth by harnessing network effects, reducing end user concerns about lock-in, and stimulating downstream production of complements and other differentiated goods that meet the needs of user segments. Simultaneously, however, opening a platform typically also reduces switching costs for users, increases forking and competition, and reduces the platform proprietor's ability to levy a tax on complementors or other firms utilizing its platform.

According to Eisenmann et al. (2008), a platform is "open" to the extent that: 1) *no restrictions are placed on participation in its development, commercialization or use*; or 2) *any restrictions are reasonable and non-discriminatory, i.e., they are applied uniformly to all potential platform participants*. The latter point would apply to, e.g., requirements to conform with technical standards or pay licensing fees. It is also important to consider that there are several distinct roles in platform-mediated networks, including: 1) *demand-side platform users, or end users*; 2) *supply-side platform users*, who offer complements employed by demand-side users in tandem with the core platform; 3) *platform providers*, who serve as users' primary point of contact with the platform; and 4) *platform sponsors*, who exercise ownership and property rights and decide who may participate in a platform-mediated network and for developing its technology (Eisenmann et al., 2008). The relationships between these roles are depicted in Figure 2.6. As each of the roles may be either open or closed for a given platform, it would be prudent to reference the relevant roles when calling a platform 'open' or 'closed'.

As an example, the Linux OS platform is open with regard to all four roles described above. On the demand (end user) side, any organization or individual can use Linux. Similarly, on the supply side, any party can offer a Linux-compatible software application. Also, any party can bundle the Linux OS with server or PC hardware, thus acting in the platform provider role. Finally, any party can make contributions to further develop and improve the Linux OS as long as it abides to the rules of the open source community that is responsible for maintaining the Linux kernel, thereby acting in the platform sponsor role.

Also more recent empirical research on open versus closed business models

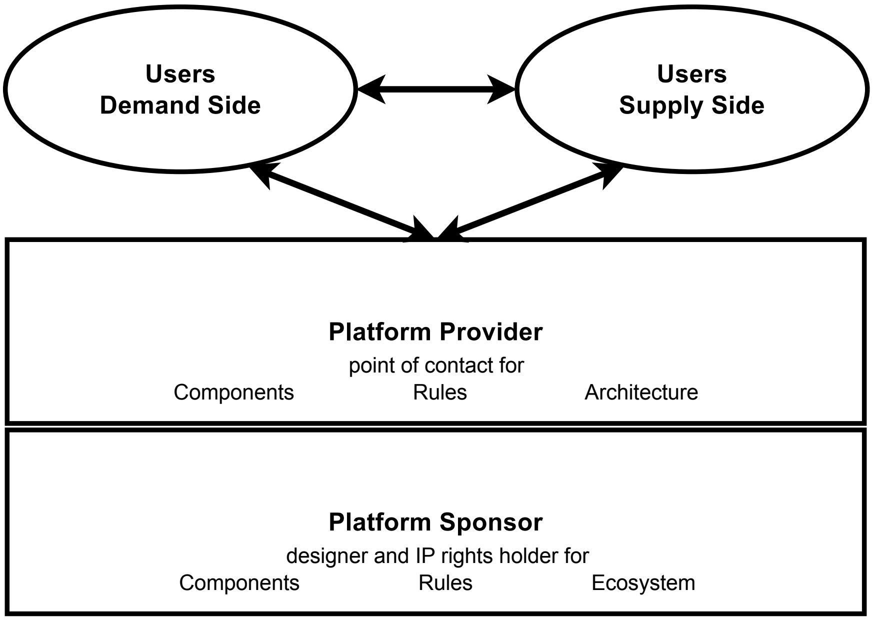

Figure 2.6: Roles in a platform-mediated network

in the particular case of mobile application stores suggests that the question of platform openness is not either/or, black or white, but is rather a choice within a continuum composed of multiple dimensions, each of which can be described as open or closed. In particular, Müller et al. (2011) identify 12 distinct value network roles where the store owners can have varying levels of control and influence, either by being the sole owner of a role or function, or partial owner through a consortium, and exerting influence on other parties through exclusive arrangements or some other means. Thus, they conclude that pure open vs. closed model discussion is somewhat outdated and expected to become less relevant, particularly as the leading mobile app stores exhibit a mix of open and closed characteristics, the so-called 'open' platforms often including some closed elements and also the 'closed' platforms including some open elements. They also argue that Boudreau's (2010) distinction between the platform strategies characterized by closed platforms, openness to complementary services, and relinquishing of the control of the platform is not sufficient, but a more granular approach to analyzing openness is needed to fully capture the mobile platform business models of players like Apple and Google.

Parker & Van Alstyne (2008) note that in contrast to traditional R&D, managers can capture open innovation by offering default contracts that grant ecosystem partners "permissionless innovation", i.e., a right to build complements without having to negotiate. This, as they argue, reduces risk, increases profits as network effects grow, and reduces hold-up. Another implication in their view is that managers in networked businesses must open their platforms and be willing to sacrifice current platform profits in order to subsidize *unknown* developers. According to Parker & Van Alstyne (2008), if you know how to pick the winning ideas that are going to succeed and also know who has them, then vertical integration is superior, but without this information, open innovation is superior.

2.5.6 Vertical Integration and Exclusivity

Typically in networked industries and platform markets, consumers visit, join, or adopt a platform (or some other kind of intermediary) such as a hardware device, computer OS, content distribution service, online payment platform, or health insurance network, in order to gain access to that particular platform's complementary goods and services offering. As has been discussed, a key activity for platform providers competing with one another is to get enough complementors on board to produce complements that in turn attract end users to their platforms. It is not just the quantity of complementors that matters, however. In many cases, platform providers seek to differentiate themselves from their rivals through either *vertical integration* (providing certain differentiating complements in-house) or *exclusivity* arrangements, i.e., getting access to particular complements or content as the sole platform provider — obviously for an exclusivity fee or contribution. Lee (2013) notes that the question whether such arrangements are pro- or anti-competitive (or harmful to consumers) is a topic of active debate and an open empirical question.

Lee (2013) studies the impact of vertical integration and exclusivity arrangements on industry structure, competition, and welfare. He does this using an econometric analysis based approach, using empirical data from the U.S. video game industry between the years 2000 and 2005 where such arrangements did take place. To simulate counterfactual environments where exclusive vertical arrangements were prohibited, he has developed and estimated a structural discrete choice model of dynamic consumer demand for both hardware platforms and their affiliated products, and combined these estimates with a model of hardware adoption by software developers. Through modeling both sides of the market, he argues, the dynamic indirect network effects exhibited in the industry are captured, also allowing agents to respond to past and anticipated future actions of others. In a particular equilibrium state specified and computed by Lee (2013), all agents' beliefs are adjusted in such a way that they are consistent with the counterfactual evolution of the industry. He also notes that the counterfactuals are only partial in that they assume that platform providers offer the same non-discriminatory contracts to all firms. Additionally, he makes the assumption that the quality and set of available products do not change.

The main finding of Lee (2013) is that *prohibiting exclusive arrangements* would have benefited the incumbent platforms and harmed the smaller platform entrants. The underlying explanation from his analysis is that without exclusive arrangements, high quality software would have primarily been released on the incumbent platform due to its larger installed base (and therefore stronger cross-side network effects), and only later, if at all, on either platform entrant included in his analysis. As a consequence, he finds that in a market without any exclusive arrangements, neither entrant would have been able to significantly differentiate itself from the incumbent. Exclusive software thus appears to have been a key leverage for platform entrants to gain traction in the networked video game industry, increasing opportunity for differentiation.

Prohibiting exclusivity, however, would appear to have stimulated increased sales of both hardware and software, by 7% and 58% respectively, primarily driven by increased software compatibility, according to the market conditions simulated by Lee (2013). Moreover, consumer welfare would have increased by $1.5 billion, but all other financial gains would have been largely captured by the incumbent platform provider.

2.5.7 Platforms and Interrelated Concepts

From the literature review and discussion on industry platforms above, we can appreciate that there are many similarities and relationships with other theoretical concepts already reviewed in this thesis. Firstly, network effects as discussed in Section 2.2.3 play a key role in attracting users to platforms, whether end users or complementors. Secondly, as also acknowledged by Cusumano (2010), platforms tend to have more than one market side to them with cross-side effects between users on different sides, as described by Parker & Van Alstyne (2000, 2005); Rochet & Tirole (2003), and other authors in what is known as two-sided market theory (discussed in Section 2.4.3). Also they used the term ‘platform’ to refer to the entity that brings the different sides of the market together. Their perspective was mainly that of economics, however, not of technology or standardization. In today’s Internet media industries we can see that two market sides are often not enough to capture the complexity of relationships between platform users. As an example, online video portals need to attract end users, content producers, advertisers, and possibly a content aggregator on board to be successful. Thus, the classic problem of subsidization of market sides become significantly more complex.

We can also see that the concept of 'business ecosystem' (Moore, 1993) with its notions of cooperation and competition, occurring in varying degrees simultaneously between firms, is closely related to that of industry platforms. Also Brandenburger & Nalebuff (1996) discuss cooperation and competition, or *"co-opetition"*, and describe complementors as companies that make ancillary products that expand a platform's market and make it more valuable to customers.

Cusumano & Gawer (2002) acknowledge that firms may often have ambivalent roles, being platform leaders in one context and complementors in another, and that some level of competition between platform leaders and complementors is often inevitable, especially when the platform leader chooses to expand the scope of its business operations. Although they did not use the term 'ecosystem' in their early publications, they have since likened the term to industry platform in the sense that ecosystems tend to form around industry platforms. In later publications, the theory of two or multi-sided markets is also referenced by Cusumano (2010).

Platforms, Communities, and Business Ecosystems as a System

Muegge (2013) is one of the few authors who have explicitly recognized and discussed the interrelatedness of the concepts platform, community, and business ecosystem, all of them relevant for an entrepreneur or would-be complementor planning to offer products or services based on shared platform assets. In his example, neither a mobile application developer nor a provider of online services is choosing "just" a specific platform or community or ecosystem, but rather a "bundled system" comprised of instances of all three subsystem types. In other words, choosing a platform often goes hand-in-hand with choosing a business ecosystem as well. Similarly, these choices also influence the choice of membership or participation in various communities, such as collaborative innovation communities and open source software communities.

According to Muegge (2013), research related to community innovation typically examines the role of communities outside the boundaries of firms in creating, shaping, and disseminating technological and social innovations and providing valuable support to others. As an example, Boudreau & Lakhani (2009) discuss the circumstances under which companies should pursue and organize collaborative communities rather than competitive markets as the source for their outside innovation. Chesbrough & Appleyard (2007) have studied open innovation related strategy and management practices extensively.

The second body of relevant research on communities relates to open source communities and projects. West & O'Mahony (2008) have studied 12 open source projects initiated by corporate sponsors and a further group of five projects originating from autonomous open source communities. Based on the obtained results, they argue that sponsors consider three design dimensions that together create a specific *participation architecture* or model of interaction and contribution in the community: 1) *production* (the way production processes are conducted), 2) *governance* (decision-making processes), and 3) *intellectual property rights* (allocation of rights to use the community's output). They also distinguish between two dimensions of openness, namely *transparency* (i.e., allowing those outside the community to follow and understand a community's production efforts) and *accessibility* (allowing external participants to influence a community's production efforts). Further discussion of communities, a term with a plethora of definitions and disparate uses, is outside the scope of this thesis.

The main conceptual argument of Muegge (2013) is that platforms, communities, and business ecosystems can be understood as different levels of analysis in a complex hierarchical system, and that *architecture* is the unifying concept linking the three levels together. Here, architecture is not meant in a traditionally technical sense only but also as describing organizational structure and form as well as patterns of interaction. Therefore, Muegge (2013) describes three levels of organization each involving a distinct type of actor: *an organization of things* (a platform), *an organization of people* (a community, such as a developer or user community), and *an organization of economic actors* (a business ecosystem), each representing organizational forms in an interconnected system as opposed to more traditional organizational forms.

Discussion

Muegge (2013) contends that for the most part, research and practitioner literature rarely considers platforms, communities, and business ecosystems together or observes their interactions in detail. Extensive bodies of research do exist on each topic individually, but they are kept largely separate due to differing publication venues. He argues further that the knowledge is scattered in many places such as practitioner books, specialized scholarly books, journal articles, and various online sources, making it rather difficult and time-consuming to collect and put all the pieces together. Yet, this is required to gain a holistic understanding of the status quo and ongoing developments in the topic area, not to mention actionable knowledge. This is largely also the gap that the author of this thesis sees in the current literature on industry platforms and business ecosystems. Thus, a key purpose for this thesis from a theoretical perspective is to bring together and, where possible, reconcile the latest research on platforms, two-sided markets, and business ecosystems into a holistic whole, a conceptual framework that would capture the essential dimensions of analysis for the comprehensive study of business ecosystems and their success factors, and ultimately, guidelines for strategic decision-making.

Chapter 3

Analysis Framework

In this chapter, an analysis framework is formulated that brings together and builds upon many of the existing concepts and frameworks discussed in the previous chapter. The goal of the framework is to capture both firm-level and ecosystem-level factors that enable value-adding complementary innovation in a thriving, vibrant ecosystem. The platforms on which complementary innovation is created and that mediate and facilitate transactions in a two or multi-sided market are analyzed as a key part of the framework. In particular, the art and practice of managing the platforms, communities of complementors and the broader ecosystem is of special interest.

In the following sections, each part of the framework is examined separately, but for a quick overview, the framework is illustrated in Figure 3.2, at the end of the chapter.

3.1 Firm-Level Analysis

3.1.1 Firm Scope and Angle of Entry

Firm scope here refers to the breadth of the firm's business activities, such as the products it makes and sells, the services it provides, and to whom and where. In the specific context of mobile smartphone business, I make a distinction between firms that primarily make money through selling CE hardware, those that monetize operating systems and commercial applications, and those that offer services or digital content that are either fully paid by customer, freemium, or advertiser funded. The models of value creation discussed in Sections 2.2.1, 2.2.2, and 2.2.3 offer valuable theoretical concepts and tools for analyzing the process of value creation in different firms.

Of the concepts mentioned above, the value chain of Porter (1985) remains the best known and most widely used, but it has been criticized for its focus on the unidirectional flow of materials into and out of a firm, largely ignoring other kinds of transactions such as knowledge or information exchange, making the value chain poorly suited for describing many knowledge-based industries such as consulting or services such as insurance, banking, or healthcare. The traditional value chain, when confined into a single firm operating in a single industry, also ignores the role of interfirm relationships as a source of competitive advantage and value creation, this being the central argument of the relational view of Dyer & Singh (1998). In line with this view, the analysis framework of this study shall consider the investments firms have made into relation-specific assets, any substantial knowledge exchange between firms, the existence of complementary resources or capabilities enabling the joint creation of new products, services, and technologies, as well as the governance mechanisms resulting in lower transaction costs between firms.

In order to analyze value creation that stems from outside the boundaries of the firm itself, it is relevant to consider the concept of value network, as defined by Christensen (1997) and Stabell & Fjeldstad (1998). Christensen (1997) aptly defined the value network as the "context within which a firm identifies and responds to customers' needs, solves problems, procures input, reacts to competitors, and strives for profit". Preceding this definition, Normann & Ramirez (1993) argue that value should be created in any way that is appropriate, without being limited by the organizational boundaries of suppliers and customers as in the value chain model, and that the offering of a firm determines the boundary points where different participants come together to co-produce value, which is also compatible with later definitions of two-sided markets and platforms.

In line with Allee (2000), who argues that existing approaches to analyzing and reconfiguring value networks have largely ignored the role of knowledge and intangible value exchange, the analysis framework of this study shall observe, where appropriate, Allee's framework of the *three currencies of value*, defining the bases of value exchange between organizations being 1) goods, services, and revenue, 2) knowledge, and 3) intangible benefits.

In reality, various monetization models may be often mixed and employed simultaneously by firms. Nevertheless, when studying the case companies, I am keen to consider the question of monetization and existing capabilities and assets, also from a historical perspective. For this purpose, I use the concept of *angle of entry* that I first introduced in Section 1.2.2 and discussed in more detail in Section 2.1.2, exploring the related theory of path dependence (David, 1985, 1994, 2001) which appears to support the foundations of this novel concept.

Angle of entry refers to the historical legacy of a firm mainly in terms of its previous business activities, capabilities, and assets which, as is argued, has had an impact on more recent choices the firm has made in its ecosystem and platform strategies. This argument is backed by the central assertion of path dependency theory, i.e., that the set of options in decision making for any given circumstance is limited by the decisions one has made in the past, even though past circumstances may no longer be valid or have any relevance.

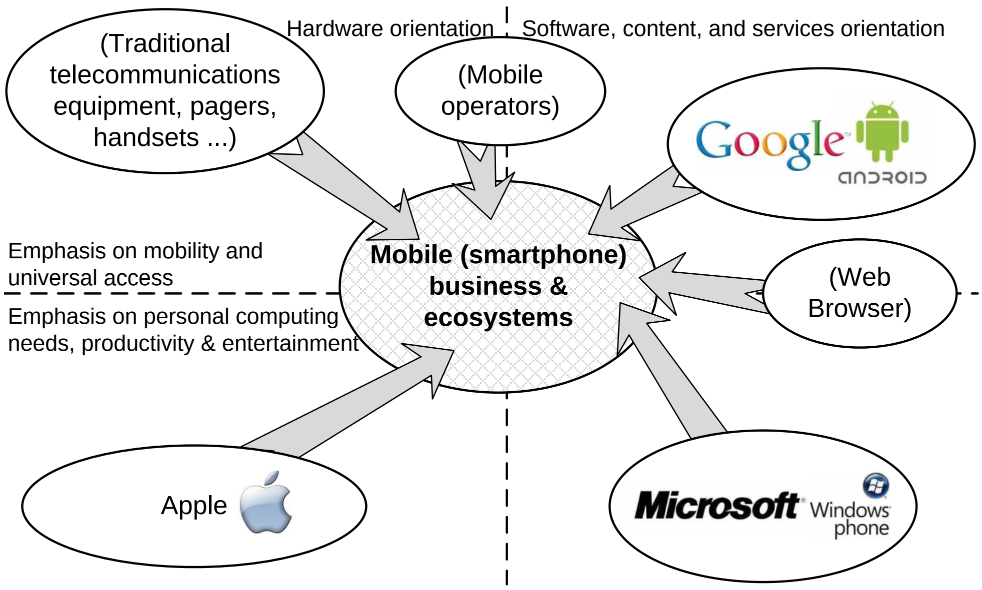

Figure 3.1: Angles of entry into mobile smartphone business (revisited)

In the context of this study, angle of entry means that when firms have expanded or refocused their business on the rapidly growing mobile sector, they have made strategic choices regarding which roles in the ecosystem or value network they desire to occupy, and also how they intend to capture value, and that these decisions have been influenced, at least partially, by the legacy of these firms, their existing businesses and positions in the markets that they occupied at the time of entry, as well as their capabilities and assets. Thus, firms have been and are in somewhat different positions as they have entered the mobile business arena and consequently stand to capture value from their ecosystems in somewhat different ways, each influenced by their unique angle of entry. For the sake of convenience for the reader, the illustration of the concept has been repeated here in Figure 3.1[1].

[1]The company/product names and company/product name logos shown in Figure 3.1 are trademarks or registered trademarks of their respective owners.

3.1.2 Platform Approach and Governance

For the study of a firm's platform approach, no other body of research has been cited as often as the theory of industry platforms by Cusumano & Gawer (Gawer & Cusumano, 2002, 2008; Cusumano, 2010). The four levers of platform leadership identified by them (see Section 2.5.2 for an elaborate description of each lever), as well as the fundamental role descriptions of platform leaders and complementors are thus taken as a basis for the study of the case companies' platforms. With regard to the first lever, *scope of the firm*, I have chosen to organize the analysis under the subsection titled 'Firm Scope and Angle of Entry', separately for each case company, due to a firm's angle of entry being closely related to the discussion of its scope. As for the other three levers of platform leadership, *product technology* is discussed under the sub-subsections titled 'Product Technology, Architecture, and Openness', whereas discussion of the third lever *relationships with external complementors* is actually split into two groups of sub-subsections titled 'In-House vs. External Focus in Complements' and 'Managing and Incentivizing Complementors' in order to separate the analysis of how much the firm innovates and produces complements in-house from how the firm manages and incentives its *external* complementors, the latter point also being relevant in ecosystem analysis, where software ecosystems and particularly application marketplaces are examined. Finally, the fourth lever *internal organization* is discussed under the sub-subsections titled 'Internal Organization and Propensity to Advance the Overall Good of the Ecosystem'.

In line with theories above, this study focuses mostly on technical and organizational concepts such as scope of offering, product architecture and modularity, external relationship management, and internal organizational structure, constituting mainly analysis on firm level. Although network effects and two or multi-sided markets play a fundamental role in platform theory, I discuss the analysis dimensions related to these concepts in my discussion of software ecosystems and mobile application marketplaces in Section 3.2.2.

In Section 2.5.4, I discussed various strategic approaches to how firms can become platform leaders, such as "coring", i.e., creating a new platform where one has not existed before, or "tipping", building market momentum and tipping the market in one's favor in order to win a platform war of competing standards or technologies as illustrated by Gawer & Cusumano (2008). Another strategic option is to expand one's platform into an adjacent market by adopting and incorporating some of the functionality of the platforms being used in the adjacent market, constituting what Eisenmann et al. (2007) call a platform envelopment attack. These envelopment attacks are further divided into conglomeration attacks, intermodal attacks, and foreclosure attacks depending on whether the platforms of the attacker and the target are functionally unrelated, weak substitutes, or complements for each other. In this study, I use the above classification to describe the platform expansion of the case companies.

As discussed in Section 2.5.4, whether the control paradigm of a platform is proprietary or shared has profound implications on the management challenges its provider faces, particularly related to the management of complementary innovation and value capture. Eisenmann (2008) notes that both models can be successful and examines factors that favor each when designing new platforms, also looking at the differing management challenges during the three distinct life-cycle stages of the platform: 1) *platform design*, 2) *network mobilization*, and 3) *platform maturity*. Unlike proprietary platforms, shared platforms are prone to free rider problems that make it challenging to protect returns from infrastructure investments or to offer user subsidies. According to him, capturing value from shared platforms can be enhanced in three ways, by restricting membership, by profiting from intellectual property, and by profiting from implementation, but all three approaches should be pursued with moderation, as they run the risk of destabilizing the platform's coalition and involve tradeoffs. In this study, the proprietary or shared aspects of the case companies' platforms in the various stages of their life cycles are examined according to the concepts above.

As discussed in Section 2.5.3, Boudreau (2008) has studied the effects of the number of complementors on the intensity of competition and level of innovation on a platform through quantitative econometric analysis, coming to the conclusion that under specific circumstances, adding too many complementors can detract from a platform's ability to generate new innovation as well as profits for the firms making complements on it, mainly due to crowding-out effects and substitution as opposed to market expansion.

Due to the qualitative nature of this study, I choose not to apply econometric analysis or any other form of quantitative analysis to the case companies' platforms or their complementors, as this would add unnecessary complexity to the specific research problem of this thesis. However, Boudreau's findings are considered valuable in that they confirm that crowding-out effects can be a problem for platforms with very large numbers of complementors, threatening both the innovation output of the platform and the profitability of individual complementors, outcomes which ultimately would adversely affect the attractiveness of the platform from end-user and complementor perspective.

As some mobile application stores have grown to the point that they have an active catalog of more than a million applications, it is likely that crowding-out effects already play a significant role in those marketplaces and platforms. Indeed, results from a mobile application developer survey conducted by App-Promo in 2012 suggest that already then, app developers were finding it increasingly challenging to "cut through the noise" and get their app discovered and downloaded (App-Promo, 2012). Even more discouraging is that according to the same survey results, 59% of apps did not generate enough revenue to actually break even on development costs, which means they actually destroyed rather than created value for their developers. Furthermore, the results suggest that 68% of developers earned $5,000 or less with their most successful app, hardly signifying a goldmine of revenue. Software ecosystem and application marketplace related dimensions of analysis are discussed further in Section 3.2.2.

As discussed in Section 2.5.6, platform providers often seek to differentiate themselves from their rivals through either vertical integration or exclusivity. Lee (2013) has studied this phenomenon and its implications on competitive dynamics, particularly the opportunity for differentiation for new entrants, as well as consumer welfare. Based on the results of his study from the video game industry, he contends that exclusive software is a key leverage for platform entrants, allowing them to differentiate and gain traction in the market more effectively, but in terms of the overall market, exclusivity actually decreases the total market revenue as well as consumer welfare. In this study, the extent of vertical integration and possible exclusive arrangements made by the platform provider are taken into consideration.

3.2 Ecosystem-Level Analysis

3.2.1 Ecosystem Approach and Governance

For analyzing the mobile business ecosystems of the case companies in this study, I rely on the definition given by Moore (1993, 1996) discussed in Section 2.3.2 and illustrated in Figure 2.5. His definition of a business ecosystem is as follows: *"an economic community supported by a foundation of interacting organizations and individuals — the organizations of the business world. This economic community produces goods and services of value to customers, who are themselves members of the ecosystem. The member organisms also include suppliers, lead producers, competitors, and other stakeholders. Over time, they coevolve their capabilities and roles, and tend to align themselves with the directions set by one or more central companies. [...]"*.

In addition to contributing the definition of a business ecosystem, Moore has identified a pattern of four distinct, sequential stages in the evolution of a business ecosystem. These stages are: 1) *pioneering* (or *birth*), when the basic paradigm of the ecosystem is being worked; 2) *expansion*, when the community broadens its scope and consumes resources of all types; 3) *authority* (or *leadership*), when the community structure becomes stable and competition for leadership and profits within the ecosystem gets brutal; and finally, 4) either *renewal*, when continuing innovation must take place for the community to thrive and remain vibrant, or *death*, if the community stagnates. Although the borders between the stages are often blurry, Moore argues that the process of coevolution remains constant and the complex interplay between competitive and cooperative business strategies remains a key topic for firm executives and managers. They are also a key topic of interest in analyzing the case companies in this study.

As discussed in Section 2.3.3, Iansiti & Levien (2004a,b) have studied the structure and health of ecosystems, combining deep managerial research with a broader understanding of networks drawn from various academic fields. Their research perspective is that of business networks, the key question being how firms should manage the complex business networks which they are a part of, which is very closely related to the research question #2 of this study. The focus of the research conducted in this study is, however, on fostering complementary innovation in the ecosystem, whereas the focus of Iansiti and Levien is on effects that promote ecosystem health that they define through three critical measures, *productivity*, *robustness*, and *niche creation*. Looking at these measures more closely, one can see that productivity including the delivery of innovations and niche creation being the capacity to create meaningful diversity are, in fact, very much related to fostering complementary innovation. Therefore, I use this terminology in the analysis of the case companies' ecosystem health.

Den Hartigh et al. (2006) suggest alternative metrics for micro (company) level analysis of business ecosystem health, broken down into partner health and network health metrics. As such analysis typically requires more detailed data, Den Hartigh et al. (2006) argue that their set of operational measures is better suited for measuring business ecosystem health on the company level and of more practical value and use to managers. Where appropriate, I use these metrics for additional analysis of the case companies' ecosystem health.

A further contribution of Iansiti & Levien (2004a,b), as discussed in Section 2.3.3, is their definition of distinct ecosystem actor roles that firms may occupy or strive for, each with a corresponding ecosystem strategy: *keystone*, *physical dominator*, and *niche player*. They also describe the additional role of a *value dominator*, but it is suggested that such firms are detrimental to an ecosystem's health, leading to starvation and ultimately even the destruction of the ecosystem. I use this terminology to describe the role of the case companies' in their ecosystems under the sub-subsection 'Ecosystem Role and Health'.

3.2.2 Software Ecosystem and Application Marketplace

The software ecosystems of the case companies in this study largely equate to their mobile application marketplaces (or stores), being the primary touchpoint for both end users and developers alike and the main platform for commercial transactions pertaining to software applications between the two parties. Using the definition of Bosch (2009) of a software ecosystem that was discussed in Section 2.4.2, I also consider any enabling, supporting or automating software solutions such as OS software and middleware on both client (device) and server side to be part of the software ecosystem. When discussing software ecosystems, however, the main focus of this study is on the complementary innovation produced by third parties in the form of commercial or free applications for certain mobile OS platforms, available on mobile application stores.

The software ecosystems considered in this study are OS-centric in the sense that the OS and its interfaces play a key role in defining what really constitutes the software ecosystem, also setting the technical boundaries for what can and cannot be done by complementors on a particular platform. As discussed in Section 2.4.2, Bosch (2009) identifies the following success factors specifically for OS-centric ecosystems that I use in evaluating the case companies' software ecosystems:

- *Minimal effort required by developers* to build applications on top of the OS, thereby enabling both breadth and quality of the application offering.
- *Generic, evolving functionality and set of features provided by the OS* that maintains attractiveness for developers. It is important for an OS to incorporate commoditizing functionality early on without alienating existing developers.
- *The number of customers that use the OS and that are accessible to developers* for monetization.

A mobile application store is a school book example of a two-sided market as discussed at length in Section 2.4.3, and thus the characteristics and metrics of a two-sided market as defined by Rochet & Tirole (2003), Parker & Van Alstyne (2005), and others are used in this study to analyze them. Naturally, the relative strength of both same-side and cross-side network effects needs to be evaluated, although unfortunately, no straightforward way exists for measuring them. The tendency of multi-homing, i.e., joining multiple platforms to make one's products available on more than one market, is a key phenomenon exhibited by developers in mobile application stores as discussed in Section 2.4.7, and therefore a relevant point of consideration in the case studies.

As discussed in Section 2.5.5, Eisenmann et al. (2008) define the openness of a platform ecosystem along four dimensions, each corresponding to a particular role in a platform-mediated network: demand-side platform users (i.e., end users), supply-side platform users (e.g., developers), platform providers (who operate the platform and interface directly with the customer), and platform sponsors (who own the platform and decide who gets to participate). This set of dimensions of openness lends itself to the analysis of many kinds of platforms, not tied to a particular industry. However, Müller et al. (2011) identify a total of 12 distinct value network roles relevant specifically to mobile application stores, namely end user, network operator, payment broker, advertisement broker, marketplace, operating system developer, testing & verification party, signing partner, software developer, content provider, software distributor, and device manufacturer. Where feasible, I use this extended list to evaluate the openness of the case companies' platforms and ecosystems.

3.3 Dimensions of Analysis

Based on the discussion above, I have put together a set of metrics representing the various dimensions of analysis that I use in the case studies of Chapter 4. This framework is presented in Table 3.1. A somewhat simplified visual representation focusing on the key metrics of analysis is presented in Figure 3.2.

Table 3.1: Dimensions of analysis

Dimension	**Metric**	**Literature Reference**
Firm scope (value creation logic and revenue model)	Sources of revenue and monetization methods	Stabell & Fjeldstad (1998), Fjeldstad & Andersen (2003)
Angle of entry	Angle of entry into mobile smartphone business	See Figure 1.2
Platform approach and governance	For each software platform used: – Product technology, architecture, and openness – In-house vs. external focus in complements – Managing and incentivizing complementors – Internal organization and propensity to advance the overall good of the ecosystem – Scope of involvement and control (priopnetary or shared)	Cusumano & Gawer (2002), Eisenmann (2008), Eisenmann et al. (2008), Parker & Van Alstyne (2008), Boudreau (2008)
	Vertical integration and exclusivity	Lee (2013)
Ecosystem approach and governance	Role of the firm in the ecosystem	Iansiti & Levien (2004a)
	Ecosystem health metrics (productivity, robustness, niche creation)	Iansiti & Levien (2004a), Den Hartigh et al. (2006)
Software ecosystem and application marketplace	Cross-side and same-side network effects: polarity and relative strength (if possible to measure)	Eisenmann et al. (2006)
	Success factors for OS-centric software ecosystems	Bosch (2009)
	Openness along various roles in the value network: end users, developers, platform providers, platform sponsors, ...	Eisenmann et al. (2008), Müller et al. (2011)
	Occurrence of multi-homing on both sides	Eisenmann et al. (2006), Hyrynsalmi et al. (2012)

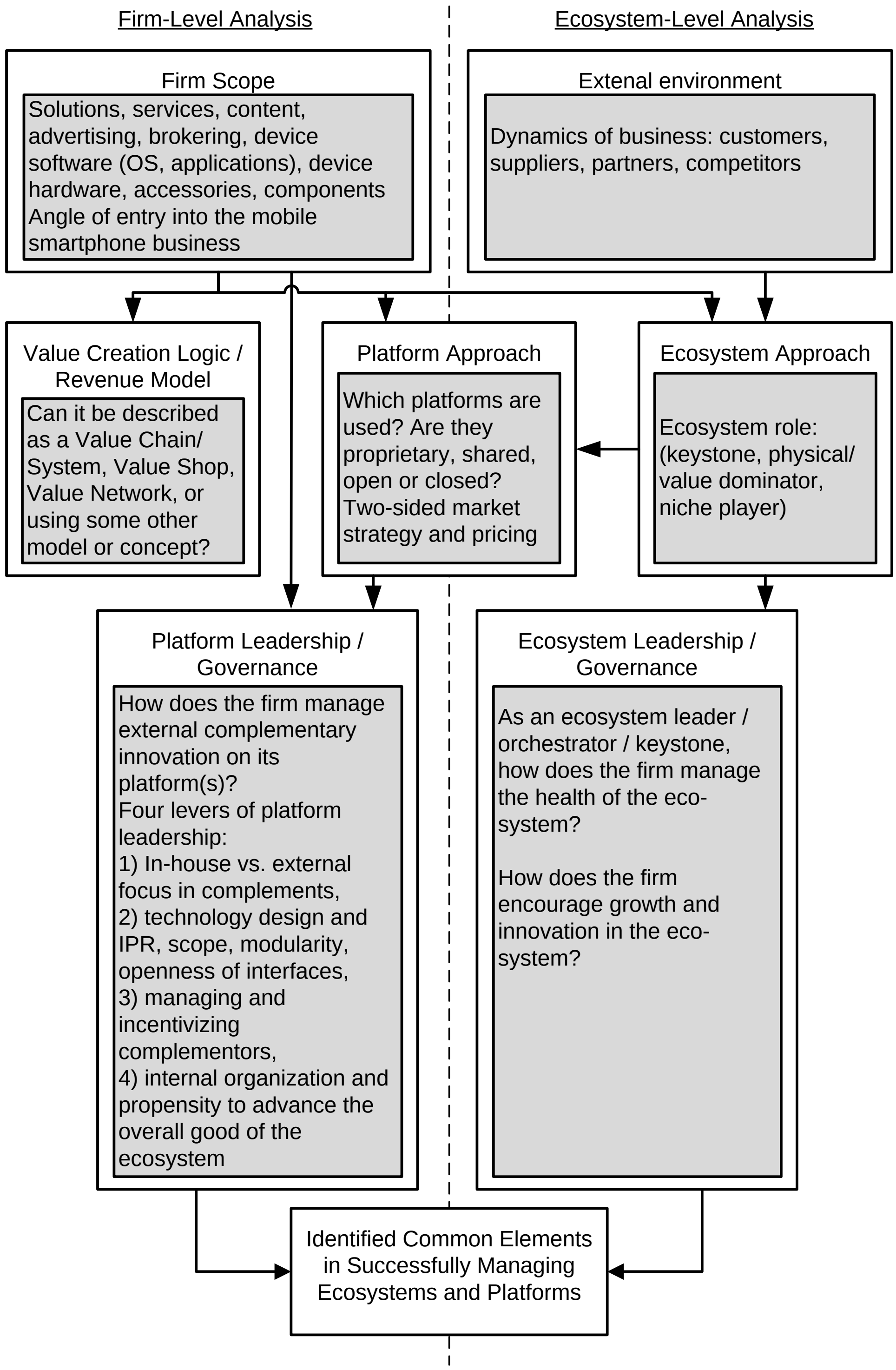

Figure 3.2: Analysis framework used for the case studies

Chapter 4

Case Studies

In this chapter, altogether three case studies conducted according to the methodology described in Section 1.4 and the analysis framework presented in Chapter 3 are presented and discussed. As noted in Section 1.4.2, the case companies Apple, Google, and Microsoft were chosen because each of them can be seen as a hub and orchestrator of a business ecosystem in the smartphone business. Each of them is also a platform provider. From the perspective of path dependency theory and the concept of angle of entry, it is an interesting notion that these three companies compete in the same arena, yet they have very different historical legacies as companies in addition to differing assets and capabilities. Indeed, this particular dimension of analysis is expected to have a significant role in explaining the firms' approaches to managing their platforms and ecosystems.

4.1 Case 1: Apple and the iOS Ecosystem

Firm Scope and Angle of Entry

According to its Form 10-K annual report filed with the United States Securities and Exchange Commission (SEC), Apple *"designs, manufactures and markets mobile communication and media devices, personal computers, and portable digital music players, and sells a variety of related software, services, peripherals, networking solutions, and third-party digital content and applications"* and the company's products and services include *"iPhone®, iPad®, Mac®, iPod®, Apple TV®, a portfolio of consumer and professional software applications, the iOS and OS X® operating systems, iCloud®, and a variety of accessory, service and support offerings"*. Moreover, the company also states that it *"sells and delivers digital content and applications through the iTunes*

Store®, App Store^{SM}, iBookstore^{SM}, and Mac App Store", acknowledging its role as a digital content vendor and broker. (Apple, 2012)

The worldwide sales of Apple products happens through its branded retail stores, online stores, and direct sales force, as well as through *"third-party cellular network carriers, wholesalers, retailers, and value-added resellers"*. The company is also engaged in selling a variety of third-party *"iPhone, iPad, Mac and iPod compatible products, including application software, and various accessories"* through its online and retail stores. The customers of Apple include consumers, small and medium-sized businesses (SMBs), and education, enterprise and government customers. (Apple, 2012)

An interesting notion is that Apple claims to sell its products (and resell third-party products) in most of its major markets directly to consumers and SMBs through its retail and online stores instead of relying mostly on indirect distribution channels. This is likely due to the company's stated belief in a *"high-quality buying experience with knowledgeable salespersons who can convey the value of the Company's products and services"* that *"greatly enhances its ability to attract and retain customers"*. The stores are designed to *"simplify and enhance the presentation and marketing of the Company's products and related solutions"*, located in desirable high-traffic locations. Also, the company believes that providing direct contact with its customers is *"an effective way to demonstrate the advantages of its products over those of its competitors"*.

The history of Apple as a company and its entry into the smartphone business was discussed briefly in Section 1.1.1. From its founding in 1977 to present day, the company has stayed true to its origin as a manufacturer of consumer-friendly personal computers, yet it has gone through several major technological transitions and has expanded its product offering to include portable media players, mobile communication devices (smartphones), and media streaming devices as well as related accessories. Additionally, the company has established itself as a major player in digital content sales and distribution through its iTunes Store, App Store, and iBookstore marketplaces.

Although Apple products continue to command a premium price in all segments (as compared to competitors' products with similar functionality), today they reach a larger group of consumers than ever before, mostly due to the rapid overall growth of the smartphone segment and the success of the iPhone there, with a total of 154 million units sold in 2013, accounting for a 15% global market share (Canalys, 2014). The company also successfully pioneered the even more rapidly growing tablet category that it dominates to date with its iPad product line. Looking at the technology adoption rates in the U.S. market, tablets reached 10% penetration in less than 3 years from their market introduction whereas it took smartphones approximately 8 years to accomplish the same (MIT Technology Review, 2012). Establishing an early lead in what appears to be the most rapidly growing product segment of the mobile communications and computing industry is a vast benefit for the company, not only because of the business opportunity, but also because of the increased network effects shared with the iPhone, strengthening the Apple iOS ecosystem.

Angle of Entry

As noted in the mini-case example in Section 2.1.2 discussing path dependence, Apple can be seen to follow its legacy as a premium-priced, niche computer manufacturer, thereby repeating the same scheme in its newer business domains such as smartphones, selling less in absolute volume terms than many competitors but capturing the bulk the of industry's revenue and profits by maintaining a very high average sales price (ASP) and gross margin for its products. In other words, Apple aims its products for the premium segment which helps ensure profitability as long as competitors cannot successfully match its offering. Aiming high also helps build brand equity and desirability among consumers.

To satisfy the demand for its products in slightly more affordable price tiers, Apple has taken up the practice of selling the two previous generations of its iPhone and iPad products at reduced prices. For example, in early 2013, the 4th generation iPhone, more than 2.5 years after beginning sales, was still being sold at 399 EUR (retail price in Finland), a price that put it only somewhat below the high-end products of Samsung at that time. As of mid 2014, the nearly 3-year-old iPhone 4S is still selling for 299 EUR. So, rather than designing new products for the mid tier, Apple caters to that segment with discounted older generation models. The first exception to this rule was the iPhone 5C available in five different colored casings, released at the same time as the iPhone 5S in September 2013, but with slightly lower hardware specifications and lower price than its high-end counterpart.

Apple's approach of discounting older models helps keep the company's R&D costs down compared to developing a portfolio of new devices at different price points. This approach is in stark contrast to that of most other handset manufacturers, but arguably Apple has proven its viability. Also in the tablet market, the more affordable, two generation old iPad 2 (along with the iPad mini) helped to satisfy the demand for more affordable iPads, leaving less room to play for other tablet manufacturers. As of mid 2014, Apple offers four different generations of iPads in two display sizes (9.7 inch regular models and 7.9 inch 'mini' models), each with progressively more powerful processors. The most affordable iPad mini lacks the high-resolution, high-pixel-density 'Retina display' of the other three models. (Apple, 2014c)

An enduring element of Apple's legacy is its closed platform approach for its products, using a proprietary OS and proprietary or otherwise incompatible peripheral interfaces. Originating from the Mac computers, it has been carried on to its portable CE devices, including smartphones and tablets. Somewhat ironically, the Macs of today are the most open of all Apple products, supporting USB 3.0 and other standard interfaces and also being capable of running Windows. However, the strong cohesion in design and UX across Apple products remains in force. The strict design and UX guidelines extend to third-party vendors of accessories and software applications as well. Such control may seem obsessive and even innovation limiting, but as the Apple UX is both different from the competition and typically highly appreciated by users due to its consistency and ease of use, it acts as a positive differentiator for multiple product lines and helps create stickiness in the Apple ecosystem. In this sense, it would appear that Apple exhibits the first-degree type of path dependence described by Liebowitz & Margolis (1995a) as noted in Section 2.1.1, as it has clearly made conscious decisions early on that have influenced the company's technology and product design choices to this day. Though some of these choices (such as sticking with Power Architecture based processors for a long time even though Intel x86 processors were more affordable and powerful) could be described as inefficient in retrospect, many of them have served to make Apple effectively stand out from the gray mass, allowing for increased differentiation and premium pricing. Also, product UX and industrial design as well as prowess in software development have remained Apple's core strengths since the early days.

Value Creation Logic

In the angle of entry diagram, depicted in Figure 1.2 and revisited in Figure 3.1, Apple is presented as entering the mobile smartphones business from the personal computing business domain, being originally focused on designing and selling hardware products. To date, the company is arguably still best described as a product company, making premium-priced computers but also a number of other devices in the areas of computing, media and entertainment, and mobile communications. However, the company has diversified itself into selling digital content and services that nicely complement the company's portfolio of devices and are consumable on them. Additionally, it has also expanded into the mobile advertising market by launching its iAd mobile advertising platform in July 2010 (Apple, 2010).

As its business strategy, Apple states that it is *"committed to bringing the best user experience to its customers through its innovative hardware, software,* *peripherals, and services"* and that it leverages its *"unique ability to design and develop its own operating systems, hardware, application software, and services to provide its customers new products and solutions with superior ease-of-use, seamless integration, and innovative design"*. The strategy also includes the continued expansion of its platform for the discovery and delivery of third-party digital content and applications through the iTunes Store that also includes the App Store and iBookstore.

There had long been indications that Apple would expand its presence in the mobile payments space, leveraging its already vast and growing base of iPhone and iPad users as well as the hundreds of millions of credit cards on file in its iTunes store and App Store. Through access to such a huge number of credit card credentials, currently used mainly for iOS app and in-app purchases as well as iTunes content purchases, Apple is arguably already now a major player in mobile payments, despite the fact that those payments are currently limited to its own closed content ecosystem. Offering a mobile payment platform that is open to third-party merchants would be the next logical step to expand the business, and so Apple Pay was announced in September 2014 (Apple, 2014d).

According to Wall Street Journal (2014), a payment service by Apple would launch the company into "what is becoming a fierce battle over how people pay through mobile devices". In the mobile payments market, Apple's rivals include eBay's PayPal service, Google Wallet, and startups such as Square Inc. and Stripe Inc. The market is clearly becoming attractive, as Forrester Research estimates that Americans will spend $90 billion through mobile payments by 2017, up from $12.8 billion in 2012 (Wall Street Journal, 2014).

Device Sales and Content Business

Despite its diversification, Apple still earns most of its revenue from device sales. Out of the $170.9 billion in net sales for fiscal year (FY) 2013 (ending September 28, 2013), Mac computer sales constituted 12.6%, iPhone sales 53.4%, and iPad sales 18.7%. The sales of iPod media players, having declined 21% compared to FY 2012, represented only 2.6% of the company's revenue. Branded peripherals and other hardware constituted 3.3% of total revenue. All in all, more than 90% of Apple's total revenue came from selling hardware and related services, not including revenue from content or separately sold software — this is reported as 'iTunes, software and services' (FY 2013) or 'Other music related products and services' (FY 2012). The revenue item 'iTunes, software and services' was $16.1 billion or 9.4% of total revenue in FY 2013, growing 25% from FY 2012. As of FY 2013, however, Apple no longer reports the sales of Apple-branded and third-party Mac software and services separately, and this source of revenue is now included in the 'iTunes, software and services' item, having amounted to $3.5 billion or 2.2% of total revenue in FY 2012. All things put together, Apple's content, software, and services business is still minor compared to its hardware sales revenue. (Apple, 2013c)

The role of Apple's digital content business in driving device sales is significant, however. The company had realized this early on, as in the year 2000, it had acquired the software technologies on which it would base its first release of iTunes in January 2001. When the first iPod media player was launched later that year, the new version of iTunes added support for the device, enabling media transfer and synchronization with Mac computers. The online iTunes store opened in April 2003, and it quickly gained popularity and became the largest music retailer in the U.S. after less than 5 years after its launch, surpassing Wal-Mart (Apple, 2008). Since then, Apple has been able to maintain and even increase its lead (EdibleApple, 2010; NPD Group, 2012). This and the iTunes revenue figures of $9.3 billion (FY 2013) and $7.5 billion (FY 2012) are testimonial to Apple's mastery of the business (Apple, 2013c, 2012). Although the original goal may have been to purely drive device sales and increase stickiness in the Apple ecosystem, it certainly is a viable business with a healthy growth rate even on its own.

As a summary, Apple's content, software, and services business is growing at a rate of 25% year on year (FY 2013 vs. FY 2012). This business has become the fastest growing product segment as of FY 2013 as a result of the slowing growth of iPhone and iPad sales. Still in FY 2012, these two product segments grew at phenomenal rates of 71%, and 59% respectively. Nevertheless, as of FY 2013, Apple still made more than 90% of its revenue primarily from device sales. Therefore, it is hardly surprising that Apple lists the principal competitive factors important to its business to include *"price, product features, relative price/performance, product quality and reliability, design innovation, a strong third-party software and peripherals ecosystem, marketing and distribution capability, service and support, and corporate reputation"*, most of which relate directly to their device products. (Apple, 2013c, 2012)

Mobile Advertising

Apple originally announced the iAd platform in April 2010, stating that it wanted to improve the monetization opportunities of developers publishing free applications. Apple's then-CEO Steve Jobs was unhappy with the mobile advertisements of the time, arguing that they detracted from the experience by taking users out of the app. He emphasized the need for mobile advertisements to deliver interactivity and emotion (TechCrunch, 2010).

During its first years of existence, iAd was not a great success. The service has been widely criticized as being too expensive for advertisers, initially requiring a one million dollar ad spend. Over time, Apple has lowered this minimum fee to $400,000 and then $100,000, but it is still considered too expensive for many advertisers. This is also due to the Cost per Mille (CPM, cost per a thousand ad impressions) and the performance-based pricing scheme where advertisers reportedly end up paying $0.50 to $1 CPM or $0.05 to $0.15 CPC (Forbes, 2012a). According to a report by Opera Software cited by Forbes (2012b), ads running on Apple's iOS command significantly higher prices than those on Android and much higher prices than all other platforms. For the iPad, the effective CPM was reportedly $3.96, for the iPhone $2.85, and for Android $2.10. This would seem to suggest that iOS has a major lead in actual ad revenues compared relative to its market share in traffic (Forbes, 2012b).

A related point of criticism is that iAd's upfront costs and pricing scheme are a gamble for performance-based advertisers whose profit depends on actions (e.g., purchases), not impressions or clicks. The share of impressions or clicks that eventually are translated into actions varies between brands, and bigger, well-recognized brands are at an advantage. Reaching a particular target demographic may also be challenging and more expensive with iAd than with rivaling mobile advertising platforms. Moreover, the conversion rates of iAd do not match that of AdMob on Android, which may at least partially be due to iOS's more engaging app experience. Finally, creating own ads for iAd is subject to Apple's sometimes lengthy approval process and is perceived to be cumbersome compared to Android. (Forbes, 2012a)

Recent data from a report by Opera Mediaworks suggests that for the fourth quarter of 2013, Apple's iOS held an impressive lead over Android and other platforms, capturing 43.4% of the traffic and 55.7% of the revenue compared to Android's respective figures of 37.7% and 31.7%. (Apple Insider, 2014a)

Model for Value Creation Process

Apple's core business of selling devices can be described using the classic value chain model. The company is responsible for the industrial design of its products as well as the design of device hardware, mobile application processors, device software and UI/UX, and most complementary services (e.g., iCloud), and therefore captures value primarily in these areas. With few exceptions, Apple has almost entirely outsourced its manufacturing operations to overseas contract manufacturers, most notably Foxconn (Hon Hai Precision Industry Co., Ltd.) that manufactures its products in China. Foxconn has been an effective and reliable manufacturing partner, but has also earned Apple some notoriety due to its reportedly poor working conditions.

As the Chinese domestic market continues to grow at a rapid pace and local labor costs rise, Apple is considering relocating its manufacturing. Manufacturers in general are turning their attention to Southeast Asian countries such as Vietnam where the cost level is lower than in China. Although Steve Jobs had commented that *"those [manufacturing] jobs aren't coming back [to the U.S.]"*, the current CEO Tim Cook said in December 2012 that Apple is indeed considering bringing some manufacturing jobs back to the U.S., and that certain product lines would carry the 'Made in the USA' label. Of course, this doesn't mean that Apple would completely withdraw manufacturing operations from China as the country is expected to be Apple's most important consumer market in the future. According to a Boston Consulting Group study, somewhat surprisingly, the U.S. is becoming one of the lowest-cost producers in the developed world, well ahead of countries such as the UK, Germany, France, Japan, and Italy. (CHaINA Magazine, 2013)

In its device business, aside from actual manufacturing, Apple is very much vertically integrated, even choosing to design its own mobile application processors instead of relying on off-the-shelf solutions from the likes of Nvidia, Qualcomm, or Texas Instruments. As already noted, it has also invested in a worldwide network of branded retail stores and care centers with dedicated, trained sales staff. This is something that very few other mobile device manufacturers have been able to do in a sustainable manner.

On the software, services, and content side, Apple's value creation is based on networked relationships. In its software ecosystem or value network, it acts primarily as a broker, bringing together application developers, content providers, and consumers. Apple provides the platform, infrastructure, and tools for the former groups, and facilitates their transactions with the latter group, consumers, earning a slice of the value of each transaction. In the case of App Store and iBookstore content purchases, Apple takes 30% of the revenue whereas the developer or publisher gets 70%. The same revenue sharing scheme also applies to in-application purchases and mobile advertising revenue.

Platform Approach and Governance

Product Technology, Architecture, and Openness

Apple relies fully on proprietary, in-house developed operating systems and platforms for its products. For the iPhone, iPad, and iPod touch product lines, iOS is the OS of choice. As noted in Section 1.1.1, iOS is based on a mix of closed source software components developed by Apple as well as open source components. The differentiating or value-adding components such as the UI and application framework are closed source to protect Apple's intellectual property and to hinder substitute innovation. A similar approach is applied to the OS X operating system that powers Mac computers. However, certain software interfaces and APIs such as the Cocoa (for OS X) and Cocoa Touch (for iOS) frameworks are deliberately open and well documented for third-party developers to develop complementary applications on top the platforms.

Using the terminology of Eisenmann (2008), Apple has clearly adopted a proprietary platform approach consistently throughout the life cycles of the iOS and OS X platforms, both currently in the maturity phase. Due its stringent control and proprietary approach, Apple has not had problems with free riders. No other platform provider or device manufacturer has access to the iOS and OS X platforms.

Although Apple has been able to maintain its niche position as a premium segment computer manufacturer, price competition has been particularly intense between competitors selling Windows-based personal computers, leading to lower margins for these players. The threat of smaller and simpler, Internet-enabled devices (such as tablets) is also acknowledged as a threat to existing Apple products, particularly its personal computers, despite the company's active role in developing and selling those newer product categories. Also, Apple notes that its financial performance substantially depends on its *"ability to continually improve the Mac platform to maintain its functional and design advantages"* (Apple, 2012).

It was long speculated that Apple would introduce its own contactless payment method in its iPhones rather than the standard method based on Near Field Communications (NFC), given Apple's reluctance so far to introduce NFC despite competitors having done so already some time ago. One alternative could have been the iBeacon, an in-door positioning system based on Bluetooth Low Energy (BLE) that also support payments and is already implemented for iOS 7 devices Expert Reviews, 2014). In September 2014, however, Apple finally introduced its mobile payment service, 'Apple Pay', based on NFC technology and a secure element (SE) chip embedded in its new iPhone 6 and iPhone 6 Plus products. The company also said the payment service would work with its newly announced wearable computing device, the Apple Watch, extending the service also to over 200 million owners of iPhone 5, 5s, and 5c. From October 2014, the Apple Pay service is available initially only in the U.S. (Apple, 2014d,e,f).

Under deals reached with banks individually, Apple will collect a fee for each transaction made with its payment service, which could amount to billions in a few years' time, as the mobile payments market is expected to more than quadruple to about $90 billion by 2017, according to Forrester Research cited by Bloomberg (2014). Although the terms of the deals aren't public, merchants typically pay fees in the range of 2 percent of the purchase price for credit-card transactions. These swipe fees, also known as interchange, help banks that issue credit cards cover fraud costs and fund reward programs. Bloomberg

(2014) notes that Apple's arrangement builds on the existing fee structures, allowing the company to tap into the swipe fees, currently amounting to more than $40 billion annually. The Financial Times reports, as quoted by Apple Insider (2014c), that Apple would earn a 0.15 percent of every Apple Pay transaction conducted over NFC.

In July 2014, Apple and IBM entered into a global exclusive partnership to "transform enterprise mobility" through a new class of business apps for the iPhone and iPad. IBM's strong capabilities in cloud computing, big data, and analytics are a welcome addition to Apple, whose devices are already very popular among business users, not only due to the BYOD trend but also the increased popularity and approval of iPhone and iPad as corporate devices (BGR, 2014). However, the enterprise IT service offering, integration and support for Apple devices has not matched that of Microsoft products, or even BlackBerry products in terms of remote device management, security, and integration.

Apple and IBM aim to address these gaps by deploying "unique" IBM cloud services optimized for iOS, including device management, security, analytics, and mobile integration, a new AppleCare® service and support offering tailored to enterprise needs, new packaged offerings from IBM for device activation, supply, and management, as well as more than 100 industry-specific enterprise solutions such as tailored apps for the iPhone and iPad (Apple, 2014b). Some of these industry-specific platform solutions, such as the one for healthcare promoted by IBM, have raised some skepticism due to numerous existing companies, even startups, having more domain expertise and offering better solutions and platforms than IBM (Forbes, 2014b). A further concern is the apparent lack of device agnosticism, and therefore iOS centricity, of the mobility management solutions. With BYOD users accounting for some two thirds of business smartphone users according to Strategy Analytics (2014) and considering the relative market shares of Android and iOS, it would be rather inconvenient for many companies to adopt a non-device-agnostic mobility management solution.

Quite aptly put, H. Shaughnessy writes on the Forbes blog that *"very few companies truly understand what modern business platforms are about or how to craft the strategy, technology and services mix"*, and although Apple is a "king" of consumer platforms, they too have shunned from building an enterprise platform, likely due to the dominant position of Microsoft (Forbes, 2014b). The Register (2014b) questions Apple's motives to partner with "Big Blue" (IBM), speculating that Apple's declining position in the consumer smartphone market would be reflected on corporate purchases as well. IBM selling iPads and iPhones preloaded with business apps with Apple providing the support does appear a smart complement to Apple's consumer-oriented channel approach, however, and helps defend Apple's position in the enterprise market.

In-House vs. External Focus in Complements

For iOS, the development of third-party applications has been possibly since March 2008 when the first SDK was made available. For OS X, application development has been possible since the beginning also using a non-Apple toolchain, most notably the GNU toolchain. Furthermore, OS X application distribution is possible via multiple channels, not limited to the Mac App Store and its stringent policies. For iOS applications, the only legitimate distribution channel is the App Store. In this sense, the OS X is more open for developers compared to iOS. In order to publish applications on the App Store, whether for iOS or OS X, the developer is required to enroll in the corresponding developer program for an annual fee of $99.

On the hardware side, Apple maintains full control of its product platform, being the only authorized maker of hardware running either OS X or iOS. Particularly in the market for personal computers and peripherals, Apple acknowledges its minority role in a market *"dominated by computer makers using competing operating systems, most notably Windows"*, and also notes that in this market, it has *"a number of competitors, many of which have broader product lines, lower priced products, and a larger installed customer base"* (Apple, 2012). These statements are made to acknowledge the risks that lie in being a proprietary platform owner with a minority market share in a market that has historically seen consolidation and is dominated by large competitors.

Apple produces a significant number of branded hardware accessories for each of its major product lines. These usually follow the same design philosophy and aesthetic as the core products and demand a price premium. Third-party accessories do exist and are typically more affordable than the Apple branded ones, but due to Apple's control over the licensing of its proprietary interfaces (such as the now obsolete 30-pin dock connector or the new 8-pin 'Lightning' connector), the price difference may not be dramatic. In addition to protecting its own branded accessory business, the company has used its proprietary interfaces as a means to control the quality and quantity of third-party accessories available, as producing compatible accessories requires its approval. For Mac computers with standard USB ports this is less of an issue, but to date, the entire iPhone, iPad, and iPod touch product lines only support Apple proprietary connectors, subjecting the peripherals for those devices fully to Apple's control.

In summary, it can be said that Apple does support the creation of external complements, but exercises significant control over it, particularly for its iOS based products. On the hardware side, branded complements (accessories) are a significant business segment for the company, and thus the company can be seen to protect that business through its licensing and approval policies.

In a somewhat surprising move, Apple announced it would acquire the subscription streaming music service Beats Music as well as Beats Electronics in May 2014. Beats Electronics (or briefly, Beats) comprises the 'Beats by Dr. Dre' family of popular consumer headphones, earphones, and speakers as well as patented Beats Audio software technology. Beats Music, on the other hand, is a subscription streaming music service that focuses on providing a personalized music experience for each user *"through a unique blend of digital innovation and musical passion"*, delivering *"the right music for any situation, any time, and any preference, personalized to your tastes"* (Apple, 2014a).

The price of the acquisition amounted to a total of $3 billion, consisting of a purchase price of around $2.6 billion plus some $400 million in Apple stock that will vest over time, making it the most expensive acquisition Apple has ever made by a wide margin (for comparison, NeXT Software was acquired by Apple for $400 million in 1997). The high price has lead to some criticism whether Apple is spending its money wisely, but it clearly is a move to stay competitive in the music streaming market, with offerings from Pandora, Spotify, Google, Amazon, and recently also Samsung threatening Apple's position. Apple itself sells songs through its iTunes store and has also launched iTunes Radio in September 2013, offering free ad-supported music to its users (Apple, 2013b). Beats brings some 250,000 monthly-paying subscribers to Apple's fold, complementing its existing services nicely (Yahoo Finance, 2014).

Managing and Incentivizing Complementors

Apple has generally been quite successful in managing its complementors particularly on the software applications side. As noted in Section 1.1.1, much of the success and rapid growth of the App Store can be attributed to a well-defined business model as well as a holistic offering of developer programs, SDKs, documentation, and training. As noted, other mobile companies had had similar efforts earlier, but they had not been effective in attracting developers or consumers in large numbers. Apple's revenue sharing scheme where the developer gets a 70% cut of the application revenue is simple and effective. Apple has been consistent in providing updates to its iOS operating system, allowing developers to gain early access to new APIs and related documentation well in advance of consumer deployment. It has also managed OS version fragmentation better than most competitors, which is a clear benefit for developers who typically need to spend a great deal of effort on validating the compatibility of their applications (TechCrunch, 2012a).

The App Store has created ample opportunities for complementors producing applications for truly diverse customer segments and purposes. In the case of iOS, Apple has generally not "stepped on the toes" of any notable complementors by blocking their applications in favor of in-house applications except in the case of core functionality such as the web browser. On iOS devices, the preinstalled Safari browser remains the only choice available whereas on computers running OS X, any compatible browser such as Mozilla Firefox or Google Chrome can be installed and used. One notable exception is Google, the services of which Apple has recently been ousting from its iOS devices, sometimes even at the cost of end-user experience, as evidenced by the poorly received Apple Maps client that abruptly replaced Google Maps in iOS6 and later versions of the OS. This points to Apple's intentions of being increasingly vertically integrated on the software side, acquiring and integrating key functionality directly into its OS platform, serving the goal of reducing dependency from rivals like Google or any other third parties that might eventually become supply bottlenecks or competitors.

As noted earlier, Apple does exercise rather stringent control over the publication of applications on the App Store. The vetting process that applications are subjected to is also a benefit for consumers as it helps maintain the quality level and safety of the application catalog. Malware is not really an issue on iOS, but the same cannot be said for Android on which a more liberal policy in distributing applications has lead to a significant malware and spyware threat.

Developers of software applications and producers of hardware accessories are not the only groups of complementors that Apple is courting to enhance its ecosystem. The content offering of the iTunes Store, one of the company's fastest growing business segments, is built on licensing deals with content producers and publishers of music, movies, TV series, books, newspapers, etc. Also advertisers, although not necessarily seen as complementors by end-users, have an increasing role in the economic viability of many complements offered, enabling ad-supported and ad-funded business models. Indeed, as also noted by Cusumano (2010), in newer multi-sided platform markets like the one where Apple operates, it is no longer enough to attract only end-users and developers.

Internal Organization and Propensity to Advance the Overall Good of the Ecosystem

Apple's organizational structure, as of 2011, is built around functional units reporting to the CEO such as 'Hardware Engineering', 'Software Engineering', 'iOS Software', 'Worldwide Product Marketing', 'Industrial Design', 'Operations', and 'Retail', complemented by supporting functions. The previous CEO Steve Jobs had established a clear system of responsibilities and expectations that didn't exist at rivaling companies. As CEO, Jobs was surprisingly involved in product-related decision-making, attending presentations and reviews to either give his approval or send the project back to the drawing board. He was known to dictate seemingly minor product details based on personal taste. Dissatisfactory projects such as the 'MobileMe' cloud service were discontinued, with the employees responsible reportedly terminated. To enforce clear accountability, Apple also insists on having a "directly responsible individual" as the go-to person for each product or task. (Electronista, 2011)

Because Apple shares only minimal information on its internal organization and ways of working, it is not clear which organizational bodies of Apple are responsible for fostering external innovation and complements. However, based on observations, it is clear that Apple takes this activity very seriously and has a clear, consistent strategy for it.

Ecosystem Approach and Governance

For Apple, its ecosystem very much equates to its industry partners acting as suppliers or manufacturing partners, distributors (mobile operators, wholesalers, retailers, value-added retailers), or complementors (including service partners, content producers, publishers, and advertisers). To a limited extent, Apple is also involved in industry standards bodies, but only when it stands to gain from such activities. As an example, Apple has been pushing the industry for smaller subscriber identity module (SIM) form factors, not being happy with the micro-SIM (3FF) form factor. In June 2012, the company won a standard battle over the nano-SIM (4FF) standard against a rivaling proposal from Nokia, RIM, and the Google-owned Motorola Mobility, with the European Telecommunications Standards Institute (ETSI) approving Apple's proposal. This raised concerns over the licensing policies of the new standard, but Apple has agreed to "fair, reasonable, and nondiscriminatory" (FRAND) licensing terms as is common with essential patents required to implement an industry standard. (Computerworld, 2012)

Ecosystem Role and Health

Per the categorization of Iansiti & Levien (2004a), Apple acts as the undisputed leader and *keystone* of its ecosystem — it provides the platforms and business models that enable sustainable value creation for a large number of players of varying sizes, occupying different roles in the ecosystem. On the software side, according to extensive comparative studies of the App Store such as the one by Hyrynsalmi et al. (2012), Apple's iOS platform had over 117,000 developers, compared to 91,000 for Android, and 18,000 for Windows

Phone. In terms of the number of applications in the catalog, Apple App Store was long a clear leader but as of July 2013 has been surpassed by Google Play with its over 1 million Android applications compared to Apple's 900,000 titles at that time (PhoneArena, 2013). These figures provide proof that there is ample *diversity* (a proxy for the ecosystem health measure of *niche creation*) in the iOS software ecosystem, second to perhaps only the Android ecosystem. Also, according to Apple, by end of 2013, the company had paid out a cumulative total of $15 billion to application developers per its revenue sharing scheme since the launch of the App Store in 2008, a big jump from the $8 billion announced in February 2013 and a good proxy for the *productivity* of its software ecosystem complementors (Apple, 2014g; TechCrunch, 2014b; The Next Web, 2013).

No statistics exist, however, on the survival rates of companies producing complements for Apple, a measure of ecosystem *robustness* identified by Iansiti & Levien (2004a). The competition for end-users' attention on the App Store is fierce, and a large and ever growing application catalog means that discovery is increasingly a problem, requiring application developers to invest more in, e.g., social media and viral marketing to ensure the continued discovery of their applications. This would suggest that the iOS app ecosystem is suffering from significant crowding-out effects that, according to Boudreau (2008), lead to diminishing returns for developers as well as a reduced level of innovation on the platform. Interestingly, as of late 2014, some developers have voiced their opinion about the stagnant state of the Apple App Store (Upstart Business Journal, 2014).

Hyrynsalmi et al. (2012) note that of the more than 170,000 iOS developers they identified as part of their data set of over 850,000 applications, 55% had published only one app. This highlights the extent of long tail innovation in the iOS ecosystem. It is fair to assume that many such one-app developers are individuals or small companies, and the level of churn is likely higher than with large, professional developers. Nevertheless, Apple's consistency and continuity in evolving its platforms has created a relatively stable environment for complementors where *obsolescence is limited* and *continuity of user experience and use cases* prevails.

By looking strictly at the hardware side of Apple's ecosystem, it can be argued that Apple leaves little room for complementary innovation as it remains the sole maker of hardware being compatible with its proprietary operating systems and thus the body of software that has been created for them. Although Apple does allow third-party manufacturers to sell compatible hardware accessories, it captures value from these products through the licensing policies of its proprietary interfaces and competes head on in many accessory categories with in-house products. By designing its own mobile application processors such as the 64-bit Apple A7 in the iPhone 5s and its successor, the A8 in the iPhone 6 and 6 Plus, the company is also exhibiting more vertical integration than many of its rivals (Samsung being a notable exception), capturing added value also from the chipset domain. Hence, it could be argued that Apple exhibits characteristics of a *value dominator* on the hardware side of its ecosystem, capturing the great majority of value created in that domain.

Software Ecosystem and Application Marketplace

As part of its business strategy statement in its Form 10-K annual report, Apple declares support for *"a community for the development of third-party software and hardware products and digital content that complement the Company's offerings"*. As argued by Kenney & Pon (2011), hardware firms and software firms rely on each other to push technology forward. Even Apple with its relatively closed iOS operating system depends upon the hundreds of thousands of application developers to continue to create desirable apps for end-users. Conversely, the developers that create iPhone apps have made a bet, a financial investment, on the continued success of the iOS platform and therefore rely on Apple to maintain and update their access to its operating system to be able to create complements.

VisionMobile (2011) estimates that an iOS app costs an average of $30,000 to develop, and hence the more than a million iOS apps available today would roughly represent an investment of $30 billion in the iOS ecosystem. The value of the ecosystem contributes to Apple's bottom line through increased device sales (as a result of the attractiveness and perceived value of the ecosystem) and revenue share from app sales. Of course, the iOS App Store in particular constitutes an ecosystem control point for Apple, as it is the only authorized marketplace for iOS apps. Apple indeed has complete control over the content selection and curation, distribution of apps, billing and monetization of apps, retailing and discovery of apps, and consumer insights, as argued by VisionMobile (2011).

Apple's iOS software ecosystem is an OS-centric one per the classification of Bosch (2009), as the development and distribution of complementary software is specific to the OS in question. Although cross-platform development of applications for iOS is possible to a certain extent, Apple has traditionally discouraged and even banned the use of cross-platform compilers, although the ban was later lifted (Computerworld, 2010; iMore, 2010). Moreover, the iOS ecosystem appears to exhibit all of the three success factors highlighted by Bosch (2009), i.e., 1) *minimal effort required by developers* due to the availability of a comprehensive SDK and developer toolchain as well as well-defined, rich APIs, 2) *generic, evolving functionality and set of features provided by* *the OS* due to the regular update cycle and development done by Apple to introduce new features and functions and refine existing ones, and 3) *(a sufficiently large) number of customers that use the OS and that are accessible to developers* which is evident in the hundreds of millions of iOS devices in use globally, including 150 million iPhones and 71 million iPads sold in its FY 2013 alone (Apple, 2013c).

Using the dimensions of openness identified by Eisenmann et al. (2008), the iOS ecosystem is open to demand-side users (i.e., end users), as anyone can join through purchasing or otherwise obtaining an Apple device running iOS. The ecosystem is also relatively open to supply-side users (i.e., developers) by allowing practically any individual or company to join the iOS developer program, although at a cost. As already noted, application development is possible only with Apple's own SDK and toolchain, and distribution and monetization takes place exclusively on the Apple App Store. With respect to the roles of the platform provider and sponsor, however, the ecosystem is closed, as Apple acts exclusively in both capacities.

By applying the extended role categorization of Müller et al. (2011), Apple exclusively occupies also the payment broker (iTunes), marketplace (iTunes & App Store), OS developer, testing & verification party, signing partner, and device manufacturer roles. In a non-exclusive but dominant capacity it also occupies the advertisement broker (iAd) and software developer role, and has significant influence over other software developers (through the terms and conditions of its developer program) and content providers as well as MNOs. Apple used to make exclusive deals with MNOs for the first launch rights of its latest iPhone products, giving the carrier exclusivity for a limited period of time, but has since given up the practice.

Multi-homing in the iOS software ecosystem appears to be a relatively rare phenomenon, with 6% or around 12,000 of 178,000 identified developers publishing also for Google Play (formerly Android Market). Even smaller fractions of iOS developers (0.4% and 0.3%, respectively) developed applications for Windows Phone or all three marketplaces. Interestingly, there appears to be no significant difference in the popularity and type of multi-homing applications compared to the total set of applications available (Hyrynsalmi et al., 2012). This would suggest that considerable diversity exists within and between the different application marketplaces, and this could be used as an argument to promote one software ecosystem over another.

Arguably, Apple is the leading player when measured by number of developers, revenue earned by developers, and by being the platform that gets most application titles first to its catalog. Multi-homing is a relatively rare phenomenon, with less than 7% or around 12,000 of 178,000 identified developers publishing also for Google Play (formerly Android Market). Even smaller fractions of iOS developers (0.4% and 0.3%, respectively) developed applications for Windows Phone or all three marketplaces. Interestingly, there appears to be no significant difference in the popularity and type of multi-homing applications compared to the total set of applications available (Hyrynsalmi et al., 2012). This would suggest that considerable diversity exists within and between the different application marketplaces, and this could be used as an argument to promote one software ecosystem over another. Arguably, Apple is the leading player when measured by revenue earned by developers, and by being the platform that gets most application titles first to its catalog. In the number of applications, it lost its leading position to Android in 2013, although both platforms currently have well more than one million apps in their store catalogs (PhoneArena, 2013; TechCrunch, 2014a; AppBrain, 2014).

4.2 Case 2: Google and the Android Ecosystem

Firm Scope and Angle of Entry

Google describes itself as a *"global technology leader focused on improving the ways people connect with information"*, aspiring to *"build products and provide services that improve the lives of billions of people globally"*. The company's famously ambitious mission statement is to *"organize the world's information and make it universally accessible and useful"*. Through innovations in web search and advertising, Google's website is a top Internet property and its brand among the most recognized in the world. (Google, 2013a)

Google's acquisition of Motorola Mobility for $12.5 billion was officially completed on May 22, 2012, resulting in its ownership of Motorola's business and assets. At that time, Google itself and many analysts attributed the deal to mainly acquiring the patent portfolio of Motorola to help protect the Android ecosystem. In subsequent patent-related legal battles, however, the Motorola patents have not proven out to be very effective. The company's reporting on this business was based on two operating segments: Mobile and Home. The former segment is focused on mobile devices and related products and services, whereas the latter is about technologies and devices that *"provide video entertainment services to consumers by enabling subscribers to access a variety of interactive digital television services"*, primarily set-top boxes for TVs (Google, 2013a).

In December 2012, Google agreed to sell the former Motorola Mobility Home division to Arris Group Inc. in order to focus and expand on smartphones amidst accelerating rivalry with Apple (Bloomberg, 2012). The transaction was closed in April 2013. Also in December 2012, Flextronics (an electronics manufacturing services company) agreed to purchase Motorola Mobility's handset manufacturing assets in China and Brazil (Flextronics, 2012). The deal also included a manufacturing and services agreement for Android and other mobile devices, and the transaction was closed in April 2013.

On Jan 29, 2014, Google finally decided to cut its losses with the former Motorola handset business as well, and Lenovo announced its agreement to buy the handset business from Google for $2.91 billion. As part of the deal, Google retains the majority of the patent portfolio of former Motorola Mobility as well as the Advanced Technologies & Projects unit. This development clearly highlights Google's desire to focus on its core business and the Android ecosystem, leaving handset manufacturing to others. (Reuters, 2014a; Google, 2014a)

Google generates revenue primarily by *"delivering relevant, cost-effective online advertising"* as the company states in its Form 10-K annual report (Google, 2013a). The AdWords and AdSense programs are at the heart of Google's advertising business model. Other businesses use Google's AdWords program to promote their products and services with targeted advertising, and additionally, the third parties that comprise the Google Network use the AdSense program to *"deliver relevant ads that generate revenues and enhance the user experience"*.

Google operates a cloud-based, digital content marketplace called Google Play with more than one million applications and games in its catalog in addition to music, movies, and books that users can discover, consume, and share on the web and on their Android devices. This content offering and marketplace rivals Apple's iTunes store and App Store as well as Amazon's MP3 store and Appstore for Android. As a further foray into online and mobile commerce, Google operates a virtual wallet service called Google Wallet that securely stores credit and debit cards, offers, and rewards cards. It enables users to tap their phone to pay in-store using Google Wallet at any location where contactless payments are accepted, at over 200,000 merchants across the U.S. Moreover, users can also pay online by signing into their Google Wallet account. For mostly consumer use, Google also offers cloud storage in the vein of Apple's iCloud, Microsoft's OneDrive (formerly SkyDrive), or Dropbox. (Google, 2014a; Google, 2013a)

Google has a Smart TV platform called Google TV that *"gives consumers the power to experience television and the Internet on a single screen, with the ability to search and find the content they want to watch"* (Google, 2013a). The platform is based on the Android operating system and runs the Google Chrome browser. It has been adopted by a number of TV and peripheral manufacturers, including Sony, Logitech, LG, Samsung, Vizio, Hisense, Netgear, TCL, and Asus. More recently, however, it appears that some TV manufacturers like Philips have chosen to promote Android (through the slogan "powered by Android") rather than the Google TV moniker, perhaps consciously distancing themselves from the Google brand (TP Vision, 2014).

Google's efforts in the area of social networking must be mentioned. Google arrived late to the game, launching its Google+ (Plus) service in 2011, described as *"a new way to share online just like users do in the real world, sharing different things with different people"*. As of late 2011 and 2012, the company has tightened the integration between Google+ and our other Google properties such as Gmail and YouTube, unifying previously separate accounts under a single sign-on system. The number of monthly active Google+ users had surpassed 300 million in October 2013, according to Google (USA Today, 2013). In comparison, Facebook had more than 1 billion monthly active users, while Twitter had just over 230 million at the same point of time.

Interestingly, Google is expanding fast into new business domains, such as automotive infotainment through the Open Automotive Alliance (OAA), announced on Jan 6, 2014 together with major automotive OEMs such as Audi, GM, Honda, and Hyundai as well as the chipmaker Nvidia. The pattern is similar to the original Open Handset Alliance, except that this time, Google is pushing for the integration of Android into the in-car environment and harmonization of the Android-based infotainment platform, presumably in an attempt to limit the forking of the Android OS as already done by some automotive manufacturers and Tier-1 suppliers. Also, Google was already a late mover compared to Apple that had announced its 'iOS in the Car' (later renamed as 'CarPlay') solution for in-car iPhone integration in June 2013 (Apple, 2013a; EFYTimes, 2014).

Building off its work with its OAA partners, Google announced and showcased Android Auto at its annual developer conference, Google I/O, in June 2014. The platform can be described as essentially a retooled version of Android that allows drivers to safely use their connected apps and mobile services while on the road (9to5Google, 2014). Google apparently researched which apps people were particularly looking for while in their car and placed a major focus on navigation, communication, and music. Android Auto integrates many of the apps drivers "know and love", like Google Maps and Spotify, to an interface that is designed and built for driving. After connecting an Android phone to a compatible car, drivers will be able to use Android apps and services specially designed for use in a car and accessible through in-dash display and controls (Open Automotive Alliance, 2014). The interface is also voice-enabled, and reportedly the apps are ran directly from a driver's phone as opposed to being natively installed on a car. This brings the advantage of easier and more frequent application updates, as well as making the Android Auto experience transferrable between compatible cars (9to5Google, 2014).

Although an SDK wasn't yet available at the time of the announcement, the APIs used in Android Auto are also shared by Android Wear, so developers are able to migrate their applications between different hardware platforms without difficulty. Compatible vehicles from some 25 automotive brands are expected by the end of 2014 (9to5Google, 2014).

Google's vision for the future of the automobile, however, goes far beyond merely integrating its popular OS and services into the vehicle. Indeed, the company has been testing its 'self-driving car' since 2010 on public roads in certain states in the U.S. that allow driverless cars for testing purposes (albeit with human supervision), with the goal to improve driving safety and ultimately, to introduce fully autonomous cars (Mashable, 2013).

Google has also launched interesting gadgets of limited commercial success such as the Google Glass augmented reality enabled spectacles. In March 2014, it announced Android Wear for smartwatches and other wearable computers, with the first such products from Samsung and LG launched in June 2014. Clearly, Google wants to be an active player also in this novel area, talked about for years and also pursued by its rival Apple.

It has also remained active in acquiring promising companies for their technology and intellectual property, hinting at its future direction. For example, Google acquired a number of robotics-related companies, including Boston Dynamics, in December 2013. One of the latest acquisitions is that of Nest, a home automation company, announced on Jan 13, 2014 for a price of 3.2 billion U.S. dollars, the second-most expensive acquisition for Google since Motorola Mobility (Forbes, 2014a). These developments would suggest that Google is actively and boldly looking to expand into new areas of business, supporting its vision of organizing the world's information and making it universally accessible, not just on computers and mobile devices but in all areas of life, in the 'Internet of Things'.

Angle of Entry

Google (NASDAQ: GOOG) is relatively young as a company, having been incorporated in September 1998 and having made its initial public offering (IPO) in August 2004. As noted in the mini-case example in Section 2.1.2, the company started out with search keyword advertising as its sole method of monetization. In addition to search advertising, Google also provides display advertising services through its DoubleClick advertising technology that includes video, text, images, and other interactive ads. These ads appear on YouTube, Google Finance, and Google Network member websites (BMIMatters, 2012).

While advertising as a whole remains Google's primary source of revenue to date, it has adopted continuous subscription-based monetization models for some its services such as Google Apps for Business, a fully cloud-based productivity software solution primarily intended for small businesses (Google Enterprise Blog, 2011). Google Apps competes as a more affordable alternative to Microsoft's Office 365 (Google, 2013e; Microsoft, 2013a). It also enables enterprises to adopt popular services such as Gmail in their own domains, allowing them to forgo the more expensive Microsoft Exchange system. Google also offers cloud storage using a freemium business model, with the basic service with 15 GB storage being free and capacity upgrades requiring an increasing monthly fee. The first increment at 100 GB costs $1.99 per month as of March 2014.

Already before Google acquired the struggling handset maker Motorola which already had become dependent on Google's Android OS platform in its smartphones, it was widely speculated whether Google would start making money by selling its own "Googlephone" or, in general, CE devices enabled with Android and Google software. As already noted, Google has mostly relied on its hardware partners to produce Android handsets and 'Chromebooks' (see Google, 2012a), laptops running Google's Linux-based Chrome OS. However, it has also directly sold their 'Nexus' branded Android devices that are intended to showcase the latest "Google experience" on a device, often at a more affordable price than the highest-end offerings of branded handset vendors. This showcasing scheme applies also to Android tablets (see Google, 2012b). Google also introduced a media-streaming entertainment device (set-top box) called 'Nexus Q' in June 2012 but later discontinued it amidst criticism for having too few features for its price. Having divested the former Motorola Mobility Home division, it is unlikely that Google will make similar products in the near future. Also with the more recent divestment of the former Motorola handset business announced in January 2014, Google is unlikely to pursue further vertical integration in smartphones and tablets, but appears to be expanding into new business domains such as automotive, robotics, and home automation, as already noted.

Google being a relatively young company with many of its current technologies and platforms only a few years old, it is hard to pinpoint any major path dependence in its platform or technology-related decisions. If any such path dependence is evident, it is probably on the business model side. Stemming from its origins as a web search provider earning its revenue from advertisers and advertising networks, direct monetization through licenses seems to be a monetization model pursued less frequently by Google, although many of its cloud-based services aimed at SMBs and other enterprise customers definitely charge license fees for usage.

While definitely the hub of the largest smartphone ecosystem currently in existence, Google is mostly sticking to its roots in terms of monetization, earning as much as 96% of its revenue from advertising (BMIMatters, 2012). This goes well with Google's intention of keeping most of its services "free" to the general public — free of course meaning ad-funded as there really are no free lunches. Undoubtedly, Google is increasingly profiting from mining the "big data" that hundreds of millions of consumers have trusted the company with, although many other companies and even governments employ similar techniques (SmartData Collective, 2012).

Value Creation Logic

As a whole, Google's operations fall within the areas of search and display advertising, the Android OS platform, consumer content through Google Play (Google's digital content marketplace), enterprise, commerce and hardware products (Google, 2014a). As already noted, search advertising based on the AdWords and AdSense programs forms the foundation of Google's advertising business model. Most of Google's AdWords customers pay on a *cost-per-click* basis, i.e., an advertiser pays only when a user clicks on one of its ads. AdWords is available also on a *cost-per-impression* basis that enables advertisers to pay Google based on the number of times their ads appear on Google websites and Google Network Members' websites as specified by the advertiser. In addition to attracting advertisers to the AdWords program, Google also attracts a larger body of website owners to the AdSense program, allowing them to make money by enabling the showing of text or image based ads alongside their web content. AdSense partners are part of the Google Network. (Google, 2013a)

Google also owns AdMob, the market-leading mobile advertising network, the acquisition of which was completed in May 2010 for $750 million. In October 2011, AdMob was featured in 89% of Android applications leveraging mobile advertising, and 50% of the top 1000 downloaded Android applications included at least one mobile ad network, which clearly highlights the dominance of AdMob on Android (Xyologic, 2011). As of June 2012, Google has integrated the AdMob technology directly into its AdWords system and interface, enabling advertisers to run effective campaigns across the more than 300,000 applications running ads by AdMob (Google, 2013a). These efforts have allowed AdWords advertisers to reach people "across all screens", on more than 2 million websites and hundreds of thousands of apps.

For its fiscal year ending Dec 31, 2013, Google earned $37.5 billion in advertising revenue (74% of total advertising revenue) from Google websites and $13.1 billion (26%) from Google Network Members' websites. In total, the advertising revenue of $50.6 billion represented 91% of Google's revenue (excluding

Motorola) in 2013. The remaining 9% or $4.97 billion are accounted for as 'other revenues' mostly driven by hardware sales. This revenue stream grew by 111% from 2012. For comparison, advertising revenue represented 95% of Google's total revenue in 2012. Furthermore, counted separately from Google revenue, Motorola Mobile earned $4.44 billion in revenue in 2013, mostly from hardware (smartphone and tablet) sales. As noted above, however, Google has divested the former Motorola handset business. (Google, 2014a)

Platform and Content Business

The area of 'operating systems and platforms' is of particular interest as Google is the owner of the world's most widely adopted smartphone OS and software platform, Android. With half a billion Android devices activated globally through September 2012 (Google, 2013a), the company is in a unique position to benefit from the rapidly growing smartphone business and the large user base with devices running Android. Although Google does not monetize Android directly, it gains extra "eye balls" for its advertisements and also valuable information about its user base's preferences, online activity, and usage patterns that are used for profile building and targeted advertising. Using Google services on an Android device requires the user to have a Google account and being logged in. In principle, this is no different from using Google services on a desktop computer, but the user cannot really use the services anonymously on an Android device. Also, opting out of targeted advertising can be quite challenging on an Android device (Lifehacker, 2011). Effectively, users of Android are at least partially "paying" for their use of the OS by being subjected to ads and various kinds of data collection and mining.

Google's value creation is mostly based on networked relationships, and specifically its advertising programs that bring together advertisers and website owners. Its advertising programs can be thought of as two-sided (or multi-sided) platforms that link advertisers (the paying side) to Google's vast user base through showing search or display advertisements, but also to Google Network Members' websites and their consumers, reaching an even wider audience. Through its AdSense program, Google also facilitates the value creation of website owners through ads embedded in web content. Google also operates Google Play, a digital content store that sells Android applications, music, books, and magazines as well as movies and TV series in select markets. The store is similar to Apple's iTunes in its purpose and scope, although there are differences in the publishing policies and costs. The revenue sharing scheme for published Android applications is similar to Apple's App Store in that the developer gets a 70% cut of the revenue.

Platform Approach and Governance

Product Technology, Architecture, and Openness

Google is known for its large number of products, most of which are actually Internet-based services. The company does have physical consumer products as well, such as the Chromebooks and Nexus series smartphones and tablets (although they are not manufactured by Google) as well as more peculiar gadgets such as Google Glass, a pair of augmented reality (AR) glasses (Huffington Post, 2013). The services range from very serious, revenue-earning web properties such as Google Search and Google Apps to a multitude of niche services that may eventually become big, be discontinued, or end up integrated into a larger service entity such as Google+ (Wikipedia, 2014). Google has a policy of validating new service concepts by launching the services as public beta versions. Services that prove successful and meet their targets for user uptake are "graduated" into commercial grade services whereas less successful ones, such as Google Wave, are eventually ramped down. Many of the current services, such as Gmail, Google News, and Google Talk, have originated as so called '20%' projects which means that individual employees or groups of employees have began work on them as company-sponsored side projects for innovating freely (eWeek, 2008).

Despite its breadth of services and a company culture fostering employee innovation, Google is reportedly not so keen to expose its products and platforms to developers outside the company. This is reflected in the anecdotal commentary of a Google engineering manager who had also worked at Amazon for many years and had noticed significant differences in the platform and service architecture approaches of the two companies (Yegge, 2011). In his view, Google does not "understand" platforms unlike Amazon which had platformized essentially its entire service portfolio and adopted a service-oriented architecture (SOA) in its computing, resulting in each service, regardless of whether internal or external, having a neat service interface which can also be exposed to external developers easily if needed. Arguably, Amazon's strength in cloud computing and as a cloud infrastructure (IaaS) and platform (PaaS) service provider can largely be attributed to this fundamental decision.

Google, on the other hand, has been slow to platformize its services and is reportedly also lagging behind in providing comprehensive API access for external developers. The golden rule of platforms being that "you eat your own dog food", meaning that internal developers should work with similar APIs and tools that external developer have access to, Google is perceived as trailing other platform providers such as Microsoft in creating platform value (Yegge, 2011). Yegge (2011) argues that *"you don't eat People Food and give your developers Dog Food"*, and that doing so will constitute robbing long-term platform value for short-term success. He also notes that, at Google, any product teams that have successfully internalized the notion that the products should be designed as externally programmable platforms from the ground up are "underdogs", and mentions Maps and Docs as examples. He further argues that as platform thinking isn't part of Google's culture, it's hard for many teams to get funding for platformization efforts. As the original article or "rant" was written in late 2011, it is quite possible that Google has made progress in platformizing many of its products. This should be expected at least, as competitors such as Amazon and Microsoft, or even Apple, play the platform game very well.

In the context of smartphone business, however, Google does have one particularly strong platform, namely Android. As noted in Section 1.1.1, Android was originally an independent company that Google acquired in 2005. The platform rose to public prominence after Google announced the founding of OHA to promote and drive its adoption. Android was heralded as the first truly open and comprehensive mobile software platform, and the claim does have truth to it in the sense that Android is an open source project under the Apache Software License (ASL) 2.0 and, to a lesser extent, GNU Public License (GPL) v2 where the code is related to the Linux kernel and standard libraries. ASL2.0 is a permissive license and does not have a strong 'copyleft' clause, thereby allowing complements and derivative work to be kept private. In the Android source site frequently asked questions (FAQ) section, Google states that this is due to its most important goal for Android being widespread adoption of the software (Android, 2013).

While acknowledging that launching a software platform is complex, Google recognizes the vital importance of openness to the long-term success of a platform, since openness is required to attract investment from developers and *"ensure a level playing field"* (Android, 2013). Nevertheless, the platform itself must also be a compelling product to end users, and to this end, Google has committed the engineering resources necessary to ensure that Android indeed is a fully competitive software platform. In addition to treating the Android project as a full-scale product development operation, the company also makes business deals as necessary to ensure that great devices running Android actually make it to the market. This helps ensure the vitality of Android both as a platform and as an open source project.

Google maintains a branch in the open source repository tree for each platform version of Android. At any given time, the most recent such branch is considered the 'current stable' version which manufacturers port to their devices and is kept suitable for release at all times. There is also a 'current experimental' branch for the development of next-generation features or other speculative contributions which may not be ready for commercial use. Bug fixes and other contributions can also be included in the stable code branch as appropriate. (Android, 2013)

Google has taken up the practice of working on the next version of the Android platform simultaneously with developing a new flagship device with an OEM partner. This means that some parts of the next version of Android including the core platform APIs are developed in a private branch. This private development branch includes changes from the experimental and stable branches as appropriate. Such a practice can be viewed as contrary to the open source ideology, but Google claims that this is in the interest of both OEMs and developers, as each can focus on a single version without having to track unfinished future work just to keep up. Device manufacturers typically want to ship the very latest software they can, with the latest features. Developers, on the other hand, value relatively stable platform APIs that do not change frequently during the development of apps.

Google states that other parts of Android that aren't related to application compatibility are developed in the open and that its intention is to move more of the privately developed parts to open development over time. Nevertheless, Google Mobile Services (GMS) including Google Play Services and the rest of Google's applications and services suite remain proprietary and are not part of the Android Open Source Project (AOSP), the truly open source part of the Android platform (CommonsWare, 2013; InfoWorld, 2014). They are, of course, available to the OEM licensees of Android under certain conditions, but they are definitely not open source (Ars Technica, 2013a). OEMs using Android need to follow a "GMS approval window", effectively forcing them to ship products running an Android release not older than nine months, if they want to keep the popular Google apps and services (Android Police, 2014; DailyTech, 2014). Google has also been criticized for "closed source creep", i.e., increasingly moving its development efforts from AOSP to the closed source, proprietary counterparts of certain Android apps and services (Ars Technica, 2013a).

In this sense, Google exhibits proprietary control over key components of the Android platform, components that the average consumer would probably consider critical to the platform, i.e., the Google Play application store, Google Maps, Gmail, etc. While it is possible to create and ship products on the AOSP code base (pending the licensing of certain audio/video codecs), most device manufacturers using Android, like Samsung and HTC, ship their Android products with the proprietary GMS suite licensed from Google to deliver the complete Android experience. Although Google doesn't charge money for GMS, it comes with numerous requirements or "strings attached" that give Google a lot of control over Android devices (InfoWorld, 2014). It is no less proprietary than iOS or Windows Phone.

However, since the most popular Android devices at least in the Western world include both the AOSP core components as well as the GMS suite, most people probably equate Android with AOSP combined with GMS. The Google Play, Drive, Maps, and Gmail related APIs that many application developers rely on in their applications are, unfortunately, also part of GMS, and so developers, too, must decide whether they want to target the GMS-equipped Android devices exclusively or make their applications compatible with the bare-bone AOSP platform with limited APIs. This question is increasingly relevant as AOSP-based hacks of Android emerge from various OEMs, the Nokia 'X' series of smartphones being one of the latest examples. According to InfoWorld (2014), some analysts believe that roughly half of the Android products in the world are running AOSP without GMS. These devices lack the GMS suite and Google Play and typically replace them with competing, proprietary services and application marketplaces, such as the Amazon Appstore for the Kindle Fire tablets or the Nokia Store for the Nokia X smartphones. All in all, while it can be said that Android (or at least AOSP) is a shared platform, Google does have a fair amount of control over Android device manufacturers through its licensing terms for GMS and its practice of developing the next version of the OS platform in a private branch.

In-House vs. External Focus in Complements

Google is well known for its extensive in-house development capabilities and fostering of innovation. It has also acquired a number of companies over the years to further enhance its capabilities in key growth areas. For example, Google announced its acquisition of YouTube for $1.65 billion in October 2006 to strengthen its video hosting capabilities. The deal was finalized a month later. The acquisition of Motorola Mobility for $12.5 billion, announced in August 2001 and completed in May 2012, remains the company's biggest acquisition to date. The latter acquisition provided Google not only with a sizable mobile technology patent portfolio but also with software and hardware engineering resources to work on smartphone and tablet products. Google did, however, later decide to step out of the loss-making handset manufacturing business and sold the former Motorola handset division to Lenovo in January 2014.

Google takes fostering external innovation very seriously and supports third-party developers working on a number of Google products and platforms, e.g., Android, Chrome, Google Apps, Google Maps, Google TV, Google+, the Google Cloud Platform, Google Analytics, and of course the advertisement platforms and APIs such as AdWords and DoubleClick. Commerce APIs (mainly related to Google Wallet and Google Checkout) as well as game development on the web and mobile are also supported. Google's developer resources can be accessed at the web address *http://developer.google.com.* Google hosts an annual developer conference, Google I/O, for all of its products and technologies usually in early summer. Additionally, Google has previously organized developer days mostly focused on its web products as well as 'code camps' or developer programs for students (e.g., Google Summer of Code) where the students get to write code for various open source software projects (Google, 2013b).

Android software development has been possible to the general public ever since the platform was announced and a preview SDK was made available in November 2007. The platform has a separate, comprehensive developer site at *http://developer.android.com.* Unlike Apple's iOS platform, the Android development tools are completely free of charge and developers can write and test applications without having to join a developer program. However, in order to publish Android applications on Google Play, a one-time registration fee of $25 is charged from the developer (Android, 2014).

Managing and Incentivizing Complementors

Google actively incentivized Android applications development through two Android Developer Challenges, the first one announced in January 2008 and the second in May 2009. Google awarded a total of $10 million in prizes to developers, distributed between ADC 1 and ADC 2. Particularly the first event helped jump-start the application catalog of the then-nascent platform with a total of 1,788 entries from participants from over 70 countries. On the event's first deadline of April 14, as many as 170+ submissions per hour reportedly occurred (Android Developers Blog, 2008). Since the second developer challenge, Android has gained enough momentum to attract large numbers of developers on its own. Similar developer challenge events have been organized for, e.g., the Google Apps suite between June and November 2012. Also smaller local events and 'hackathons' have been organized sporadically, such as the one on the Google Drive SDK in March 2013.

Google wisely adopted a similar revenue sharing scheme as Apple for its application marketplace, but with a less stringent publishing process. With no thorough inspection of submitted applications taking place, however, Android has suffered from malware considerably more than rivaling iOS and Windows Phone platforms that do employ a vetting process for submitted applications. As of early 2012, Google has taken measures against this, such as introducing an in-house automated anti-virus system ('Bouncer') to remove malicious apps from the marketplace, resulting in a reduction of potentially malicious app downloads by 40% (SC Magazine, 2012).

Google is known neither to impose limitations on its complementors nor to block certain third-party applications, should they have overlap with in-house offerings. For example, Google allows third-party web browsers, such as Firefox for Android, to be used freely on Android devices. However, when it comes to developer APIs, Google has gained a bit of infamy in restricting or deprecating certain interfaces and APIs with relatively short notice, as is the case with the CalDAV API used for calendar synchronization (Google, 2013c).

Much like Apple, also Google is courting content producers and publishers of music, books and magazines, movies, TV series, etc. in order to build a comprehensive content offering on Google Play. Although millions of songs are available in the store in addition to a multitude of books and other content, Google is many years behind Apple in making its content offering global. While only the United States and the United Kingdom had the complete breadth of content available in early 2013, diverse content has since been made available in dozens of countries — as an example, Google Play Music is available in 43 countries and Movies in more than 90 countries as of August 2014 (Google, 2014b).

Internal Organization and Propensity to Advance the Overall Good of the Ecosystem

Google's work culture is regarded as legendary, and the company has regularly topped the charts for the most popular workplaces in the U.S. Not only was Google an icon of success among Internet companies, but also for many, the company represented the most successful blend of culture and technology in Silicon Valley (ICMR India, 2004)

It is commonly perceived that Google's lack of unnecessary managerial hierarchies and giving its engineers "a free hand to work" or more liberties in deciding how they use their working time has been a crucial factor behind the company's success. The famous "20% rule" already mentioned above is an example of how this culture manifests itself. As Google product teams and even individual engineers typically have a high degree of independence, innovative ideas are cultivated. Due to the public beta culture of Google, nascent products (services) may be exposed to consumers and developers at a relatively early stage, helping to stimulate the interest of external complementors.

Google has a developer relations team that is comprised of a diverse group of developer advocates originating from different parts of the world (Google, 2013d). Typically, each developer advocate specializes in one or more Google products or developer APIs, and together they cover the whole range of Google products and platforms.

Ecosystem Approach and Governance

For Google as a whole, its most important ecosystem partners are advertisers that bring in the most of the revenue. Almost as important are its Google Network Members that participate in Google's AdWords, AdSense, and DoubleClick programs and host Google's advertisements on their websites, expanding the target audience for advertisers reachable through Google. In the context of Android, however, Google's ecosystem equates to its industry partners such as mobile device manufacturers and operators, as well as complementors (including service partners, content producers, publishers and website owners, and advertisers). Google itself (excluding Motorola) acts as a device vendor only to a limited extent and sell its Nexus devices through direct online retail.

Google's self-stated goal is to ensure a successful ecosystem around Android, but without forcing anyone to participate. As Android's code is open source, anyone can modify and distribute the software to meet his/her own needs. The focus of Google and OHA members is on releasing "great devices" into a competitive marketplace, and then incorporating the innovations and enhancements made into the core platform as the next version. What this means in practice is that the Android engineering team typically focuses on a small number of "flagship" devices, and develops the next version of the Android software to support those product launches. The advantage of this approach is that these flagship devices carry much of the product risk and "blaze a trail" for the broad OEM community, who can follow up with a number of devices that take advantage of the new features. According to Google, this also ensures that the Android platform evolves according to the actual needs of real-world devices. (Android, 2013)

Google has not been very consistent in its Android strategy in terms of exclusivity. For the most part, Google has had the practice of working with a single OEM and a carrier partner for bringing a new major release of Android to the market, but usually rotating those partners for each release (PC Magazine, 2012a). As an example, the very first release (1.0) was launched exclusively on T-Mobile in late 2008, and the device (T-Mobile G1) was manufactured by HTC. Other carriers began offering the device later under a variety of names. Android 2.0 'Eclair' saw its debut in Verizon Wireless' Droid smartphone in October 2009, manufactured by Motorola (at the time still an independent company). The minor Android release 2.3 'Gingerbread' debuted in the Samsung-made Nexus S smartphone that included both Google and Samsung brands prominently on the device as well as an uncustomized version of the Android UI (as opposed to the Samsung TouchWiz skinned Galaxy S devices). The device and all subsequent Nexus branded devices (and the preceding HTC/Google Nexus One which ran Android 2.1) are so-called 'Google Experience Devices' that feature prominent Google branding and the Android UI and Google mobile services as-is, without handset manufacturer modifications. For Android 3.0 'Honeycomb', Motorola was chosen as the lead device manufacturer, this time producing a range of tablets under the Xoom sub-brand. This version of Android was special in that it was designed for large-screen tablets only, while Android 2.3 remained the latest version available for smartphones.

For the release of Android 4.0 'Ice Cream Sandwich', Google again worked with Samsung to produce the Galaxy Nexus lead device launched in November 2011, this time featuring Samsung's Galaxy brand despite being a co-branded Google Experience Device. At the same time, Samsung continued selling various versions of its vastly successful Galaxy S II still running Android 2.3. These devices began receiving updates to Android 4.0 only in March 2012, and some countries received updates as late as August 2012. As manufacturer-skinned Android devices (such as the Samsung Galaxy S series) typically require extensive work to make the custom UI and applications work on the newer platform software release, the updates often lag behind several months. This has contributed to the Android platform fragmentation problem, as there are a large number of devices in use and even on the market still running older-than-current versions of the OS platform. This, of course, complicates things for developers as they cannot assume that the great majority of Android device users are running the latest version of the platform.

By allowing OEMs to customize the Android experience, Google has effectively aggravated the fragmentation problem. With Android 4.0, Google intended to reduce the need for OEM skinning and customization, but so far at least Samsung is sticking to its TouchWiz UI which is featured on its Galaxy S III launched in May 2012. For the minor Android release 4.2 'Jelly Bean', LG was chosen as the OEM partner for producing the Nexus 4 smartphone which has received very positive reviews. Android 4.4 'KitKat' followed in late October 2013, being showcased in the Nexus 5 smartphone, again produced by LG. The Android 'L' release, expected in late 2014, is to bring major design changes as well as fundamental new features such as interlocking apps (i.e., apps talking to one another) (TechRadar, 2014c). As of mid 2014, there have been rumors regarding an upcoming Android program called 'Android Silver' that would allow Google to enforce more stringent requirements on the specifications of the devices made by participating OEMs and also apparently to sharply limit the number of non-Google apps that can be pre-installed, or at least to ensure that phone owners will be able to uninstall them (TechRadar, 2014a).

True or not, Google did announce an initiative called 'Android One' in June 2014, aimed at the very low end of the smartphone market especially in emerging markets like India where the demand is high for affordable, yet high quality smartphones with reasonable data plans (Google, 2014c). Google has worked with suppliers and OEM partners to define reference platforms for devices that would all meet a minimum set of technical specifications, including a 4.5 inch display and a quad-core processor supplied by MediaTek, which are powerful enough to support all of Google's mobile services while keeping the price down to a reasonable 100 USD or less (BBC News, 2014). Although Android-based smartphones have been available in such price points for quite some time, the UX and performance of such devices has often left much to be desired.

With Android One, Google is clearly seeking to solidify its grasp of the rapidly growing entry-level smartphone segment, while at the same time unifying the Android experience with relatively fixed hardware specifications, and limiting fragmentation by prohibiting OEM skinning of Android One devices. Even more importantly, by introducing the large masses of emerging market users, transitioning from feature phones to smartphones, to Android and Google services in a controlled manner, Google is able to secure an ever-growing audience for its mobile advertising business. To capture growth in this important business, it is clear that the emerging markets need to be harnessed more extensively than before. With smartphone platform competitors such as Microsoft and the operator-backed Firefox OS seeking to tap those same opportunities in emerging markets, Google is taking proactive steps to ensure it remains in the leading position.

One of the biggest concerns for Android OEMs was whether the (previously) Google-owned Motorola Mobile division would gain preferential treatment that would put other Android OEMs at a disadvantage. Traditionally, OS vendors such as Microsoft have shunned from producing in-house devices in large scale so as to not alienate OEMs licensing the OS in question. However, as even Microsoft seemed to have abandoned this principle with the launch of its Surface device family, there was speculation whether Google was also inclined to put more weight behind its in-house handset maker despite the ecosystem risks involved. Had this happened, with Google devices gaining an upper hand in the Android ecosystem, the other OEMs would surely have actively sought alternatives to Android. This is actually the case with Samsung that develops its own 'Tizen' OS that has, however, faced a series of delays and setbacks. The first Tizen products appeared in late 2013 in the form of a smart digital camera and a developer-oriented tablet, with smartwatches from Samsung following in April 2014. Somewhat surprisingly, however, Samsung announced their next generation smartwatches being based on Android Wear, not Tizen, in June 2014. The company did announce a Tizen smartphone to be sold at least initially in Russia with other markets planned (CBC News, 2014). Although Samsung is currently the dominant smartphone manufacturer turning over billions of dollars in sales, to create a viable alternative to Android is not at all easy or quick for them.

The concern eventually proved unsubstantiated, as Google decided to divest its loss-making handset division in January 2014. Had Google really gone vertical, it could have benefitted the Windows Phone ecosystem that has struggled to gain real commitments from other OEMs besides Nokia. However, already before its announced acquisition of Nokia's handset business, Microsoft was rumored to introduce a Surface smartphone line as well (PC Advisor, 2012; DNA India, 2013). With Microsoft having acquired Nokia's handset business and licensed rights to the Nokia brand for mobile use for 10 years, there are few truly neutral options available anymore for handset OEMs seeking to license a smartphone OS.

Ecosystem Role and Health

Per the categorization of Iansiti & Levien (2004a), Google is clearly a *keystone* — it is a platform provider on many levels and enables value creation for its entire ecosystem through those platforms. Websites earn revenue by hosting Google's advertisements, and advertisers benefit from Google's broad consumer reach and effective targeted ads that have a high conversion rate. Android OEMs benefit from having a state-of-the-art mobile OS platform that is essentially royalty free and currently enjoys higher consumer adoption rates than any competing platform. Handset accessory makers appreciate the fact that they can work with standard interfaces and are not bound to the whims of any single OEM. Developers benefit from having access to a broad installed base of Android device owners for which to develop commercial or free applications. They also generally appreciate Android's openness and nonrestrictive philosophy in, e.g., application distribution. Mobile operators benefit from the overall consumer trend favoring smartphones over feature phones, fueled in many markets by the availability of affordable Android handsets, allowing them to sell increased numbers of more expensive devices coupled with data plans. Unlike its rival Apple, Google derives very little direct revenue from most of these business activities as it does not charge for Android licenses, nor does it sell devices in major volumes. Because of this, it is easy to see Google as the "good guy" that is eager to allow its ecosystem members to make profit and thrive as they best see fit.

There is at least one area where Google has exhibited worrisome behavior, though. The area in question is web search advertising, the company's bread and butter. Google has been accused of anticompetitive behavior and abuse of its dominant position in search advertising where it captured 74.5% of total U.S. revenue in 2012. For comparison, Microsoft's share of U.S. search advertising revenue was just 8% in 2012 (Time, 2013). A monopoly in a given market is not illegal in itself, however. Seeking to achieve or maintain such a position through anticompetitive practices is illegal. In particular, Google has reportedly required its publisher partners to show Google ads exclusively, i.e., if a publisher wants to show any Google ads to its visitors, it is limited to Google ads. Due to Google's dominant position in the search advertising market, few publishers can afford not to agree to Google's terms and forfeit Google ad revenue altogether (Digiday, 2012). If there was more competition in the market, the publishers could keep a larger portion of the ad revenue generated by their sites. This is obviously not in Google's best interest, as it wants to extract and keep as much value from advertisers as possible. Publishers, however, need to be able to auction their advertising inventory to the highest bidder and not be limited to a single advertising broker. From this perspective, Google can be seen as a *value dominator*.

Nevertheless, the Federal Trade Commission (FTC) that had been investigating Google's conduct since June 2011 finally ruled on Jan 3, 2013 that there was not sufficient evidence that Google had violated any antitrust laws or policies. Google did, however, agree to a settlement that required it to change its business practices, particularly to allow advertisers more flexible use of rival search engines. Also under the settlement, Google agreed to meet its prior commitments to allow competitors access on FRAND terms to patents on critical standardized technologies needed to make popular CE devices such as smartphones, tablets, laptops, and gaming consoles (Federal Trade Commission, 2013). The resolution was obviously a victory for Google and a bitter defeat for competitors such as Microsoft, but the debate over the topic is sure to continue.

As for the productivity of Google's ecosystem, let us first look at advertising performance which directly relates to the business model of Google and its advertiser & publisher partners. Firstly, Google's display advertising network serves up 180 billion ad impressions each month and reaches 90% of all Internet users, according to ComScore U.S. statistics from October 2011 (Kim, 2012). Google therefore has the largest audience reach of any online advertising network. At least as important to advertisers and publishers hosting ads is the click-through rate (CTR) that measures how effectively the ad impressions generate 'clicks', i.e., user-initiated actions leading the user to another website where he/she may purchase goods or services or learn about them. For Google's display ad network, the average CTR was 0.4% in 2011 which compares very favorably to Facebook's estimated average CTR of 0.051% (based on an independent analysis by Webtrends in 2010). Looking at the cost side, the average CPC for Google is around $0.75 whereas Facebook's CPC is around $0.80. So, with almost ten times better CTR and similar CPC, Google offers superior return on investment (ROI) for its advertisers. Google also offers better ad targeting and format options than, e.g., Facebook (Kim, 2012).

Looking at the Android ecosystem, the Google Play marketplace had over 1 million Android applications in its catalog as of July 2013, putting it ahead of Apple's App Store with some 900,000 applications at that time (PhoneArena, 2013). As of August 2014, Android's app count has surged to more than 1.3 million (AppBrain, 2014), although iOS is not far behind with a reported 1.2 million apps as of June 2014 (TechCrunch, 2014a). This is a sign of healthy diversity (a proxy for niche creation) as well as productivity, as already during 2012, Android had been able to effectively close the gap in the numbers of applications available compared to iOS which still had a clear lead earlier as confirmed by, e.g., Hyrynsalmi et al. (2012). In that same study, Android had more than 90,000 individually identifiable developers compared to more than 170,000 iOS developers. Unlike Apple, Google does not disclose its payouts to developers from Google Play, commenting only that the payouts have been growing at a breathtaking pace (TabTimes, 2013).

For evaluating robustness, no statistics exist on the survival rates of these developers, but a similar high proportion of individuals and small companies can be assumed as with iOS developers, as 58% of the Android developers on Google Play had published only one application. Again, this translates to higher churn than with big, professional developers. Also, Android's fragmentation (i.e., breadth of different OS platform versions and OEM-customized variants in use) means that the platform scores less favorably in terms of *limited obsolescence* and *continuity of user experience and use cases*, metrics associated with the ecosystem health measure of robustness according to Iansiti & Levien (2004a). The share of low quality applications in Google Play is also surprisingly high, 18% in June 2014 as reported by AppBrain (2014).

Software Ecosystem and Application Marketplace

Google's mobile software ecosystem is built around the Android OS platform, the runtime environment for over a million available Android applications. The Android platform is complemented by Google Play, an entirely cloud-based, digital entertainment store for phones, tablets, and computers that offers millions of songs and books and thousands of movies in addition to the vast catalog of Android apps and games. In addition, Google offers a new music subscription service, All Access, letting people listen to more than 20 million songs for $9.99 a month on any device (Google, 2014a). Per the definition of Bosch (2009), the Android ecosystem is an OS-centric ecosystem, although most Google services and content available on Android are also accessible from the web.

As with iOS, the Android ecosystem appears to possess all of the three success factors identified by Bosch (2009), i.e., 1) *minimal effort required by developers* due to the availability of a comprehensive SDK and developer toolchain as well as well-defined, rich APIs, 2) *generic, evolving functionality and set of features provided by the OS* due to the regular update cycle and development done mostly by Google and its OHA partners to introduce new features and functions and refine existing ones, and 3) *(a sufficiently large) number of customers that use the OS and that are accessible to developers* which is obvious due to Android being the most popular smartphone OS platform by a wide margin, accounting for 80% of all smartphones shipped in 2013 according to Canalys (2014).

Android applications, however, are not automatically available on other platforms unless the developer/publisher has chosen to publish on multiple platforms, which usually implies separate development effort and cost. Multi-homing, as this phenomenon is called, appears to be quite rare, especially for smaller developers/publishers. Hyrynsalmi et al. (2012) note that only around 12,000 or 13% of the nearly 92,000 Android developers included in their study were also publishing for iOS. Only 0.9% of the Android developers also published their apps for Windows Phone and 0.6% for all three platforms, suggesting that multi-homing is very rare for any other combination of platforms except Android and iOS.

What makes Google Play different from Apple's App Store or iTunes is that it is nonexclusive — several other application stores exist for Android, independent from Google. Some companies such as Amazon, Barnes & Noble, and Nokia (the former device business of which now belongs to Microsoft) have intentionally forked the Android OS for their own purposes and have replaced Google Play with a proprietary application marketplace on their devices, e.g., Amazon Appstore, as discussed in Section 4.2. Forked versions of Android are also popular in China, particularly with the country's largest operator China Mobile that created its own fork called 'OPhone', complete with its own services and app store tailored for the local Chinese market. Also so-called application 'sideloading', i.e., downloading applications from various web sites not run by Google, is possible on Android, though this poses security concerns as the apps are usually not verified in any way and could be potentially harmful. While such a liberal approach to application distribution can be seen as a disadvantage to Google itself and Android developers who have to cope with the complexity of multiple distribution channels as well as the platform fragmentation and (partial) incompatibility created by the various forked versions of Android, it is actually one of the key reasons why Android is so popular today, across geographies and price points. Apple's stringent control over iOS application distribution does ensure good security and promotes better quality of apps, but it also ultimately limits the utility and mass-market appeal of the platform especially outside the Western world.

Along the four dimensions of openness identified by Eisenmann et al. (2008), the Android ecosystem is open to demand-side users (end users), supply-side users (developers), platform providers (as multiple application marketplaces are allowed, and OEMs are allowed to customize the Android experience), and partially also platform sponsors (as the OHA members and other parties contribute in varying degrees to the continued development of the Android platform, either through AOSP or through other means). Why Android is only partially open to platform sponsors is because Google still maintains control over which contributions are accepted into the AOSP, it develops and licenses the proprietary, non-open source GMS separately with stringent terms and conditions, and in general has the final say in the evolution of Android.

By applying the extended role categorization of Müller et al. (2011), Google exclusively occupies the payment broker role, the OS developer role together with its supporting consortium (OHA), and non-exclusively the advertisement broker, marketplace (Google Play), testing & verification party, signing partner, and software developer roles. After the divestiture of the Motorola handset business Google no longer occupies the device manufacturer role, but it certainly has a lot of influence on device manufacturers through the various controls points in Android, GMS most notably. Google is not known for making exclusive deals with MNOs, although especially in the past, it has worked with a lead device manufacturer and lead carrier for each new Android release (e.g., HTC and T-Mobile for the first Android smartphone, then Motorola and Verizon Wireless for Android 2.0). However, there was no real exclusivity period and other manufacturers and carriers could follow quite quickly.

4.3 Case 3: Microsoft and the Windows Phone Ecosystem

Firm Scope and Angle of Entry

Of the three case companies included in this study, Microsoft (NASDAQ: MSFT) is the oldest, having been founded in 1975, highlighting how young the personal computing industry is, despite being significantly older than the mobile communications industry. According to its Form 10-K annual report filed with the SEC, the company's mission is *"to enable people and businesses throughout the world to realize their full potential by creating technology that transforms the way people work, play, and communicate"*. Microsoft develops and market software (its traditional domain), services, and hardware devices to its customers worldwide, having offices in more than 100 countries. (Microsoft, 2013b)

Microsoft is most well known for its PC operating systems, starting with Microsoft Disk Operating System (MS-DOS) in the early 1980s and continuing with Windows, and its suite of office software, Microsoft Office. However, Microsoft has OS products available for a variety of computing devices, servers, phones, and other intelligent devices. Being a true software powerhouse, the company provides server applications for distributed computing environments, productivity applications, business solution applications, desktop and server management tools, software development tools, video games (through Microsoft Studios, its in-house developer and publisher of video games), and online advertising. (Microsoft, 2013b)

Microsoft is also increasingly active in designing and selling its branded hardware devices, most recently the Surface Pro and Surface RT tablet computers, running Windows 8 Pro and Windows RT respectively. In the gaming and entertainment console market, Microsoft has a strong position with the Xbox 360 and Kinect for Xbox 360, also making accessories for the Xbox 360 as well as the PC. Xbox One, the successor to Xbox 360, was announced in June 2013 and began sales in 13 countries in November 2013, with other markets to follow later. (Microsoft, 2013b; ExtremeTech, 2013b)

Cloud-based solutions are an important part of Microsoft's offering, providing customers with software, services, and content accessible over the Internet by means of shared computing resources located in centralized data centers. These services and solutions include Microsoft Office 365, Microsoft Dynamics CRM Online, Windows Azure, Bing, Skype, Xbox LIVE, and Yammer. Furthermore, in addition to selling individual products and services, Microsoft offers suites of products and services. (Microsoft, 2013b)

Conducting research and developing advanced technologies for future software, hardware, and services are key activities at Microsoft, helping the company fulfill its objectives of growth and meeting its customers' needs by *"delivering a family of devices and services for individuals and businesses that empower people around the globe at home, at work, and on the go, for the activities they value most"*, clearly putting emphasis on mobility and accessibility of services in people's everyday lives, both in personal and professional context.

Despite its dominant position in the PC OS market and productivity software as well as its strong position in gaming and entertainment consoles, Microsoft has struggled to be successful in portable media players as well as smartphones, also including the software and services related to these devices. After nearly five years since its first launch, the 'Zune' media player devices were discontinued in October 2011 (International Business Times, 2011). In June 2012, Microsoft announced it would discontinue all Zune services and instead focus on the Xbox Music and Xbox Video brands.

Microsoft also needs to sort things out with its channel partners, as it would appear that Windows Phone handsets are at a disadvantage in the retail channel, where particularly the major U.S. carrier stores and their sales representatives seem to recommend the iPhone and various Android models over a Windows Phone smartphone, discouraging customers from buying them (PhoneArena, 2014b). This is not to say that they are wrong in doing so, as they often recommend phones based on either positive reviews or personal experiences, but in any case, the Nokia/Microsoft Windows Phone handsets are often overshadowed by the more familiar models from Apple, Samsung, LG, HTC, and other manufacturers. Moreover, according to statistics from the research company IDC (2014b), the market share of Windows Phone had contracted by almost 1 percentage point to just 2.5% in Q2 2014 compared to Q2 2013, sending an alarming message to Microsoft that it needs to change its game if it wants to stay relevant in the smartphone business.

Angle of Entry

First-degree path dependence as described by Liebowitz & Margolis (1995a) is visible in Microsoft's product offering, as the key design decisions of its OS and application products clearly exhibit dependence on past decisions. Looking at its PC OS families, first MS-DOS and then Windows, native MS-DOS support was carried over into Windows for a very long time, remaining a part of the OS up until Windows 98. Windows Millennium Edition (or 'Windows Me'), released in September 2000, was the first mainstream Windows to do away with loading legacy MS-DOS components. However, it did not run on an NT-based hybrid kernel like the Windows 2000 released less than a year earlier, but instead it relied on the legacy monolithic Windows kernel used in the previous, MS-DOS based versions of Windows. It was not before Windows XP, released in October 2001, that Microsoft was finally able to move to a new, more efficient kernel architecture also in its consumer OS and sever the ties with the MS-DOS legacy (Computer History Museum, 2001).

Looking at Figures 1.2 and 3.1, it is clear that Microsoft represents a distinct angle of entry into the smartphone business. Like Apple, the company has its origins in personal computing, although not on the hardware side of the business but rather on the software side, specifically in PC OS products and productivity applications. The long experience that Microsoft has from developing various OS, also for embedded use such as automated teller machines (ATMs), point-of-sale (POS) terminals, and PDAs, could be perceived as a technical advantage, although the usage patterns and UI paradigms of those devices differ significantly from smartphones.

Perhaps due to these differences and the legacy of having predominantly worked on a desktop PC OS, Microsoft was not very successful in creating a UX for its PDA and smartphone OS that would appeal to mass-market consumers. One could even argue that Microsoft exhibited up to third-degree path dependence per the categorization of Liebowitz & Margolis (1995a), meaning that it was sticking to a suboptimal UI paradigm and design (stylus-based UI with small menu items) based on its legacy desktop UI, although at least since mid 2007, finger touch was seen as the superior paradigm by consumers.

A counterargument in defense of Microsoft could be that the company was simply following on the path that had been very successful in the PC industry and doing things in a drastically different way in the smartphone business would have been greatly time-consuming and costly. After all, in a similar situation, Nokia also faced great pains in making Symbian S60's UI finger-touch friendly[1], beginning with the announcement of S60 Touch in October 2007, and while eventually succeeding, spending way too much time and money on the effort at a time when competition relying on alternative solutions was moving fast and getting tougher (All About Symbian, 2007). In a way, the company was first too early, then too late — Nokia had indeed developed a touch UI earlier, but had abandoned its further development as a result of shortsighted management, as I noted in Section 1.1.1.

As discussed earlier in the section on the history of smartphones (1.1.1), Microsoft has offered a licensable OS for smartphones since 2003, first Windows Mobile, later Windows Phone, while relying on handset manufacturers to make and sell the devices, a perfect replica of its business model in the PC industry, except that in the mobile industry, there was significantly more competition. No OS had an overwhelmingly dominant position, although at its peak in 2006, more than two thirds of smartphones globally were running the Nokia-backed Symbian OS. Windows Mobile held 14% of the smartphone OS market at the same time (Canalys, 2006). Despite Microsoft's efforts to renew the Windows Mobile experience in version 6.5 and make it more finger-touch friendly in order to increase consumer appeal, the experience was never a match for the iPhone, launched in 2007, or Android devices that started appearing in late 2008 (WP Central, 2009).

Microsoft was to discover that its traditional strengths and near-monopolistic power did not carry over from the PC business to the smartphone business. The 'Wintel' hegemony, stemming from the early strategic relationship with the chip manufacturer Intel and IBM, the father of the modern PC, had made

[1]Even after years of heavy investment into software and UI development, the Symbian touch UI experience remained clumsy and lackluster compared to the competition. Although the late versions of Symbian circa 2011 ('Anna' and 'Belle') were actually quite OK to use, the burden of legacy in Symbian was just too much for Nokia, and Symbian had become obsolete also in other ways by the time the largest gaps in the UI and UX were addressed. The unwise statements of Nokia's then-CEO helped seal the fate of the OS platform that had once powered more than two thirds of smartphones worldwide.

Microsoft arguably the most powerful player in the PC industry, but the mobile industry played by different rules. With the rise of Google's royalty-free Android OS platform, the very business model that had earned Microsoft so much money, OS licensing, was being threatened to become obsolete. Meanwhile, Apple's sudden surge with its iPhone and other iOS products was redefining consumer expectations with regard to smart computing devices and their UX, causing trouble to incumbents. Microsoft, too, was forced to reconsider its horizontal business model based mostly on OS and software licensing, as it could not afford to be marginalized in the mobile business, and support for its Windows Mobile OS was rapidly declining among handset OEMs. Even the all-new Windows Phone 7 that featured a completely redesigned, dynamic tile-based UI dubbed 'Metro' could not attract significant support from the handset OEMs, mainly Samsung, LG, and HTC that already at that time were putting most of their efforts into designing Android devices that were not only better received by consumers but also had a stronger and perceivably more open ecosystem.

As noted in Section 1.1.1, the struggling Nokia provided the perfect opportunity for Microsoft to secure support for Windows Phone. While Nokia was still the largest smartphone manufacturer globally when the strategic partnership with Microsoft was made, its fortunes quickly declined, with Nokia 'Lumia' smartphones and Windows Phone being marginalized into low single-digit market share (ZDNet, 2013a). The resulting financial troubles eventually led Nokia to sell its loss-making handset business to Microsoft. After the transaction was closed in April 2014, Microsoft had become a branded handset manufacturer, with the right to use the Nokia brand name for up to 10 years (The Telegraph, 2013).

Already before the acquisition, however, Microsoft had introduced its Surface line of tablet computers to address the massive market gap it had left for Apple to conquer with iPad. Furthermore, Microsoft had attempted to enter the mobile phone market with its 'Kin' branded devices in the spring of 2010, but with abysmal results (Wired, 2010). The Kin devices were developed by the team from the company Danger, Inc.[2] that Microsoft had acquired in February 2008, for reportedly as much as $500 million (GigaOM, 2008). The devices were not real smartphones as they could not run apps or games, but were advertised for their easy-to-use social networking features, but the problem was that many Android smartphones available at the time could do the same and more, in addition to being true smartphones capable of running apps. Microsoft canceled the Kin products after only six weeks of very poor sales, despite having the large U.S. carrier Verizon Wireless acting as a distributor

[2] As an interesting detail, Andy Rubin, one of the co-founders of Danger, left the company in 2003 to found the company Android, acquired by Google less than two years later.

(CBS News, 2010).

Value Creation Logic

Microsoft generates revenue by developing, licensing, and supporting a wide range of software products and services (including cloud-based services), but also by designing and selling hardware devices, and by delivering online advertising to a global customer audience. From its cloud services, the company earns revenue primarily from usage fees, advertising, and subscriptions. It also provides consulting and product and solution support services, in addition to training and certifying computer system integrators and developers. (Microsoft, 2013b)

Microsoft's business model is perhaps best described using the value network concept, described in Section 2.2.3, where it occupies the role of an OS and applications provider in multiple value networks representing various industries, most notably the traditional PC industry but also the smartphone and tablet computer industry as well as embedded automotive computing systems. In both PC and smartphone/tablet industries, the OS is a critical element and control point in the value network, largely determining which hardware and software components and complements are available for use on the complete product, be it a desktop PC, a tablet, or a smartphone. The OS has been and continues to be a major source of revenue for Microsoft especially in the PC industry where viable alternatives, particularly Linux and OS X (though available only on Apple's Mac computers), still enjoy relatively small market shares.

According to statistics from July 2014, various versions of Microsoft Windows had a joint 92% market share among desktops (NetMarketShare, 2014). This uniquely dominant market position explains why Microsoft is able to capture a disproportionately large share of value from desktop computers through its OS. In the server market, however, Linux is steadily gaining ground, growing its market share at the expense of Windows and Unix based servers, having accounted for 28.5% of all server revenue in the fourth quarter of 2013 (IDC, 2014a). When it comes to tablets, however, Microsoft is a very small OS player, as only 2% of the tablets sold during 2013 ran Windows, compared to 62% for Android and 36% for iOS (Gartner, 2014b). In smartphones, Microsoft enjoys a similarly low OS market share, with Windows Phone having accounted for only 3.2% of units sold in 2013 (Gartner, 2014d). This apparent failure at cracking the mobile OS market has led Microsoft to pursue also other means of monetization, although the decision to acquire Nokia's handset business hints at Microsoft's continued commitment to its mobile OS and products based on it.

Device Sales and Content Business

The question remains, however, whether Microsoft can successfully be a horizontal services company, licensing its software and cloud services to various customers, while at the same time being a vertically integrated hardware company, selling its own devices running on its own OS and utilizing its own services. Owing to its legacy as a software and services company, Microsoft has generally refrained from exclusive arrangements and has pursued vertical integration only for its gaming and entertainment console Xbox, where it controls the whole value chain, from published software titles and content (through Xbox Music and Xbox Video) and the OS to the hardware specifications and contract manufacturing (Businessweek, 2005). Even many business applications like the Microsoft Office suite are also available for competing platforms like the Mac, although typically lagging behind the Windows versions in their release cycles and features (The Register, 2014a).

Pursuing horizontal and vertical business models at the same time can be difficult and even more so when a company tries to excel both in services and hardware in the same market, at the same time. A combined services and devices company can't really use its services for differentiation on its hardware products, as those same services are (or should be) accessible to horizontal service customers, yet it must maintain the competitiveness of both businesses. Nokia and Google faced this dilemma, too, and eventually had to choose between services and devices.

For the fiscal year ended Jun 30, 2014, Microsoft changed its financial reporting structure, now reporting most of its B2B revenue[3] under the 'Commercial' reporting segment, further divided into 'Commercial Licensing' and 'Commercial Other'. It is clear, however, that B2B licensing remains Microsoft's most profitable business, generating \$38.6 billion or 92% in gross margin from \$42.0 billion in revenue for the Commercial Licensing business. For comparison, the 'Devices and Consumer Hardware' business generated only \$947 million or 8.2% in gross margin from a total of \$11.6 billion in revenue, almost entirely from computing and gaming hardware (i.e., Xbox). The phone hardware business, acquired from Nokia, generated only \$54 million in gross margin from a post-acquisition revenue of \$2.0 billion, and after subtracting the operating expenses amounting to \$746 million, contributed an operating loss of \$692 million. (Microsoft, 2014a)

[3]Microsoft's 'Commercial' reporting segment excludes revenue from Windows and Windows Phone OEM licensing as well as academic and other non-volume licensing of Windows and Office.

Patent Business

Microsoft also has a substantial patent portfolio, numbering more than 40,000 patents in 2013 as reported by GeekWire (2013), and indeed IP licensing is also an important source of revenue for the company. With its many OS-related patents, Microsoft has been able to assert a credible threat of patent infringement lawsuits on device manufacturers using the Android OS platform. The first IP licensing agreement between Microsoft and a handset OEM using Android, namely HTC, was reached in April 2010 (Microsoft, 2010). HTC, who had also been a long-time licensee of the Windows Mobile (and later Windows Phone) platform, had agreed to pay royalties to Microsoft for every Android handset it produces. Although the figures were not disclosed, a Citi analyst source cited by ZDNet (2011) estimated the royalties to be in the range of $5 per handset.

Thus, Microsoft was earning substantial revenue from Android, a competing platform it had nothing to do with. However, as reported by Reuters (2011), Microsoft did not stop there, but went next for the big players like Samsung, reportedly demanding as much as $15 royalty per device running Android. Samsung was already at that time expected by analysts to surpass Nokia as the world's largest handset manufacturer. Samsung obviously sought to reduce the royalty payments, agreeing to manufacture also some Windows Phone devices along its Galaxy-branded Android devices. In September 2011, a patent licensing agreement was reached between Microsoft and Samsung, giving Samsung "legal coverage" for its use of the Android OS in its smartphones in return for undisclosed royalty payments, although estimates of around $10 per device were mentioned, based on the cross-licensing nature of the deal (GeekWire, 2011; Betanews, 2011). At any event, this signified another major IP-related victory for Microsoft, who had secured substantial per-unit royalties from a company that was soon to become the largest smartphone manufacturer in the world.

Soon enough, this practice of Microsoft coercing Android OEMs into patent licensing agreements was dubbed as Microsoft's "Android tax". Making things even worse, also Oracle became active against Google and the Android OEMs in its claims of Android infringing on Java patents[4] (CBS News, 2011).

As of April 2013 and over a period of three years, Microsoft has made licensing agreements with some twenty Android device manufacturers, including Samsung, HTC, LG, Amazon, ZTE, Nikon, and Hon Hai (a.k.a. Foxconn). According to Microsoft itself, these deals mean over 80 percent of Android

[4]In May 2014, Oracle won a second round of court battles with Google over the use of its Java APIs in Android, overturning a previous decision that Google wasn't violating Oracle's IP (Tech Times, 2014).

devices sold in the United States and more than half of Android devices sold worldwide are covered by licensing agreements (Digital Trends, 2013b).

So, whereas Google is not directly profiting from Android, it is turning out to be a really lucrative business for Microsoft, especially with Android device shipment volumes expected to reach nearly 1.4 billion by 2015 (Gartner, 2014c). By doing the math, even with conservative royalty estimates, it's easy to reach the conclusion that Android is effectively a multi-billion dollar business for Microsoft, already today. Somewhat ironically, ZDNet (2013b) called Android Microsoft's most profitable mobile OS, estimating that the company's revenue from the Android related IP licensing deals could amount to as much as $3.4 billion in 2013, whereas in comparison, Microsoft's own Windows Phone fails to make much difference in the market (ZDNet, 2013a). Also a Nomura analyst quoted by Business Insider (2013) has estimated that Microsoft's revenue from Android royalty payments amounts to $2 billion in 2013. These are not modest figures.

Aside from some Asian manufacturers mainly active in their domestic markets, only Google has stood up against Microsoft's patent assertions, having acquired Motorola Mobility's substantial patent portfolio with the specific intention of warding off patent-related attacks on Android. According to FOSS Patents (2014), however, in the pending Microsoft-Motorola and Apple-Motorola lawsuits, it is not clear how much Google's Motorola patents would protect Motorola as an Android OEM. So far, the patents have offered only at best partial protection against Microsoft's claims (FOSS Patents, 2013). With Google having sold the former Motorola handset business to Lenovo, depending on how the deal is structured, it could be that Google wouldn't be affected in any way by any further patent enforcement against Motorola Mobility (FOSS Patents, 2014). However, if Google really wants to protect the Android ecosystem like it claims, it would have to reach a global patent licensing agreement with both Microsoft and Apple covering its device OEM partners. So far, no such agreement is in place, and the litigations and counter litigations will likely continue for some time.

Platform Approach and Governance

Product Technology, Architecture, and Openness

The history of Microsoft's mobile OS platforms begins with Windows for Pocket PC 2002, powered by the Windows CE 3.0 kernel and foundations, available in late 2001. Besides the standard PDA version, Pocket PC 2002 offered a touchscreen-based 'Phone Edition' that was used for smartphones. Microsoft also kept a separate OS product line for non-touch smartphones, beginning with the Smartphone 2002. For Windows Mobile 2003, the first proper Windows Mobile release, the touch and non-touch variants of the OS were called 'Windows Mobile 2003 for Pocket PC Phone Edition' and 'Windows Mobile 2003 for Smartphone'. Beginning with Windows Mobile 6.0, released in February 2007, these two variants were renamed as 'Windows Mobile [version] Professional' for touch and 'Windows Mobile [version] Standard' for non-touch devices. (Spirit Data Capture, 2010)

The complicated naming convention was finally dropped for Windows Phone 7 that was released in October 2010, still based on a Windows CE kernel but featuring a completely new UI and application framework. While the 'Metro'[5] UI received acclaim from many critics for its clean look and integrated "hubs", consumers were generally less impressed, many being used to the traditional application-centric UI and home screen grid layout of the iPhone and Android smartphones (ZDNet, 2010). The initial lack of many popular applications for the Windows Phone platform also put off many users. While the sales of Windows Phone 7 handsets remained low, there was little financial incentive for most app developers to develop or port their apps for the platform. Although the situation improved slightly over time through Microsoft's and Nokia's continued evangelism as well as substantial direct financial support (e.g., Microsoft paying subsidies of up to $600,000 per Windows Phone app to developers), Windows Phone continued to lag behind both iOS and Android in number of apps, number of developers, and total revenue earned from app purchases (Seeing through Windows, 2012). On top of these costly subsidies, Microsoft together with Nokia spent $24 million to create an app development program called 'AppCampus' at Aalto University to foster mobile app development for the Windows Phone and Windows platforms. The three-year program has been running since spring 2012 (AppCampus, 2014).

In October 2012, Microsoft unveiled Windows Phone 8, yet another major overhaul of its mobile OS, featuring improvements to the UI such as variable-sized live tiles and support for new, more powerful hardware and displays as well as new features such as NFC (Microsoft, 2012c). Major changes, however, took place also under the skin of the OS — Microsoft had replaced the aging Windows CE kernel of the core OS with the NT kernel, the same as used in the regular Windows 8 (WP Central, 2012). This unfortunately meant breaking the upgrade path for Windows Phone 7.x handsets and their applications. Customers who had recently bought Windows Phone 7.x devices were upset, as their devices were effectively rendered obsolete, although Microsoft promised one last update, version 7.8, which was supposed to bring many of the new

[5]As of late 2012, the 'Metro' moniker was reportedly replaced with the name 'Microsoft Design Language' as the newest way to refer to the design language and tiled style that first emerged with Windows Phone 7 (ZDNet, 2012c; MSDN, 2014f).

features of Windows Phone 8 to the older handsets. For app developers, the break in compatibility meant that any new app development for Windows Phone 8 would be incompatible with Windows Phone 7.x, although older apps would continue to run on Windows Phone 8 (Engadget, 2012). As the news came out, it was most unfortunate for Nokia, who had just launched a new range of Lumia handsets running Windows Phone 7.5, making these devices already obsolete in the eyes of many consumers.

As per the terminology of Eisenmann (2008), Microsoft has adopted a proprietary platform approach consistently throughout the life cycles of its regular Windows and Windows Phone platforms. Both platforms are owned, developed, and provided solely by Microsoft, and although OEMs may license the platforms by paying a fee, Microsoft retains 100% control over the roadmap, development, and interfaces of the platforms. While regular Windows is clearly in the maturity phase, it too has gone through a major overhaul in its UI for Windows 8, which has lead to some pushback. Windows Phone, on the other hand, is four years old, but is still struggling to build up its scale through user acquisition. Although a global number three in market share, the platform appears stuck far behind the leaders Android and iOS, having currently only low single-digit market share, a non-sustainable position. The former Nokia handset business, the largest manufacturer of Windows Phone devices, made a loss of nearly $700 million in the quarter following its transfer to Microsoft (Reuters, 2014b). This reflects the struggling state of the Windows Phone platform.

Microsoft is known for its strict closed-source policy across its OS products and applications, and the mobile OS platforms Windows Mobile and Windows Phone have not been exceptions in this regard. Even Nokia, having entered into a strategic partnership agreement to use Windows Phone exclusively for its smartphones, had to rely on public APIs for developing its differentiating Nokia Lumia apps on top of the Windows Phone platform. Unlike with open-source OS platforms like Android, no changes to the UI, application framework, or middleware were allowed on Windows Phone. Although Windows Mobile, to a certain extent, had been customizable by handset OEM licensees in its graphical looks, this was and is not possible on Windows Phone. Thus, any and all customization by the OEMs has to be done through applications. This is again a remarkable difference to Android, where the TouchWiz (Samsung), Sense (HTC), Motoblur (Motorola), Xperia (Sony) skins have brought considerable and often positive UI differentiation to the vast selection of Android devices on the market.

Using Windows Phone has generally required the payment of a per-unit license fee, estimated to be around $10 to $15 for most device manufacturers, but information from the Chinese smartphone manufacturer ZTE suggests license costs as high as $23-$31 per handset (Neowin, 2012). In March 2014, however, it was reported by The Times of India (2014) that Microsoft had waived the license fee altogether for two Indian handset manufacturers known mostly in their domestic market, Lava and Karbonn. Previously, such deals were unheard of, as some sources suggest even Nokia had to pay Microsoft between $20 and $30 per each Lumia smartphone sold (The Times of India, 2014). Already in October 2013, however, Bloomberg (2013) reported that Microsoft had asked HTC to load Windows Phone on some of its handsets as a second option to Android while reducing or even eliminating the license fee. These developments, along with comments from an Indian handset company executive, would seem to suggest that Microsoft is exploring new models for the struggling Windows Phone, realizing that the older paid-license model did not work well, even with Nokia (The Times of India, 2014).

In-House vs. External Focus in Complements

One of the key strengths of Windows on the PC is the extremely large number of applications available, so many that no other platform comes even close. The same was true already for MS-DOS before Windows established itself as the preferred application environment. Indeed, Microsoft has always actively encouraged the development of software applications and other complements on its platforms, and its programming and developer tools, such as QuickBASIC for MS-DOS (first released in 1985), Visual Basic (1991), Visual C++ (1993), and Visual Studio have been generally highly regarded by professional developers and software publishers, although also alternative commercial development tools and integrated development environments (IDEs) were available for MS-DOS and Windows (InfoWorld, 2013; Hanselman, 2013).

The Microsoft Windows SDK, available for download for free, includes the tools, compilers, headers, libraries, code samples, and a help system for developers working on applications for Windows (MSDN, 2014a). It also includes the .NET Framework, a software framework developed by Microsoft that comprises the Framework Class Library (FCL) as well the Common Language Runtime (CLR). The .NET Framework is designed to run Windows applications and XML Web services and offers language interoperability, meaning that each supported language that conforms to the Common Language Infrastructure (CLI) specifications may use code written in other languages. Code written and compiled for the .NET Framework is managed code[6], as it runs on an application virtual machine, the CLR. This makes the .NET framework similar to Java. (MSDN, 2014b)

On the mobile front, Microsoft also has an SDK for Windows Phone that includes the necessary compiler, emulator, Visual Studio Express IDE, and other tools for application and game development on the Windows Phone platform. More advanced versions of the Visual Studio IDE (purchased separately) may also be used with the SDK. Unlike earlier versions of Windows Phone or Windows Mobile that included the .NET *Compact* Framework, Windows Phone 8 includes a Windows based CLR called CoreCLR that is shared with Windows 8 and supports the .NET Framework. (MSDN, 2012; MSDN, 2014c)

Microsoft operates the Microsoft Developer Network (MSDN), an online developer network on which it hosts a wide range of developer resources, including libraries, tools, and information. Although the network operates on a paid subscription basis with a multitude of developer programs available for joining, many resources such as the MSDN Library of technical documentation can be accessed for free on the web (The Guardian, 2011). Additionally, Microsoft hosts an online community site called Channel 9 under MSDN that provides a wiki and an online discussion forum for developers and users, also featuring corporate video logs and promotional videos for showcasing some of the latest things going on at Microsoft that would not otherwise be reachable by such a broad audience (WebProNews, 2005).

Despite supporting third-party development of software, Microsoft is well known for maintaining secrecy over the technical specifications and inner workings of its platforms, choosing to reveal only certain APIs for allowing application or device driver development. As a result of the U.S. Department of Justice's successful antitrust lawsuit against Microsoft, the company was forced to share portions of the Windows API with the industry (and sell licenses for reasonable prices), also putting the Windows division and other related teams under the oversight of the U.S. federal government for a period of 10 years since May 12, 2001. Since that period expired in 2011, T. Huckaby of Dev Pro Connections (2011) argues that Microsoft has again taken steps toward secrecy, an unfortunate development for the partners, developers, and customers who used to enjoy Microsoft's practice of sharing its product roadmap and news of upcoming cutting-edge technologies.

As an example, Microsoft's decision to restrict early access to the Windows Phone 8 SDK prior to the new OS version's launch to only the developers of the most downloaded apps was met with strong criticism, some developers calling it a "cruel joke" (ZDNet, 2012a,b). At a time when Microsoft should have gotten developers excited about the new OS and as many "cool" new apps as possible on the market catalog from day one, it had chosen, in some bizarre

[6] Managed code is never interpreted, and a feature called just-in-time (JIT) compiling enables all managed code to run in the native machine language of the system on which it is executing, which leads to good performance. Additionally, the memory manager prevents memory fragmentation and increases memory locality-of-reference to further increase performance. (MSDN, 2014b)

logic, to make it hard for developers to write those apps, presumably in an effort to keep the new features secret for launch. ZDNet (2012a) further notes that while you can go for secret features and be picky with developers when you are on top of the game, you cannot when you are at the bottom, and that getting people excited about the new features should have been Microsoft's top priority.

Any firm producing complements for Microsoft products would do wisely to be aware of Microsoft's practice of occasionally *enveloping* key complement areas or adjacent platforms, particularly those that the firm sees as critical control points for value capture in the future. Cusumano & Gawer (2002) note that *"Microsoft often prefers to crush complementors that start looking like competitors"*, and at least since the MS-DOS days in the early 1990s, the company has been known to trample complementors, one example being the introduction of a hard drive compression utility called 'DoubleSpace' in MS-DOS version 6.0 released in 1993 that directly competed with Stac Electronics' popular 'Stacker' utility (InfoWorld, 1993). While Stacker was a separately sold product, DoubleSpace was bundled with MS-DOS for free. Microsoft had earlier negotiated with Stac Electronics for a license to its technology, without conclusion. Stac Electronics sued Microsoft for patent infringement and won, requiring it to remove the infringing code from MS-DOS (The New York Times, 1994a,b). Eventually, Microsoft reintroduced a new hard drive compression utility called 'DriveSpace', with a new compression algorithm that no longer infringed on any patents.

Platform envelopment and the different types of envelopment attacks defined by Eisenmann et al. (2007) were discussed in Section 2.5.4, where I also mentioned the example of Microsoft introducing the Windows Media Player as part of the Windows OS distribution, constituting a *foreclosure* attack on RealNetworks and its RealPlayer. Such an attack means incorporating or bundling the equivalent functionality of a complement directly into a platform, thereby rendering the complement largely obsolete. Similarly, when Microsoft bundled its Internet Explorer web browser as part of Windows 95 and 98 and claimed it was part of the OS, it was clearly a foreclosure attack on rivaling browser provider Netscape (U.S. Department of Justice, 1999).

Furthermore, according to the U.S. Department of Justice (1999), Microsoft was concerned about the popularity of certain middleware and applications based on middleware APIs that had the potential to weaken the applications barrier to entry associated with Windows, stating that *"the more popular middleware became and the more APIs it exposed, the more the positive feedback loop that sustains the applications barrier to entry would dissipate"*. Two specific forms of middleware, Sun's Java technologies and Netscape's Navigator browser were particularly shunned by Microsoft. (U.S. Department of Justice, 1999)

All in all, it can be said that Microsoft is a powerful, yet somewhat unpredictable partner to its complementors. While the vast majority of complements for its desktop and mobile operating systems are produced by third parties, the company does not shun stepping on the toes of complementors when it sees a strategic advantage or major business opportunities in making in-house complements.

Managing and Incentivizing Complementors

As already noted, Microsoft operates several developer and partner programs as well as network subscriptions for various audiences. Among them are 'DreamSpark' for students and accredited schools and educational institutions, 'BizSpark' to encourage startup businesses to build their solutions on the Microsoft stack, 'Microsoft Partner Program' for companies seeking to formalize their commercial relationship with Microsoft and obtain accreditation for their Microsoft products related competencies, 'Microsoft Action Pack' subscription for registered and qualifying members of the Microsoft Partner Network, providing internal-use, full-version software and sales resources, and of course MSDN currently with six different subscription options: 'MSDN Operating Systems', 'MSDN Platforms', 'Visual Studio Professional with MSDN', 'Visual Studio Test Professional with MSDN', 'Visual Studio Premium with MSDN', and 'Visual Studio Ultimate with MSDN' (MSDN, 2014d; Microsoft Partner Network, 2014a; The Guardian, 2011). Additionally, there used to be a 'WebsiteSpark' program launched in 2009 for small professional services firms specializing in providing web development and design, but that program ended in March 2013 (ZDNet, 2013c).

Microsoft has had a hard time encouraging developers to write applications for the Windows Phone OS platform, largely because the platform's market share is so low that it would be hard to get any return on the required investment, let alone cover the costs of additional R&D. This is not a secret, and Microsoft itself has acknowledged already in the past that it contributed money to developers to help them create apps for Windows Phone. In the spring of 2012, half a year ahead of Windows Phone 8's launch, it was reported that Microsoft paid anywhere from $60,000 to $600,000 to application developers to incentivize them in building or porting their apps for Windows Phone, the kind of cash that many developers would have trouble raising on their own (CNET, 2012).

As cited by The Times, the makers of the popular location-based social networking service Foursquare admitted that they could never have built a version of their app for Windows Phone without monetary contributions from

Microsoft (CNET, 2012). This highlights the attitude that many developers, even major ones, have had toward Windows Phone. Looking at the smartphone OS market shares for 2013 as reported by Gartner (2014d), if you can reach 94% of the world's smartphone users just by focusing on two platforms, i.e., Android and iOS, why spend money on development only to be able to target an additional 3% of smartphone users? The ROI would be negative in most cases.

The above highlights a significant difference between Microsoft and its arch rivals Google and Apple, as the latter two companies do not need to pay developers to create apps for their mobile OS platforms, at least not today, nor in 2012. Google did organize two Android Developer Challenges in 2008 and 2009, and has given away Android devices to developers attending its conferences. Ever since the market share of Android skyrocketed, however, no incentives have been necessary to attract developers to the platform. With Windows Phone, the stagnant market share is clearly a problem, discouraging developers from investing into development on the platform. If, on the other hand, Windows Phone could show some significant growth and increase its market share, developers would likely give it a higher priority (CNET, 2012).

Like with Apple and Google, applications developers are not the only group of complementors that Microsoft is attracting to its ecosystem and platforms. Microsoft has a comprehensive content offering in the form Xbox Music and Xbox Video that are, despite their name, accessible also on the Windows 8 and Windows Phone 8 platforms and on the web besides the Xbox 360 and Xbox One consoles, and Xbox Music has client apps available also for Android and iOS (GameSpot, 2013). Xbox Video allows users to rent or purchase their favorite movies or TV shows for viewing, while Xbox Music offers ad-supported streaming, paid subscription streaming, and purchase of music titles, with the catalog amounting to over 38 million tracks as of 2014 (MSDN, 2014e). Thus, Microsoft also needs to court entertainment and media publishers as well as advertisers to maintain and enhance its content business, bringing together and serving multiple sides of a multi-sided platform market.

Internal Organization and Propensity to Advance the Overall Good of the Ecosystem

Until mid 2013, Microsoft was organized into five product divisions, also called business segments, each with a distinct mission and purpose within the company (Microsoft, 2013b):

- *Windows Division* is responsible for the Windows OS, Surface, and PC accessories.

- *Server and Tools* provide product and service offerings that include Windows Server, Windows Azure, Microsoft SQL Server, Windows Intune, Windows Embedded, Visual Studio, System Center products, and Enterprise Services. Enterprise Services is composed of Premier product support services and Microsoft Consulting Services.
- *Online Services Division*'s offerings include Bing, Bing Ads, and MSN.
- *Microsoft Business Division* is responsible for Microsoft Office, Exchange, SharePoint, Lync, Yammer, Microsoft Dynamics business solutions, and Office 365.
- *Entertainment and Devices Division* provides the Xbox 360 gaming and entertainment console, Kinect for Xbox 360, Xbox 360 video games, Xbox 360 accessories, Xbox LIVE, Skype, and Windows Phone.

However, in July 2013, Microsoft announced a reorganization that saw the company reassign its products and operations into four engineering groups ('Operating Systems', 'Devices and Studios', 'Applications and Services', and 'Cloud and Enterprise') plus the 'Dynamics' unit and six corporate affairs groups ('Advanced Strategy and Research Group', 'Marketing Group', 'Business Development and Evangelism Group', 'Finance Group', 'Legal and Corporate Affairs Group', and 'HR Group') (Microsoft, 2013c). The Devices and Studios Engineering Group includes all of Microsoft's hardware business: Xbox, Microsoft Mobile (the former Nokia handset business), Microsoft Hardware, and Surface.

Microsoft's organizational culture has been described as very achievement oriented and internally competitive, with the notorious 'stack ranking' performance review system being used until 2013, originating from General Electric and its then-CEO Jack Welch in the 1980s. This system essentially forced managers to rank their employees on a Gaussian bell curve, meaning that even in a very high performing team, there always had to be some low performers who were often fired. In November 2013, it reached the news widely that Microsoft was to give up this controversial practice.

As already mentioned, Microsoft is active in engaging and supporting its developers through its online networks and communities (MSDN and Channel 9), its diverse developer programs, and its developer conferences and events, most notably the annual 'Build' conference aimed at developers using Windows, Windows Phone, the Windows Azure cloud computing platform, and other Microsoft technologies. Microsoft also employs significant numbers of 'developer evangelists', senior employees dedicated to associating with developers on all levels, at large events as well as more informal gatherings, both online and offline, advocating the company's technologies and offering toward the developer community. The goal of a developer evangelist is to *"secure platform adoption and revenue growth through evangelism, community engagement, relationship marketing and a vibrant solutions ecosystem"* as stated in a job posting by Microsoft. While trying to win the "hearts and minds" of developers, they help Microsoft stay abreast of any emerging issues with their platforms and products and provide a direct feedback channel for developers.

Microsoft is also known to have a philosophy known internally as "eating our own dog food", meaning the common practice of using pre-release and beta versions of products internally among Microsoft employees in an effort to test them in real-world practical situations before commercial launch. Although the "dogfooding" is reportedly limited to quite small environments, typically only the product groups that write code, it can be quite powerful, as the people responsible for the implementation are forced to use their own product, in all its good and bad. As the pre-release product quality improves, Microsoft scales up the internal testing efforts and increases the test population size, up to tens of thousands of people. Exemplary dogfooding occurs also when a firm's internal developers are forced to use the same tools that external developers would use. Presumably this practice is used for the Visual Studio IDE and other Microsoft build tools that are known for their high quality. (ZDNet, 2003)

As noted earlier, through the Microsoft Partner Network and other programs geared at enterprises, SMBs, and even individuals, Microsoft supports the adoption and use of its technologies, and the creation of complementary innovation on top of these technologies. It also offers learning solutions and certifications to professionals seeking accredited qualifications for Microsoft products and technologies.

Ecosystem Approach and Governance

For Microsoft, perhaps the most important part of its ecosystem consists of the Microsoft Partner Network, comprising more than 400,000 firms of all sizes as members. The common denominator among these companies is that they all use Microsoft technology-based solutions as part of their customer solutions and business infrastructure. Microsoft states that *"all partners in the Microsoft Partner Network are recognized for their business and technology expertise"*, and that those with "proven expertise" are awarded a gold or silver competency depending on their level of proficiency in one or more Microsoft technology competencies, adherence to Microsoft best practices, and customer reviews. (Microsoft Partner Network, 2014b)

Microsoft's focus on its enterprise customers is understandable, as Microsoft Business Division was the company's largest business segment in terms of revenue and especially in terms of operating income that amounted to $24.7 billion and $16.2 billion respectively in the fiscal year ended June 30, 2013 (Microsoft, 2013b). Although this reporting segment also included consumer revenue from retail-packaged product sales of the Office product family, for the most part it represented B2B revenue, generated from the sales of licenses and subscriptions for the core Office product set, Office 365, SharePoint, Exchange, and Lync, representing 90% of the division's revenue, as well as the Microsoft Dynamics business solutions (Microsoft, 2013b). Also in Microsoft's new financial reporting structure, Commercial Licensing is by far the most profitable reporting segment (Microsoft, 2014a).

In the PC industry, Microsoft has collaborated with Intel, the processor and chip manufacturer, for more than 20 years across engineering, sales, and services functions to jointly create and deliver *"leading business and IT solutions for a more dynamic and efficient infrastructure"* (Microsoft, 2014b). This powerful alliance of the leading PC chip manufacturer and leading OS provider, often called Wintel, led to disproportionately large value capture and high margins for the two companies in the PC ecosystem, leaving only crumbs for other players such as PC hardware and component manufacturers, although companies like HP and Dell also became very successful in building and selling PCs. Although Intel has been challenged by Advanced Micro Devices (AMD) particularly in the server processor market but also in mainstream PC chips, it remains the leading chip manufacturer in the PC ecosystem, just like Microsoft remains the leading OS provider (Businessweek, 2012). In the mobile business, however, both companies have struggled to capture significant market share.

Ecosystem Role and Health

Per the categorization of Iansiti & Levien (2004a), Microsoft is the clear leader and *keystone* of its ecosystem — it is not only a platform provider but a technology provider and enabler in multiple adjacent industries on many levels, literally for hundreds of thousands of firms. In the Microsoft Partner Network alone, there are more than 400,000 member companies that depend on Microsoft technologies for critical business functions and value creation. The number of firms that use Microsoft products in their daily operations is of course much larger. Microsoft itself reports that more than 1.1 billion people use Office, and that 1.5 billion people use Windows daily (Microsoft, 2014c). Although the figures include private users of the products, they are absolutely staggering numbers — no other software company comes close to such a tremendous global penetration rate. In the PC industry, Microsoft's position as the dominant OS provider and the power that comes with it has lead the company to misuse that power occasionally, as discussed in the sections above. Due to this behavior, Microsoft can also be considered a *value dominator*.

Windows Phone, however, is another story. Although the platform has managed to increase the size of its application catalog to a respectable 300,000 apps as of August 2014, adding 100,000 apps in less then a year and 50,000 apps in just four months, it is still behind the behemoths Android and iOS, both of which have well over one million apps in their official store catalogs (PhoneArena, 2014a; TechCrunch, 2014a; AppBrain, 2014). As discussed earlier, however, Microsoft's substantial incentives to developers played no small part in this. While there is adequate diversity in the ecosystem, the sustainability of that diversity remains questionable, as most developers still clearly prioritize Android and iOS over Windows Phone, and this behavior is changed currently only through incentives. As in the previous case studies, I use diversity as a proxy for the ecosystem health measure *niche creation*.

Microsoft's current policy is obviously to "seed" application development on Windows Phone so that it would attract more users and gain more market share, mitigating the "app barrier" that has dragged down the platform for so long and has prevented many smartphone users from switching to it. While some industry experts and even scholars (see Bresnahan et al. (2014), also discussed later) have already called such efforts doomed, Microsoft appears to have a firm belief in its capabilities to bring the Windows Phone ecosystem to prominence. Otherwise it would have not bought Nokia's handset business and would not keep spending more than $700 million in quarterly operating expenses of said business, in addition to all the money that it spends on the platform development, marketing, and incentivizing developers (Microsoft, 2014a).

Although I do not perform quantitative analysis of Windows Phone developers' ROI in this study nor do I have access to such information, based on the discussion above, it would seem that the ROI is either very low or negative without Microsoft's incentives. As for the other productivity-related metrics identified by Iansiti & Levien (2004a), a positive change in productivity over time has been observed in the sense that the growth in the number of apps in the Windows Phone Store has accelerated within the past year, and the delivery of innovations seems to have improved in the sense that the time lag between appearance of new technologies and their adoption in the Windows Phone ecosystem seems to have reduced, both in OS level features as well as in applications (Microsoft, 2014c,d; StreetInsider, 2014). So, while the ecosystem health measure *productivity* as a whole has probably improved for Windows Phone, individual ecosystem participants, particularly app developers, commonly suffer from low ROI for Windows Phone app development projects and are thus dependent on Microsoft's incentives, meaning that the Windows Phone ecosystem's productivity is very much dependent on Microsoft's continued investment capability and direct incentives to developers.

As for the ecosystem health measure robustness, the primary metric suggested by Iansiti & Levien (2004a) is the survival rate of ecosystem participants, which is rather difficult to measure, as statistics on the entries and exists of app developers for Windows Phone are rather difficult to get. As for the additional metrics of robustness suggested by Iansiti & Levien (2004a), *limited obsolescence* has been a challenge particularly due to the break in forward compatibility between Windows Phone versions 7.x and 8, but *continuity of user experience and use cases* has been quite good, with the Metro UI principles and UX remaining largely consistent across all releases of Windows Phone beginning from 2010. The *persistence of ecosystem structure* and *predictability* of the Windows Phone ecosystem have not been very good, as Microsoft has caused turmoil by acquiring the Nokia handset business, thus becoming a branded Windows Phone device manufacturer itself, and by waiving the Windows Phone license fee for many manufacturers altogether in an attempt to win back OEM support and gain market share from Android. Such dramatic changes in the ecosystem's structure and basic business principles do not imply a high level of robustness.

Software Ecosystem and Application Marketplace

Microsoft can be seen to have at least two distinct software ecosystems, one centered around its Windows OS for Intel-based desktops, laptops, tablets, and servers, i.e., Windows 8 and Windows Server 2012, and the other centered around Windows Phone. Additionally, the Windows RT is considered part of the Windows 8 OS family, although it is only available pre-installed on devices using a 32-bit ARM architecture, mainly tablets like the Microsoft Surface RT and certain models from Asus, Dell, Lenovo, and Samsung, some of which have been already discontinued. The generally poor reception of Windows RT has been attributed to its limited selection of applications, lack of many features available in the full version of Windows 8, and slow performance on the ARM-based hardware it has shipped with, when compared to similarly priced tablets running on Intel Atom processors and the full version of Windows 8 (ExtremeTech, 2013a). The Windows and Windows Phone ecosystems are obviously not completely separate, as they share many core technologies and developer tools, and have a common developer network and community, and of course, a common proprietor, sponsor, and provider — Microsoft. In this case study, I focus solely on the Windows Phone software ecosystem.

Microsoft's Windows Phone software ecosystem is an OS-centric one according to the classification of Bosch (2009) discussed in Section 2.4.2, as the development and distribution of complementary software (i.e., apps) is specific to the OS in question. The interfaces of Windows Phone play a key role in setting the technical boundaries for what can and cannot be done by complementors on the platform. Furthermore, when looking at the three success factors for OS-centric ecosystems identified by Bosch (2009), Windows Phone clearly fulfills the criteria for *minimal effort required by developers* due to its well-defined APIs and a comprehensive SDK and developer toolchain with one of the best IDEs available for any platform, Visual Studio, as evaluated by InfoWorld (2013).

When it comes to *generic, evolving functionality and set of features provided by the OS*, Windows Phone started out with a limited set of features and functionality compared to its main competitors, but Microsoft has been able to fill most gaps due to its continued development of the OS, supported by the efforts of Nokia who provided many value-adding enhancements in the form of apps while the corresponding features were still missing from the OS. However, some common smartphone features such as multiple home screens and widgets are still missing from Windows Phone, although this is so by design choice rather than due to any natural constraints of the platform. Some other common features, like a pull-down notification bar, have been added only recently, in Windows Phone 8.1 (TechRadar, 2014b). Also, the intelligent personal assistant 'Cortana', remarkably similar in function to Apple's 'Siri' that debuted on the iPhone 4S in 2011, was introduced in that same release along with many other noticeable improvements (Microsoft, 2014d).

The last of the three success factors, *the number of customers that use the OS and that are accessible to developers*, is the Achilles' heel of Windows Phone. As I have noted earlier on several occasions, Microsoft has been unable to grow the market share of Windows Phone beyond low single-digit figures, and recently, the market share has shown signs of decline rather than much needed growth, falling to just 2.5% in Q2 2014 (IDC, 2014b). It is very hard to keep developers interested with that kind of market share. At minimum, Windows Phone should get closer to the 10% mark and preferably above in order to be in a sustainable position. As installed base is more relevant than market share for developers, the forward compatibility break between Windows Phone versions 7.x and 8 certainly didn't help, although more than 80% of the platform's worldwide installed base consisted of Windows Phone 8 devices in February 2014 (WMPoweruser, 2014).

Using the dimensions of openness identified by Eisenmann et al. (2008) discussed in Section 2.5.5, the Windows Phone ecosystem is open to demand-side users (i.e., end users), as anyone can join through purchasing or otherwise obtaining a device running Windows Phone. The ecosystem is also relatively open to supply-side users (i.e., developers) by allowing as good as any individual or company to join the Windows Phone Dev Center, the official developer program, at a cost of $19 per year, down from $99 previously (WP Central, 2013). Application development is possible only with Microsoft's own SDK and toolchain, and distribution and monetization takes place exclusively on the Windows Phone Store. With respect to the roles of the platform provider and sponsor, however, the ecosystem is closed, as Microsoft acts exclusively in both capacities.

By applying the extended role categorization of Müller et al. (2011), Microsoft exclusively occupies also the marketplace (Windows Phone Store), OS developer, and testing & verification party roles. In a non-exclusive but dominant capacity it also occupies the payment broker (credit/debit card registered with Microsoft account, Microsoft gift card, PayPal, and in some cases, operator billing are the allowed payment methods), advertisement broker (adCenter), software developer, and device manufacturer roles. For providing code signing certificates for Windows Phone, Microsoft relies on Symantec as an exclusive partner (Symantec, 2014). Otherwise, Microsoft is not known for exclusive arrangements with Windows Phone, although Microsoft's main Windows Phone partner Nokia did sell certain Lumia smartphone models exclusively to major U.S. carriers AT&T, Verizon Wireless, and T-Mobile US. Through its Xbox Music and Xbox Video services, the company has some influence on content providers as well.

As already discussed, Microsoft's attempts to lure manufacturers into the Windows Phone ecosystem have not been very successful, as before the Nokia partnership, it had only managed to gain partial, non-exclusive support from handset manufacturers such as HTC, Samsung, and LG. Somewhat ironically, Windows Phone is yet to gain as much market share and as many licensees as its predecessor Windows Mobile had during its heyday, roughly between 2004 and 2007, when the platform had up to 17% global market share as noted in Section 1.1.1. The dynamics of the smartphone business were different back then, however, and mainly Android changed that for good, making the monetization model based on OS licensing obsolete. Apple's introduction of the iPhone made smartphones attractive to mainstream consumers and brought the UX and usability into focus, areas where Microsoft had fallen behind.

The availability of high-profile applications was also a problem for Windows Phone, although according to statistics from August 2014, the platform had as many as 300,000 apps available (PhoneArena, 2014a). This figure is still, of course, a far cry from the 1+ million apps of Google Play and Apple App Store, but it is not insignificant either. The biggest problem has mostly been the lack of sufficient developer incentives to develop applications for a platform with such a low market share, which has caused developers to focus their efforts on the iOS and Android platforms where their chances of earning return on their investment are substantially better. In March 2014, however, Nokia's head of developer relations said that the Windows Phone app ecosystem was "getting there", acknowledging that there is a tipping point for developers in the sense that when the installed base is large enough, Windows Phone can support their business model (Trusted Reviews, 2014).

In its annual report for the fiscal year ended June 30, 2014, Microsoft acknowledges that competing platforms have application marketplaces with scale and significant installed bases on mobile devices, and that the variety and utility of applications available on a platform are important factors that influence device purchasing decisions, further agreeing that users incur costs to move data and buy new applications when switching platforms. Therefore, in order to compete, Microsoft also notes that it must *"successfully enlist developers to write applications for [its] marketplace and ensure that these applications have high quality, customer appeal, and value"* and that efforts to compete with rivaling application marketplaces may increase its cost of revenue and lower its operating margins. (Microsoft, 2014a)

A positive notion about the Windows Phone app ecosystem is that due to the significantly lower number of applications and developers on board compared to its main competitors Android and iOS, harmful crowding-out effects probably do not manifest themselves as much as is the case with said competitors, resulting in a better chance of getting one's apps noticed and downloaded. As I explained in Section 2.5.3, Boudreau (2008) argues that under specific circumstances, adding too many complementors can detract from a platform's ability to generate new innovation as well as profits for the firms making complements (e.g., applications) on it, mainly due to crowding-out effects and substitution as opposed to market expansion.

Based on the comprehensive study on multi-homing in mobile software ecosystems by Hyrynsalmi et al. (2012), the majority of developers publishing their apps for Windows Phone were exclusive to that platform, while only very few developers, less than one percent, who had published apps for iOS and Android had also published their apps for Windows Phone, suggesting that in a sense, Windows Phone app developers did not have to compete much with developers from the other platforms. Thus, this realization would seem to support the idea that the Windows Phone app ecosystem is not suffering from crowding-out effects as much as the Android and iOS ecosystems. Although Hyrynsalmi et al. (2012) analyzed a data set comprising a total of 850,000 apps across the three major marketplaces, it must be noted that Windows Phone was still in a nascent stage of development, and the transition to Windows Phone 8 with its significant architectural changes had not yet taken place.

One of the key findings of Hyrynsalmi et al. (2012) is that a multi-homing publishing strategy is utilized only by a low percentage of developers (6.8%). Taking into account that the study was published in 2012, it is still quite remarkable that the two major app ecosystems of iOS and Android, very much comparable in number of apps and developers at that time, had so few multi-homing developers publishing apps for both ecosystems, less than six percent. More recent analysis on app developer multi-homing by Bresnahan et al. (2014) suggests that when two platforms have roughly equal market shares, incentives arise for the highest demand apps to multi-home. They find that there is a particularly strong demand similarity for apps that are successful on either platform, and that such apps are highly likely to be roughly equally successful on the other platform as well, leading to the notion of *demand symmetry* which is largely reflected in supply, as much of the developer incentive to supply an app is determined by expected realized demand. The simple rationale is that when the one platform has approximately the same number of users as the other platform, the other platform represents an equally large profit opportunity as the one platform due to demand symmetry.

In their sample data for modeling app supply for iOS and Android, Bresnahan et al. (2014) find that the supply on one platform is highly symmetrical with the supply on the other, and thus multi-homing is the most common supply behavior in the sample, consisting of applications that are popular on either platform. They note, however, that it is unclear whether the results would extend to much less popular apps. Unfortunately, Windows Phone is not included in the study, as the authors note that *"at this stage, the market has strongly tipped away from both Blackberry and Windows Phone"*, calling both platforms "completely irrelevant", despite acknowledging Microsoft's very expensive incentives to keep Windows Phone from "completely dying off".

4.4 Synthesis of the Results

In this section, I review the results obtained from the case studies conducted in the previous sections in light of the research questions originally formulated in Section 1.2.3. After all, the purpose of the analysis framework of Chapter 3 is to guide and direct the study of the case companies in such a way that the relevant observations, based on existing theories and literature, are made during the course of gathering and analyzing information on the companies, with the goal being to obtain answers to the research questions and thus fulfilling the research objectives set for this study in the first place.

The joint results of the multiple case analysis are first synthesized on a per-question basis in Sections 4.4.1, 4.4.2, 4.4.3, and 4.4.4, then finally together, as a whole in Section 4.4.5, allowing for the identification of common success factors. The impact of the results and their practical and theoretical implications are discussed in Chapter 5, however.

4.4.1 Q1: Angle of Entry and its Impact on the Success Factors of Ecosystems

How do a firm's legacy and angle of entry into the mobile business affect the success factors of its ecosystem?

Case 1: Apple and the iOS Ecosystem

As discussed in the case study, Apple's angle of entry is computer hardware and consumer electronics, as illustrated in Figure 3.1 in Section 3.1.1. The company's products have particularly appealed to those involved in the creative side. For decades, many industrial and graphic designers and people working in marketing and advertising have commonly used Mac computers, but the user base and appeal of the products is much broader. Many people prefer Macs for their powerful simplicity and ease of use, enabling the user to get things done without too many steps or technicalities. Macs have been and continue to be premium-priced products, which means not nearly everyone is able or willing to afford them, yet the products have a high level of desirability. This gives all Apple products, not just Macs, a premium aura driven by brand equity. According to Forbes (2013), Apple's brand was valued at $104.3 billion, ranking #1 in the world in November 2013.

Due to the premium pricing of Apple products across categories, Apple enjoys very high gross margins, contributing to the company's financial results. Although providing cloud services (iCloud) and an extensive content offering (App Store & iTunes) to consumers, as well as operating a mobile advertising platform (iAd), Apple still earned more than 90% of its revenue in its FY 2013 from the sales of devices and related services, not including content (Apple, 2013c). Based on this, I argue that Apple has the following success factor:

- **A1**. *Vertically integrated business model with clear focus on device hardware sales, supported by services and content (that serve to drive hardware sales)*

As I noted in the case study as well as the mini-case example in Section 2.1.2, an enduring element of Apple's legacy is its closed platform approach for its products, using a proprietary OS and proprietary or otherwise incompatible peripheral interfaces. Originating from the first Macintosh computers, it has been carried on to all later Apple products, iPods, iPhones, and iPads, with a strong cohesion in design and UX remaining in force. Moreover, the strict design and UX guidelines extend to third-party vendors of accessories and software applications as well. Due to this approach, Apple UX has been and continues to be a clear differentiator from that of competitors' products, typically highly appreciated by users due to its consistency and ease of use. Apple's decades-long tendency to "think different" with its innovative UX and design while targeting a very high level of consumer satisfaction exhibits first-degree path dependence. However, the use of proprietary peripheral interfaces on Apple hardware, another long-enduring path-dependent decision, is not a positive differentiator for Apple and its ecosystem, as it generally tends to drive up the cost of even simple accessories like cables, although providing a useful control point for Apple.

So, there is no ambiguity as to what Apple's primary revenue model is — *sales of premium-priced products differentiated through superior UX and a first-class complementary service and content offering.* The decision to remain strictly in the premium segment can also be thought to reflect first-degree path dependence, although in recent years, older-generation iPhones and iPads have been sold at more affordable prices in an attempt to capture value also in the mid-price tiers. For the sake of clarity, I formulate the above as the following success factor for Apple:

- **A2**. *Differentiation through superior UX and a first-class complementary service and content offering*

Moreover, a psychological phenomenon known as the 'halo effect' projects the positive perception of certain Apple products on other Apple products as well. Apple has capitalized on this effect multiple times to its benefit. When the iPod media player first became popular, it was reported that Mac computer sales had picked up, too (Macworld, 2006). Later, this same effect propelled iPod users to buy iPhones (Macworld, 2012). Driven by the halo effect, owners of iPhones and iPads are buying even more Macs than in the iPod era (eWeek, 2012). Thus, I conclude that Apple and the iOS ecosystem possess the following success factor:

- **A3**. *Strong brand equity enabling premium pricing and halo effects across the product portfolio*

Case 2: Google and the Android Ecosystem

As per earlier discussion, Google's angle of entry is Internet (cloud) services, content, and advertising, or more specifically, Internet search and advertising, as illustrated in Figure 3.1 in Section 3.1.1. The company is relatively young, having been incorporated as late as September 1998, with an IPO in August 2004. When the business started out, search keyword advertising was its sole method of monetization, and it remains the company's bread and butter to this day. Google's effective search algorithm, based on counting and qualifying backlinks, along with AdWords technology that allowed the smart auctioning of search keywords to advertisers are what originally made the company so successful (Wired, 2005; Businessweek, 2006).

Search advertising based on the AdWords and AdSense programs forms the foundation of Google's advertising business model, and in addition, the company also provides display advertising services through its DoubleClick advertising technology that includes video, text, images, and other interactive ads. Additionally, Google has adopted continuous subscription-based and freemium monetization models for some of its services such as Google Apps for Business, and Google Drive. Most of its services continue to be free to consumers as long as they endure the advertising. Thus, Google's primary revenue model can be described as *sales of search and display advertisements on the web and on mobile devices*, which is complemented by *sales of subscriptions for SaaS apps and other cloud-based services.* Although Google does sell certain hardware products such as Chromebooks, the Nexus devices, and certain gadgets like the Google Glass, these do not represent significant revenue to Google.

Being such a young company, Google does not exhibit noticeable technological path dependence, or at least it is hard to pinpoint any major path dependence in its platform or technology-related decisions. If there is path dependence at Google, it has to be on the business model side, as so many services are advertising funded, without the user directly paying anything. Even Google's OS platform for smartphones and tablets, Android, is not generating direct revenue for Google through means other than advertising. Of course, Google does get its share of the transaction fee on Google Play that amounts to 30% of an application's price, shared with the distribution partner.

In the mobile smartphone business, Google's strength is that it does not suffer from a "burden of legacy" like so many other players that have been immersed in the hardware side of the business, often struggling to keep up in the technology race while trying to anticipate and appease the needs and preferences of consumers. By focusing mostly on the web and cloud services that are largely independent of devices and hardware, Google has saved itself from a lot of complexity. The brilliance of its business model is that its monetization is not dependent on fickle consumers looking to buy the latest and greatest smartphone or other gadget. No matter which device people use to access the Internet, odds are that they will be using Google services or at least accessing some Google Network Members' websites, which means Google earns revenue. As long as Google services are loved by consumers, the company has few reasons for concern. At least for the time being, Google is one of the most loved brands by consumers in the world, ranking #3 according to Sustainable

Brands (2013). In brand value, it is #5 according to Forbes (2013).

Finally, as Google does not seek vertical integration or physical domination in the smartphone business, having divested the former Motorola handset business, it leaves more freedom for device manufacturers and complementors to innovate on top of its platforms. Therefore, I identify the following success factors for Google and its ecosystem:

- **G1**. *Platform-agnostic business model, independent of devices and hardware*
- **G2**. *No burden of legacy, enabling a clear focus on cloud services, software, and content*
- **G3**. *More freedom for complementors to innovate on top of Google technologies*
- **G4**. *Google and its services are loved by consumers, also high brand equity*

Case 3: Microsoft and the Windows Phone Ecosystem

As illustrated in Figure 3.1 in Section 3.1.1, Microsoft's angle of entry is computer software, more specifically operating systems and applications. Having been founded in 1975, the company has a long history of working on various Windows OS products and business applications for the PC but also for other platforms, most notably the Office productivity software suite.

Today, Microsoft develops and market software, services, and hardware devices to its customers worldwide. Having been in the gaming and entertainment console business for more than a decade, the company also recently became a branded handset manufacturer, with its acquisition of the Nokia handset business completed in April 2014. Most of the company's revenue is derived from commercial (B2B) licensing of its business and productivity applications, mainly Office, as well as its Windows OS family, excluding its smartphone OS, Windows Phone, however. The mobile version of Office used to be exclusively available only on Windows Phone before a version of it was launched for the iPad and iPhone, albeit with limited functionality (TabletPCReview, 2014). Interestingly, Windows Phone licensing has always been rather insignificant as a revenue source, and indeed, Microsoft has even waived the license fees for some handset manufacturers using the OS. Hence, I identify the following success factors for Microsoft and the Windows Phone ecosystem:

- **M1**. *Business model largely focused on B2B licensing of Office, the world's most popular productivity software suite, as well as other business apps and services*
- **M2**. *Windows Phone includes Office while other platforms have limited functionality*
- **M3**. *Microsoft can afford to waive the license fee for Windows Phone*

As noted in the case study, Microsoft has exhibited at least first-degree, possibly third-degree path dependence by carrying over legacy OS components and support for the text-based MS-DOS operating system into the 2000s, with the first mainstream Windows running on an NT-based hybrid kernel, Windows XP, being available in late 2001. This testifies that Microsoft has been slow to renew its core OS architecture and get rid of legacy design decisions that have led to suboptimal performance and bloated software (van Wensveen, 2007).

One could argue, however, that Microsoft's path dependence in its OS development at least partially stems from its desire to maintain compatibility with the vast application base that existed for MS-DOS and the early versions of Windows, also upholding the application barrier that has made it so difficult for other OS vendors to gain a foothold in the mainstream PC market — IBM tried it and failed, and Linux is still far from becoming mainstream outside the server market (Ars Technica, 2013b).

As discussed, Microsoft was not very successful in creating a UX for its PDA and smartphone OS that would appeal to mass-market consumers. It can be argued that Microsoft exhibited up to third-degree path dependence in modeling the Windows Mobile UI after its legacy desktop UI, also sticking to a suboptimal stylus-based UI paradigm when finger touch was already seen as the superior paradigm by consumers. Therefore, I do not see any other success factors stemming from Microsoft's particular angle of entry that would help the company prosper in the smartphone business.

4.4.2 Q2: Success Factors of Ecosystems

How does a leading firm successfully orchestrate an ecosystem to foster value-adding complementary innovation?

Success Factors Stemming from the Ecosystem Leader's Role and Governance

All three case companies, Apple, Google, and Microsoft, have clearly adopted the *keystone* role, while acting as the undisputed leaders in their respective mobile business ecosystems. As discussed in Section 2.3.2, a keystone is a company in a leadership role that is valued by the rest of the community, enabling all ecosystem participants to invest toward a shared future in which they anticipate profiting together. Thus, a keystone has to advance the overall good of the ecosystem, as opposed to overpowering it and/or draining all value out of it. The latter behavior is attributed to *dominators* that can be detrimental to an ecosystem if left unchecked. A physical dominator pursues either vertical or horizontal integration with the goal of encompassing a large portion of its ecosystem in itself, whereas a value dominator tends to create little if any value itself, instead robbing most of the value created by other ecosystem participants.

Interestingly enough, while all three case companies generally speaking act like keystones, each of them can also be seen to exhibit dominator behavior. Apple is the *only* device hardware manufacturer in the iOS ecosystem, thus capturing *all* value generated from iOS device hardware sales. Due to a high degree of vertical integration, the company captures value also from its in-house designed chipsets. It also maintains strict control over the manufacturers of hardware accessories and peripherals through its proprietary electrical interfaces such as the Lightning connector. Third-party manufacturers seeking to produce accessories for Apple products using any proprietary interfaces must pay a costly license fee (in 2005, up to $10 or 10% of product cost, whichever was higher) to Apple as part of its 'Made For iPod/iPhone/iPad' program, although Apple reportedly lowered the fee in early 2014 (Apple Insider, 2014b). Such a forced revenue-sharing policy with the accessory manufacturers exhibits characteristics of a value dominator, but at the same time, can be useful in ensuring that all accessory manufacturers comply with the compatibility, quality, and design requirements and guidelines set by Apple. I choose not to consider it a success factor for Apple and the iOS ecosystem.

Microsoft is known for its disproportionate value capture in the PC ecosystem through its Windows OS and Office license fees, exhibiting value dominator characteristics, and it has tried to enforce a similar model in the Windows Phone ecosystem, although without much success due to the OS platform's weak position in the market and unpopularity among handset OEMs. As noted in the case study of Microsoft, however, Microsoft captures billions of dollars worth of IP-related royalty fees annually through its patent licensing agreements with mobile device manufacturers using the Android OS, thus extracting value from the Android ecosystem without contributing anything in return. Although harmful to the Android ecosystem, this is actually a success factor for Microsoft (and possibly the Windows Phone ecosystem as well, if Microsoft is able to get commitments from OEMs to work on Windows Phone in addition to, or instead of Android):

- **M4**. *Strong IP portfolio to defend own OS, also enabling value extraction from rivaling ecosystems*

In its mobile business ecosystem, Google appears to be the fairest player out of the three companies. In the case study of Google, I explained how the various Android ecosystem participants benefit from Google's key decisions in governing the ecosystem. I rephrase them here as the following success factors, one of which is also shared with the Windows Phone ecosystem:

- **G5**. *OEMs benefit from having a state-of-the-art mobile OS platform, essentially royalty free and enjoying higher adoption rates than any competing platform*
- **G6, M5**. *Accessory makers appreciate that they can work with standard interfaces (and are not bound to the whims of any single OEM)*
- **G7**. *Developers value the openness and nonrestrictive philosophy in application distribution*
- **G8**. *Mobile operators benefit from the transition to smartphones, fueled in many markets by the availability of affordable Android handsets, driving up demand for mobile data plans*

Furthermore, websites earn revenue by hosting Google's advertisements, and advertisers benefit from Google's broad consumer reach and effective targeted ads that have a high conversion rate. Due to Google's dominant position in search advertising, however, this is the one area where Google has been accused of anticompetitive behavior, effectively forcing most publishers to agree to Google's terms and conditions that allow the search giant to capture a very large portion of the advertising revenue. If there were more competition, the publishers could keep more of the revenue to themselves.

Success Factors Stemming from the Ecosystem's Health

With regard to the health of the mobile business ecosystems of Apple, Google, and Microsoft, I have discussed the health metrics of *productivity*, *robustness*, and *niche creation*, using *diversity* of the application catalog and developer base as a proxy for niche creation, and growth in the number of applications and payouts to developers as a proxy for productivity. Robustness has been more difficult to evaluate due to a lack of statistics on the survival rates of firms producing complements for a particular platform, especially application developers, and thus I have used the additional metrics of *persistence of ecosystem structure*, *predictability*, *limited obsolescence*, and *continuity of user experience* *and use cases.* In Table 4.1, I summarize the findings from the case studies regarding ecosystem health metrics for each of the three ecosystems.

Table 4.1: Ecosystem health metrics evaluated

Ecosystem Health Metric	**Apple (iOS)**	**Google (Android)**	**Microsoft (WP)**
Productivity (Catalog & Payout Growth)	High	High	Low
Robustness:	High	Medium	Medium/Low
- Persistence of Ecosystem Structure	High	High	Low
- Predictability	High	Medium	Low
- Limited Obsolescence	High	Medium	Medium
- Continuity of UX and Use Cases	High	Medium	High
Niche Creation (Diversity)	High	High	Medium

Based on these results, I conclude that out of the three case companies included in this study, Apple has succeeded best in fostering its ecosystem's health, at least when the metrics of productivity, robustness, and niche creation are considered per the definitions of Iansiti & Levien (2004a,b). Google and its Android ecosystem rank very close to Apple, scoring high in all metrics except robustness, where the substantial fragmentation of Android lowered its score for limited obsolescence and continuity of user experience and use cases. Hence, I formulate the following success factors for the ecosystems of Apple and Google respectively:

- **A4**. *Healthiest ecosystem based on metrics of productivity, robustness, and niche creation*
- **G9**. *Healthy ecosystem based on metrics of productivity, robustness, and niche creation*

Success Factors Stemming from the Software Ecosystem and Application Marketplace

As discussed in the case studies, the iOS ecosystem, the Android ecosystem, and the Windows Phone ecosystem are OS-centric software ecosystems according to the criteria of Bosch (2009), discussed in Section 2.4.2. The iOS ecosystem and the Android ecosystem also easily fulfill the criteria for the three success factors identified for such ecosystems, namely 1) *minimal effort required by developers*, 2) *generic, evolving functionality and set of features provided by the OS*, and 3) *the number of customers that use the OS and that are accessible to developers*, although for Android, the first success factor is somewhat adversely affected by the platform's fragmentation. While Windows Phone clearly fulfills the criteria for the first success factor, having a comprehensive SDK and toolchain as well as well-defined APIs, it has lagged behind the other two ecosystems in providing the functionality and set of features that developers expect from a platform, although it has recently shown significant improvement in catching up with its competitors. The Achilles' heel of Windows Phone is, however, the last success factor, as it ranks low in the number of customers that use the OS and that are accessible to developers. Based on this evaluation, I recognize the following success factors for the iOS ecosystem (A), Android ecosystem (G), and Windows Phone ecosystem (M):

- **A5, M6**. *Minimal effort required by developers*
- **A6, G10**. *Generic, evolving functionality and set of features provided by the OS*
- **A7, G11**. *The number of customers that use the OS and that are accessible to developers*

In the case studies, I discussed the number of apps each of the three ecosystems had in their application catalogs on a number of occasions. As of August 2014, Android's app count has surged to more than 1.3 million, with iOS not far behind with a reported 1.2 million apps as of June 2014. Microsoft reported Windows Phone has 300,000 apps as of August 2014. I also noted that with such figures, the competition for end users' attention on the iOS App Store is fierce, meaning that app discovery is increasingly a problem, requiring developers to invest more in, e.g., social media and viral marketing to ensure the continued discovery of their applications. The Android ecosystem, with a similarly high number of applications in the Google Play store (which is not even the only application marketplace for Android), is presumably suffering from the same crowding-out effects that eventually lead to diminishing returns for developers as well as a reduced level of innovation on the platform, as argued by Boudreau (2008) and discussed in Section 2.5.3. Indeed, some developers have voiced their opinion about the stagnant state of the Apple App Store as of late 2014.

As I discussed in the case study of Microsoft, the majority of developers publishing their apps for Windows Phone were exclusive to that platform, while only very few developers, less than one percent, who had published apps for iOS and Android had also published their apps for Windows Phone, according to the study of Hyrynsalmi et al. (2012). I argued that in a sense, this meant that Windows Phone app developers did not have to compete much with developers from the other platforms, meaning that the Windows Phone app ecosystem is not suffering from crowding-out effects as much as the Android and iOS ecosystems. Of course, the lower absolute number of apps and developers in the Windows Phone ecosystem as compared to the Android and iOS ecosystems also makes crowding-out effects less likely to occur.

Although multi-homing has been a very rare phenomenon for Windows Phone developers, Bresnahan et al. (2014) have modeled the app supply for Android and iOS in the case of symmetrical demand[7], finding that the supply on one platform is highly symmetrical with the supply on the other, and thus multi-homing is the most common supply behavior, at least as far as popular applications on either platform are concerned. Windows Phone is excluded from the study, although due to its very low market share in the U.S. market as well as globally, there wouldn't be any demand symmetry, not by a long shot. Also in the study of Hyrynsalmi et al. (2012), based on global application catalog data, multi-homing was more common between Android and iOS although still quite rare, with 13% of Android developers and only 6% of iOS developers multi-homing as of 2012.

According to the developer mindshare survey of VisionMobile (2014), Android is the most popular platform among developers, consistently beating iOS in all regions, although the differences are quite small in North America and Western Europe. In these two regions as well as Japan, the majority of developers actually prioritize iOS over Android, leading to the perception of "iOS first, then Android". The most plausible explanation for this is that particularly in developed markets where iOS has a high market share, the platform continues to provide better monetization opportunities for the majority of developers, most of whom still view iOS as the most rewarding and engaging development platform. Moreover, iOS is the preferred platform for 59% of its developer base, thus commanding the highest developer loyalty among all mobile OS platforms (Vision Mobile, 2014). Based on the discussion above, I therefore identify the following ecosystem success factors:

- **A8**. *Most likely ecosystem to benefit from multi-homing developers*
- **M7**. *Harmful crowding-out effects less likely to occur in application marketplace*

4.4.3 Q3: Success Factors of Platforms

How does a leading firm successfully manage a product/industry platform to enable value-adding complementary innovation?

[7] Demand symmetry arises from roughly equal market shares for the two platforms particularly in the U.S. market, 52% for Android and 42% for iOS, as of May 2014 according to comScore (2014).

In each of the case studies, I evaluated the openness of the software ecosystem in question using the dimensions of openness identified by Eisenmann et al. (2008), discussed in Section 2.5.5. Because the question of openness is equally if not more relevant to platform management and thus research question #3, I have chosen to discuss it here. The results of the evaluations are summarized below in Table 4.2:

Table 4.2: Ecosystem dimensions of openness evaluated

Dimension of Openness	**Apple (iOS)**	**Google (Android)**	**Microsoft (Windows Phone)**
Demand-Side Users (End Users)	Open	Open	Open
Supply-Side Users (Developers)	Open	Open	Open
Platform Providers (Marketplaces)	Closed (Apple only)	Open (Google, Amazon, Samsung, others)	Closed (Microsoft only)
Platform Sponsors (OS Development)	Closed (Apple only)	Semi-Open (Google, OHA, OAA, others through AOSP)	Closed (Microsoft only)

From the table, we can see that the there are no significant differences between the three ecosystems in terms of their openness toward end users and developers. A minor difference is that the developer program for iOS is more costly than the programs for Android and Windows Phone, and joining it is a prerequisite for testing developed iOS apps on real Apple hardware as opposed to just using a simulator.

When it comes to the roles of platform provider and platform sponsor, however, we see a similar approach for iOS and Windows Phone, but a clearly differing approach for Android. As I discussed in the case study of Google, the Android ecosystem has several alternative application marketplaces, although Google Play is the largest one and is mandatory on devices that support Google Mobile Services. Some players like Samsung offer their own application marketplace alongside Google Play, while some others like Amazon have completely removed Google Play along with GMS, using a forked version of the open-source Android (i.e., AOSP) complemented with a proprietary set of services.

Although the latter kind of behavior increases fragmentation in the Android ecosystem, Google had chosen to allow it based on the ideals of freedom and open innovation that Android was built on. As discussed in the case study of Google, however, the company may be more inclined to limit fragmentation and control the software experience in future Android products by introducing a certification program for device OEMs rumored to be called Android Silver. Without any official statements from Google, however, it is difficult to say exactly how and when such a program would be realized. The Android One initiative for entry-level smartphones, however, does already control the specifications and experience. Still for the time being, however, Android is by far the most open OS platform also in terms of the platform sponsor role — as AOSP is open source, it can be freely modified and utilized by manufacturers of various products, not just handsets. Modified versions of Android have been used in various application domains, e.g., in automotive infotainment by Audi (CNET, 2014). Based on the arguments above, I identify the following success factors:

- **A9, M8**. *Keeping the platform provider and sponsor roles closed (under proprietary control) helps keep fragmentation in check, but may limit market share growth*
- **G12**. *Being open with regard to end users, developers, platform providers, and platform sponsors enables a high degree of open innovation, but may lead to severe fragmentation*

In addition to the four dimensions of openness, I discussed the findings of Müller et al. (2011) in Section 2.5.5, outlining 12 distinct value network roles where owners of mobile application marketplaces (or more aptly, leaders of software ecosystems) can have varying levels of control and influence, either by being the sole owner of a role or function, or partial owner through a consortium, and exerting influence on other parties through exclusive arrangements or some other means. Based on the evaluations done in the case studies, I have come up with the results illustrated in Table 4.3.

From the results, we can see that Google is acting in a non-exclusive capacity in five out of seven roles where it is an "owner", occupying the value network role in question. For comparison, Apple has non-exclusivity only twice out of eight ownership roles, and in the other instance, the company still has significant influence on the external parties (i.e., software developers). As for Microsoft, the company acts in a non-exclusive capacity in four out of seven ownership roles. Microsoft does have some influence on device manufacturers through its licensing policy and fees. All three companies act as content retailers through their branded content stores and have made deals with the leading content providers in the world. Out of the three companies, Apple's content offering available through iTunes, the iBookstore, the App Store, and the Mac App

[8] In the past, Google has worked with a lead device manufacturer and lead carrier for each new Android release. However, there was no real exclusivity period and other manufacturers and carriers could follow quite quickly.

Table 4.3: Control and influence along the value network

Value Network Role	Apple (iOS)	Google (Android)	Microsoft (WP)
Marketplace	owner, exclusive (iTunes, App Store)	owner, non-exclusive (Google Play)	owner, exclusive (WP Store)
Payment Broker	owner, exclusive (iTunes)	owner, exclusive (Google Wallet)	owner, non-exclusive (MS Acct., Wallet)
Advertisement Broker	owner, non-exclusive (iAd)	owner, non-exclusive (AdMob)	owner, non-exclusive (adCenter)
Operating System Developer	owner, exclusive	owner/consortium, exclusive (Android/AOSP)	owner, exclusive
Software Developer	owner, influence	owner, non-exclusive	owner, non-exclusive
Testing & Verification Party	owner, exclusive	owner, non-exclusive	owner, exclusive
Signing Partner	owner, exclusive	owner, non-exclusive	- exclusive (Symantec)
Software Distributor	- -	- -	- -
Content Provider	retailer, influence (iTunes, iBookstore)	retailer, some influence (Google Play Music)	retailer, some influence (Xbox Music & Xbox Video)
Device Manufacturer	owner, exclusive	- influence (esp. lead OEM[8])	owner, some influence (licensing fees)
Mobile Network Operator	- influence	- some influence (lead operators[8])	- -
End User	- -	- -	- -

Store is the largest, most mature, and most profitable one. Thus, it can be argued that Apple has the most influence on content providers out of the three companies. Based on the results obtained and the arguments above, I identify the following success factors:

- **A10**. *High degree of vertical integration through exclusive ownership of all core elements in the value network, full control of the publishing process, and a strong influence on external complementors and providers*
- **G13**. *Non-exclusive process of application development, verification, and*

publishing

At first sight, the success factors A10 and G13 would seem to be in conflict — how can a strongly exclusive model and a non-exclusive model both be successful? To answer the question, one must look at the broader ecosystems of Apple and Google and understand their business models. Apple is all about selling premium-priced devices with a superior design and UX, thus controlling and perfecting every little detail in the products and services of the company is absolutely core to the company's success. Although Apple needs external complementors and content providers to complete its offering, it has to make sure absolutely nothing compromises the Apple experience and brand perception that allows it to maintain its high profit margins.

As for Google, however, devices and their experiences are not so important per se, as long as people use Google services and are subjected to the advertisements through which the company earns the vast majority of its revenue and profit. It is in Google's best interests to promote the proliferation of Android as much as possible, and being too exclusive or restrictive in its policies for app publishing and sales would be counterproductive. Also, as Google no longer manufactures Android devices in-house, it has little reason to pursue the kind of vertical integration that Apple is known for.

Thus, the success factors A10 and G13 cannot be combined in any single ecosystem, and indeed, either of them will not suit just any ecosystem without knowing more about the said ecosystem's structure and about the business model of the company acting as the leader or keystone of the ecosystem.

Success Factors Stemming from the Platform Approach and Governance

As discussed in the case study of Apple, the iOS platform is based on a mix of closed source software components developed by Apple (and the company NeXT Software that Apple acquired in 1997) as well as open source components originating from BSD Unix and diverse open source projects. It is particularly noteworthy that the differentiating or value-adding components such as the UI and application framework are closed source to protect Apple's intellectual property and to hinder substitute innovation. Only Apple employees have access to the iOS source code.

Also Google keeps the portion of Android source code related to GMS and Google Play closed source, although the core Android platform without the Google-branded apps or services, AOSP, remains open source. Google has been criticized for "closed source creep", i.e., increasingly moving its development efforts from AOSP to the closed source, proprietary counterparts of certain

Android apps and services. OEMs using Android may get access to the GMS source code, but only if they agree to Google's licensing terms and follow the GMS approval window, as discussed in the case study of Google.

For Google, and actually for any company, less open source code means more work for the company's competitors. Microsoft, on the other hand, has always believed in a closed source model, in fact so much that it has revealed certain interfaces of its Windows OS only as a result of court orders to do so, as was discussed in the respective case study. Windows Phone is also closed source, but exposes a set of APIs to OEMs and developers. Based on the above, I formulate the following success factors:

- **A11, G14, M9**. *The software components of the platform that meaningfully differentiate it from the competition or otherwise create significant added value based on proprietary IP are kept closed source*
- **A12, G15, M10**. *The platform exposes enough APIs so that OEMs, accessory makers, and developers are able to create products and apps with meaningful differentiation*

Looking at how the three case companies manage their complementors and external innovation on their respective platforms, Google would appear to have the healthiest and most predictable approach. As discussed in the case study, Google is neither known to impose limitations on its developers nor to block certain third-party applications, should they have overlap with in-house offerings. As an example, Google allows third-party web browsers, such as Firefox for Android, to be used freely on Android devices, and even basic functionality like the call dialer can be implemented by third parties. This is definitely not the case with Apple, where any third-party apps seen as replacements or competitors for in-house Apple apps like the Safari browser are automatically rejected. Also Microsoft does not allow alternative browsers to the Internet Explorer in Windows Phone, and through its API restrictions, it is not possible to replace any built-in functionality. Making things worse for Microsoft, the company is known for occasionally trampling or crushing its complementors through actions that are formally known as envelopment attacks, often being of the foreclosure type, as discussed in the case study. Such behavior is very discouraging to complementors, as they can never be too sure whether their platform provider is going to run them out of business.

- **G16**. *The platform has the most nonrestrictive policy for complementors, not limited by protective clauses against competition or substitution*

The iOS, Android, and Windows Phone OS platforms all have comprehensive developer programs, SDKs, and various online and offline resources and events such as developer conferences to attract and support developers in creating applications for the platforms. Each platform has also adopted a roughly similar revenue sharing scheme. What sets them apart, particularly Windows Phone from the rest, is the sustainability of commercial application development on the platform. As discussed in the case study of Windows Phone, Microsoft has resorted to heavily subsidizing app developers to write or port their apps for Windows Phone in order to keep the store catalog even remotely on par with the Apple App Store and Google Play. Subsidies anywhere between $60,000 and $600,000 have reportedly been needed to get developers on board. This is clearly a problem for Microsoft, as Apple and Google do not need to incentivize developers on their platforms. The underlying reason, as was discussed in the studies, ultimately boils down to the low market adoption of products based on Windows Phone, i.e., the low installed base of the platform, also reflected in its persistently low market share. Thus, the identical success factor **A7/G11** for Apple and Google, *the number of customers that use the OS and that are accessible to developers* is equally valid here.

4.4.4 Q4: Commonalities between Successful Platform Management and Ecosystem Orchestration

What is the interplay between successfully orchestrating an ecosystem and managing a product/industry platform? Are the success drivers similar?

As I discussed in the previous section, the question of openness is equally relevant to platform management as it is to ecosystem orchestration. Also questions of control, exclusivity, and influence in multi-sided platforms, their value networks, and the broader ecosystems are largely related to one another. Therefore, regardless of whether looking strictly at the individual platforms or the ecosystems surrounding them, I consider the following success factors as highly relevant:

- **A9, M8**. *Keeping the platform provider and sponsor roles closed (under proprietary control) helps keep fragmentation in check, but may limit market share growth*
- **G12**. *Being open with regard to end users, developers, platform providers, and platform sponsors enables a high degree of open innovation, but may lead to severe fragmentation*

The following success factors stemming from each ecosystem leader's angle of entry and business model can also be thought to have wide-ranging implications to both ecosystem orchestration as well as platform management, as they often implicitly define the domains where ecosystem participants or platform complementors are able to thrive:

- **A1**. *Vertically integrated business model with clear focus on device hardware sales, supported by services and content (that serve to drive hardware sales*
- **G1**. *Platform-agnostic business model, independent of devices and hardware*
- **G2**. *No burden of legacy, enabling a clear focus on cloud services, software, and content*
- **G3**. *More freedom for complementors to innovate on top of Google technologies*
- **M1**. *Business model largely focused on B2B licensing of Office, the world's most popular productivity software suite, as well as other business apps and services*
- **M3**. *Microsoft can afford to waive the license fee for Windows Phone*

Apple's business model rules out third-party value creation from device hardware sales for iOS ecosystem participants, and also the iOS platform is not open to third-party device hardware manufacturers, being exclusive to Apple. The scope of the iOS platform and ecosystem for external complementors is therefore limited to software applications, hardware accessories, and various types of digital content sold through iTunes, the App Store, or other Apple-controlled stores.

Google's platform-agnostic business model, on the other hand, allows Android ecosystem participants to freely create value in practically any way they see fit, although Android devices supporting GMS must include Google Search, Gmail, Google Play, and other popular Google services. Thus, any form of third-party value creation except search advertising is, at least in principle, viable in the Android ecosystem. Furthermore, by using AOSP without GMS, it is possible for device OEMs to replace Google services altogether and capture value from the value network roles normally occupied by Google.

Microsoft's Windows Phone platform and ecosystem both benefit from the fact that the company still earns the vast majority of its revenue outside of the mobile industry, allowing it to heavily cross-subsidize the development of the platform and its surrounding ecosystem. This is particularly evident in the large developer subsidies paid out by Microsoft as well as the company's decision to waive the license fee for Windows Phone, at least for certain OEMs.

4.4.5 Overview of the Results for Q1–Q4

An overview of the study results across all research questions and case companies is presented in Tables 4.5 and 4.6, divided in two tables due to layout requirements. A key purpose of the overview is to facilitate identifying the success factors that were *common* across two or all three of the case companies and their ecosystems. After all, as stated in Section 1.3, the high-level goal of this study is to identify common success factors in leading mobile business ecosystems, based on a multiple case study of the said three companies chosen because of their distinct angles of entry, as explained in Section 1.4.2. Although the *individual* success factors of the ecosystems of each of these companies are quite interesting as such, in order to have any generalizability of the results to the smartphone business beyond the three companies, commonalities need to be identified.

If a success factor is exhibited by all three ecosystems, I consider it *confirmed*, being generalizable to the analysis of other firms and their ecosystems in the smartphone business not covered in this study. As a rule of thumb, such success factors should be valid for any mobile business ecosystems, being highly relevant for their success.

If, on the other hand, a success factor is exhibited by exactly two ecosystems, I consider it *partially confirmed*, meaning that it may be generalizable to the analysis of other firms and their ecosystems in the smartphone business, but this may be subject to certain preconditions relating to the business model of the ecosystem leader or the structure of the ecosystem under analysis. Such success factors may therefore be valid for many but not all mobile business ecosystems.

If a success factor is exhibited by just one ecosystem, I consider it a firm or context-specific success factor that is based on either the unique characteristics or the angle of entry of a firm, or a very specific business context, e.g., serving a specific market segment or niche. Such success factors are most often not generalizable, particularly when they arise from the path-dependent evolution of a firm, or from unique resources, capabilities, or interfirm linkages that are difficult to imitate.

Common Success Factors of Ecosystems

- **Partially Confirmed**: **CSF1**. *Accessory makers appreciate that they can work with standard interfaces (and are not bound to the whims of any single OEM)* (**G6, M5**)
- **Partially Confirmed**: **CSF2**. *Healthy ecosystem based on metrics of*

productivity, robustness, and niche creation (**A4, G9**)

- **Partially Confirmed**: **CSF3**. *Minimal effort required by developers* (**A5, M6**)
- **Partially Confirmed**: **CSF4**. *Generic, evolving functionality and set of features provided by the OS* (**A6, G10**)
- **Partially Confirmed**: **CSF5**. *The number of customers that use the OS and that are accessible to developers* (**A7, G11**)

The first common success factor (CSF1) suggests that standard interfaces should be the preferred choice to get as many accessory manufacturers on board as possible, and also to enable sustainable value creation for these companies as opposed to value extraction from them. This makes senses both intuitively as well as based on the evidence discussed in the case studies.

The second common success factor (CSF2) is essentially saying that healthy ecosystems are those that measure high in productivity, robustness, and niche creation, which is the central argument of Iansiti & Levien (2004a,b), thus confirmed here for the iOS and Android ecosystems, but not conclusively for Windows Phone. As discussed in Section 4.4.2 and illustrated in Table 4.1, the iOS and Android ecosystems both scored highly in terms of productivity, robustness, and niche creation, whereas the Windows Phone ecosystem lagged behind in all three metrics to a varying degree.

Finally, the last three common success factors above (CSF3, CSF4, CSF5) confirm at least partially that the three identical success factors of OS-centric software ecosystems identified by Bosch (2009) also apply to mobile software ecosystems and the smartphone business. Interestingly, the iOS ecosystem exhibits all three success factors, whereas the Android and Windows Phone ecosystems exhibit strictly speaking only two.

Common Success Factors of Platforms

- **Partially Confirmed**: **CSF6**. *Keeping the platform provider and sponsor roles closed (under proprietary control) helps keep fragmentation in check, but may limit market share growth* (**A9, M8**)
- **Confirmed**: **CSF7**. *The software components of the platform that meaningfully differentiate it from the competition or otherwise create significant added value based on proprietary IP are kept closed source* (**A11, G14, M9**)

- **Confirmed**: **CSF8**. *The platform exposes enough APIs so that OEMs, accessory makers, and developers are able to create products and apps with meaningful differentiation* (**A12, G15, M10**)

The sixth common success factor (CSF6) advocating proprietary control of the platform provider and sponsor roles to stop fragmentation from becoming a problem is partially confirmed, as both Apple and Microsoft practice it successfully to this end, whereas Google does not. Also confirming the success factor, Apple and Microsoft have been unable to grow the global market shares of their OS platforms over the 20% mark (and actually, Windows Phone is far from even 10%), and recently their market shares have been stagnant. However, even Google has taken steps toward strengthening its control of the Android platform and reducing its fragmentation through the adoption of the GMS approval window, and may take things even further through the rumored upcoming Android Silver program, which it can probably afford to do, given Android's largely dominant position in the market. The Android One initiative, announced in June 2014, is already a step in this direction, limiting participating OEMs to a stock Android experience with little variation in hardware specifications.

The seventh common success factor (CSF7) is confirmed by all three case studies, highlighting the fact that all three leading mobile ecosystems use closed source, at least to a certain extent, to protect their differentiating or otherwise value-adding software components, often based on their proprietary IP. As discussed, iOS and Windows Phone are closed source whereas Android, although commonly referred to as open source, is only partially open source — the core platform, AOSP, is indeed open source, but a good deal of the platform's value add is being developed by Google and its lead OEM partners as closed source. Google's reportedly increasing use of closed source in the overall Android project serves as further evidence to confirm this success factor.

The eight and last common success factor (CSF8) is also confirmed by all three case studies, stating the rather simple fact that all platforms must expose enough APIs and other external interfaces that complementors are able to create complementary products (e.g., apps, accessories) that have meaningful differentiation and thus business potential. If this were not the case, the breadth of complementary innovation on a platform would be severely limited, and the complement business would be diminished to a dire cost-based competition with little room for profit-making.

Common Success Factors of Both Ecosystems and Platforms

As discussed earlier, the common success factor CSF6 (also known as A9, M8) is also related to the orchestration of the broader ecosystem, making it the only common success factor that is equally valid in both platform and ecosystem management. One could argue, however, that CSF1 and particularly CSF3–5 also have to do with platforms of some kind, so actually nearly all of the eight common success factors identified above are applicable to OS-centric mobile business ecosystems and platforms. Only CSF2 pertains specifically to ecosystems, as the ecosystem health measures are originally defined for business ecosystems, not platforms.

Thus, all in all, I have come up with two confirmed common success factors, CSF7 and CSF8, generalizable to other mobile business ecosystems and platforms, as well as six common success factors that are at least partially confirmed, CSF1–CSF6, but would need further validation through other case studies in order to get conclusive results about the extent of their generalizability. For easy reference, all eight common success factors are summarized in Table 4.4.

Table 4.4: Common success factors for ecosystems and platforms

ID	Common Success Factor	Status
CSF1	Accessory makers appreciate that they can work with standard interfaces (and are not bound to the whims of any single OEM)	P. Confirmed
CSF2	Healthy ecosystem based on metrics of productivity, robustness and niche creation	P. Confirmed
CSF3	Minimal effort required by developers	P. Confirmed
CSF4	Generic, evolving functionality and set of features provided by the OS	P. Confirmed
CSF5	The number of customers that use the OS and that are accessible to developers	P. Confirmed
CSF6	Keeping the platform provider and sponsor roles closed (under proprietary control) helps keep fragmentation in check, but may limit market share growth	P. Confirmed
CSF7	The software components of the platform that meaningfully differentiate it from the competition or otherwise create significant added value based on proprietary IP are kept closed source	Confirmed
CSF8	The platform exposes enough APIs so that OEMs, accessory makers, and developers are able to create products and apps with meaningful differentiation	Confirmed

Table 4.5: Overview of results obtained for research questions – part I

Research Question	**Apple and the iOS ecosystem**	**Google and the Android ecosystem**	**Microsoft and the Windows Phone ecosystem**
Q1: Angle of Entry and its Impact on the Success Factors of Ecosystems	- Vertically integrated business model with clear focus on device hardware sales, supported by services and content - Differentiation through superior UX and first-class complementary services and content - Strong brand equity enabling premium pricing and halo effects across the product portfolio	- Platform-agnostic business model, independent of devices and hardware - No burden of legacy, enabling a clear focus on cloud services, software, and content - More freedom for complementors to innovate on top of Google technologies - Google and its services are loved by consumers, also high brand equity	- Business model largely focused on B2B licensing of Office, the world's most popular productivity software suite, as well as other business apps and services - Windows Phone includes Office while other platforms have limited functionality - Microsoft can afford to waive the license fee for Windows Phone
Q2: Success Factors of Ecosystems	- Healthiest ecosystem based on metrics of productivity, robustness, and niche creation - Minimal effort required by developers - Generic, evolving functionality and set features provided by the OS - The number of customers that use the OS and that are accessible to devs - Most likely ecosystem to benefit from multi-homing developers	- OEMs benefit from having a state-of-the-art mobile OS platform, essentially royalty free - Accessory makers appreciate that they can work with standard interfaces - Developers value the openness and non-restrictive philosophy in app distribution - Mobile operators benefit from the transition to smartphones, fueled by Android handsets - Healthy ecosystem based on metrics of productivity, robustness, and niche creat. - Generic, evolving functionality and set of features provided by the OS - The number of customers that use the OS and that are accessible to devs	- Strong IP portfolio to defend own OS, also enabling value extraction from rivaling ecosystems - Accessory makers appreciate that they can work with standard interfaces - Minimal effort required by developers - Harmful crowding-out effects less likely to occur in app marketplace

Table 4.6: Overview of results obtained for research questions – part II

Research Question	**Apple and the iOS ecosystem**	**Google and the Android ecosystem**	**Microsoft and the Windows Phone ecosystem**
Q3: Success Factors of Platforms	- Keeping the platform provider and sponsor roles closed helps keep fragmentation in check, but may limit market share growth - High degree of vertical integration through exclusive ownership of all core elements in the value network, full control of the publishing process, and a strong influence on external complementors and providers - Differentiating or proprietary IP based software components are kept closed source - The platform exposes enough APIs so that OEMs, accessory makers, and developers are able to create products and apps with meaningful differentiation	- Being open with regard to end users, developers, platform providers, and platform sponsors enables a high degree of open innovation, but may lead to severe fragmentation - Non-exclusive process of application development, verification, and publishing - Differentiating or proprietary IP based software components are kept closed source - The platform exposes enough APIs so that OEMs, accessory makers, and developers are able to create products and apps with meaningful differentiation - The platform has the most nonrestrictive policy for complementors, not limited by protective clauses against competition or substitution	- Keeping the platform provider and sponsor roles closed helps keep fragmentation in check, but may limit market share growth - Differentiating or proprietary IP based software components are kept closed source - The platform exposes enough APIs so that OEMs, accessory makers, and developers are able to create products and apps with meaningful differentiation
Q4: Commonalities between Successful Platform Management and Ecosystem Orchestration	- Keeping the platform provider and sponsor roles closed helps keep fragmentation in check, but may limit market share growth - Success factors stemming from the angle of entry and business model	- Being open with regard to end users, developers, platform providers, and platform sponsors enables a high degree of open innovation, but may lead to severe fragmentation - Success factors stemming from the angle of entry and business model	- Keeping the platform provider and sponsor roles closed helps keep fragmentation in check, but may limit market share growth - Success factors stemming from the angle of entry and business model

Chapter 5

Conclusions

5.1 Discussion of the Results

The high-level goal of this study was to identify common success factors in leading mobile business ecosystems, specifically those led by the three companies that were chosen for a multiple case study: Apple, Google, and Microsoft. The reason for choosing exactly these companies was that each of them has historically been active in different businesses outside the traditional telecommunications industry before successfully entering, and as of late, dominating the smartphone business, pushing aside long-standing incumbents with roots in the telecommunications equipment industry. Here, 'success', although it could be defined in many ways, simply refers to the ability of a firm to establish itself in a new business domain previously dominated by incumbents such as Nokia and BlackBerry, and to create a sustainable ecosystem of complementary products and innovation around itself. As we have seen, this is clearly true for at least the Google Android and Apple iOS ecosystems. Therefore, identifying and understanding the various success factors that have led to such a major, unprecedented change in the industry and market structure, being able to learn from them and create guidelines for strategic decision-making based on them was the practical goal of this study.

From a theoretical perspective, as discussed, very few researchers have attempted to bring together the separate but interrelated theories of platforms, two-sided markets, and business ecosystems, despite the fact that these concepts largely describe similar phenomena and underlying mechanisms, even if from somewhat different perspectives. Thus, bridging the different theoretical concepts with notable similarities and making sense of them in a holistic way was also a key purpose of the study. This is essentially what I have done, bringing together and, where possible, reconciling the latest research in the above-mentioned fields, combining their key elements in a holistic conceptual framework that I hoped would capture the essential dimensions of analysis for the comprehensive study of mobile business ecosystems and their success factors, the research problem at hand.

Also interestingly, very few researchers have attempted to explain the changes in the smartphone industry structure using the theory of path dependence, drawing on analysis of past events and decisions and their impact on the present. Already before doing any actual research, my hypothesis was that the 'angle of entry' of a firm could at least partially be used to explain some of the ecosystem or platform related success factors. This hypothesis essentially became the first research question (*How do a firm's legacy and angle of entry into the mobile business affect the success factors of its ecosystem?*), and I was able to validate it through the case studies. The success factors influenced by the angle of entry of each case company were discussed in Section 4.4.1.

5.1.1 Practical Contribution of the Study

Based on the synthesis of the three case studies conducted, the success factors identified for ecosystems and platforms, or commonly for both, were discussed in Sections 4.4.2, 4.4.3, and 4.4.4, grouping together identical or similar success factors across the three case companies and their ecosystems. Based on this grouping, the common success factors, eight of them in total (CSF1–CSF8), were evaluated by me as either 'confirmed' (CSF7 and CSF8), when all three ecosystems or platforms clearly exhibited them, or as 'partially confirmed' (CSF1–CSF6), when two ecosystems or platforms exhibited them. The common success factors were summarized in Table 4.4, and the long list of success factors was presented in Tables 4.5 and 4.6.

I argue that partially confirmed success factors are no less relevant and impactful than the confirmed ones, but their generalizability may be subject to certain preconditions relating to the business model of the ecosystem leader or the structure of the ecosystem under analysis. Such success factors may therefore be valid for many but not all mobile business ecosystems. It is also quite possible that they are just as valid as the confirmed success factors, but the relatively limited set of three case studies included in my study was insufficient to confirm this. Getting further confirmation for the partially confirmed success factors would be a natural continuation of the study.

Looking at the theoretical background and the analysis framework that I devised based on existing theory according to the research process discussed in Section 1.4.1 and illustrated in Figure 1.3, it is interesting to note that I was indeed able to get some expected results (CSF2) from the case studies with regard to the theory of ecosystem health by Iansiti & Levien (2004a,b), and I was also able to (partially) confirm the success factors for OS-centric software ecosystems (CSF3–CSF5) defined by Bosch (2009) as being applicable to the mobile software ecosystems of the three case companies, iOS qualifying for all three success factors and Android and Windows Phone for two. From this simplified perspective, the much weaker market position of Windows Phone compared to iOS and Android may seem anomalous, but closer analysis of the situation reveals that Windows Phone has had problems in multiple areas, also evident in the ecosystem health evaluation illustrated in Table 4.1, but especially in the area of sustainably attracting consumers to the devices, which would lead to the build-up of a credible installed base, which in turn would sustainably attract developers to the platform. Microsoft, however, is going the opposite route, paying substantial subsidies to get developers on board for the most important apps in the hopes of attracting consumers and driving the sales of the devices up, but at least so far, the results have been nothing to cheer about.

What has received little attention so far, and what I consider to be a significant finding, is that all three mobile business ecosystems rely on closed source code and other control-oriented policies in the management of their OS platforms and the OEM licensees using those platforms (excluding Apple, who does not license out iOS). Even Google is increasingly using closed source code in the Android ecosystem to separate key apps and services from the open-source AOSP, this already being the case for the most well-known Google-branded services as well as the Google Play store. Thus, the common success factor CSF7 (*the software components of the platform that meaningfully differentiate it from the competition or otherwise create significant added value based on proprietary IP are kept closed source*) is confirmed and the conclusion to be drawn is that while an open source approach definitely has advantages in fostering open innovation, platform leaders in the smartphone business also need closed source to be successful, despite exemplary efforts by Google to provide an open-source mobile OS free of charge.

A second finding is that all three mobile business ecosystems, or rather all three platforms, expose enough APIs so that OEMs, accessory makers, and developers are able to create products and apps with meaningful differentiation (CSF8). This may seem obvious now, but originally, Apple under Steve Jobs did not plan to release a third-party SDK for the iPhone at all, and many past mobile OS platforms, like Symbian, have been notoriously difficult to develop for. Also Windows Phone, when it was first released, lacked many key APIs severely limiting app developers' access to device functionality, one of the reasons why it has been such a rocky road for the platform.

5.1.2 Theoretical Contribution of the Study

The theoretical concept of 'angle of entry' in the context of the historical legacy and path-dependent evolution of a firm's previous business activities, capabilities, and assets having an impact on more recent choices and decisions the firm has made in its ecosystem and platform strategies is my original contribution, although it builds on the basic concepts of path dependency theory as defined and elaborated on by David (1985, 1994, 2001), Arthur (1989), and Liebowitz & Margolis (1995a) among other authors. In this study, I have successfully applied angle of entry to the analysis of the three case companies in the specific industry context of smartphone business, allowing me to better structure and visualize the findings that specifically relate to the companies' decisions stemming from their historical legacy and path-dependent evolution. The angle of entry, being clearly different for each of the three case companies, also served as a key criterion for the selection of the companies, proving its utility for this purpose. Yet, I haven't applied the concept to other industry contexts or research settings and cannot argue for its usefulness in such cases. Nevertheless, I see the concept as a promising tool for analysis of path-dependent strategies and decision-making.

Furthermore, the holistic analysis framework presented in Chapter 3 brings together and builds upon many existing theoretical concepts and frameworks such as platforms, two-sided markets, and business ecosystems, hitherto largely treated separately by the research community, capturing both firm-level and ecosystem-level factors that enable value-adding complementary innovation in a thriving, vibrant ecosystem. This analysis framework proved out to be effective in getting answers to the research questions of this study and could easily be applied to other studies of similar scope, yielding even more insights.

5.2 Reliability and Validity of the Results

The vast majority of the descriptive data used in the case studies is collected from publicly available sources on the Internet. This naturally implies at least some level of uncertainty, as many articles and news stories are authored and published on the Internet with quite relaxed criteria for scientific rigor and accuracy. Furthermore, articles in many industry expert communities and blogs do reflect, at least partially, the opinions and attitudes of their authors, although for the most part, they are often highly informative and factual. I have exercised the proper level of criticism when using such sources, typically having sought secondary confirmation for important pieces of information.

In the case of press releases, public announcements, and annual reports issued by corporations listed on stock exchanges in the United States or elsewhere, however, we can be reasonably sure that the information is both reliable, as this is typically mandated by legal requirements, and valid, as the firm in question arguably knows well how to measure and report metrics related to its business. We can expect a fairly good level of reliability and validity also for white papers issued by firms on topics that are closely related to their business, although the role of commercial white papers in B2B marketing is fully recognized, and therefore, the need to consider potential biases in such publications is apparent.

Reports issued by companies offering market research and industry advisory services usually have good validity, as the firms have well-established methodologies and practices for tracking, analyzing, and reporting on the phenomena that they study, as it is at the core of their business. Reliability is typically also good, as the large number of iterations in recurring reports that have been published over the years has contributed to the accuracy. However, for some newer metrics that have not yet been tracked and analyzed for an extensive period of time, caution and judgment need to be exercised, as there may not yet be enough historical data to draw far-reaching conclusions based on them. To avoid this problem, the individual components of the analysis framework presented in Chapter 3 are thoroughly grounded in scientific publications most of which are widely recognized and cited in the scientific community. Hence, the metrics used in the analysis of the case companies are well-established in research and their reliability and validity, supported by a broad, comprehensive set of descriptive data on the case companies, is justified.

Additionally, I acknowledge my use of tacit knowledge and intuition gained through working in a strategic advisory and management role in the ICT industry for nearly a decade, and my continued interest in the dynamics of networked business. It would be impossible to find proper references for all this accumulated knowledge, but where possible, Appendix A is used for listing references that are not scientific per se but provide valuable insight into a topic.

5.3 Managerial Implications

The strategic management of firms operating in a networked economy or business ecosystems is considerably more complex than of most firms operating in traditional industries. The fact that the value creation of a firm may be highly dependent on the firm's relationships with other firms, possibly even more than on tangible assets and resources, has added a significant amount of complexity to the problems that firm executives and managers face in their management processes, particularly in strategic and product-related decision-making. As argued by Dyer & Singh (1998), the critical resources of a firm may extend beyond its boundaries and those resources may be embedded in interfirm routines and processes. Moreover, firms that make relation-specific investments and combine resources in unique ways may realize an advantage over competing firms unable or unwilling to do so. Thus, the network of relationships in which a firm is embedded is a key determinant of competitive advantage for that firm.

Individually maximizing behavior of firms, typically aiming to maximize profit, revenue growth, or other key financial performance indicators, is not leading to optimal results for firms operating in business ecosystems, at least not in the long run. As Moore (1993, 1996) argues, traditional models of management, based on product and service competition and process improvement are necessary but no longer sufficient for firms to survive in a modern, rapidly evolving business environment. It is essential for managers to pay close attention to the economic environments of their firms as well as to other firms influencing their evolution.

The related paradigm of *systems thinking* necessitates seeing a firm as part of a wider economic ecosystem and environment where it influences — and is influenced by — other firms. Firms within a business ecosystem coevolve capabilities around innovations, working both cooperatively and competitively to support new products, satisfy customers, and incorporate the following round of innovations. Special firms in ecosystems, keystones, act in a leadership role that is valued by the rest of the community, promoting the health and renewal of the ecosystem through sustained innovation, while keeping harmful dominators in check. Keystones enable all ecosystem participants to invest toward a shared future in which they anticipate profiting together. Thus, a keystone has to advance the overall good of the ecosystem, as opposed to overpowering it and/or draining all value out of it.

In this study, I have focused specifically on mobile business ecosystems and the smartphone business, and I have come up with a set of common success factors for such ecosystems, summarized in Table 4.4. Having an understanding of these success factors and their underlying preconditions should guide the strategic decision-making of executives at any company aspiring to become a significant player in the smartphone business, either as a platform provider or as the leader of a wider business ecosystem. They may be valuable for companies aspiring to take on lesser roles in the existing mobile business ecosystems as well. It is important to note, however, that it is by no means guaranteed that a firm will sufficiently achieve success for itself or its ecosystem by striving to possess *only* these success factors — the list is not meant to be fully exhaustive based on this study alone. Additional success factors not discussed in this study may well be required. Not possessing the common success factors identified in this study is, however, likely to significantly reduce the chances of success for any aspiring ecosystem or platform leader, so striving to possess them should be a priority.

5.4 Suggestions for Further Research

Three extensive case studies were included in this study, allowing me to identify eight common success factors for the orchestration of ecosystems and management of platforms. Two of these success factors could be reasonably confirmed, whereas the other six were partially confirmed, not yielding conclusive results about their generalizability. As said, getting further confirmation for the partially confirmed success factors would be a natural continuation of this study, likely involving at least additional case studies (e.g., Samsung, Huawei, Lenovo, or even Xiaomi) and perhaps even more detailed measurement and analysis of the relevant metrics related to the success factors to be confirmed. The analysis framework developed as part of this study should be valid also for the extended research, although it would be prudent to consider including the findings of any new research on platforms, two-sided markets, or business ecosystems into the framework as seen fit.

Another possible research path would be to develop the concept of 'angle of entry' further, validating its applicability in other industry contexts. Such studies would not need to be set in the mobile or CE industry at all, as long as enough information is publicly available on the historical legacy and key decisions made by the firms under analysis over the course of their existence. For purposes of confirming the success factors discovered in this study and perhaps identifying some additional ones, it would be interesting to study not only firms whose primary business is smartphones but also firms from adjacent but partially overlapping industries such as Amazon (online retailer and e-commerce platform) and Facebook (the most popular social network in the world).

Furthermore, to achieve better coverage of three generic angles of entry identified in Figure 1.2, namely traditional telecommunications equipment manufacturers, mobile operators, and web browser makers, companies such as BlackBerry, Vodafone, Verizon Wireless, China Mobile, certain Japanese operators as well as past joint initiatives such as WAC could be interesting subjects for further study, even if their current relevance is limited. The proliferation of HTML5 and other web technologies remains a field to be closely followed, as large multinational network operators like Telefónica and Deutsche Telekom appear to be promoting alternative platforms and ecosystems based on HTML5, Firefox OS most notably. Most operators would like to see a viable third ecosystem emerge beside Android and iOS, giving them more bargaining power with respect to their handset suppliers and also more choice for their customers.

At least so far, Windows Phone has been unable to fulfill this role, and Microsoft's closed platform policy coupled with the company's desire to own the customer relationship and data through the Microsoft account goes against the similar interests of some operators, not to mention the integration of Skype in Windows Phone upsetting operators fighting OTT services eating into their revenue. As Apple cuts off revenue and consumer touchpoints from the operators in even more ways than Microsoft, the Android ecosystem and its handset OEMs remain the only even remotely operator-friendly alternative, but operators nevertheless see Google as a potential threat to their business, turning excess reliance on Android into a vulnerability.

Thus, an alternative open mobile platform like Firefox OS developed by the neutral, non-profit Mozilla Foundation would allow operators to reduce their dependence on Android and perhaps also regain part of the power they once had in mobile application discovery and distribution. However, Firefox OS faces the challenge that any other platform faces: getting enough end users and developers on board to establish and sustain a healthy ecosystem enabling complementary innovation and viable business for all ecosystem participants. Both same-side and cross-side network effects, the latter particularly important to two or multi-sided platforms, play a decisive role in the adoption process. Incentives and subsidies have been the traditional way to drive adoption, but as the case of Windows Phone shows, sometimes this may not be enough if the ecosystem lacks critical success factors. Therefore, it would be very interesting to study the success factors specifically related to HTML5-based mobile application platforms.

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Appendix A

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