

Standards Competition and the Role of Intermediation in the Supply of Mobile Applications

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Abstract

The development of ubiquitous computing and mobile commerce is premised on an infrastructure of interoperable networks, operating systems and applications. As technologies evolve to create this infrastructure this process sometimes gives rise to a standards competition. This research examines such a competition between mobile application development platforms and the resulting intermediation services. In particular, the research describes the nature of these intermediation services and assesses the relative value they represent for standards promulgators, application buyers and suppliers. The findings of asymmetric value suggest that value chain level assessments of intermediation can provide a rich topic of research on technical and industry evolution as well as provide additional insights into the strategic aspects of standards competition for those who start them as well as those affected by them.

1. Introduction

The growth of network technologies, including fixed, mobile, wireless and satellite networks, combined with the proliferation of user devices, has created new opportunities for ubiquitous computing in which users are able to access a wide array of content, applications and information services in a variety of contexts. While ubiquitous computing can potentially enable transactions related to areas as diverse as healthcare, government and recreation, the ability to access information via these networks requires a high degree of compatibility between diverse software and hardware technologies across system layers, including networks, server and end-user devices (Lyytinen & Yoo, 2002). The conditions for and cost of overcoming these compatibility challenges will, in turn, have several implications. Compatibility, or a lack thereof, influences the nature of user experience, including where services are available and which services are available. As has been experienced in the desktop computer software market, compatibility issues can also influence which firms are able to offer applications, content and information

services. Finally, compatibility issues may also create a need for intermediaries to solve the problem and nature of the incompatibility will influence the market conditions for these intermediaries.

While these issues are relevant across a variety of information technology industries, the mobile/cellular industry is expected to play a significant role in serving as the basis for ubiquitous computing and hence represents an interesting example. Indeed, this industry is faced with significant compatibility challenges in interconnecting technologies offered by mobile network operators, handset and network equipment manufacturers, and content and information providers, among others. In this industry, the provision of content such as ring tones, games, video clips, and information services, occurs in a highly fragmented market. The fragmentation exists horizontally, such as between competing network technologies (e.g., GSM, CDMA), as well as vertically, in technologies such as mobile device architectures, operating systems and application development platforms. In some cases, to overcome the fragmentation, and to create advantages for themselves, firms develop either proprietary or open standards aimed at resolving compatibility issues. The result is a market-based competition between technologies in which the winner becomes the de facto standard.

To date, research on standards competition has been primarily concerned with the firms involved in the competition itself (see e.g. Wegberg, 2004; Weiss & Cargill, 1992), while little is known about the broader implications of this phenomenon. In the research reported on here, we seek to address this gap through an investigation of the following questions: How do standards-competition-driven incompatibilities create opportunities for intermediation? What is the nature of the intermediation? How do the intermediaries subsequently shape the dynamics of competing standards as well as the market conditions for application developers? The answers to these questions will enable us to generate knowledge about the nature, scope and conditions for success of intermediaries that attempt to resolve technical incompatibilities, as well as the downstream effects of competing standards and intermediation on mobile application developers.

The context of the mobile application market is one where multiple application platform standards compete and a de-facto standard has not emerged. The incompatibilities have given rise to three forms of intermediation, namely cross-platform porting, interoperability testing and certification. Among these three, certification is the most extensive and formalized service offered and hence is the focus of our investigation. Our findings are based on data gathered through interviews with the top management of a leading certification intermediary and various upstream and downstream industry professionals, as well as data gathered from the trade press.

This research contributes to the nascent yet growing literature on standards and provides empirical evidence on the broader implications of standards competition, particularly on market structure. Further, this work builds on the research on intermediaries developed in the electronic commerce literature and describes the effects of asymmetric intermediation, where the intermediary is biased towards one party, in this case the buyer.

The paper is structured as follows. We begin by briefly discussing the extant literature on standardization, standards competition and intermediation. This is followed by the section describing the nature of the mobile application industry, competing application development standards, and the resulting intermediation services. We then discuss the case of certification intermediation with a focus on application certification programs and its structural implications for the mobile value chain. Finally, drawing on the case of certification intermediation we discuss the broader implications of intermediation in standards competition.

2. Standards Competition and the Role of Intermediaries

The complexity of modern technology has led to an increase in the number and variety of standards that affect a single industry or market. Standards may be created to specify processes, such as those for quality management, designs or compatibility/interfaces (Weiss & Cargill, 1992; Farrell & Saloner, 1992). In this complex environment standardization reduces technological uncertainty in a market and increases possibilities of market coordination, economies of scale and availability of compatible products (Farrell & Saloner, 1988; Funk & Methe, 2001; Tassej, 2000). However, while these benefits are greatest when a single standard emerges, technology can be standardized through several processes, which can result in multiple standards that compete for dominance. The standards competition can be a rather complex progression, which can take several years, involve multiple actors in related markets, and span multiple versions of evolving standards. As such, standards competition includes both the processes by which standards are created as well as the mechanisms by which they achieve dominance in a market, each of which is discussed below.

2.1 Standards and Standardization

Standards development occurs through two general processes – Committee-based and Market-based standardization (Farrell & Saloner, 1988). In committee-based standardization a standard is selected ex-ante by a committee and then introduced into the market. The key arguments in favor of this centralized committee-based approach are its potential for increased consensus, larger economies of scale, avoidance of future anti-trust litigations and affordable product prices (Wegberg, 2004). Conversely, in market-based standardization, competing technologies/standards are introduced into the market, which establishes a ‘de-facto’ standard ex-post through market competition. The proponents of the market-based approach point to the basic drawbacks of the centralized approach, which include the possibility of stifling innovation in an immature market, a static, inflexible outlook toward a dynamic market, a time-consuming approach, and the possibility of mandating an inferior standard/technology (Keil, 2002; Lee, O Neal, Pruet, & Thomas, 1995; Wegberg 2004b).

To balance the pros and cons of these approaches, a hybrid standardization process has emerged (Wegberg 2004b; Weiss & Cargill, 1992). In this model several standard candidates are created by semi-open standards consortia as well as possibly by individual

firms. These candidates compete in the market until a de-facto standard emerges. One example of such a hybrid competition is occurring in the mobile market, where the consortium-created operating system Symbian competes against Windows Mobile¹.

The strategy employed during a standards competition can have potentially significant implications for so-called high-tech firms (Ehrhardt 2004; Funk & Methe, 2001; Besen & Farrell, 1994; Egyedi, 2001; Shapiro & Varian, 1999; Stern, 2002), with de-facto standard ownership serving as a basis for competitive advantage (Windrum, 2004). In addition to firm-specific outcomes, standards competitions are also seen as an important step in the process of technological progression (Nelson & Winter, 1982; Utterback & Abernathy, 1975) (Anderson & Tushman, 1990; Tushman & Anderson, 1986) as well as being influenced by and having influences on the industry context (M. L. Katz & Shapiro, 1986; Weitzel, Beimborn, & Konig, 2006).

While there is a growing literature on standards, standardization and even standards competition, research on the broader implications of standards competition on an industry's structure per se has been somewhat limited (see e.g. Iversen & Tee, 2006; Katz & Safranski, 2003). In particular, the implications of standards competition in creating and shaping business opportunities of intermediation have not been investigated.

2.2 The Role of Intermediaries

Standards competition, particularly in the area of interface standards, give rise to incompatibilities. While firms that develop standards, referred to here as 'standards promulgators', maneuver to capture market share for their technology, users of that class of technology, whether it be an operating system or a video screen, must grapple with the resulting fragmentation. The resulting challenges create an opportunity for intermediation.

Intermediaries exist in a wide variety of industries from international trade to real estate and typically fulfill a variety of roles while undertaking diverse functions. Typical intermediary roles include brokers that connect buyers and suppliers, retailers, entities that transform goods, and information brokerage (Whinston et al, 1997).

These roles include a variety of functions that can be broken into roughly four categories. First, intermediaries reduce search and hence transaction costs and smooth out the transaction process. Reducing friction occurs through both aggregation and pricing efficiencies. As aggregators, intermediaries act as a warehouse for otherwise dispersed products and services. This function can be observed especially in retail and distribution markets, where instead of requiring buyers to negotiate individually with appropriate

¹Symbian-OS enjoys the largest share of the global mobile operating system market. It is jointly owned and supported by Nokia, Ericsson, Panasonic, Siemens AG, and Sony-Ericsson. Windows Mobile, Symbian-OS's chief competitor, is an operating system that looks very similar to Microsoft's desktop versions of Windows. Palm-OS is a compact operating system developed and licensed by PalmSource, Inc., which primarily targeted personal digital assistants (PDAs). Today, many Palm PDAs can be used as mobile phones; all of which support a version of Palm-OS, making it an important application development platform.

suppliers – an intermediary reduces transaction costs by aggregating demand of multiple buyers and suppliers. This aggregation helps intermediaries realize benefits of economies of scale and scope (Resnick et al., 1994; Sarkar, Butler, & Steinfield, 1998; Whinston, Stahl, & Choi, 1997). Intermediaries can also reduce transaction frictions through efficient pricing of goods. As intermediaries interface between the suppliers and buyers, they are able to mediate effective price-points for a good based on their knowledge of the goods' demand and supply (Bailey, 1998; Spulber, 1996).

Second, intermediaries also absorb risk. Risk absorption is a primary source of value for intermediaries in, for example, international trade (Perry, 1992). Thirdly, intermediaries can act as market information repositories (Whinston et al., 1997). The information can include the knowledge of supplier products, its specifications, quality, and availability; as well as the knowledge of buyer requirements, preferences and willingness to pay (Sarkar et al., 1995). With such a role the intermediaries are well positioned to provide two functions. First, they are able to act as *experts* in ensuring quality of both products and transactions (Biglaiser, 1993; Biglaiser & Friedman, 1994). Product review providers, such as the well known reviews of Consumer Reports, are examples of intermediaries performing the expert function. Second, they are able to efficiently *match buyers with appropriate suppliers* by facilitating information exchange and reducing search costs (Biglaiser, 1993; Cosimano, 1996).

Finally, intermediaries provide a mechanism for increasing market trust by monitoring and preventing opportunistic behavior by buyers and suppliers. As intermediaries typically have to participate in the market in the long-term across various transactions, intermediaries have high incentives to ensure that market transactions are completed. Intermediaries are hence seen as increasing market trust, where they act as trusted third parties that limit opportunistic behavior (Bailey & Bakos, 1997). They are able to assess suppliers, their products and sometimes buyers in guaranteeing quality market transactions (Biglaiser & Friedman, 1994).

Given these diverse functions and roles intermediaries in a standards competition are likely to provide many of these functions. Of particular importance is likely to be the functions of assessing quality and smoothing the transaction process. In the case of intermediation in interface standards, the smoothing of the transaction process is likely to include both inter-connection of the physical product as well as between the buyers and suppliers.

3. Standards Competition and Intermediation in Mobile Applications

Given the importance of the mobile industry to the future of the information society, it represents an important case in which to examine the broader implications of a standards competition. In the following sections we describe the mobile industry and some of its technologies, including application development platforms, and discuss standards competition.

While a complete depiction of the mobile industry might best be achieved using a so-called value network or ecosystem model, here for the sake of simplicity we employ a value chain metaphor (see Porter, 1985). Examining the value chain from the mobile application perspective, researchers have identified five core segments in the mobile industry (Barnes, 2002; Karvonen & Warsta, 2004). These segments include the – 1) *mobile content providers*, which create, aggregate, and distribute mobile content; 2) *mobile application developers*, which package mobile content for mobile devices; 3) *mobile platform providers*, which provide the necessary implementation tools for deploying mobile applications; 4) *mobile device manufacturers*, which provide information-processing capable mobile devices; and 5) *mobile network operators*, which fulfill a variety of roles including setup and management of the mobile network to provide access to end-users. As is the convention in value chain models, the relative position of these firms in the value chain can be described as *up* or *downstream*, with downstream firms being closer to the complete product or service. In the case of the mobile industry content providers and application developers are referred to as the *downstream* firms and the platform providers, device manufacturers, and network operators (in their role as purchasers of network equipment, handsets and applications) are referred to as the *upstream* firms.

It should be noted that, the network operators and device manufacturers often exercise their preferences over downstream players in the mobile value chain. The downstream players, on the other hand, are more diverse in their background. The *content providers*, for instance – either come from peripheral industries such as media, entertainment, and finance or are smaller content developers that operate specifically in the mobile realm developing mobile content such as ring tones and games. The content developers are often credited for value creation, with typical business models based on subscription or download revenue sharing with network operators. The other set of downstream players, the *mobile application* developers, are software development agencies that specialize in developing applications for mobile devices. Their role in the value chain is particularly interesting, as they are often the core technical facilitators of the emerging media, with strong dependence on the different segments of the mobile media value chain.

It should also be noted that here the focus is on the situation where a standard created in one segment of the value chain has implications for firms both up and down the chain. Furthermore, the standard is strictly a technical standard. This can be differentiated from the growing body of research on vertical information systems, whereby an information system that spans several layers of the value chain is standardized (see e.g. Wigand et al., 2005). In this latter case, the standardization is often intimately tied to a business process.

3.1 Mobile Application Development Platform Standards

Mobile applications are software products that are specifically designed to execute on mobile devices. Although mobile applications are similar in nature to more common forms of software products (desktop applications), the development issues for developing mobile application are quite unique due to their dependence on rapidly evolving technologies in different segments of the mobile value chain. Karvonen et al (2004), highlight this dependence of mobile applications along four technological layers - the

mobile operating system, mobile development platform, mobile devices and the mobile network (Karvonen & Warsta, 2004). Depending on the nature and functionality of an application it can interface with many standards across different layers. This interfacing is achieved by, what are commonly known as, Application Programming Interfaces or APIs. These APIs are the tools that can be used to gain access to the layer-specific features required by an application. For instance, a location-based multimedia application might require and use the mobile network's *location APIs* for mapping; the mobile device's *camera-controlling APIs* for collecting visual imagery; and the operating system's *file-system APIs* for data storage. It is important to note here that the ability to run the application will be limited by the APIs used in its development, and if a different set of APIs is required the application simply will not run. These dependencies are depicted in Figure 1.

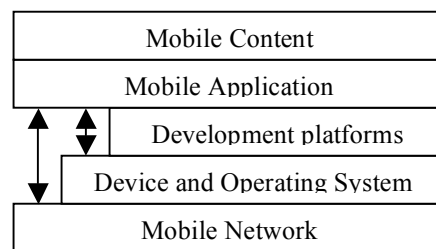


Figure 1: Layer model spanning network and content technologies

In order to circumvent the complex dependency of mobile applications across multiple layers, application development platforms were introduced. A so-called application development platform essentially packages available APIs at different layers, and provides a standardized mechanism to access various layer-specific features, such as functions of the operating system or of a mobile phone.

Software development faced similar issues in the desktop computer market. There the issue of inter-dependency was resolved through application development platforms such as Sun's Java and Macromedia's Flash. With great success in the desktop realm it is expected that such operating-system-independent development platforms will alleviate much of the mobile development issues. However, different standards of such development platforms compete in the market today - Sun's J2ME and Qualcomm's BREW are prominent examples.

Java 2 Micro Edition (J2ME) is an open standardization initiative that has evolved from its success in the desktop and server markets. Similar to the J2SE standard, J2ME is a platform that includes a 'virtual machine' that runs on top of the device operating system. In that sense J2ME applications can run on different Java enabled mobile devices. J2ME is standardized by an expert group of leading mobile device manufacturers, wireless carriers, and software vendors using the traditional Java Community Process (JCP)² of

²The Java Community Process is an open and participative process to develop and revise the Java technology specifications. The process is initiated by a Java Specification Request (JSR) submitted by a JCP member, which is reviewed by the community. Once the JSR is accepted an expert group is formed

designing publicly available specifications. On the other hand, BREW is a proprietary standardization initiative by Qualcomm that is specifically designed for the network operators. It is a development platform that runs on top of the device operating system, as well as, an application distribution mechanism that allows end users' to shop, purchase, download, and install software over the operators' network, hence providing a vertically integrated distribution control to the network operator. The process streamlines the development, deployment, and billing of applications for both developers and the network operator. (See (Qualcomm, 2005) for details).

Although, a development platform can technically integrate the functionality provided by these API packages, due to rapid device innovations, the development platforms are not able to fully integrate various devices and network specific APIs. Device manufacturers realizing this dependency provide their own flavors of integrated device-specific standards. Nokia, for instance, provides platforms like Nokia Series 40, 60, 80, and 90 that are based on the integration of Symbian-OS and Nokia device APIs. RIM's Blackberry is another example, where additional blackberry-specific APIs are integrated with the J2ME development platform.

Clearly mobile technologies are highly complex and interdependent. Attempts to mitigate these complexities, through the creation of standard application development platforms, have been thwarted by the emergence of multiple standards. While Qualcomm and Sun are busy maintaining, updating and promulgating these standards, application developers are faced with a complex technological and strategic environment. Thus, whereas standards are often associated with a reduction in uncertainty, the emergence of a standards competition can increase uncertainty. This uncertainty can present an opportunity for intermediation.

3.1. Standards, Compatibility and the Nature of Intermediation

The standards competition itself raises additional application compatibility issues, wherein the applications based on one development platform standard are not able to execute on devices and networks supporting a different development platform standard. This incompatibility has led to a fragmented market, where the distribution and use of an application is limited by the degree of the standard's acceptance by the upstream device manufacturers and network operators (See – (Tarnacha & Maitland, 2006a, 2006b)). For example, applications developed with BREW can be accessed by Verizon Wireless customers but not those of Cingular.

The complexity resulting from this situation creates issues related to access and availability (not all applications are available to all users), technical competency (developers cannot be expert on all technologies), and consequently quality assurance

through nomination, which is responsible for further specification development, and community and public reviews to finalize the specification (See the Java Community Process (SunMicrosystems, 2005) for details)

(network operators are unsure of an application's performance). To overcome these issues a variety of intermediation services have emerged.

In order to address the issues of access and availability technological solutions are available that provide developers with tools to convert or adapt their applications across standards. Such tools allow the developers to design applications using different standards creating multiple standard-specific versions of an application. This aids the developers in distributing their application to buyers accepting different standards, increasing the number of customers that might purchase the application. Examples of such tools include AppForge Crossfire³, and Tira Jump Product Suite⁴.

Technological solutions, however, may not achieve complete compatibility across standards. Intermediation in such situations can potentially provide a mechanism for better, if not complete, compatibility across standards. Various intermediaries provide what can be called 'compatibility services' in the mobile application markets. Such services functionally mimic the automated tools, but are able to assist the developer on application-specific conversion issues. Again, the result is multiple standard-specific versions of the application that can be distributed to buyers accepting specific standards. In the application development market such intermediaries are referred to as 'cross-platform porters'.

Additionally, the standard-fragmented application market creates a need for testing applications for compatibility and interoperability. Although such activities can be performed in-house by the application developers, to gain third-party objectivity they are outsourced to testing agencies/labs that specialize in conducting compatibility and interoperability testing. Such intermediaries perform application testing on devices and networks that accept the standard, thereby assuring application quality on the intended devices and networks.

In addition to intermediaries that address market fragmentation, certain intermediaries can also certify or review applications for consumers. In the mobile application markets, due to complex standard adoption by rapidly evolving mobile devices, standard providers or promulgators such as Sun, Qualcomm, Microsoft, and Symbian sponsor application certification programs. Such certification programs verify an applications adherence to the standard by testing applications. Although, such programs are sponsored by the standard promulgators, they are outsourced to third-parties that specialize in certification testing. Such intermediaries are often referred to as Authorized Testing Labs (ATLs) that function as a partner of the certification sponsor approving or rejecting applications based on a certification sponsors mandated criteria.

As a first step in understanding the role of intermediation in standards competition we specifically examined the case of certification intermediation for three key reasons. Firstly, application certification has increasingly become a norm in the fragmented mobile application market due to increasing number of interrelated standards in mobile

³ <http://www.appforge.com/products/index.html>

⁴ <http://www.tirawireless.com/jump/products.asp>

application development. Today, application developers incorporate application certification as an essential strategy in developing, testing and deploying their applications. This importance creates a ripe opportunity for examining the role of certification intermediation in standards competition. Secondly, certification intermediaries are contractually free to provide additional compatibility services such as interoperability testing and cross-platform porting. This prospect critically positions the certification intermediary for providing services to both certification sponsors and the developers. Certification intermediaries are uniquely positioned to play a unique dual-role in the mobile application value chain, where they act as a gatekeeper for the upstream certification sponsors as well as provide technical and marketing assistance to downstream suppliers of mobile applications. This allows us to conceptually understand the structural implications of certification intermediation on the evolving mobile value chain. Finally, as certification programs are formalized processes, it allows structural visibility and hence affords systematic analysis of certification intermediation.

4. The Case of Certification Intermediation

The case is informed by several onsite interviews with the top management team and certification program managers at a leading global certification intermediary in the summer of 2006. The certification intermediary is an authorized testing lab (ATL) for testing and certifying applications for many key mobile application certification programs such as the J2ME, BREW, Symbian and Windows Mobile development platforms. In addition to the interviews at the certification intermediary, the case is also informed by several open-ended interviews of mobile application developers, publishers, and application distribution technology vendors in the U.S in the fall of 2005. Further, the case is supported by secondary sources such as trade press articles and news released by various platform vendors.

The section is organized to describe the nature and process of certification in the mobile application markets. Then we discuss the need and strategic rationale for certification programs. We conclude the section with discussion on the effects of certification intermediation on the evolving mobile application value chain.

4.1 Mobile Application Certification Programs

Today, the global mobile application development market is highly fragmented due to the availability of multiple development standards. With the availability of multiple development standards, application certification has increasingly become a norm in the mobile industry. All mobile application development platform providers such as Sun (J2ME), Qualcomm (BREW), Symbian and Microsoft (Windows Mobile), sponsor certification programs. These certification programs essentially are designed to test and verify the adherence of mobile applications to a particular development standard, providing digital certificates and proprietary logos for approved applications. These certificates and logos can then be used by the application developers to deploy the certified application on various mobile devices and networks for eventual consumption. Such certification programs are critical as most network operators mandate that applications be certified prior to deployment on their networks and devices. Some of the major application platform certification programs are listed in Table 1.

Table 1: Key mobile platform certification programs and their sponsors

Certification Program	Platform	Certification Sponsor
Java Verified ⁵	J2ME	Sun Microsystems Inc.
True BREW ⁶	BREW	QUALCOMM
Symbian Signed ⁷	Symbian-OS	Symbian Partners: Nokia, Sony-Ericsson, Siemens, Panasonic, and Ericsson
Designed for Windows Mobile Logo Program ⁸ with Mobile2Market ⁹	Windows Mobile	Microsoft Corp.
PalmSource Compatibility Program, and Palm OS® Business Solutions Program ¹⁰	Palm-OS	Palm Source Inc.

Application certification, as a strategy in the mobile industry, is not limited to application platform providers. Various device manufacturers sponsor certification programs that partially or completely adopt certification criteria from platform providers. Motorola, for instance, sponsors separate certification programs for testing J2ME applications¹¹ (Mahmoud, 2002) and Windows Mobile applications¹² (Motorola, 2006). Further, various network operators also sponsor customized certification programs that partially or completely adopt platform certification criteria to ensure proper application behavior on their networks. Examples of such programs include Cingular Certified Solution¹³, Virgin Mobile¹⁴, and Vodafone Live¹⁵, to name a few.

4.2 Application Certification Process

Although certification sponsors are diverse in their background, the basic process of certification programs is quite similar. The certification process typically entails the following steps –

1. *Developer Registration and Contractual Agreements:* The developer registers with the certification program, signing contracts with the certification sponsor on the legal and technical scope of the certification program.
2. *Application Submission:* Applications are then submitted to an online submission portal.
3. *Authorized Certification Testing:* The developer can either choose an authorized testing lab or is assigned an authorized testing lab by the certification sponsor.

⁵ See <http://javaverified.com/>

⁶ See http://brew.qualcomm.com/brew/en/developer/resources/bd/ext_test.html

⁷ See <https://www.symbiansigned.com/app/page>

⁸ See <http://www.microsoft.com/windowsmobile/downloads/designedfor.msp>

⁹ See <http://msdn.microsoft.com/mobility/windowsmobile/partners/mobile2market/>

¹⁰ See <http://www.palmos.com/dev/programs/palmpowered/> and

http://www.palmsource.com/press/2003/061803_BuSol.html

¹¹ Quality Partners (Authorized Testing Lab): <http://www.qpqa.com/motorola/iden/>, Accessed 1st Aug 06

¹² NSTL Inc (Authorized Testing Lab): <https://www.nstl.com/motorola/gui/default.asp>, Accessed 1st Aug

06

¹³ <http://developer.cingular.com/developer/testing/index.jsp?itemId=400025>

¹⁴ www.nstl.com/about_nstl/press_docs/virginmobile.pdf

¹⁵ <http://www.via.vodafone.com/vodafone/via/displayContent.do?contentId=2671&navId=5631>

4. *Application Testing*: The application goes through a testing process based on the certification sponsors developed test plan. In some cases this is preceded by an automated “pre-test” that ensures adherence to basic guidelines.
5. *Application Signing*: Applications that pass the testing process are forwarded to a “certificate/signing authority” (examples include Verisign and GeoTrust), which digitally sign the application with a unique application certificate. The application developer can then use the certification logo for marketing and distributing the application. The signing ensures that the application adheres to the program requirements and that it has not been tampered with since the signing process.

In addition, almost all certification programs provide a marketing mechanism for distributing certified applications. Once an application goes through the certification process and is approved for logo usage, certification programs provide a means to promote signed applications. This marketing support is provided by the certification sponsors by publishing the certified application on an online catalog that is accessible to various application publishers and network operators. An example of such an online catalog is the Microsoft’s Mobile2Market program that catalogs the Windows Mobile certified applications¹⁶. In addition, the certified applications are widely accepted and certification is often a pre-requisite to deploy the application on a network operator’s portal for eventual end-user sale and consumption. This provides a form of indirect marketing support for the certified applications. Vodafone, for instance, mandates Java Verified application certification for deployment and sale to their subscribers¹⁵. Verizon Wireless, on the other hand, mandates True BREW certification for selling an application to their subscribers¹⁷.

4.3 The Rationale for Application Certification

Essentially, application certification is a business framework for approving and distributing applications. However, application certification has become increasingly prevalent in the mobile industry due to the technical context in which the applications are developed and distributed. Three reasons for the need of application certification are often cited by standard providers, network operators and device manufacturers – 1. the criticality of application security; 2. the need for technical integration; and 3. managing rapid technological evolution.

1) *Application Security*: One of the most common reasons cited by certification program sponsors is the need for application security. Conscious of the security issues raised by Viruses, Trojans and Spam in the desktop realm, various standard providers, device manufacturers and network operators strongly support certification to manage such threats in the mobile realm. Application certification provides a framework for guaranteeing application security and controlling security threats.

2) *Technical Integration*: Another reason for the prevalence of application certification is that application development on a platform does not forbid a developer to use APIs that are not explicitly provided by the platform. The developer can choose to do so in order to gain access to certain features (device or network specific) that the platform

¹⁶ Mobile2Market Launch: <http://www.microsoft.com/presspass/press/2002/apr02/04-17mobileapppr.mspx>

¹⁷ Verizon Wireless and True BREW Certification:
<http://www.vzwdevelopers.com/aims/public/BrewLanding.jsp>

APIs do not provide. This leads to loose definition of a “platform-based application”. Certification here provides the necessary integrating force for defining the standard.

3) *Rapid Platform Evolution*: Development platform standards are continually evolving due to rapid technological advances at various layers of the mobile industry. This “catching-up” of development platforms, continually creates newer versions to facilitate application development on new features. Upstream supporters and adopters of the platform selectively implement the newer versions, creating fragmentation within a platform. Device manufacturers, for instance, provide devices that implement different version of the supported development platform. From the developer’s viewpoint, this makes mapping a development platform version to the available devices an exigent task. Certification here affords a version control mechanism, whereby certification programs provide the mapping information, encouraging systematic adoption of a singular development platform as opposed to haphazard use of a particular platform version.

4.4 Certification Intermediation and its Structural Effects

This increasing significance of application certification has not only altered the way development standards compete, but has also influenced the mobile application market structure. One of the more visible effects on market structure has come in the form of certification intermediation, where certification intermediaries provide what has become an essential service.

The need for certification intermediation is partly shaped by the administrative and technical competencies required to manage a certification program. As managing a certification program typically entails interfacing with a multitude of developers, the certification sponsors either offshore management of the entire certification program or the application testing components to intermediaries that have the necessary testing infrastructure and expertise. This infrastructure includes possessing and understanding the operation of hundreds of mobile devices as well as maintaining service contracts with multiple network operators via numerous service plans. A certification sponsor can authorize multiple testing labs to distribute the certification workload - in the mobile application industry this number ranges from one to five.

Globally there are less than ten such authorized certification labs that certify mobile applications for various certification sponsors. Although, only a handful, these certification intermediaries are critically positioned in mobile value chain for the provision of mobile applications. They facilitate the provision of mobile applications by acting as agents for both the upstream as well as downstream actors.

On one hand, they act as trusted agents of upstream actors such as network operators, device manufacturers and standard providers, who typically enjoy higher bargaining power in the value chain. As trusted agents of upstream actors they provide two basic functions. First, they perform a ‘gate-keeping’ function against potentially insecure applications that might disrupt a network or cause a handset to malfunction. This ensures the upstream actors that they can safely introduce innovative applications to end-users to drive-up their revenues. Second, as they interface with downstream players directly they are in a position to relay downstream market information such as certification submission

trends and issues to the certification sponsors. This information is often global in nature and allows the certification sponsors to identify technical and regional concerns that can be systematically addressed to control the supply of applications.

On the other hand, certification intermediaries can assist the downstream actors along two essential dimensions. First, they are able to act as information repositories for various certification requirements and processes. As certifications are increasingly becoming critical in marketing and deployment of applications on various handsets and networks, this information is particularly important in reducing time-to-market for application development and distribution. Certification intermediaries are also positioned to provide consulting services to downstream actors that can speed up global deployment of content and applications for eventual end-user consumption. Second, certification intermediaries are in a prime position to reduce uncertainty created due to rapid technological advances in mobile devices. Newer device models with additional features are introduced in the market on a regular basis. Although the devices are typically backwards compatible, an application might not behave as expected on newer devices for various reasons. This situation is exacerbated requirements that applications be tested on mobile devices that have not been released in the commercial domain (also referred to as pre-commercial handsets). A certification intermediary is provided with such pre-commercial handsets, which creates an opportunity for the certification intermediary to provide application developers with testing services on such devices.

To sum up, certification intermediaries due to their critical position in the mobile value chain have important implications for the evolving industry structure and the supply of mobile applications. They perform the traditional role of intermediaries as well as provide additional functions in the mobile value chain.

5. Discussion

In a market with competing standards where a de-facto standard has not emerged, intermediation can come in various forms. It can be driven, on one hand, by the need to resolve standard incompatibilities, while on the other, by the need to differentiate one standard from another. Certification intermediation is an example of the latter, where intermediaries as trusted third-parties assist standard providers in promoting their standards. As discussed above, such intermediaries are also well positioned to provide compatibility services. Hence, we draw from the case of certification intermediation in the mobile application market to elaborate the nature and roles of intermediaries in standards competition.

The literature on the role of intermediaries in a market informs us of the functions of intermediaries. Although the functions are more appropriate in explaining the role of intermediaries such as distributors, retailers, and brokers, they can also be used to explain the role of intermediaries in standards competition. For instance, certification intermediaries, with competencies in certification testing can reduce transaction costs by managing more than one certification program, thereby providing aggregation benefits for developers desiring multiple certifications. Further, as discussed above, they can also act as information repositories, where they can provide information on standard

requirements and best practices for developing quality applications, as well as, match consistent quality suppliers with upstream buyers.

Certification intermediation is a common occurrence in many markets, where independent experts, such as Consumers' Reports, provide product evaluations, which can be considered a form of certification intermediation. These certification intermediaries leverage their expertise to test and rate products by suppliers along multiple dimensions and provide independent reports to buyers. In doing so, they aid both the suppliers and buyers by matching buyers with appropriate suppliers and their products (Biglaiser, 1993; Cosimano, 1996). The literature on intermediation provides a symmetric description of this relationship, where both buyers and suppliers benefit almost equally from such certification intermediation (See Figure 2).

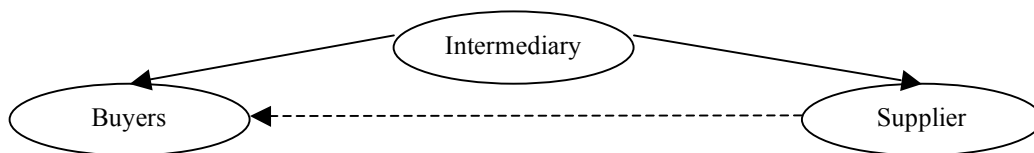


Figure 2: Symmetric Certification Intermediary

Note: Arrows represent value flow

However, based on the case of certification intermediation in the mobile applications market, two distinct issues stand out in such a depiction. First, buyers of applications are network operators who have higher bargaining power due to their control of the assets that are required for application distribution (the cellular network). This leads to a power asymmetry in the value chain altering the role of certification intermediaries. Certification intermediaries in such a situation position themselves closer to the powerful buyers and often certify supplier products based on mandated buyer requirements. The value provided by the certification intermediary then is asymmetric towards the more powerful buyers.

Second, as multiple development standards compete in the mobile applications market, an additional entity that influences the nature of certification intermediation – the standard providers or promulgators – is created. Such promulgators for reasons discussed in the sections above, provide certification programs that are highly critical for suppliers as buyers often mandate such certifications. Standards promulgators and their hired certification intermediaries' then act as agents for the power buyers, providing asymmetric value to the buyers. Figure 3, highlights the difference in the value intermediation provides to buyers and suppliers.

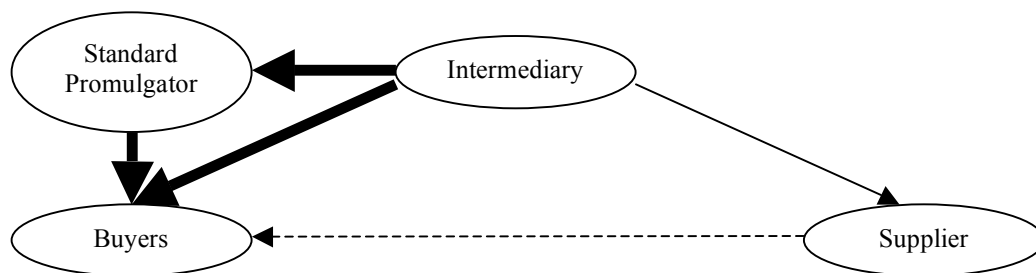


Figure 3: Role of a Certification Intermediary in Standards Competition with Power Asymmetries
Note: Arrows depict value flow and thicker arrows depict greater value

By virtue of such power asymmetry, certification intermediaries act as agents of buyers and standard promulgators in their attempts to orchestrate the mobile ecosystem. Despite this inequity, suppliers still draw value from certification intermediaries by benefiting from certification program aggregation and consulting services that – a) provide information about standard certification aiding fast and quality deployment; and b) reduce product deployment uncertainties when standards are complex and evolve rapidly.

In summary, we have found that standards-competition-driven incompatibilities create opportunities for intermediation by creating a need for porting, compatibility testing and certification and that demand for these services are infrequently met by standards promulgators or network operators. In the case of certification, the intermediary provides asymmetric value in its alliance with the standards promulgators and buyers, yet still provide some value to suppliers.

The asymmetric distribution of value by certification intermediaries, derived from the market power of the buyers, points to the need for greater market-level rather than transaction-level assessments of the roles of intermediaries. In this research certification intermediaries have been shown to provide both traditional intermediary functions such as aggregation, quality assurance and buyer/seller matching, as well as those related to the market (rather than the transaction) such as ecosystem orchestration and uncertainty reduction. These observations are summarized in Table 2.

Table 2: Functions of Certification Intermediaries in Standards Competition

Observed traditional intermediary functions	Evident additional intermediary functions
1. Aggregation benefits	1. Uncertainty Reduction
2. Information Repositories	2. Value Ecosystem Orchestration
• Quality Experts	
• Buyer Seller Matching	

We might also consider the subsequent effects of these intermediaries on the standards competition as well as the application developers. In regards to both our analysis is tentative and largely inconclusive. While the intermediaries certainly make a complicated situation somewhat less so, and in this way provide value to the application developers, their services are not free and thereby add to the cost of the application development. However, it is possible that without the intermediaries the costs of navigating the complex standards might be even higher. Similarly, it is difficult to come to definite

conclusions about the effects of intermediation on the standards competition. By being familiar with multiple standards the intermediaries may be in a position to steer developers toward one platform or another and in this way influence the competition and perhaps bring it more quickly to an end. Conversely, by providing expertise in multiple standards and helping overcome complexity the standards competition may be prolonged by the presence of the intermediary. Therefore we leave these questions unanswered and will be the subject of future investigations.

6. Conclusion

Visions for ubiquitous computing and mobile commerce assume a pervasive infrastructure of networks, operating systems and applications that inter-operate in a fluid manner. Such a scenario will require years of both technical and industry evolution to be achieved. In this research we have illuminated one area in which this work has begun, in particular a standards competition that is currently under way between several mobile application development platforms.

By investigating the broader implications of this standards development, namely the resulting demand for intermediation services, we have contributed to a developing standards literature and filled an important gap. While the extent standards literature identifies firm, technology and industry-level consequences of standards competitions, the level of the value chain was left untouched. The findings of the research reported here indicate that standards competitions have significant implications for the value chain, inserting intermediaries that interact with a variety of firms in different positions on the value chain as well as serving as repositories for vast amounts of technical knowledge.

This research, being exploratory in nature, inherently raises more questions than it answers. Future research might attempt to model the influence of these intermediaries on the standards competition to assess whether they serve to extend or shorten the life of such competitions and their strategic implications for the buyers and standards promulgators that they serve. Models might also be developed to improve understanding of the role of certification intermediaries across a range of software development activities to assess the generalizability of their benefits.

References

- Anderson, P., & Tushman, M. L. (1990). Technological Discontinuities and Dominant Designs: A Cyclical Model of Technological Change. *Administrative Science Quarterly*, 35(4), 604.
- Bailey, J. P. (1998). *Intermediation and Electronic Markets: Aggregation and Pricing in Internet Commerce*. Unpublished PhD Dissertation, Massachusetts Institute of Technology.
- Bailey, J. P., & Bakos, Y. (1997). An Exploratory Study of the Emerging Role of Electronic Intermediaries. *International Journal of Electronic Commerce*, 1(3), 7-20.
- Barnes, S. J. (2002). The mobile commerce value chain: Analysis and future developments. *International Journal of Information Management*, 22(2).

- Besen, S. M., & Farrell, J. (1994). Choosing how to compete: Strategies and tactics in standardization. *The Journal of Economic Perspectives*, 8(2), 117.
- Biglaiser, G. (1993). Middlemen as Experts. *RAND Journal of Economics*, 24(2), 212-223.
- Biglaiser, G., & Friedman, J. W. (1994). Middlemen as Guarantors of Quality. *International Journal of Industrial Organization*, 12, 509-531.
- Chandrasiri, P. (2005). *Application Certification - Prevention is Better Than Cure!*, from Java Conference' 05, http://it.sun.com/eventi/jc05/pdf/03_Chandrasiri.pdf
- Cosimano, T. F. (1996). Intermediation. *Economica*, 63(249), 131-143.
- Egyedi, T. M. (2001). Strategies for de facto compatibility: Standardization, proprietary and open source approaches to Java. *Knowledge, Technology, and Policy*, 14(2), 113-128.
- Ehrhardt, M. (2004). Network effects; standardisation and competitive strategy: how companies influence the emergence of dominant designs. *International Journal of Technology Management*, 27(2,3), 272.
- Farrell, J., & Saloner, G. (1988). Coordination Through Committees and Markets. *The Rand Journal of Economics*, 19(2), 235.
- Farrell, J., & Saloner, G. (1992). Converters, Compatibility, and the Control of Interfaces. *Journal of Industrial Economics*, 40(1), 9-35.
- Funk, J. L., & Methe, D. T. (2001). Market- and committee-based mechanisms in the creation and diffusion of global industry standards: The case of mobile communication. *Research Policy*, 30(4), 589.
- Iversen, E. J., & Tee, R. (2006). Standards dynamics and industrial organization in the mobile telecom sector. *Info : the Journal of Policy, Regulation and Strategy for Telecommunications, Information and Media*, 8(4).
- Karvonen, J., & Warsta, J. (2004). *Mobile multimedia services development: value chain perspective*. Paper presented at the Proceedings of the 3rd international conference on Mobile and ubiquitous multimedia MUM '04.
- Katz, J. A., & Safranski, S. (2003). Standardization in the midst of innovation: Structural implications of the Internet for SMEs. *Futures*, 35(4), 323.
- Katz, M. L., & Shapiro, C. (1986). Technology Adoption in the Presence of Network Externalities. *The Journal of Political Economy*, 94(4), 822-841.
- Keil, T. (2002). De-facto standardization through alliances--Lessons from Bluetooth. *Telecommunications Policy*, 26(3), 205-213.
- Lee, J.-R., O Neal, D. E., Pruett, M. W., & Thomas, H. (1995). Planning for dominance: A strategic perspective on the emergence of a dominant design. *R & D Management*, 25(1), 3.
- Mahmoud, Q. H. (2002). *Testing Wireless Java Applications*. Retrieved 1st August, 2006, from <http://developers.sun.com/techttopics/mobility/midp/articles/test/>
- Motorola. (2006). *Motorola Q Developer Guide*. Retrieved 1st August, 2006, from <http://developer.motorola.com/?path=1.2.7.37.497>
- Nelson, R. R., & Winter, S. G. (1982). *An Evolutionary Theory of Economic Change*. Cambridge, MA: Belknap Press.
- Porter, M. E. (1985). *Competitive Advantage: Creating and Sustaining Superior Performance*. New York: The Free Press.

- Qualcomm. (2005). Brew Step-by-Step Guide: http://brew.qualcomm.com/brew/en/developer/resources/ad/step_by_step.html.
- Resnick, P., Zeckhauser, R., & Avery, C. (1994). *Roles for Electronic Brokers*. Paper presented at the Telecommunications Policy Research Conference.
- Rubinstein, A., & Wolinsky, A. (1987). Middlemen. *The Quarterly Journal of Economics*, 102(3), 581-594.
- Rülke, A., Iyer, A., & Chiasson, G. (2003). The ecology of mobile commerce: charting a course for success using value chain analysis. In B. E. M. T. J. Strader (Ed.), *Mobile Commerce: Technology, Theory and Applications* (pp. 122-144). Hershey, PA.: Idea Group Publishing.
- Sarkar, M. B., Butler, B., & Steinfield, C. (1995). Intermediaries and Cybermediaries: A Continuing Role for Mediating Players in the Electronic Marketplace. *Journal of Computer Mediated Communication*, 1(3).
- Sarkar, M. B., Butler, B., & Steinfield, C. (1998). Cybermediaries in Electronic Marketplace: Towards Theory Building - The Transaction Cost Approach. *Journal of Business Research*, 41(3), 215-221.
- Shapiro, C., & Varian, H. R. (1999). The Art of Standards Wars. *California Management Review*, 41(2).
- Spulber, D. F. (1996). Market Microstructure and Intermediation. *Journal of Economic Perspectives*, 10(3), 135-152.
- Stern, R. H. (2002). Standardization and competitive advantage. *IEEE Micro*, 22(6), 4.
- Sun Microsystems. (2005). Java Community Process: <http://jcp.org/en/home/index>.
- Tarnacha, A., & Maitland, C. F. (forthcoming). The effects of standards competition on market entry: The case of the mobile application markets. In *The Standards Edge: Unifier or Divider? : The Bolin Group*.
- Tarnacha, A., & Maitland, C. F. (2006). *Entrepreneurship in Mobile Application Development*. Paper presented at the Eighth International Conference on Electronic Commerce, Fredericton, New Brunswick, Canada, August 14-16, 2006.
- Tassey, G. (2000). Standardization in technology-based markets. *Research Policy*, 29(4-5), 587-602.
- Tushman, M. L., & Anderson, P. (1986). Technological Discontinuities and Organizational Environments. *Administrative Science Quarterly*, 31(3), 439.
- Utterback, J. M., & Abernathy, W. J. (1975). A dynamic model of process and product innovation. *Omega*, 33, 639-656.
- Wareham, J., Rai, A., & Pickering, G. (2005). Standardization in Vertical Industries: An Institutional Analysis of XML-Based Standards Infusion in Electricity Markets. *Electronic Markets*, 15(4), 323.
- Wegberg, M. v. (2004). Standardization Process of Systems Technologies: Creating a Balance between Competition and Cooperation. *Technology Analysis & Strategic Management*, 16(4), 457.
- Weiss, M., & Cargill, C. (1992). Consortia in the Standards Development Process. *Journal of the American Society for Information Science*, 43(8), 559-565.
- Weitzel, T., Beimborn, D., & Konig, W. (2006). A Unified Economic Model of Standard Diffusion: The Impact of Standardization Cost, Network Effects and Network Topology. *MIS Quarterly*, 30, 489.

- Whinston, A. B., Stahl, D. O., & Choi, S.-Y. (1997). *The Economics of Electronic Commerce*: MacMillan Publishing Company.
- Williamson, O. (1975). *Markets and Hierarchies: Analysis and Antitrust Implications*. New York: Free Press.
- Windrum, P. (2004). Leveraging technological externalities in complex technologies: Microsoft's exploitation of standards in the browser wars. *Research Policy*, 33(3), 385.
- Yavas, A. (1992). Marketmakers versus Matchmakers. *Journal of Financial Intermediation*, 2(1), 33-58.