Platforms for Smartphone Applications

A Network Analysis of Ecosystems and Criteria for Selection from an Application Developer Perspective

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David Hellekalek, Bakk.techn.
Contact: hellekalek@gmail.com

University of Innsbruck

Department of Information Systems, Production and Logistics Management

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Abstract

The growing smartphone market and the strong trend towards third party applications open up new room for application developers. This domain stretches across a multitude of different smartphone platforms. For a single company it might be unfeasible or impossible to develop applications for all of them. The goal of this thesis is to give a guideline for application developers for making their choice among platforms. To achieve this goal, the concepts of an ecosystem as well as technical issues are considered. The ecosystem is assessed through the method of Network Value Analysis. The resulting criteria are then illustrated by analyzing and comparing the Android and iPhone smartphone-platforms. The thesis closes with analyzing differences and similarities between the platforms and explaining how they affect application developers.

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1 Introduction

The market of modern smartphones is undergoing large and fast developments. Due to the recent development of new platforms and devices with noticeable success on the mass-market, new opportunities to develop applications for these devices opened up. The increasingly big customer-base not only allows for higher revenues, it also acts as an enabler for applications that depend on a big number of users, for example social applications. Initially triggered by the Apple iPhone, a smartphone relying on an easy-to-use touchscreen interface and integration of web-based services which attained a large user-base, a new type of smartphone became increasingly popular. The key features of those devices consist of a touch-screen and a user-interface optimized for this kind of input, internet connectivity including a web-browser, and GPS. This allows the users to browse the web relatively comfortable, no matter where they are.

The authors of the book *Principles of Information Systems* describe smartphones as "a phone that combines the functionality of a mobile phone, personal digital assistant, camera, Web browser, e-mail tool, and other devices into a single handheld device" (Stair & Reynolds, 2007, p. 111). According to these authors, further progress will be made through the development of new smartphone-applications. They list the manufacturers of the smartphones, the mobile network operators and third-party software developers as creators of smartphone applications (Stair & Reynolds, 2007, p. 111).

Platforms are the fundament on which the smartphones and the applications are built. In essence, the platforms consist of an operating system and a set of standards, for hardware capabilities, interoperability of components and for application programming interfaces (APIs). In most cases the companies that maintain them are diversified multicorporate enterprises with hardware and software capabilities or networks of companies that combine the necessary competencies.

The big success of *Apple's iPhone OS* platform with the *iPhone* and *iPod Touch* product-lines (Apple Inc., 2009c) is accompanied by efforts of other companies and alliances of companies, which created other platforms and devices with features as described above. As examples, *Research in Motion (RIM)* revamped its *Blackberry OS* for touch input, the *Open Handset Alliance (OHA)* led by *Google* created the *Android* platform and *Nokia* evolved their *Symbian* and *Maemo* platforms, to just list a few.

Apart from customers and the companies or networks that stand behind each of these platforms, there are various other important actors, for example mobile network operators, application markets and governmental regulations. Altogether, they form a business ecosystem where the participants are interlinked and pursue different goals and policies towards each other.

One important actor whose point of view is taken in this thesis, are the application developers. They are the companies which develop software for the end-users of the smartphone. Due to the theory of positive feedback, which is explained in (Shapiro & Varian, 2003, pp. 173-225), it is unlikely that all platforms will survive today's rivalry. It can be a vital decision for application developers, to decide into which platforms they should invest their resources. This thesis provides a guiding framework for this task.

1.1 Smartphones

In the beginning of the introduction, the term smartphone was described as "a phone that combines the functionality of a mobile phone, personal digital assistant, camera, Web browser, e-mail tool, and other devices into a single handheld device" (Stair & Reynolds, 2007, p. 111). Here, a more detailed description is given. Furthermore, this paper focuses on a specific kind of category, which is to be defined here.

Handheld Computers, also called *Personal Digital Assistants* (PDA) emerged during the late 1990s. The book *Information Technology for Management* (Turban, Leidner, McLean, & Wetherbe, 2006, p. 194) lists *Palm Pilot* and *Pocket PC* as examples. They commonly featured a contact-sensitive display which had to be operated with a special pen called 'stylus' that acted as a tool for navigating through menus as well as for writing. The basic key features were management of calendar and contacts, which could be synchronized with a PC, therefore often also called 'organizer'. They lacked mobile connectivity, which was, if at all, available through wireless LAN or through Bluetooth via a mobile phone. Later models also featured word processing and presentation tools compatible with *Microsoft Office*, as well as multimedia players. In addition to the software that was pre-installed on the device, it was possible to install applications from third party developers.

At the same time, mobile phones became increasingly popular and in 1997 the *WAP Forum* was founded (WAP Forum, 2000, p. 4) and shortly thereafter announced the

Wireless Application Protocol (WAP) standard, which allowed viewing specially programmed small websites with WAP-enabled mobile phones. Furthermore, mobile phones became enhanced with very basic calendar features and extended contacts management. Due to the limited processor power, memory and input possibilities, these features were of limited scope. Java 2 Micro Edition (J2ME) allowed installing additional applications from third-party developers but suffered from the same limitations.

Progress was fast and in 1996 Nokia released the *Nokia 9000 Communicator*, followed by the *Nokia 9110 Communicator* in 1999 (Nokia, 1999, p. 2). Since the term smartphone is not clearly defined, it is difficult to say whether they were the first devices of that kind. Browsing through literature, it became evident that numerous authors consider the *Nokia 9000* or the *Nokia 9110* as the first smartphone. The main smartphone features consisted of a full keyboard, an e-mail client, a web-browser, a calendar and contact-management. E-mail and web were always accessible through an internet connection over the GSM network, which was the common network for mobile phones at that time.

Since then, ten years have passed and the world has seen countless new smartphones with numerous improvements. For a very long time, this class of mobile devices failed to attract the interest of the broad masses. Many people perceived smartphones as very complicated and difficult to use.

Beginning with the release of the *Apple iPhone* in the year 2007, (Apple Inc., 2007) respectively the worldwide availability of the *iPhone 3G* in 2008, (Apple Inc., 2008) smartphones obtained a popularity far beyond what they were able to achieve before (Canalys, 2008b). Apple alone sold more than 11 million iPhone smartphones (Apple Inc., 2009c). The main differences to the other, less successful smartphones were the marketing and the design of handling. To explain the difference in handling, it has to be considered that most smartphones were operated with a stylus or a keypad. The first type always required two hands, one to hold the smartphone, the other to hold the stylus. The keypad type made it difficult to navigate, for example in menus. The iPhone features a touch-screen that is to be operated with the bare fingers. The user-interface of the software is optimized for this kind of operation which means that controls like buttons are of sufficient size. With a size of about 3.5 inches, the screen is relatively big, which also supports this kind of input and at the same time, makes it easier to read web-pages and e-mails. The basic functionality besides phone calls and text messaging consists of e-mail, a high quality

web-browser, music and video playback, calendar, maps and contacts management. For writing, the phone displays a virtual keyboard on the screen which is subsequently operated by touching the respective letters. Text prediction and correction algorithms ease the use. Apple also runs an application store, where independent application developers can offer their products. Apple controls the applications with a quality assurance team before publishing them in this market, not only to ensure that they work but also to ensure that they comply with the look and feel of the basic applications. This standardization is another measure to ease usage of the iPhone.

Since this concept proofed to be very successful in the consumer market, other companies also started developing similar platforms. Interestingly, these companies are not exclusively established producers of mobile phones. Like Apple, the founder of this type of smartphone, some of them come from other operating areas. A prominent example is the Open Handset Alliance which was initiated by Google and created the Android platform. Other examples for companies that created direct rivals to the iPhone are Research in Motion, Palm, Nokia and HTC, the latter with Android as well as with an improved Windows Mobile.

Since smartphones are often used to access the internet, it is interesting to have a look on usage behavior. While internet usage through computers peaks during office hours and the evening, internet usage through mobile phones follows a flatter curve with a sole drop during the middle of the night (Yamakami, 2008a, pp. 571-573).

1.2 Goals and Methodology

The smartphone market is currently undergoing interesting developments. Due to the speed of these developments, it is important to analyze the current state, which is very different from how the situation was a few years ago. One big change which the new smartphone platforms introduced was the appearance of central application markets and a high popularity of third party applications. Apple's *App Store* for example counts more than two billion application-downloads as of September 2009 (Apple Inc., 2009d). In November, Google announced the acquisition of *AdMob* for a sum of 750 million US Dollars, a company founded in 2006 which specializes in serving advertisement in smartphone applications (Google Inc., 2009f). These figures demonstrate that the market for third party smartphone applications is likely to be of significant size. Due to the multitude of

platforms which is described in section 2.1.1, it is important for application developers to decide for which platforms to invest their resources. The goal of this thesis therefore lies in finding the relevant criteria to analyze the ecosystems around these platforms. These criteria are then applied to conduct an actual analysis of selected platforms. Examples for such criteria can be the structure of the network, a bias of a network towards a certain target audience or differences in technical capabilities.

To actually conduct the analysis, existing methods are to be searched and investigated. An appropriate method is then used to select criteria and conduct an actual analysis. Due to the rapid developments, the focus is not laid in a spotty inventory of the current state, but on building a framework for a recurring review and on generic criteria.

2 Platforms and Technologies

This chapter analyzes existing platforms and describes the major technologies in the current smartphone market. Furthermore, criteria most relevant to smartphone application developers are deduced.

2.1 Definitions

The definitions start with giving an overview of current smartphone platforms and their major characteristics. Subsequently, the most important technologies used in these smartphones are treated.

2.1.1 An overview of current smartphone platforms

This section gives an overview of smartphone platforms which have recent handsets available in Austria. It is evident that the terms platform and operating system are very closely related. The operating system plays the biggest role for a platform. The standards defined for platforms often result out of abilities and limitations of the operating system. All platforms offer the possibility to install software developed by third party developers, a term which stands for software developers which are not associated with the producer of the platform or the smartphone. Nevertheless are there different levels of openness. Apple for example makes it impossible to install unapproved software on their devices. While there are ways to bypass these measures, this possibility will not be considered in this paper. There are potential implications that range from loss of warranty to illegality. For all of the non-exclusive platforms it must be noted, that it would theoretically be possible to restrict access for third party application developers.

Platform	Smartphones (examples)	Exclusive[1]	third-party applications restricted[2]
Android	HTC Hero, Samsung Galaxy, T-Mobile G1	No	No
Blackberry OS	Blackberry 9500 'Storm'	Yes	No
iPhone OS	Apple iPhone 3GS	Yes	Yes
Symbian OS 9.4[3]	Nokia 5800, Samsung I8910 HD	No	No
Windows Mobile 6.5	HTC Touch HD	No	No

Table 2-1 – Smartphone Platforms

In alphabetical order, the first platform is the *Android* platform which is backed by the Open Handset Alliance (OHA). The OHA is a consortium of 50 companies including mobile operators, handset manufacturers, software companies, semiconductor companies and commercialization companies (Open Handset Alliance, 2009b). The *T-Mobile G1*, the first Android based smartphone is a good example of the roles of some of those 50 companies. T-Mobile is the mobile network operator who primarily sells the device and branded it with its logo. An unbranded and slightly modified version is sold to registered application developers under the name ADP1 (Android Developer Phone 1). The T-Mobile G1 is produced by the handset manufacturer *HTC Corporation*, with a processor of the semiconductor-company *Qualcomm*. Google as a software developer supplied applications like Google Maps, Google Mail (Gmail) and the Android Market, a store where users can download free applications as well as charged ones. The Open Handset Alliance promotes Android as an open platform which can easily be adapted and expanded (Open Handset Alliance, 2009a). Developers are free to provide additional applications to the platform's users through the Android Market run by Google as well as through other channels of their choice, for example their own website. Android is an open source platform based on Linux.

[1] This column shows whether the platform is used exclusively for products of the company that owns the platform. Fields labeled "no" signify that devices from different manufacturers are available, which usually means that the platform can be licensed for own products.
[2] "Yes" means that there is an authority which decides whether an application will be made available to the end-users. "No" means that there are no restrictions on where end-users obtain their applications or what they install.
[3] Symbian OS 9.4 is the lower boundary. Subsequent versions (Symbian OS 9.5) are also included.

The second platform is called Blackberry. It is founded on the Blackberry Operating System and the Blackberry smartphones which make use of it. The platform is closed source and exclusively used by its developer, *Research in Motion (RIM)*. The Blackberry product-line became popular due to being optimized for quick and easy handling of e-mail (ALA Tech Source, 2008, p. 12). The traditional Blackberry's face consists of a comparatively broad display and a full keyboard beneath it. They are noted for their push-mail feature which, without going into the technical details, allows e-mail to be received instantly, virtually without any significant delay. The most recent model, the Blackberry 9500 'Storm' dropped the keyboard in favor of a bigger display, which is touch-sensitive and offers a virtual keyboard. RIM runs a distribution platform called *App World* where third party software developers can offer their applications to the end users.

The iPhone platform is another important smartphone platform. It is run by *Apple Inc* and used for two product lines: the iPhone which is currently in its third generation and the *iPod touch*. They share many similarities, especially the look of the device and the identical user interface. The important difference is that the iPod Touch lacks some functionalities of the iPhone, most prominently the phone functionality. Therefore only the iPhone can be considered a smartphone. Both series of devices run an operating system known as *iPhone OS* which is based on the *Mac OS X* operating system which originates from the PC and notebook branch of Apple. The special importance of this platform is mainly derived through its big market success in the two years since it was introduced to the market. In those two years Apple sold 50 million iPhone and iPod touch devices (Apple Inc., 2009d). It can be assumed that the success was accomplished due to a combination of clever marketing, attractive features and design. The only way users can install new application onto their devices leads through Apple's *App Store*, which allows application developers to publish their applications and counts more than two billion downloads (Apple Inc., 2009d). The iPhone OS is closed source and not being licensed to other companies.

Symbian was founded by Ericsson, Motorola, Nokia and Psion in 1998, the first three being among the leading producers of mobile phones at that time. Symbian is the market leader with a market share of approximately 50% of all smartphones sold in the second quarter of 2009 (Canalys, 2009). Symbian is open for third party developers, but it is necessary to have the application tested and cryptographically signed by a quality assurance authority before users of Symbian based devices can install it (Symbian

Software Ltd., 2008). Symbian OS originally was closed source software but was transformed into an open source project and license model backed by the *Symbian Foundation* in April 2009. Like Android, Symbian has a consortium of member companies behind it (Symbian Foundation, 2009). Some of those members are actually participating in the Open Handset Alliance as well as in the Symbian Foundation. The open source version of Symbian is still under development, the closed source version can be licensed by smartphone producers for their own products.

This section closes with Windows Mobile, developed by Microsoft. It is a platform which is used for smartphones as well as for PDAs and other advanced portable devices. Although it has a long history and was quite successful with PDAs, its market share in Q2 2009 smartphone sales was only 9% (Canalys, 2009). One drawback of Windows Mobile is the lack of optimization for touchscreen devices. Coming from the PDA sector, it is optimized for usage with a stylus. Producers of Windows Mobile smartphones tried to circumvent this by enhancing the user interface with their own extensions. An example is *TouchFLO* by HTC which features larger buttons and icons which are easier to hit with a finger. Microsoft is currently working on a newer version of the Windows Mobile operating system for better touchscreen support. At the same time, Microsoft is working on a central application market similar to *Apple App Store* and *Android Market*. Although Microsoft is selling various devices itself, the company currently does not sell any smartphones. The Windows Mobile platform is being licensed for their own products by manufacturers of portable devices.

There are several other platforms which are not considered. OpenMoko is a Linux based device which propagates openness to a very high degree. Even the plans for some of the hardware are open for the public. The network behind the platform is small compared to the five platforms that were explained in detail and no smartphone was released to the market in the past twelve months, neither is there any indication of upcoming releases. Linux Mobile (LiMo) is another platform without significance in Europe. Although the alliance behind this Linux based platform contains important market players, LiMo based smartphones were only released to the Asian market so far. WebOS, the Linux based platform of Palm's *Palm Pre* smartphone had some presence in the press in summer 2009. Due to lack of availability in Europe, it will not be expounded more closely. In chapter 4 further criteria will be applied to restrict this pre-selection of five platforms to two, which will then be analyzed in detail.

2.1.2 The significance of third party application developers

All of the platforms listed in section 2.1.1 allow their users to install applications which were developed by third party developers. The latter term denotes software developers who are independent from the companies that run the platform. They create applications that usually have functionalities which are not offered by the pre-installed software that comes with the smartphone. They follow different business models, some applications have to be bought while others are free. Examples are navigation systems, where the developers aim at earning money through sales and free interfaces for news portals where the sponsor of the application aims at revenue through other means. These and other possibilities will be analyzed in depth later. The benefit for the user is that these additional applications can greatly expand the possibilities of utilizing his or her smartphone. Therefore platform carriers with a high number of available third party applications actively promote this fact, for example Apple proudly announced the 85,000 applications and two billion downloads in their *App Store* (Apple Inc., 2009d). This is not the only way in which a platform carrier profits from high numbers of applications and application downloads. In the case of App Store as well as with many other central application markets, the operators of that market collect high margins, in the case of App Store 30% of revenues.

2.1.3 Technologies used in modern smartphones

This section explains selected important technologies and structures of today's smartphones that are relevant for assessment in the following sections and chapters. Only technologies which have notable differences from platform to platform are described. GPS for example is not described for that reason, all platforms listed in table 2-1 on page 7 carry support for it and its availability depends solely on the hardware that is used.

APIs for programming applications

APIs (application program interfaces) allow applications to access functions offered by the platform (Stair & Reynolds, 2007, p. 134). They are usually linked to the use of a certain programming language and SDKs (Software Development Kits) which application developers employ to program their products. Developers are usually supported by vast

libraries of documentation for the platforms. Since APIs are responsible for allowing applications to make use of the platform's capabilities, the extent of what the APIs offer is another important dimension. Applications can only make use of hardware features like a built-in camera or GPS, if the API offers access to these functionalities.

Proprietary and Open Source Platforms

Blackberry OS, iPhone OS (OS X) and Windows Mobile are proprietary[4] operating systems. Android and Symbian are published as open-source. Although there are several possibilities for the underlying legal models, open-source generally means that the source-code of the software is freely available and can be modified. This makes it easier to assess the quality and capabilities of the software as well as allowing adjustment of any part of it if necessary. Generally open-source software is free of license charges. Nevertheless it usually has an underlying license which for example can obligate to publish the source-code of all work that is based on that software. Open-source software development can be considered as a collaborative process since anybody can contribute (Stair & Reynolds, 2007, p. 160). Linux, which forms the base of the Android platform, is a well-known example for open-source software. Proprietary platforms on the other side usually don't allow this degree of openness. They are sometimes not available for outsiders at all, in other cases they are sold for a license fee. They might offer APIs to adapt or extend parts of them, their developers might incorporate their customers' wishes concerning adaptations, but it is not possible for the companies that base their products on them, to modify them at will. Symbian is a special case: although it is now available under an open-source license, it was a proprietary platform for many years. It is important to note, that proprietary applications can be combined with open-source platforms and vice versa. With Android, Google put itself into the position of founding a platform that is continuously developed and improved by a multitude of companies while keeping the possibility to influence it according to their needs. Since Android and iPhone OS, as well as Nokia's S60 phones, use browsers based on the open-source library *WebKit,* there is a good homogeneity which makes deploying web-based applications easier (Yamakami, 2008b, p. 61). Shapiro and Varian discuss the topic "Openness Versus Control" from a potential

[4] A definition for the term 'proprietary': "A company can develop a one-of-a-kind program for a specific application (called proprietary software). Proprietary software is not in the public domain." (Stair & Reynolds, 2007, p. 146)

industry-standard-setter's point of view. Even though not being analyzed here, it is relevant when considering the long-time prospects of a platform (Shapiro & Varian, 2003, pp. 196-203).

Multitasking

Multitasking describes the capability of running several applications at the same time (Stair & Reynolds, 2007, p. 134). All five platforms in section 2.1.1 support multitasking to a certain extent. The iPhone platform allows only very limited multitasking: With the exception of some privileged preinstalled applications, it is not possible to have more than one active application at a time which can restrict the possibilities of usage. An example for such a privileged application is the music player. It is not possible though, to have an application running in the background and waiting for events or situations which make it pop up, which is a frequent scenario for location based applications that activate themselves based on proximity to defined areas. The other four platforms of section 2.1.1 all support multitasking without any noticeable restrictions. Like for all computing platforms, there is a constraint of available memory space which limits the possible number of concurrently running applications. Since smartphones have less memory than PCs, this constraint is more relevant to them. It does not depend on the platform though, but on the hardware that is used. One hypothesis to explain why the iPhone platform does not allow full multitasking is the factor that it puts additional load on the batteries, which are frequently considered as one of the weakest points of modern smartphones. Battery life is not considered in this thesis because it depends on too many factors (platform, hardware, age of battery, the application itself, etc.). While it is not so important for the selection of a target platform, this topic has to be considered in the testing of an application. For example it can save an inexperienced buyer of navigation software some frustration to recommend a car-charging kit. It also makes sense to optimize an application for reduced power consumption.

Touch Screen

Touch screens combine display and input at the same place. The applications can display control elements like buttons and the user can press them by touching them on the display. This kind of flexibility allows application developers to realize their own ideas of user

interaction instead of being restricted to hardware keys. Some touch screens even allow using multiple fingers at once, this technology is called multitouch. An example is zooming pictures by touching the display with two fingers and then moving them away from each other, an apparently intuitive gesture for enlarging something. While all of the platforms listed in section 2.1.1 support multitouch, this does not necessarily mean that all devices support it as well. While developers programming for iPhone OS or Blackberry OS know for sure that all touchscreen devices of that platform are in fact multitouch capable, developers programming for the other three platforms have to keep in mind that alternatives for owners of multitouch-incapable devices are indicated.

Digital Signature

Digital signatures are mathematical models and algorithms that allow verification of the integrity and source of data (Russell & Gangemi, 2006, p. 190). For example a platform can have a built-in restriction which denies installation of any software unless it contains a digital signature issued by a defined authority. Since software could potentially be altered on purpose with malicious intents or inadvertently for example due to faulty storage, digital signatures are also used to ensure the integrity of the software. Verification of integrity is present in all platforms that are listed in section 2.1.1. There are big differences though as in which signatures are accepted or who can issue valid signatures. For the iPhone OS, the Apple App Store is the only place where users can obtain applications. As far as Symbian is concerned, applications have to be submitted to a central authority which then signs the application. On Symbian-based devices, only applications with signatures of this authority can be installed, but it does not dictate distribution channels. Like the Apple App Store, this authority performs a gate-keeping role since they can decide whether an application is made available to the users or not. BlackBerry applications have to be signed with a certificate obtained from R.I.M. if they use parts of the API which BlackBerry defined as critical. Android and Windows Mobile allow the installation of any software, the developer can create the signature freely himself. In this case, the users are warned that they are installing potentially dangerous software though. In the case of Android, the clean way without warning is to distribute via the Android Market, in the case of Windows Mobile the signatures have to be obtained from a central authority again to avoid those warnings.

For most of the platforms, there are ways to circumvent the signature authorities. These methods are aimed at developers, so that they can test their applications on actual devices before submitting final versions to these authorities. This issue is not treated in more detail since it is very technical and not relevant to publishing applications on a bigger scale.

2.1.4 Technologies independent from smartphone platforms

There are some technologies, which are platform-independent. The most important one are web-based applications. These are applications that are not installed on the user's device, but instead are run in a web-browser. Web-based applications follow the principle of a thin client since almost any device with a recent web-browser can access them (Stair & Reynolds, 2007, p. 112). They do not rely on the smartphone's APIs since they are targeted at technologies like HTML and *Ajax*. Therefore the developer can freely choose the programming language that he wants to use. Nevertheless some smartphone platforms offer additional APIs which enable websites to access some of the phone's special functionalities. In case that developers wish to make use of those functionalities, they have to include a method which detects the accessing platform and adequately accesses the API. Unlike when programming applications that actually run on different platforms, developers of web-based applications do not have to build different versions of their applications but merely have to adapt specific parts of them to accommodate more than one platform.

2.2 Criteria for Selection and Analysis

The technical characteristics of smartphone platforms can be differentiated into two categories: criteria for application development, this especially covers software developer kits, and technical capabilities or limitations of the platforms. The first group determines the difficultness or ease of application development while the latter opens or restricts the possibilities of what concepts can be realized for a platform.

2.2.1 Application Development Criteria

There are several criteria which influence the process of software development. Based on my own experience with software development, the programming language, the software development kit (SDK) and the documentation play a central role.

The programming language determines the syntax which is to be used. Theoretically, different programming languages might create big differences in program structure as well. At the current time, programming languages appear rather homogenous though: All programming languages for the platforms listed in table 2-1 on page 7 qualify as object oriented. They are all based either on C++, C# or Java. As a result, this point is unlikely to prove any significant differences. Therefore there are two important factors in this field: Programming for platforms which use different programming languages implies extra cost for transforming the code from one language to the other. The other point is whether the team has experience with the programming language which is to be used.

The SDK represents the main set of tools that programmers use for software development. Modern SDKs include a text-editor that is highly optimized for the task of programming, tools to compile the software and emulators to test it without requiring an actual physical smartphone. In addition, SDKs frequently include tools for application development techniques like the unified modeling language (UML) (Object Management Group, 2009) or unit testing (Software Engineering Technical Committee of the IEEE Computer Society, 1986). The software developers need to install and configure these tools. While working on their projects, the manageability of these tools inevitably influences the speed and quality of software development. Often, the biggest part of an SDK is embedded into an integrated development environment (IDE) which is extended for the specific platform. An IDE "combines the tools needed for programming with a programming language into one integrated package" (Stair & Reynolds, 2007, p. 545). Examples for IDEs are *Eclipse* and *Microsoft Visual Studio*. Whether the developers already have experience with those tools can also influence their performance. The next important point is the quality of the tools. It is difficult to measure since its perception strongly depends on what the developers do and how they do it. For example good interfaces to enhance the IDE might be essential for some developers but irrelevant for others, depending on whether they want to incorporate additional tools into it. Equally, a certain design may accommodate some and strain others. If the developers do not want to use the IDE, either because they do not have experience with it or because they are bound to a certain operating system on which the IDE does not work, it is theoretically possible to integrate the SDKs tools into another IDE.

The third point is documentation and the availability of assistance by experts from the platform's carriers. These points are difficult to measure and no reasons to assume noticeable differences in documentation could be found. While it is easy to find cases

where experts from platform carriers like Apple or OHA helped application developers with complex platform-related problems, it is virtually impossible to measure the general quality and availability of such assistance. Likewise, an active community of developers can be important when looking for help, but it would exceed the scope of this thesis to analyze these communities. No existing analyses were found.

Therefore the following points are recommended for closer analysis when considering the selection of a platform:

- Is there pre-existing experience with the platform's programming language in the team?
- If developing for more than one platform, how many different programming languages will be used?
- What effort is required for deployment of the SDK?
- Is the IDE included in the SDK and is it utilizable? If not: What is the cost for integrating the SDK into another IDE?
- Is there pre-existing experience with the IDE that is to be used?
- What is the quality of the IDE and the SDK?

Whether the operating system of a platform is proprietary or open source is not considered relevant here. The advantage that an open-source operating system can be modified will only be relevant if the developer plans to sell a package of a phone with modified operating system plus his additional applications which rely on these modifications. The majority of the phones on the market will run on official versions of the operating system, which will not include these modifications and hence will not be able to run applications which rely on them. While it theoretically is possible to get a modification incorporated into the official release of the operating system, this process would require much time and effort. Since stability of the operating system is essential, modifications are undergoing detailed reviews and tests. If they are not beneficial to the platform in general (i.e. only useful for a certain application) it is not unlikely that they will be rejected. Even if they get accepted, there is a long way between development of a new version of the operating system and its rollout on the end-user's smartphone, which can easily take half a year or even much longer. The other aspect of open-source is the possibility to analyze the source-code,

without planning to edit it. This allows to analyze the safety of the operating system and to gain detailed information on how the methods, which are accessed through the API, work. These aspects are not considered either. A thorough security audit of the source code requires huge resources (Cowan, 2003, p. 38). A possible advantage through better knowledge of the underlying implementations of the API's methods is difficult to measure or generalize. A related third possibility, finding and exploiting functionalities which are not documented in the API, is irrelevant to this thesis as well: It is impossible to predict the necessity, usefulness and reliability of such undertakings in a generalized context.

These characteristics only apply, if the applications are actually developed to run on a platform. If the application is to be run on a server and to be presented to the user as a web-based application, different rules apply. In this case, the developers primarily need to research the differences in the web-browsers of the platforms. Since Android, iPhone OS and Symbian S60 all base their browsers on the WebKit framework, websites who work on one of these three platforms are likely to work on the other two as well, without any additional effort. The browsers can contain extra features, for example *Google Gears* or *Adobe Flash*, which can enhance the user's experience but demand alternative solutions for users without these browser enhancements. Nevertheless, as far as web-based applications are concerned, the differences between the platforms are too small to require a selection of supported platforms. A viable solution would be to create one basic web-application which functions on all platforms, which should be possible without differentiation as long as the website conforms to the standards of the World Wide Web Consortium (W3C). Afterwards, it is still possible to add optimizations and enhancements for certain platforms. Furthermore, when focusing on selected platforms with native applications[5], a web-based application can be offered to the users of the other platforms. Development of web-applications is a topic with plenty of literature available. Therefore it will not be discussed here. It should be noted though, that the developers can choose the technologies that are to be used on the server-side, where most of the work is done, independently from the platform.

[5] These are applications which are executed on the devices

2.2.2 Capabilities and Limitations of Platforms

The capabilities or limitations of the platforms are an essential factor, which in some cases can immediately rule out a certain platform. If a function cannot be implemented on a specific platform, there are two alternatives: The first one is to create the application anyway and attempt to work around the missing function as good as possible. If the first solution is not feasible or simply impossible, the only other option is to drop that platform.

Generally, the API's documentation of a platform is a reliable way of checking for the availability of a feature since it is the connection between platform and application. Secondly, it can be necessary to screen the available hardware. If the API for example contains an interface for RFID[6]-related functions, this does not necessarily mean that is feasible to use them. The number of phones with such capabilities might still be very small.

Heterogeneity in the devices based on a specific platform will also impact the costs of application development. Applications will have to be tested on different smartphones to ensure they work on all of them. A Google search with appropriate search terms[7] can easily reveal that instances of incompatibility can and will occur if this testing is not done. Adaptations for different screen sizes may be necessary and memory usage must be kept within the bounds of the weakest device. Depending on the application's features, more relevant characteristics will surface. It must be noted that different smartphones might also use different versions of the same platform. In this case, some parts of the API may be unavailable on smartphones running older versions.

Multitasking is an especially important point since it might not seem so obvious. Many application concepts like instant messaging heavily depend on the application running in the background, being displayed on the screen only when a message arrives or a conversation is going on. The iPhone for example suffers from a limitation in multitasking, but is also a good example for a workaround. Third party applications[8] are always terminated when the user goes to the home screen to launch another application, thereby preventing them from running in the background. As a solution to that problem, iPhone OS

[6] RFID stands for „Remote Frequency Identification". Fields of use include identification of goods and mobile payments. (Stair & Reynolds, 2007, p. 105)
[7] The search term *Android "not working on" Galaxy* brings up several complaints about applications which are not working on the Samsung Galaxy smartphone. Instead of Galaxy, the name of any other recent Android smartphone model can be used to produce similar search results.
[8] In this context this means all applications which are not pre-installed as part of the system.

runs a system service in the background which listens for incoming notifications sent by a web-service run by Apple. Applications can register to this service and be started by it (Apple Inc., 2009b). The developers of an instant-messaging application can therefore intercept incoming messages with their own servers and remotely trigger a start of the application to display the message or commence a conversation. Instead of putting the application to the background on the phone, it is afterwards closed again and the task of waiting for messages delegated to their servers. If the background task cannot be delegated to a web-service, for example in the case of an application which is meant to notify the user of information relevant to his current location, this workaround is not possible.

The next point is not technical but nevertheless follows a similar pattern. The three questions are: Is the platform restricted to a single application market? What are the terms of this market and does the application fit into these terms? In the same way as lack of technical features can make it impossible to provide an application for a certain platform, lack of conformity with the application market's terms can make this impossible as well if the developer depends on that market. This means that the application market has to be seen as a bottleneck and it is important to consider how its controller will use that power.

In summary, this part consists of checking whether the platform offers the functionality required by the application:

- Does the API offer methods for the functionalities planned to implement? If not, are there feasible workarounds?
- Does the majority or at least a sufficient part of the smartphones of that platform support the planned functionality (especially relevant: GPS, screen size, storage, RAM)?
- Is there a central application market and if yes, does distribution of the application depend on it? If yes, does the application conform to this market's terms? What costs come along with using this market? Even if the distribution of the application does not technically depend on the market, it can still be the only way of reaching the majority of the platform's users!

To assess the criteria in this part, it is important for the application developing company to have a good estimate of their team's knowledge and experience since many of the criteria are related to how well the platform fits with the existing knowledge in the company. Some criteria like the quality of an SDK are potentially subjective. For example when a

developer is asked to assess the quality of an SDK, his findings can be influenced by his working style and his personal perception of how a good SDK should look like. This has to be accounted for when delegating assessment tasks.

2.3 Summary

This chapter outlined the available smartphone platforms and provided an insight on the technologies which are used. There are more than five smartphone platforms which are actively being developed and marketed. Between these platforms, there are significant differences in how they allow third party application developers to access their customer-base.

Two important categories of technologies could be identified. Technologies which limit the capabilities of devices based on a specific platform are important since they can make certain application concepts impossible. Technologies related to software development influence the cost of creating applications. A selection of criteria for analysis is derived from these aspects.

3 Market and Business Ecosystem

This chapter discusses the theory of business ecosystems and the players who are involved. The first part focuses on the theory and explains the concepts that are used. The second part applies this theory.

3.1 Definitions

To begin with, the concepts of *value networks* and *business ecosystems* need to be explained. Based on that, ways of analyzing value networks will be illustrated. Definitions are a fundament for deriving the criteria which are relevant for application developers to decide what platforms to serve.

3.1.1 Value Network

There are several definitions of what a value network is. Stabell and Fjeldstadt see value networks as companies which link clients together using mediating technology. Phone companies are listed as an example: their clients want to be connected to each other for communication (Stabell & Fjeldstad, 1998, p. 427).

Although not defining the term "Value Network", the work of *Normann* and *Ramirez* has to be mentioned. With their concept of "Value Constellations", they proposed a shift from a value chain to a value creating system. They display the company *IKEA* as an example for a firm that successfully built up a value constellation of partners that in combination achieve great success in value creation (Normann & Ramirez, 1993, p. 66ff.).

The proposals of Normann and Ramirez lead towards the direction of the following definition, which can be considered very appropriate for the field of this thesis: *"A value network is any set of roles and interactions in which people engage in both tangible and intangible exchanges to achieve economic or social good."* (Allee, 2008, p. 6)

Allee suggests internal value networks where exchange between work groups or departments of the same organization happens as well as external-facing value networks which are between organizations, their suppliers, investors, strategic business partners and customers. These networks can cross industry boundaries, for example in the form of

innovation networks or networks of people with a shared common purpose (Allee, 2008, pp. 6-7).

Due to its openness, the value network of the *Open Handset Alliance (OHA)* can easily serve as a possible interpretation of Allee's definition. In this network, there are several tangible transfers. For example the network operator *T-Mobile* sells smartphones whose production it delegated to *HTC*. Due to the tangible nature of hardware (readily produced smartphones) it qualifies as a tangible transfer even though it was not possible to find out anything about the quantity of compensational monetary flows in the other direction. There is also an example for intangible transfers: Google and other members of the OHA employ programmers which work on the Android operating system, which is an open source project. This means that T-Mobile can use it without directly paying for it. This example only displays two exchanges between three members of this value network. The Open Handset Alliance has 50 members and the value network might extend even beyond that alliance. The network clearly spans across several industries and might have hundreds or thousands of exchanges.

3.1.2 Business Ecosystem

James Moore suggests "that *a company be viewed not as a member of a single industry but as part of a business ecosystem that crosses a variety of industries*" (Moore, 1993, p. 76). In the ecosystem, companies work around an innovation, competitively as well as cooperatively, to satisfy the customers and drive innovation ahead. The success of a member of the ecosystem depends on its own performance as much as on the performance of the ecosystem (Moore, 1993, pp. 75-76).

Moore defines four stages of development for business ecosystems, which all have specific cooperative and competitive challenges. They start with the birth of the ecosystem, where the actors define a new value proposition around a seed innovation. The competitive challenges in this stage are to protect ideas from others who might copy them and to get a good starting position by tying up good partners. The next step is the expansion where the cooperative goal is to bring the offer to a large market. The competitive challenge in this phase is for the actors to make sure that their implementations become the market standard. After the expansion-stage comes the leadership-stage. In leadership-stage the foundations for an advance have to be laid. It is necessary to provide a vision for the future which

keeps suppliers and customers interested. The leading actors now have to maintain their strong positions. The final phase is self-renewal. In this stage the cooperative challenge is cooperating with innovators to bring new ideas to the ecosystem. The challenge is to keep the innovations in the ecosystems and to maintain the customer base. A lack of self-renewal leads to the death of the ecosystem. Other ecosystems take its place (Moore, 1993).

These definitions can also be related to smartphones and the networks around them. The smartphone platforms fulfill the role of the innovation around which the ecosystem works. The hardware manufacturers, software developers, network operators and so on, are the actors of those ecosystems and span across several industries. This concept bears similarities with the concept of value networks. The concept of business ecosystems appears to be geared towards competition and development. The concept of value networks on the other side targets analysis of the exchanges that happen in the network. These exchanges are an important part of understanding what happens in the business ecosystems, thereby linking the two concepts together.

3.1.3 Value Network Analysis and Network Value Analysis

To understand value networks or ecosystems, several approaches have been developed. In this thesis one of these models will be used for analysis of the ecosystem. A selection of two models which seemed promising is presented here.

Value Network Analysis (VNA) is a concept introduced by Verna Allee. She incorporated teachings of social sciences and business sciences to create a method for analyzing the financial and non-financial aspects in value networks (Allee, 2008, p. 10). The foundations of Value Network Analysis are roles, transactions and deliverables. Roles represent participants in the network. Depending on the level of detail, they may be individual persons or any aggregate, examples being working groups, companies or whole nations. The second point consists of the transactions between the participants, which can be tangible or intangible. They are separated by whether the transfers are based on formal contracts or flows of information and benefits without a contract. Deliverables are the things that are moved in the transfers (Allee, 2008, p. 14). There are three underlying questions for the analysis of the value network. The exchange analysis treats the pattern of exchanges and the network's value creation. The impact analysis questions the impact of

value inputs on the roles in terms of value realization. The value creation analysis investigates the best ways to create, extend and leverage value. This can happen "through adding value, extending value to other roles, or converting one type of value to another" (Allee, 2008, p. 14). Since there are noticeable intangible transfers in smartphone platforms, Allee's method seems like an appropriate way to analyze the value networks around these platforms. An example for an intangible transfer is when workers of one company in the network give assistance to another company which makes use of their interfaces. For example Apple might have helped Google to integrate the Google Maps service into the iPhone. This example also points out one major difficulty in the context of this thesis: In many cases it is not possible to attain anything else than speculations. Companies usually do not make such detailed information publicly available, therefore it is not possible to say in which ways Google or Apple employees informally helped each other. The nature of intangible transfers, which are essentially without a contract, makes it almost impossible for people outside the company to analyze them unless they are published in press releases or similar.

The second concept reviewed is *network value analysis (NVA)*, introduced by Joe Peppard and Anna Rylander (Peppard & Rylander, 2006). While having a name very similar to the concept explained above, it actually works differently. The first of five steps consists of setting the boundaries of analysis. To do this it is necessary to take the perspective of a so-called *network focal* which is an entity whose business model relies on the network. The second step consists of identifying all other actors in the network which have influence on the value which the network focal delivers to its end-customers. The third step then analyzes how the network members obtain value through their network membership. This also includes the question what they perceive as valuable, since this can differ from member to member. The following step then inspects the influences in the network. Influences are all links between members which relate to the value dimensions that were identified in step 3. Links that do not affect the value dimensions are not considered (Peppard & Rylander, 2006, pp. 134-136). There are four categories of influences: Exchange of goods and services, expression of affect, exchange of information and lastly, influence (Tichy, Fombrun, & Tushman, 1979, p. 508). Only links with influence on the network focal are of interest. The fifth step is called "analyse and shape". A network value map is used to give an overview of the network. Furthermore, network dynamics in play and implications for future scenarios, value dimensions of the users, the roles of the

participants and challenges have to be analyzed in this final step (Peppard & Rylander, 2006, pp. 135-136). Since network value analysis is clearly geared towards taking the point of view of a specific participant in the network, it fits very well to the methodology of this thesis: The network focal is to be defined as a (hypothetical) third party application developer company.

3.1.4 Network Externalities

Network externalities are an essential factor for assessing the impact of a platform. Shapiro and Varian provide an apt definition: "When the value of a product to one user depends on how many other users there are, economists say that this product exhibits network externalities, or network effects." (Shapiro & Varian, 2003, p. 13)

Katz and Shapiro name three important differences between competition of individual products and competition between systems: expectations, coordination and compatibility (Katz & Shapiro, 1994, p. 93). In systems competition, users favor systems which they expect to become popular (Gao & Iyer, 2006, p. 121) since this ensures availability of the system on long-term and therefore secures the own investments made for switching to that system. Coordination is necessary to avoid deadlock situations where two companies depend on each other but none of them is willing to take the first step in an investment into a new product (Katz & Shapiro, 1994, p. 94). For a long-term cooperation, trust is very important since its coordination cannot solely rely on contracts (Uzzi, 1997, p. 43). The third point, compatibility or interoperability, is another issue specific to systems competition. Compatibility is a trade-off between reaching more users and restricting innovation (Katz & Shapiro, 1994, p. 95).

In systems competition, it is important that the networks have a hub firm which performs a leadership role in the network to aggregate and direct the network's resources. The hub also has to ensure that innovation stays inside the network and away from the competition (Dhanaraj & Parkhe, 2006, pp. 659-660).

Lock-in is another important term in systems competition. It describes the state of being dependant on one provider or technology. Here, it would mean being dependant on one platform. For application developers, lock-in should only play a minor role. One main factor for being locked-in is switching costs. In the case of applications for smartphones,

the switching costs are mainly the experience and routine which are lost through changing the platform and have to be re-gained as well as existing program-code which cannot be reused. While this cannot be ignored, it can be assumed that it can be handled, if it really is necessary to switch. With a good selection of target platforms this should be a rare event. It is advantageous if there are several choices for finding partners in this network, especially if they are competing with each other, since both increases the own bargaining power in such situations (Lavie, 2007, pp. 1193,1203). For the users of a platform, the situation is different. It is quite common to purchase new mobile phones subsidized by a mobile network operator which in turn obligates the customer to keep his contract for several years, paying a fixed minimum of monthly fees. During that time, the user is locked-in to the phone he bought and thereby as well to its platform. The only options to get a new phone before the end of that time-span are to buy it at full price without subsidies or to enter an additional contract. Depending on the circumstances, both options can be very unattractive. The way this interacts with the decision for which platform to develop an application is, that it is likely to prolong the time it takes for users to switch from an inferior to a superior platform, which enhances the stability of the user base.

The concept of *positive feedback* is vital for understanding the business of smartphone platforms and reflecting about the possible developments of their ecosystems. "Positive feedback makes the strong grow stronger … and the weak grow weaker." (Shapiro & Varian, 2003, p. 174) In this context, this definition can be interpreted in the way that a big ecosystem can attract many and powerful partners, therefore having a lot to offer to the customers. Examples are good hardware, a big selection of high quality applications and other attractive supporting offers and services. There is a clear correlation between the number of applications offered for a platform and the platform's market share. For example in Q2 2009, Apple's market share in smartphone shipments was 13.7%, Android based smartphones had a share of 2.8% (Canalys, 2009). In September 2009, Apple announced that 85,000 applications are available in their App Store (Apple Inc., 2009d) while Android counted about 12,000 applications at this time (AndroLib.com, 2009a)[9]. While there are examples where positive feedback almost eliminated competition, there is no reason to assume that one smartphone platform would manage to achieve this. One reason for that is that the competition of these ecosystems happens on several markets with

[9] Due to different criteria for acceptance of applications and cases of multiple submissions of almost identical applications, these numbers can only give a rough estimate about the popularity of a platform's market. Nevertheless, a 7-fold difference provides a strong indication.

different preferences. For example a survey conducted in February 2008 revealed that 77% of the interviewed companies' smartphone spending is used for BlackBerry devices (Choney, 2008). Figures show that total market share of the BlackBerry platform around that time was only about 15% (Canalys, 2008a), which illustrates that companies have a higher preference for BlackBerry smartphones than the average smartphone buyer.

Positive feedback is important on an application level as well. There are concepts which depend on a large number of users. Applications where the benefit for the user depends on content contributed by other users are a good example. Imagine what eBay or Facebook would be without their vast amount of users. Related to positive feedback, there is a mechanism called 'tipping' which describes "the tendency of one system to pull away from its rivals in popularity once it has gained an initial edge" (Katz & Shapiro, 1994, p. 106). Heterogeneity and differentiation are limiting this effect and allow sustaining multiple networks (Katz & Shapiro, 1994, p. 106). Secondly, on ecosystem level, it is possible that lack of positive feedback keeps the user base small. This in turn could result in a lower number of application developers being attracted to that platform (Katz & Shapiro, 1994, p. 94). Due to the rapid developments at the moment, it is difficult to illustrate this. Since economies of scale are important for online markets (Porter, 2001, p. 67), in the end, a low number of users could result in the closure of the platform or some of its associated facilities (i.e. central application market). This does not necessarily mean that it is not possible to make profit by developing applications for platforms with fewer users. It could be that there are not only fewer users, but also fewer competitors. Katz and Shapiro indicate that higher demand for applications may result in greater variety at lower prices under the premise that entry barriers are low (Katz & Shapiro, 1994, p. 99). A higher number of users on a platform increases demand for applications, as long as the individual preferences of the users do not differ too much. Especially when positive feedback plays an important role for an application's success, it can be better to be number one or two in a small environment than being number ten elsewhere. Tipping is more likely when there are high economies of scale and a low demand for variety. A decrease in either of those attributes reduces the likeliness of tipping (Shapiro & Varian, 2003, p. 188).

3.2 Criteria of Selection and Analysis

In the following segments, the actors of the market are outlined. Criteria for analysis are examined and selected. The steps taken consist of introducing the actors in the ecosystem and presenting the position of application developers in that ecosystem. The most important point of interaction between ecosystem and application developers, are the application markets which will also be outlined. Intermediates are a category of their own and also perform a role of connecting actors to each other. Finally, the findings are combined with network value analysis to shape an outline of criteria for a later concretization of analysis.

3.2.1 Actors in the smartphone market

The business ecosystems of smartphones feature a big number of very different players. At the core, there are hardware manufacturers, hardware assemblers, software companies, the creators of the platforms and companies that combine the individual parts supplied by those actors into a finished smartphone product under their brand name. The hardware manufacturers build the components of which smartphones are built, for example microprocessors and radio communications chips. They also include companies which assemble these parts to build complete smartphones. The other part for making a smartphone functional is supplied by the platform. It consists of operating system and basic applications. The actor who eventually decides about the success of the ecosystems is the client who decides for a smartphone and the respective platform. Customers generally buy their smartphones through retail or their mobile network operators, but direct selling can be considered as well. Apart from buying a smartphone, the customers can also buy services and applications. The next big groups of actors are the intermediates who stand between ecosystem and consumer, sometimes being involved into the ecosystem as well. They act as brokers between consumers and the business ecosystem. The most prominent ones are mobile network operators and retailers, but also regulatory agencies can be counted as intermediaries. MNOs provide telecommunications services to their clients, thereby enabling them to use smartphones. Frequently they bundle these services with special offers for devices. The suppliers of telecommunication infrastructure are important as well, since they provide the means of establishing mobile communications networks capable of high coverage and high data-transfer rates. Hardware manufacturers have to ensure that their products are compatible with those technologies, at least if they are expected to

become widely adapted. Due to their general role and lack of direct links, they are not directly associated to smartphone-platform ecosystems. The application developers are another central participant in this network, they are presented in the following subsection.

To illustrate this network, a sub-selection of important actors and transfers is shown in figure 3-1. The boxes represent the participants in the ecosystem. The arrows depict links between these actors. Size of boxes and arrows is motivated by clearness and does not indicate size or importance of participants or linkages. In many cases there are return services for the transfers, they are not shown to avoid cluttering.

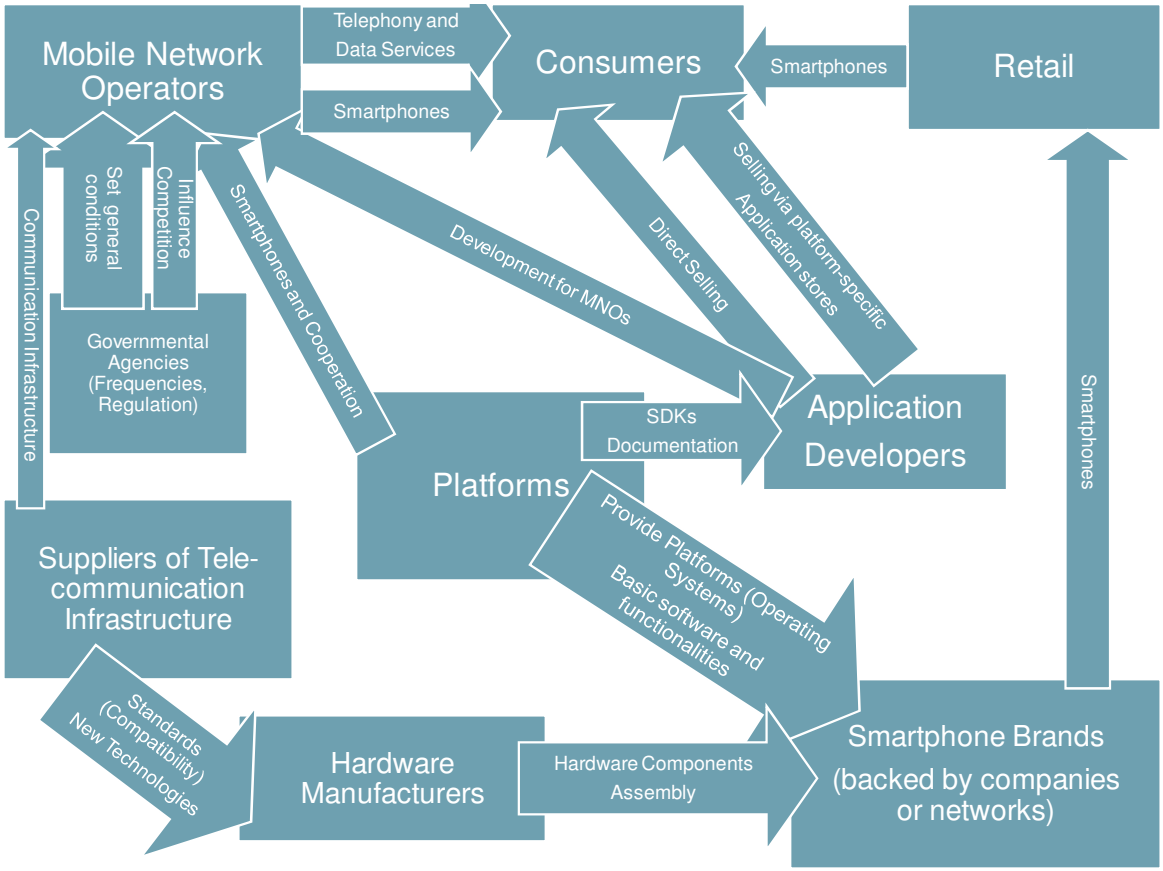

Figure 3-1 - Overview of Actors related to Smartphone Platforms

Consumers are stronger linked to the ecosystem than one might assume: Besides probably being tied to their mobile phone by the contract with their operator and their investment of learning to handle their smartphone the applications bought at a platform-specific store are

often tied to their account in that store and not to their actual device[10]. Therefore, they can upgrade to a newer device of the same platform and continue to use the applications they bought. Hence a customer has several reasons to stay with the platform he initially chose.

3.2.2 The Application Developer's Position in the Ecosystem

As indicated by the title of this thesis, one important link of application developers to the ecosystem is its center, the platform. This part was treated in detail in chapter 2. The other important link is their customers. Apart from the end-users, these can also be mobile network operators or clients that are completely outside the ecosystem. In these cases it is likely that the client sets the target platforms, thereby making a selection of platforms unnecessary for the application developers. By creating innovative, quality applications, application developers also positively impact the ecosystem around that platform. The more time an application developing company spends focusing on a specific platform, they more they get tied to it. This is a type of lock-in which is called "brand-specific training" (Shapiro & Varian, 2003, p. 117). Due to this kind of lock-in, it is in the best interest of the application developers to be part of a successful ecosystem. If the market success of the platform declines, so does the number of reachable customers for the application developers. In the end, this could force them to switch to supporting other platforms, where they will be competing with firms who already have lots of experience. Therefore it is important to anticipate future developments of the ecosystem to be at the right place at the right time, or at least not at the wrong place at the wrong time.

3.2.3 Application Markets

There can be several ways how application developers can offer their products to the customers. They can offer their own places for download and billing if the platform allows that, or they can make use of the application market or store of the platform. The runners of these stores usually take a percentage of the revenue for this service as well as demanding a one-time or recurring fee for being registered developer at the store. If the provider of the store audits applications before they are listed in it, he might also demand

[10] Examples: Apple's AppStore ties the bought applications to an iTunes account while Android Market ties them to an account with Google. In both cases the user can re-install the application at no cost on other devices where he uses the same account.

fees for that process or have the charge included in the membership-fee. A 70/30 cut is used for almost all mayor platform's, namely Apple App Store (iPhone OS) (Apple Inc., 2009e), Android Market (Android) (Google Inc., 2009g), Ovi Store (Symbian) (Nokia, 2009) and Windows Marketplace for Mobile (Windows Mobile) (Microsoft Corporation, 2009). App World (Blackberry) is an exception, bearing an 80/20 cut (Schenck, 2009). 70/30 means that 70 percent of net revenue of an application goes to the application's developers and 30 percent to the runner of the store. Those 30 percent are not only consumed for using the store to promote and provide the product, they generally also include credit card billing fees. Of course not only the costs are important, the services matter as well. While a service like obligatory auditing of apps through the store's providers can put a hassle on the application developer, services like tax collection allow to safe time or cost for external providers of these services. Many countries have different sales tax or VAT regulations which have to be considered if the market's operator is not doing this for the vendors. The markets generally provide facilities to the application developers for uploading their applications, adding a product presentation[11] and setting the price. The market clients on the respective smartphones of a platform then allow the users to browse the store, install or uninstall applications and being notified about updates, which they can subsequently install as well. It is common that these clients have a prominent place for displaying 'featured' applications for promotion of applications. There is another less obvious, yet very important, aspect in these application markets: Some of them offer APIs for applications to allow purchasing additional content from within the application. For an example, just imagine a game where the player can purchase additional levels or equipment. The common replacement methods for markets without that option are either purchasing additions via the application developer's own channels, which makes it necessary to provide full billing information to them, or to put the additions in the market to be installed in addition to the main application.

3.2.4 Intermediates

In this context, intermediates will be defined as the companies or entities which stand between the end-users of the smartphones and the business ecosystems which are formed around the platforms. Due to this nature, it can be assumed that they are involved with

[11] Commonly in a predefined format, for example a title and a description, each with a defined maximum length and a set number of accompanying images.

those ecosystems in one way or another. Amberg, Figge and Wehrmann see mobile network operators as intermediates between customers and service providers (Amberg, Figge, & Wehrmann, 2003, p. 141). Similarly, this thesis treats MNOs as intermediates between whole business ecosystems and their clients.

The mobile network operators perform a number of tasks which are relevant for ecosystems as well as end-users: Frequently they act as sellers of hardware, providing the smartphones to their customers. They provide the basic infrastructure which is required for smartphones, namely telephony and data connectivity. In addition to that, there are extra services, relevant to smartphones, which they might offer. Examples are HSDPA, which builds on UMTS technology to allow faster data connectivity or visual voice mail as a visual interface to access stored voice messages. They can also limit the possibilities of the platforms by interdicting certain forms of usage. Voice over IP (VoIP) is a technology which allows phone calls over a data connection. Since VoIP makes it possible to use a smartphone's data connection to make or receive phone calls bypassing the MNO's telephony plan, some mobile network operators prohibit the use of this technology in their networks. Especially in the case of Apple's iPhone exist cases where mobile network operators acquired the right of being the exclusive seller of their device in a certain region, a move that was probably motivated by the device's high popularity. Some MNOs, for example the *Vodafone Group*, even run their own application stores (Vodafone Group, 2009). They only have this possibility if the platform allows foreign application stores. Although MNOs occasionally undertake special investments in promoting smartphones of a certain platform, they generally offer a wide range of mobile devices, including smartphones of different platforms. The iPhone offers an interesting example for a close cooperation with MNOs. In most countries it is only available in connection with a contract with a partnering MNO. In many countries MNOs have acquired the exclusive right to sell the device. These iPhones are then also locked so that they cannot be used with other operators. Since some countries have laws which demand phones to be available without being locked to an operator, they are available without contract or lock but at far higher prices.

Mobile network operators affect application developers in several ways. First, their plans have the power to influence the usage behavior of the users. For example consumers are not very likely to use tourism-related applications when they are in another country since

data roaming[12] is very expensive in many areas (European Regulators Group, 2008, p. 12). Even within a country, they can forbid forms of usage or promote certain technologies. Voice-over-IP based telephony applications are a good example. No matter whether based on *Skype* or *SIP* protocols, some MNOs banned usage of such applications on their networks since it cannibalizes the revenue they aim to gain through telephony since these technologies use data connections instead. These are only examples: Theoretically a mobile network operator could take any technology based on data-connections and block it or demand a special, potentially unattractive, billing for it from its customers. At this place, another intermediate comes into play. Depending on a country's legislation, regulatory agencies can intervene and forbid such blockades. This makes this field very dynamic, together with the big heterogeneity between countries and their MNOs, it is too big to analyze here. An application developer who specifically targets certain regional markets should check for such issues though. The third point is that several possibilities for cooperation between application developers and mobile network operators exist. First, application developers are sometimes hired to execute projects for MNOs. Secondly, some mobile network operators have their own channels of bringing applications to their customers, be it an application store or recommending certain applications on their website. Although these points can be relevant for application developers in general, they are not relevant for platform selection since they are unlikely to bias platforms in a relevant manner.

The second big intermediate between the business ecosystems of the platforms and their customers are the retailers. Mobile phones are often net-locked, which means that they only work on a predefined MNO's network. Retailers usually offer phones with net-lock in combination with plans of partnering mobile network operators as well as phones that are open for all providers. While retailers usually cover a broad spectrum of platforms, they still might cooperate with certain platforms for advertising campaigns, therefore cannot necessarily be seen as a hundred percent neutral in respect to the different smartphone platforms. No important points of contact with application developers could be found.

Another category of intermediates, which is less obvious than the previous, are regulatory bodies. They mainly set the general conditions in which the business ecosystems can build their offerings. These conditions range from technical demands to competition law. There

[12] In this context, roaming means usage of a foreign MNO's network. This allows customers to use their mobile phones in other countries.

are several points where these bodies become relevant. Applications need to be legal and responsibilities towards the customers have to be accounted for. If the applications are to be sold in different countries, lots of taxation rules can come into play. Only the last part is of importance for platform selection since there are differences between the application markets considering who is taking care of taxes. They either retain the taxes and take care of them for the merchants or leave it up to the application sellers to collect and pay taxes in the different countries.

3.2.5 Selection of relevant criteria

Analysis will be done based on the concept of Network Value Analysis (NVA) (Peppard & Rylander, 2006). Setting the focal for the analysis is the first step for a NVA. In this case the focal is an application developing company which will not be defined any closer since the analysis will consider anything that is relevant to application developers in general, surpassing the subset of criteria which a precisely defined application developer would generate.

The next step is to identify the other participants in the network that influence the value which the focal delivers to its customers (Peppard & Rylander, 2006, p. 134).

Generalized, the following participants could be found:

- The Supplier(s) of the platform
- Advertisement companies
- Other application developers
- Consumers
- Mobile Network Operators
- Application hosting providers

Since the analysis is about the ecosystem, only participants in that ecosystem are considered. In a concrete execution of the analysis it is possible that other participants which are not on the generalized list can be found. Governmental agencies are likely to influence the value which the focal delivers since they can burden developers with legal issues and taxes. They are not included since they are not specifically affecting specific ecosystems and due to the multitude of different countries and laws.

The third step consists of identifying the value dimensions in the network. Value dimensions describe the perception of what a participant gets out of a network (Peppard & Rylander, 2006, pp. 134-135). Since the participants are generalized at this stage, only a small subset of possible value dimensions can be listed.

- Platform Suppliers: Market power, using the platform to support their other business unit's activities, sales, setting standards, growing their ecosystem, control, sale of licenses and services
- Advertisement companies: Presenting their advertisements to smartphone users, build and sell new advertisement space
- Consumers: Communication, facilitating work, information, entertainment, showing off
- Mobile Network Operators: Attracting new customers, selling new services, stronger use of their services, satisfying customers
- Application hosting providers[13]: New customers, market share

The point "other application developers" is left out here, since no differentiation between the focal application developers and others is done. The value dimensions for application developers depend on their business model. The classic value dimension would be profit through selling their applications. Since a significant part of available smartphone applications is available for free (AndroLib.com, 2009b), it seems natural that there are other business models as well. Some application developers gain revenue by displaying advertisement in their applications. For them, value is generated through a high number of users which ideally also click advertisements once in a while. Other applications serve the purpose of delivering content. In this case, if the application developer was contracted by the creator of that content, the value dimension probably lies in creating a good reputation as application developer to get further orders.

The value dimensions are important for understanding how the network works as well as what expectations the other participants have in relation to the focal. Since it is virtually impossible to find out what the perceived value dimensions are for other participants in the network, knowledge out of experience and literature combined with logic reasoning is the foundation for this step.

[13] Hosting providers are generally not necessarily belonging to the ecosystem. It turned out though, that Google App Engine is used by some applications. Google is an important part of the ecosystem around the Android platform.

Identifying the value linkages is the fourth step. It is narrowed down by the preceding steps: Only linkages related to the value dimensions identified in step three are considered. These linkages are called ‘network influences’ and consist of any linkages that impact behavior or value dimensions of a network participant (Peppard & Rylander, 2006, p. 135). These influences exist in four categories: exchange of goods and services, expression of affect, exchange of information, influence. This step, which will be done in the concretized analysis, concludes the identification of criteria. The fifth and ultimate step is drawing conclusions based on the data gathered in these four steps (Peppard & Rylander, 2006, p. 136). These steps are an adequate way of narrowing down criteria to what is directly relevant to application developers. At the same time, going through this process creates a better understanding of the ecosystem and ideas for the analysis.

One difference to the approach proposed by (Peppard & Rylander, 2006) has to be pointed out. In the original approach for Network Value Analysis, the network should consist of roles and not of specific organizations. The authors assume analysis of ecosystems like “mobile content and services”. Here, more narrowed-down ecosystems are analyzed, therefore in the following chapter specific organizations will be used. The current subsection used the original approach with roles to generate a template for that.

3.3 Summary

In this chapter, the fundamental terms ‘business ecosystem’ and ‘value network’ are explained. Two methods of analyzing value networks are outlined and the concept of network externalities is studied.

In the second part of this chapter, the main actors of business ecosystems around smartphone platforms are identified and explained. Focus is laid on application developers and application markets. The closing section combines findings of this part with the concept of network value analysis to identify criteria for analyzing a generalized ecosystem around a smartphone platform as preparation for a concrete analysis in the next chapter.

4 Selection and Analysis of the Platforms

In this part of the thesis, the findings of the previous chapters are applied on the example of two platforms. The platforms are selected as to provide the possibility to analyze two differently compound ecosystems.

4.1 Selection of two Platforms for Analysis

I elected several criteria to limit the number of candidate platforms. In section 2.1.1 criteria have already been introduced but not stated as specifically. The first criterion is that the device needs WCDMA data connectivity. Names for commonly used variations of this technology are UMTS, HSPA/HSDPA and 3G or 3.5G. They are available throughout most developed countries and provide a rate of data-transfer which can go up as far as double-digit megabit-figures per second. As long as network coverage is not especially bad, this allows usage of online-based applications like browsing the web. A touchscreen of a size of at least three inches is a typical characteristic of recent smartphones. Operating them without extra tools like a stylus is important to make handling easy. Since fingers have a bigger touching point than a Stylus this also implies an interface which expects less precision. This is important for using the smartphone in environments like a shaky bus in public transportation or while walking. The third point is the availability of telephony over the normal mobile network. Therefore pure VoIP phones are not considered. Since common definitions of the term ‘smartphone’ expect them to have a web-browser and an e-mail client, these are also required. Many innovative applications rely on location-based data therefore GPS is included as criterion. Since this thesis was written in Austria, availability of hardware on the Austrian market is deemed a requirement as well. June 30 2009 was drawn as deadline in this respect.

Table 4-1 lists the platforms which are available in Austria and fulfill all criteria. Symbian is an exception: There is only one criterion which it does not fully cover yet. Due to its 44% market share in recent phone shipments (Canalys, 2009) it is included in the table nevertheless. The required features listed in that table have to be available for stock devices and not through add-ons.

	Android	Symbian v9.5	Windows Mobile	iPhone OS	Blackberry OS
Data connectivity over WCDMA	Y	Y	Y	Y	Y
Touchscreen which is to be operated with the fingers (diagonal >= 3″)	Y	N	Y	Y	Y
Telephony over mobile network available	Y	Y	Y	Y	Y
Browser and e-mail client included	Y	Y	Y	Y	Y
GPS	Y	Y	Y	Y	Y
Available in Austria[14]	Y	Y	Y	Y	Y
Fulfills all criteria above	Y	N	Y	Y	Y
Example for device	T-Mobile G1	Nokia 5800[15]	HTC Touch HD	Apple iPhone 3G	Blackberry 9500 "Storm"

Table 4-1 – Criteria for Analysis

Table 4-2 lists the platforms which are not considered with the respective reasons. There are even more platforms but not enough information about them could be gathered to verify whether they comply with the criteria. In all these cases it could be verified that neither mobile network operators nor big retail chains offer devices based on those platforms, which means that they do not comply to at least one criterion.

[14] In retail stores or at mobile network operators in Austria

[15] Even though shipping with a Stylus, it proved easy to use with the fingernails. Criteria are strictly applied all the same, since the designed way of input also affected the design of the user interface.

Platform	Reason for discarding
Maemo	Not available in Austria[16]
LiMo	No devices available in Austria
OpenMoko	Screen size too small (2.8″)
Symbian v9.5	Touchscreen operated with Stylus[17]
WebOS	Not available in Austria[18]

Table 4-2 – Platforms not considered

In addition to the elimination criteria applied in the first part of this section, there are also differentiation criteria. One attribute that is likely to influence the ecosystem is whether the platform is available to other companies than the creator of the platform. If they are, this means that within the platform's ecosystem several manufacturers of smartphones will compete against each other. Each additional company which licenses the platform adds their concepts and innovations to the ecosystem. An open platform has a stronger potential to become an industry standard, than a closed platform (Shapiro & Varian, 2003, p. 198). Out of the four remaining platforms listed in table 4-3, one exclusively used and one licensable platform is picked for the detailed analysis of the ecosystem. Whether a platform is based on an open-source model provides a second point of differentiation. Another point, which is especially relevant for application developers, is whether they can use other channels besides the platform's central application market.

	Android	Windows Mobile	iPhone OS	Blackberry OS
Platform is exclusive to platform creator	N	N	Y	Y
Platform is open-source	Y	N	N	N
Central market as single point of providing applications	N	N	Y	N

Table 4-3 – Openness of smartphone platforms

[16] The platform became available through the "Nokia N97" device during the creation of this thesis but could not be considered any more at this point.
[17] Devices which do not suffer from this limitation are planned but did not become available in time to be considered in this thesis.
[18] The platform became available through the "Palm Pre" device during the creation of this thesis but could not be considered any more at this point.

Android is the first platform which is selected. Not only that it is open for companies to use for their smartphones, its openness is even more promoted by being open-source. This means that theoretically there would be no limits for a smartphone manufacturer to adapt the operating system to his needs. Android's market share is small but growing (Canalys, 2008a), (Canalys, 2009).

IPhone OS is selected as the closed counterpart. The iPhone OS is exclusively used in Apple's *iPhone* smartphones and *iPod Touch* media players. No information hinting that any other company would hold a license to use it could be found. Being derived from the Apple OS X operating system, some parts of it are open-source as well. This is not of relevance though, since Apple is owner and exclusive user of the platform, therefore having full access to the source-code anyway. Apple alone is responsible to direct the development of the platform. Since the iPhone product line is the only type of smartphone which uses iPhone OS, it is used synonymously to the platform. The iPhone has the highest market share of the four platforms in table 4-3 and is still growing (Canalys, 2008a), (Canalys, 2009).

These two platforms show the maximum possible distance in table 4-3 since they differ in all three points. Android-based devices as well as iPhones are being sold in almost all developed countries, in the case of Android in form of several different smartphones from different manufacturers, in the case of the iPhone in the form of *iPhone 3G* and *iPhone 3GS*, the first not being produced any more.

4.2 Network Value Analysis and Evaluation of Criteria

In this section the actual evaluation is done separately for each of the two platforms. In the following chapter, the platforms are compared and discussed based on the results of this analysis. For each platform, the analysis starts with network value analysis and ends with an assessment of the technological criteria which are displayed in section 2.2.

The first step of the network value analysis consists of defining the network focal. The same focal will be assumed for both analyses. It is defined as an application developer. Application developers can be entities of any size, ranging from single persons to project groups in big trusts. Here, a generalized approach is chosen, therefore the application developer is not defined any further.

4.2.1 Open Handset Alliance – Android

The focal is defined as an application developer, as described in the introduction of section 4.2. The following step is to identify other participants in the network which influence the value which the focal delivers to its customers. The following notable actors adhering to this criterion could be found:

- **Google** is a leading founder of the Open Handset Alliance and holding a major position in the ecosystem: Google initially acquired Android Inc., the company which founded the Android platform, hosts the site 'android.com' and runs the Android Market. Several paths of influence lead from Google to application developers. Google holds a leading role in the development of Android OS. This covers topics like fixing bugs, adding new features and major influence on when new versions of the platform are released. Google is organizing the *Android Developer Challenge*[19] which is directly targeted at application developers. The company is also providing generic application hosting services[20] with the product *Google App Engine*[21]. The company is making a big part of its revenues through sale of online advertising and offering a framework for advertisement[22] within smartphone applications as well. Furthermore Google provides smartphone applications, some exclusive to Android, others available on several platforms[23]. Google is also responsible for *Android Market*, Android's main application store.
- **AdMob** is a company offering an advertisement framework which can be included in smartphone applications[24]. The framework is available for other platforms as well.
- **Verizon** is a mobile network operator in the USA. The company reportedly spent 100,000,000 USD on advertising the *Motorola Droid* Android smartphone which they exclusively sell in the United States (Chang, 2009). Verizon has announced

[19] The Android Developer Challenge (ADC) is a contest between application developers which was held twice so far and paid out a total of about 7,000,000 USD in prizes to the developers of the winning applications (Google Inc., 2009b), (Google Inc., 2009a).
[20] Application hosting services allow running a back-end of a smartphone application on servers. The data-exchange between the smartphone-portion and the server-portion of the application is handled via internet. This is especially important when information is to be accessed by several users or from several places like smartphone and desktop.
[21] Google App Engine is a cloud computing service which allows running applications on servers in Google's data centers. There are a number of competitors providing similar services (Lenk, Klems, Nimis, Tai, & Sandholm, 2009).
[22] This service is available for Android and iPhone platforms (Google Inc., 2010a).
[23] Examples for such applications are *Google Maps* and *Google Goggles*.
[24] AdMob and Google signed a contract about AdMob's acquisition through Google, but the US Federal Trade Commission (FTC) has not approved this acquisition yet (Vascellaro, 2009).

plans to supply their customers with applications through their own application store (Higginbotham, 2009).

- **T-Mobile** is a mobile network operator in the USA, Germany and several other countries. The first Android smartphone was sold under T-Mobile's brand bearing the name 'T-Mobile G1'.
- **Consumers**: There are several million consumers using Android-based smartphones[25]. They are the potential customers of application developers which program for the Android platform. Customers can also influence the value of an application through the mechanism of positive feedback as explained in section 3.1.4 and through contributions like reporting bugs or recommending an application to others.
- **Other Application developers** have the potential to influence the value delivered by the focal by being competitors or by dragging more customers to the platform. Cooperation can also be possible, for example applications might complement each other[26].

After this step it is clear that some parts of the ecosystem do not play a big role for application developers. For instance no direct connection to hardware manufacturers could be found, therefore they are not listed. HTC Corporation for example is the manufacturer of several Android-based smartphones including the first model sold on the market. Even though likely to be contributing to the development of the operating system, no indications of having a leading role in this process could be found. Therefore their influence on application developers is rather indirect than direct. In the case of hardware component manufacturers like semiconductor companies there is no indication of any influence at all. Similarly, mobile network operators in general do not have direct influence on the value which the focal delivers to its customers. Verizon is an exception since they have planned opening their own application market.

The third step can only be executed vaguely since it treats the perceived value the participants obtain from the network. The information of this part is derived from extensive screening of news and press releases as well as experience and logic reasoning. Therefore these are possible dimensions of perceived value:

[25] This number is according to (Canalys, 2009) under the assumption that the quarters following 2009's second quarter had similar or higher sales.
[26] An example would be an application made to backup data of other applications. These other applications could provide standardized methods via which the backup application can access their data for backup.

- **Google**
    - Market power to shape the smartphone market as to support their other activities and goals.
    - Providing a platform on which their existing applications can be offered to mobile devices on Google's terms.
    - Gathering information (i.e. consumer behavior, interests, etc.).
    - Dominating the mobile advertisement market.
    - Profit through sale of smartphones.
    - Acquiring customers for existing services (advertisement, application hosting).
- **AdMob**
    - Presenting advertisement to as many users as possible.
    - Customers who buy advertisement space.
- **Verizon**[27]
    - Attracting new customers.
    - Having an attractive smartphone to rival the iPhone which, in the USA, is exclusive to the competing MNO *AT&T*.
    - Profit from margins in their own application market.
    - Selling data-services in addition to voice service or increase use of services.
- **Consumers**
    - Communicating in all common ways including voice, texting and e-mail.
    - Entertainment.
    - Facilitating work.
    - Information (browsing the web, location based information, navigation).
    - Showing off.
- **Application Developers (others and focal)**
    - Profit through sale of applications.
    - Profit through advertisement in applications.
    - Profit through development of applications for enterprise customers.

[27] T-Mobile is dropped from lists and tables from this point onward for better overview. T-Mobile has the same value dimensions as Verizon, minus the item "Profit from margins in their own application market".

Influence From / On	Google	AdMob	Verizon	Consumers	Application Developers
Google	-	- Competitor in advertisement	- Competitor in marketplace	- Creating brand image for Android - Own applications and services[28] - Application market - Showing advertisements in own and third-party applications	- Marketplace for applications - Sale of advertisement space - Development of platform - Developer tools - Incentives[29] - Competitor
AdMob	- Competitor in advertisement	-	-	- Showing advertisements in third-party applications	- Sale of advertisement space
Verizon	- Upcoming competitor in marketplace - Promoting Android	-	-	- Creating brand image for itself and for Android - Sale of subsidized smartphones linked to long-term contracts - Application market - Providing under-lying services[30]	- Marketplace for applications
Consumers	- Use of applications / information - Viewing advertisements - Downloading applications - Growing the user-base	- Viewing advertisements - Statistics	- Buying phones - Paying for use of services - Downloading applications	-	- Buying applications - Using applications (positive feedback) - Viewing advertisements - Recommending applications
Application Developers	- Selling applications through Android Market - Using Google's application hosting services - Including Google's advertisement space in their applications - Proposals for improvements of platform	- Including AdMob's advertisement space in their applications	- Selling applications through Verizon's market	- Providing applications that satisfy their value dimensions	-

Table 4-4 – Value Linkages (Android)

[28] i.e. Google Mail, Google Maps, Google Calendar, Google Docs
[29] Android Developer Challenge
[30] Voice and data connectivity

The fourth step consists of defining the value linkages between the participants, limited to the previously identified participants and perceived values. Table 4-4 shows these linkages, also called 'network influences'.

The fifth step is to analyze the findings of the previous steps. It becomes evident that even though Android seems very open, Google controls critical bottlenecks like the central application market (see section 2.2.2) or development of the platform and the provision of development tools. Google also exerts influence in the advertisement market but does not control it since it has a notable competitor there. This could change since Google and AdMob agreed on the acquisition of AdMob by Google, FTC's approval of this deal is pending (Vascellaro, 2009). Google is actively trying to increase the number of application developers and applications by organizing competitions for application developers with several million USD in prizes (Google Inc., 2009b). It seems natural that Google would support these endeavors by providing quality development tools and documentation as well. Android Market is very open, for example applications are generally accepted and only removed if violations of the terms are reported (Google Inc., 2009c). In addition to promoting creation of third-party applications, Google is very active at developing applications on their own. Many of these applications are available to other platforms than Android as well. Since Google usually offers its applications for free, the company can depict a strong competitor to application developers if their applications overlap. The Android Market is a core pivot since it is the default way for customers to download applications. Verizon has not launched its planned application market yet. Google uses all kinds of information it gathers, for example Android phones have a setting which, if activated, allows Google to assess the user's position "for better search results and other services"[31].

The Android brand is partly promoted by Google but also by mobile network operators, mainly Verizon and T-Mobile who both launched national (USA) and international advertisement campaigns for Android smartphones sold under their brands. Since smartphones are commonly sold subsidized and linked to long-term contracts, they also bind the customers who buy Android-smartphones to that platform for up to two years. Handset manufacturers that sell under their own brand-name might also run their own

[31] Description in security-settings menu on a T-Mobile G1 Android smartphone running platform version 1.6

advertisement campaigns. As mentioned before, their effect on application developers is at best indirect though.

Consumers influence the application developers through buying the applications and through viewing advertisements, the latter also influencing the advertisement companies, for instance Google and AdMob. Each new user grows the market power of the Android platform, probably one of Google's goals. By using Google's preinstalled applications, the customer binds himself to Google's services. Additionally the customer provides Google with usage statistics and various bits of information about himself. The more intense use of data-services on smartphones relative to regular mobile phones can provide MNOs with higher revenues if the users have to buy more extensive data-plans. Consumers will rate applications in the Android Market and presumably also recommend them by word-of-mouth, which is especially important for applications which depend on positive feedback. It was not possible to find information on whether Android is targeted at specific groups of customers.

Application developers can attempt to satisfy the value dimensions of the customers, for example entertainment, socializing, communication, facilitating work or getting information are dimensions which are standing to reason. Due to the platform's openness, distribution of applications can happen through the market and theoretically also through other channels. In the latter case the developers have to find means of reaching the customers in terms of promotion and delivery. The one-time registration-fee of currently 25 USD (Google Inc., 2009d) is not considered of noteworthy influence.

Some of the criteria related to application development and technological foundations of the platform can be assessed as well. An SDK including an IDE is provided for computers running under Microsoft Windows, Mac OS X or Linux operating systems (Google Inc., 2009e). The IDE is implemented as an enhancement to the publicly available Eclipse-IDE. This allows high flexibility regarding which operating system is used for the workplaces of the developers. Developers might profit from previous experience with development of Java Applications in Eclipse: Android's programming language shares Java's syntax. The variety of Android devices with different screen-resolutions and platform versions[32] is bound to increase the effort of developing an application that runs on the largest part of

[32] 99% of the Android smartphones run on one out of three different platform versions, each of these having a share of approximately 20 to 50 percent (Google Inc., 2010c).

Android smartphones: Developers have to ensure that their application is displayed without errors on different screen-resolutions. Furthermore it is necessary to test the application on several platform versions and, if problems appear, work those out.

4.2.2 Apple iPhone

This subsection begins with step two, identifying the participants in the network which influence the value which the focal delivers to its customers. Consult the introduction of section 4.2 for step one, defining the focal. In the ecosystem around the iPhone platform, the following important participants could be found within the boundaries of the criteria:

- **Apple** is historically experienced with hardware and software as a seller of computers and periphery devices as well as the *Mac OS* operating system and several applications. The company also has years of experience with portable multimedia devices due to the iPod product line which became very popular (Apple Inc., 2009a). Apple designed the iPhone smartphones and also owns the operating system which they use. The hardware itself is assembled by the company *Foxconn* (Arrington, 2008) while the individual components come from a variety of suppliers. While the operating system's kernel[33] is open source, a big part of the operating system is proprietarily made by Apple, therefore giving the company full control about its development. Apple runs *App Store*, the exclusive channel for providing applications to the users of the iPhone. In addition, Apple runs the iTunes store where users can buy music and videos for their iPhones. This store is also available for other products, especially the iPod product lines and playback on computers. Apple provides developers with tools and documentation.
- **AdMob** is a company offering an advertisement framework which can be included in smartphone applications. Due to the framework being available for other platforms as well, this company is listed in the analysis for Android too.
- **AT&T** is a mobile network operator in the USA and the exclusive seller of iPhones in that country. These iPhones are locked to this operator. Internationally the situation differs from country to country but in many cases it is similar to the

[33] Kernel: "The heart of the operating system, which controls the most critical processes." (Stair & Reynolds, 2007, p. 623)

approach in the USA. AT&T is closely working together with Apple to promote the iPhone since both companies are greatly profiting from its success.

- **Consumers:** The number of worldwide iPhone owners is in a two-digit million range (Apple Inc., 2009c)**.** They are the potential customers of application developers which program for the iPhone platform. Although not part of this analysis, it cannot be neglected that *iPod Touch* media players are compatible and add even more potential customers, depending on whether the concept of an application is suitable to work with them. Consumers can influence the value of an application through the mechanism of positive feedback as explained in section 3.1.4 and through contributions like reporting bugs or recommending an application to other iPhone owners.
- **Other Application developers** have the potential to influence the value delivered by the focal by being competitors or by dragging more customers to the platform. Co-operation can also be possible, for example applications might complement each other.

Since the iPhone is designed by Apple, the manufacturer Foxconn clearly has no influence on application developers since the company appears to be solely acting in accordance to Apple's orders. Therefore similarly to Android's ecosystem, a big part of the ecosystem around the iPhone does not directly play a role for application developers.

The third step consists of identifying the value dimensions of the participants in form of the perceived values they gain from the network. This was done through screening of news and press releases combined with experience and logic reasoning. Due to the nature of perceived value it was not possible to find definite verifiable value dimensions. The following presumed dimensions were identified:

- **Apple**
    - Becoming central supplier for all kinds of content for iPhone-users (primarily applications, music and video) and gaining revenues through that position.
    - Growing the user-base to have more customers and leveraging economies of scale.
    - Profit through sale of smartphones.
    - Profit by selling MNOs the right to be the exclusive provider of the iPhone.

    - Promoting other products, mainly Apple computers and Mac OS X.
    - Selling licenses for hardware which enhances the iPhone, for example docking stations with music speakers.
- **AdMob**
    - Presenting advertisements to as many users as possible.
    - Customers who buy advertisement space.
- **AT&T**
    - Attracting new customers by having a unique product.
    - Selling data-services in addition to voice services or increase use of these services.
- **Consumers**
    - Communicating in all common ways including voice, texting and e-mail.
    - Entertainment.
    - Showing off.
    - Facilitating work.
    - Information (browsing the web, location based information, navigation).
- **Application Developers (others and focal)**
    - Profit through sale of applications.
    - Profit through advertisement in applications.
    - Profit through development of applications for enterprise customers.

Now that the participants and their perceived values are identified, the fourth step consists of finding value linkages between the participants based on these findings. This is done in table 4-5.

These four steps provide several interesting points for the final analysis which makes the fifth step. Apple is in total control of its iPhone platform, which is something that application developers have to consider when creating applications for the iPhone. According to articles in newspapers and especially in blogs, Apple can be very restrictive and deny acceptance of applications for many reasons, including lack of quality, limited utility or duplicating functionality of pre-installed iPhone applications. Since Apple's App Store is the only channel for publishing apps, the risk of an app being rejected can be quite a threat because big development effort might be lost (Perez, 2009). There is a framework to sell additional content from within an application via the App Store's facilities.

Influence From / On	Apple	AdMob	AT&T	Consumers	Application Developers
Apple	-	-	- Providing a popular, unique product - Selling exclusivity rights	- Brand image of Apple in general as well as brand image of the iPhone product-line - Application market - Multimedia store	- Marketplace for applications - Development of platform - Developer tools - Deciding about approval of applications - Incentive to buy Apple products for development[34]
AdMob	-	-	-	- Showing advertisements in third-party applications	- Sale of advertisement space
AT&T	- Monthly payments for each iPhone-customer[35] - Promoting the iPhone	-	-	- Creating brand image for itself and for the iPhone - Sale of subsidized iPhones linked to long-term contracts - Providing under-lying services[36]	
Consumers	- Downloading applications - Downloading music and videos - Growing the user-base	- Viewing advertisements - Statistics	- Buying iPhones - Paying for use of services	-	- Buying applications - Using applications (positive feedback) - Viewing advertisements -Recommending applications
Application Developers	- Selling applications through App Store - Proposals for improvements of platform - Yearly membership fee[37]	- Including AdMob's advertisement space in their applications	-	- Providing applications that satisfy their value dimensions	-

Table 4-5 – Value Linkages (iPhone)

[34] The Xcode IDE which comes with the SDK runs only on Mac computers with OS X (Apple Inc., 2010a).
[35] According to different sources, AT&T pays for the right of being exclusive seller of iPhones in the USA by handing over to Apple a percentage of the turnover generated with contracts linked to iPhone sales (Hoffmann, 2007).
[36] Voice and data connectivity as well as extra features like visual voice-mail, an interface for easier voice-mail access.
[37] Developers who wish to sell applications in Apple's AppStore have to pay a yearly fee of currently 99 USD (Apple Inc., 2010b).

The close cooperation between Apple and MNOs like AT&T who act as exclusive sellers in some regional markets also allows coordinated promotion of the iPhone platform. For example an advertisement might praise the advantages of the iPhone and end with a line like “get it now, only at AT&T”. It is unknown how Apple and AT&T share the cost of such advertisement. Since AT&T sells the iPhone subsidized, accompanied by long-term contracts and locked to AT&T’s network, this also creates a form of lock-in of the customers to the iPhone platform. AT&T allegedly pays for the right of being exclusive seller of iPhones in the USA by handing over to Apple a percentage of the turnover generated with contracts linked to iPhone sales (Hoffmann, 2007). The iPhone’s HSDPA internet connectivity can be made available to a laptop to provide it with internet access. This type of usage is called “tethering” and puts additional load on AT&T’s mobile network without providing additional revenues. Furthermore it cannibalizes mobile-broadband internet access offers which MNOs sell explicitly for the purpose of accessing the internet with a computer. Apple therefore removed all tethering applications from the App Store, thereby protecting AT&Ts interests (Keizer, 2008). Later Apple updated the firmware to allow MNOs to decide whether tethering is possible for a customer. This allows them to charge the customers for usage of this feature. The tethering-topic depicts a good example for some of the relationships in the ecosystem.

Consumers can download free and paid applications. Further revenue for application developers can be generated through advertisement space in applications and through sale of additional content or paid activation of extra functionalities, which is even possible from within the applications. According to the theories of (Porter, 2001, p. 67) a growing size of the iPhone’s user-base should allow for better economies of scale, besides depicting potential new customers for application developers. By rating applications in the market, writing reviews and word-of-mouth recommendation, customers influence the success of applications based on the experiences they made with it. The relevancy of iPhone users for mobile network operators like AT&T lies in their demand for data-services which are needed for browsing, e-mail and many applications. It was not possible to isolate a clear preferred type of customer.

Application developers can publish applications following different models for gaining revenue via sales or via advertisement. Generally the goal is to satisfy customer’s value dimensions, for example entertainment, information, communication or facilitating work, to give them a reason to use the application. Sale is limited to the App Store, therefore only

applications that can be expected to be accepted by Apple are an option. The yearly fee of 99 USD which application developers have to pay (Apple Inc., 2010b) is no issue compared to the other costs of software development like wages. Nevertheless it potentially generates a yearly income of more than ten million USD for Apple[38].

Concerning technological foundations and application development, there are several important aspects. Developers profit from a high level of homogeneity. All devices have the same screen-resolution. Under normal circumstances, they also run on the same version of the iPhone operating system. The main difference between the iPhone, iPhone 3G and iPhone 3GS smartphones lies in their hardware. For example the newer models have more processing power and new sensors like a digital compass, which the older models do not offer. While this has to be considered to be aware that some features of an application might not work for some users, it does not explicitly require additional testing of the software. The SDK is only available for Mac systems with Intel processor running on Mac OS X (Apple Inc., 2010a). This means that developers who do not own such a system have to get one to develop iPhone applications. The IDE included in the SDK is called *Xcode*. It is the same IDE that Apple provides for development of applications for Mac OS X. The programming language in which iPhone applications are to be developed is *Objective-C*. Therefore previous experience with using a Mac, with the Xcode IDE or with Objective-C can help reducing the training period.

4.3 Summary

Two platforms were selected for analysis in this chapter. The selection incorporated the intent of finding differences between the platforms. In accordance to this, analyses unveiled many similarities but also several differences between the platforms. These results will be discussed in detail in the next chapter.

[38] According to (Apple Inc., 2009d) there are more than 125,000 registered developers.

5 Comparison

This chapter compares the smartphone platforms Android and iPhone based on the findings of the previous chapter. First the differences in market and ecosystem are displayed, then the technological differences. The chapter ends with pointing out the similarities.

5.1 Differences in the Ecosystem

One important difference between the platforms is the number of users they have since this defines the potential size of the market for an application developer. It is difficult to find detailed, up-to-date information on these numbers. According to (Apple Inc., 2009c) the number of iPhone users is somewhere in the two-digit million figures. Reports of recent sales (Canalys, 2009) indicate that the number of users of the Android platform would be somewhere in the one-digit millions. This report also shows that both platforms are still growing in absolute terms as well as in market-share. It is impossible to perform a meaningful comparison though, since the Android platform was only available for one year at the time of writing this thesis. The most successful Android smartphone so far is the *Motorola Droid*[39] which was launched in November 2009. Due to these rapid developments this aspect will not be discussed any further. The only thing that can be said based on the current data is that the number of iPhone users is significantly higher than the number of Android users. It is impossible to predict whether this will still be the case in a year or two. One important difference which is easier to analyze and which has the potential of influencing the number of users is, whether exclusivity agreements were made with mobile network operators. In many countries the iPhone is only being sold by one exclusive MNO, in the case of the USA this is AT&T. If staying with another operator is more important for a consumer than having an iPhone, he will decide for another phone or smartphone. In the case of the Android smartphones, there are some exclusivity agreements as well, for example in the case of the Motorola Droid, which is exclusively being sold by Verizon (Motorola Inc., 2009). Due to the multitude of Android smartphones, some of which even available in retail stores without telephony contracts, consumers who decide for that platform always have options of getting one, no matter what their operator is. This also makes it easier for developers to get devices to test their

[39] The Motorola Droid, also sold as Motorola Milestone, currently is the only Android 2.0 device and therefore accounts for the 21.1% of devices using Android 2.0/2.0.1 shown in (Google Inc., 2010c).

applications on, since they do not have to sign a telephony contract which they might not want.

The activities of the pivot companies in the ecosystems, Apple and Google, create another important difference. Apples activities lie in fields as selling hardware, operating systems, computer applications and music. Apple does not pursue notable activities in the field of developing smartphone applications, apart from the basic applications with which iPhones are shipped (i.e. e-mail client, browser, alarm clock, etc.). Therefore, Apple does not behave as a competitor to smartphone application developers. Google on the other side is primarily focused on advertising and internet services. These services are often provided for access via a web-browser, but Google also provides smartphone applications as additional or exclusive way of accessing some of the company's services. This can make Google a competitor to other application developers. A noteworthy example is *Google Navigation*, a free navigation application, currently limited to the USA (Google Inc., 2010b). Such a free application reduces the likeliness for Android users to spend money on navigation applications from other vendors. Furthermore, Google can have many more ties to application developers than just being the provider of the platform and the associated market. Google provides application hosting services and sells advertisement space in smartphone applications. This can make application developers more dependent on Google than they initially planned if they did not consider these aspects.

The probably most important difference lies in the field of distribution channels and especially in the central application markets. As described in the previous chapters, Apple exercises absolute control about the App Store. If an application does not suit Apple for any reason, they can deny publishing it, thereby making it impossible to reach any customers. Of course there are rules about the criteria applications have to fulfill to be eligible to being accepted, but interpretation of these criteria can vary from case to case. The upside of this measure is that it should ensure a decent level of quality which can be considered as in the best interest of the consumers. The downside is the absolute dependency on Apple which application developers have to bear with. In the case of Android, all applications are initially accepted and published in the market automatically. There is no review and they are published without long delays. The terms to which applications have to comply cannot be considered very strict (Google Inc., 2009c). If applications violate these terms, they can be removed by Google. Users have the possibility to notify Google if they think that an application should be removed. It is

possible to publish applications outside the market as well, by letting the user download them via a browser and manually install them. This way a user can even install a third-party market application which can then again provide the level of simplicity customers are used to from the original market. This is especially relevant for companies that plan to create adult applications, since these are banned from App Store as well as from Android Market. In the field of Android, there are companies which try to fill this gap by offering their own market applications especially for this purpose. It cannot be determined yet whether any of them will ever come to importance though. The bottom line is that for Android phones, it is difficult to deliver content which is not accepted in the market, for iPhones it is impossible. App Store offers one important feature which does not exist for Android Market: There is an API to create applications which allow the user to buy additional content from within the application. This way for example a limited free version of a game can ask the user to upgrade to the full version and let him continue playing after paying, without making it necessary to go to the market to install another version. It will not be discussed here how big the advantage of this possibility really is. Regardless it is clear that an easier buying-process results in fewer points for the potential buyer to back off. Therefore this possibility definitely has a positive impact on the potential revenues and only the magnitude of this impact stays undetermined. On the Android-platform, developers can publish dummy-applications in the market which instruct the main application to unlock additional features or content. They can only be purchased in the market and not from within the application itself. This can be a solution in some cases but it does not provide the same level of comfort and functionality as App Store's in-application-purchasing. Another issue lies in the field of accessing the market. IPhone applications can be downloaded on a computer via iTunes and then synchronized to the iPhone when it is connected to that computer. This way a user who browses the web on his computer and sees a link for an application he is interested in can download the application without any steps on the iPhone except for synchronization. The Android Market can only be accessed on the smartphone itself. Even though there are interfaces to search the market via a computer's web-browser, the user has to download the application on the smartphone. The main uncomfortable point here is the process of finding the application again. Therefore websites related to Android applications frequently display QR Codes[40]

[40] QR-Codes (Quick Response Codes) are two-dimensional barcodes which can represent text, for example URLs. The smartphone can read these codes via its built-in camera.

which allow opening the market and searching the application in one step without having to enter any text on the smartphone.

There is one more important difference between the ecosystems which does not have much direct effect on application developers on short term, but can have important effects on the whole ecosystems in the long run. The product of the iPhone-ecosystem is the iPhone. It is not necessary to differentiate between the device and the underlying platform since they are treated as one entity and no other vendors are using the platform. The product iPhone, as combination of hardware and platform, is fully linked to Apple and Apple's brand image. When Apple plans a product the company has to ensure that it is aligned to their brand-image. Android on the other side is just a platform. The products that are based on it are being sold under names like "T-Mobile G1", "Motorola Droid", "HTC Hero" or "Samsung Galaxy"[41]. The vendors can choose to which extent they want to emphasize the Android platform and to which extent they want to link it to their own brand image. This allows higher diversity of products since there is no specific brand-image which has to be served. Manufacturers can complement each other to address all kinds of customers. A downside of Android's diversity is that it leads to heterogeneity in devices, which requires additional effort from application developers. This aspect is discussed in the next section.

5.2 Technical Differences

Apart from the differences in the ecosystem, there are also several important differences in the technical framework-conditions.

The first big difference is multitasking. Multitasking is explained in section 2.1.3. Android supports full multitasking while iPhone OS only allows Apple's applications to run in the background. It shall only be recapitulated here, that applications which are supposed to run in the background can only be implemented on the Android platform. A workaround for the iPhone consisting of starting an application through a push-notification sent via web is described in section 2.2.2. Whether it can be used depends on the details of the application's concept.

[41] The phones listed are meant as examples for different vendors and do not represent a complete listing of Android-based smartphones.

The second big difference is heterogeneity or homogeneity of devices. While the three different types of iPhone's sold so far provide a high level of homogeneity, the situation is the opposite for Android smartphones. The platform defines limits to the possible heterogeneity through the definition of the API. For example only certain screen resolutions are allowed. Nevertheless, within these boundaries, very different smartphones were made. The two main differences that can be found within the Android platform are screen-resolution and platform version. In a manner similar to web-designers who have to ensure that their websites look good on computers with different screen-resolutions, Android developers have to make sure that their applications work with the different formats specified in the API. In addition to that, it is important to ensure compatibility with the commonly used versions of the platform. At the moment it is necessary to cover three of them to reach 99% of the users, namely Android 1.5, Android 1.6 and Android 2.0 (Google Inc., 2010c). These two types of heterogeneity add additional workload on developers. They need to proactively evade problems by considering these aspects during creation of the application. In addition to that, they have to test their application on different screen-resolutions and platform versions. Input is another source of heterogeneity with Android, likely having less influence than the previously listed issues though. The first characteristic is that some Android smartphones come with hardware keyboards while others do not. Text input is abstracted via the API, so the developer does not have to take any measures to treat this. The second characteristic is multitouch, a technology described in section 2.1.3. Some Android smartphones support it while others do not. Therefore the developer always has to build the software as to work without multitouch. Additional effort can be taken to add support for multitouch to give users with capable phones an optimal experience. In the case of the iPhone, multitouch support is given on all devices. Therefore an iPhone developer does not have to consider different styles of touch input.

A third issue is availability of the SDK. The Android SDK is available for Windows, Mac OS X and Linux (Google Inc., 2009e). The iPhone SDK is only available for Mac OS X (Apple Inc., 2010a), which is less common than Windows and only runs on computers sold by Apple. Therefore it is necessary to buy this equipment and accommodate with Mac OS X if another desktop computing platform was used before. This potentially burdens the developers with equipment and learning cost which they don't have in the case of Android.

5.3 Important Similarities

Besides the differences listed, there are also many similarities between both platforms which are important. These similarities are especially interesting since a developer might choose to develop for Android as well as iPhone. Both platforms fulfill the criteria listed in the selection-process in section 4.1. This implies that the devices are similar in their basic capabilities and in the way they are operated by their users. Both ecosystems share the circumstance that the hardware manufacturers have no direct influence on application developers.

For both platforms, the major channel of distributing applications is their central application market. The differences between these markets have been explained in the previous sections. In both cases revenue can come from sales of applications or services connected to them as well as by including advertising space. Offering free applications is not burdened with any cost in either of the markets, except for the Android Market registration-fee or App Store's yearly developer-membership fee, both being below 100 USD and therefore not significant for developers (Apple Inc., 2010b), (Google Inc., 2009d). For paid applications, both markets demand a share of 30% of the application's price (Google Inc., 2009g), (Apple Inc., 2009e). When using free applications, the first standardized advertising banners a user usually stumbles upon are coming from AdMob or Google. They are available on Android as well as on the iPhone. Google's program is currently in beta-stage and is not open for everybody (Google Inc., 2010a). Therefore AdMob can be considered the main player in this field[42] on both platforms. The markets are filled with ten-thousands of applications developed by thousands of developers (Apple Inc., 2009d), (AndroLib.com, 2009a). Both markets allow users to rate applications which they downloaded and even to write short reviews. The average of these ratings is then displayed next to the applications' names to help the users with assessing whether an application is worth downloading. Publishing applications without sufficient quality assurance or ignoring the feedback of the users can potentially lead to bad ratings and reduce the popularity of the product. On the other side, an application which is downloaded a lot and has good ratings will make its way up in the applications listing. Since the list always starts at the top, these applications are seen first by the user which increases their likeliness of being downloaded. It can be considered unlikely that a user would scroll down

[42] As mentioned in the previous chapters, AdMob agreed to being acquired by Google for 750 million USD. The deal is waiting for approval by the US Federal Trade Commission (Vascellaro, 2009).

to an application listed at a very late spot, for example beyond the 100th position. In this case users find the application only by searching with very specific criteria or even the application's name itself, or by being given a direct link to it.

It was not possible to find indications for significant differences in the demands of the customers. For example the top-ranked applications in both markets cover topics like entertainment[43], communication (i.e. Facebook or Skype applications), customization (wallpapers, ringtones), information (i.e. stock tickers and RSS-feed readers), facilitating work (i.e. calendar synchronization) and navigation (i.e. turn-by-turn navigation for cars as well as public transportation schedules for pedestrians). On both platforms the ecosystem's hub companies, Apple and Google, are using the platforms as means of promoting some of their core services. The iPhone is highly integrated into Apple's *iTunes Store* where users can buy music and videos for their phone and for their computer. The Android platform integrates Google's services, especially *Google Mail* and *Google Calendar* which are automatically synchronized with Google's servers. Furthermore Android phones usually come with preinstalled applications for *Google Maps*, *YouTube* and *Google Talk*. The decision whether these applications are to be included is made by the vendors of the smartphones and requires Google's approval.

Both platforms heavily rely on data-connectivity since many applications work with live data. This allows mobile network operators to sell high-volume data plans and makes the users dependant on network availability. Both platforms' phones offer WLAN access, which can be used at home or work for optimized connectivity, as well as when travelling to avoid high roaming charges.

5.4 Summary

One of the main findings of this chapter is that application developers are highly dependent on Apple or Google. Apple is exerting power through its absolute control of their platform. Google promotes openness but besides having major influence on the platform, influences the ecosystem through their other activities. These include sale of in-application advertising, application hosting services and behaving as a competitor to application developers.

[43] Both App Store and Android Market have their own section for games.

Characteristic	Android	iPhone
Number of users	1-9 million	10-99 million
Are there exclusivity agreements with mobile network operators?	Only for some devices	Yes, but not in all countries
Is the platform's pivot company a competitor to application developers?	Yes	No
Are Applications screened before being published?	No	Yes
Is it possible to bypass central application market?	Yes	No
Is it possible to buy content from within apps, using the application market's facilities?	No	Yes
Is multitasking supported?	Yes	Only for Apple's applications
Is multitouch supported?	Only on some devices	Yes
Are the devices homogeneous?[44]	No	Yes
Is the SDK available for more than one computing platform?	Yes	No

Table 5-1 – Differences between the platforms

Other major differences were identified in the fields of distribution of applications and heterogeneity within the platform. Additionally important similarities between the platforms were highlighted. Table 5-1 summarizes the most important differences which were described in detail in this chapter.

[44] In terms of resolution and platform version

6 Conclusion and Prospects

This chapter summarizes the findings of this thesis. Since the modern smartphone market is still developing very fast, thoughts on possible future developments are given.

6.1 Conclusion

The leading question is whether smartphone application developers have to perform a selection of platforms. This question can clearly be answered with yes. The exemplary analysis of two platforms pointed out important differences. It became evident that porting an application from one platform to another is connected to many issues requiring significant effort stemming from differences in APIs, programming languages, IDEs and publishing-terms for application markets. Limiting development to a selection of platforms requires a thorough assessment of candidate platforms. The goal of such an analysis is to make an optimal decision about which platforms to support and which platforms to drop. This thesis pointed out several criteria to be assessed this process and exemplified them on the Android and iPhone platforms to demonstrate these differences.

The criteria which have to be analyzed are separated into technical criteria and characteristics of market and ecosystem. Technical criteria have the advantage that they are dominated by properties which can easily be verified since they are hard facts which do not leave room for different interpretations. Especially the capabilities of a platform's API can often display knock-out criteria, since some application concepts depend on certain functionalities. These criteria should be identified and evaluated first since they can render analysis of other criteria obsolete. There are also technical criteria which are related to the actual software development process. These criteria are very important since they can significantly influence the cost of development.

Criteria related to market and ecosystems are generally more complex than technical criteria. The findings of this thesis show that there are several important characteristics in these areas. Besides being important for the decision which platform or platforms are to be selected, they give important hints for strategic concerns. For instance they help application developers to understand and minimize the mechanism of lock-in. In a market which is developing as fast as the smartphone business, flexibility is vital. Therefore it is important to avoid detriments to flexibility like being locked-in to a platform or partner.

Network Value Analysis proved itself as a good tool for analyzing a business ecosystem. The method provides a clear structure and avoids getting lost in unnecessary details. In this thesis, it allowed identifying key relations in the ecosystem while still maintaining a good overview. The concepts of network economics are important for understanding the behavior of some players in the ecosystem. This is important for determining the own position in the ecosystem and for protecting the own interests.

In the field of distribution channels, centralized application markets were identified as playing a key role. While being a great way to reach the customers, they are also a bottleneck via which the hub-company of a platform can exert control over application developers. Therefore it is important to thoroughly analyze their terms and conditions and how they are actually applied.

The concept of positive feedback goes along with the general topic of network externalities. Applications whose success relies on positive feedback need a big number of users. For developers who are not willing or able to provide native applications for all platforms, creating a web-based application can be a viable solution. A native application for key platforms can be used to promote the application and to provide an optimal experience to the users of these platforms. The web-application can then be offered to the users of other platforms to allow them to participate as well. It might be necessary to drop some features to create a commonly compatible web-based application but it should still be possible to reach an acceptable level of quality with it. Since smartphones, by definition, have a web-browser at their disposal, the application will be accessible on all platforms. This approach can also be used to bridge over the time it takes to create an optimized client for a specific platform.

No specific recommendation towards Android or iPhone will be made at this point. This would only be possible if the analyses would be conducted by a real application developer company which already has a concretized concept for an application. This was not done in this thesis since the goal of this document is to provide a template for performing such an analysis and to point out why such an analysis is important. Due to the rapid developments in the smartphone business, such an analysis would only stay relevant for a very short period.

6.2 Prospects

The smartphone business is undergoing large and fast developments. Previously important players like Nokia and Microsoft are continuously losing market share in a rapidly growing market. At the same time new competitors like Apple and the Open Handset Alliance reach annual growth rates of several hundred percent (Canalys, 2009). In addition to the platforms presented in section 2.1.1 even more new platforms are being launched since various companies are hoping for their share of the market. If a relation to computing platforms is made, it seems very unlikely that all these platforms will survive. For instance, according to analysis of website pageviews, Microsoft Windows (several versions grouped together) has a market-share of over 90% being followed by Mac OS X with approximately 4.7% (StatsCounter, 2010). The remaining few percent are shared along a number of niche operating-systems. Windows, with its share of over 90% can be seen as a standard. There is no indication that any smartphone platform will gain such a market-share and become a standard, although it cannot be ruled out either. What seems more likely is that the market will be shared among few big smartphone platforms. Platforms profit strongly from economies of scale since their cost is almost completely unrelated to the number of devices sold. The same holds true for third-party-applications as well. For this reason, application developers will rather be attracted to big platforms, following the principles of positive feedback (Katz & Shapiro, 1994, p. 94). According to (Shapiro & Varian, 2003) low demand for variety and high economies of scale are the two main factors which increase the likeliness of tipping: one technology winning due to positive feedback and the others failing because there is no room left for them (Shapiro & Varian, 2003, p. 188). If this holds true, the only point left open for discussion is how high the demand for variety is. Presumably it is not high enough for all platforms to survive on the long-term.

The iPhone and Android platforms were described in detail in this thesis. As seen in the introduction of this thesis, there are several other platforms. According to (Carton & Crumrine, 2010), iPhone, Android and Blackberry are the platforms that consumers are most interested in at the moment, based on the question “Which Mobile OS would you prefer to have on the Smart Phone you plan on buying?” (Carton & Crumrine, 2010). Even though it seems that these are the platforms that matter most in the US-market at the time of writing this thesis, other big players like Nokia or Microsoft are taking action to return to their old glory. Nokia is launching *Maemo* as a new smartphone platform and in parallel

improving the *Symbian* platform which is used on many of their smartphones. Microsoft is working on *Windows Mobile 7* to become a major market player again. Touch interfaces and central marketplaces exist or are planned for these platforms. These two characteristics seem to be important parts of the current trend.

The central marketplaces are dominated by free and low-price[45] applications (AndroLib.com, 2009b), (Frommer, 2009). This makes it interesting for developers to make use of features like *in-app purchasing*, which allows users to buy content and enhancements from within an application. For example a news-reader application could offer the user to remove advertisements for a small fee and allow buying access to new sources. Since this possibility was very new at the time of writing this thesis, it will be interesting to see whether it proves itself as a way of increasing revenues compared to fixed-price applications.

Application developers will have to attempt to foresee how the ecosystems develop and will have to try to back the right horse. The future will show which ecosystems are the healthiest and which niches will open up between them. Independently from the selection of ecosystems, developers will have to continuously identify the needs of smartphone-owners and supply them with applications which feed those needs. Although the smartphone-market is not new per se, it is young as a mass-market. It is growing fast and most likely there is still much room for innovation. Be it new needs that are yet to be detected, new application concepts or whole new business models.

[45] In App Store, an average price of 2.55 USD was found among the top 100 selling apps (Frommer, 2009). A screening of Android Market led to similar results.

Glossary

Abbreviations

ADP	Android Developer Phone
API	Application Programming Interface
FTC	Federal Trade Commission
GPS	Global Positioning System
HTC	HTC Corporation
HTML	Hypertext Markup Language
HSDPA	High-Speed Downlink Packet Access
HSPA	High-Speed Packet Access
IDE	Integrated Development Environment
IP	Internet Protocol / Intellectual Property
J2ME	Java 2 Micro Edition
LAN	Local Area Network
LiMo	Linux Mobile
MNO	Mobile Network Operator
NVA	Network Value Analysis
OHA	Open Handset Alliance
OS	Operating System
PC	Personal Computer

PDA	Personal Digital Assistant
RAM	Random Access Memory
RFID	Radio-Frequency Identification
RIM	Research in Motion
SDK	Software Development Kit
SIP	Session Initiation Protocol
UML	Unified Modeling Language
UMTS	Universal Mobile Telecommunications System
USD	United States Dollar
VoIP	Voice over IP
W3C	World Wide Web Consortium
WAP	Wireless Application Protocol
WCDMA	Wideband Code Division Multiple Access
WLAN	Wireless LAN

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