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The emerging value network in the mobile phone industry: The case of Japan and its implications for the rest of the world

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ABSTRACT

This paper considers how the mobile phone industry is changing from a value chain to a value network using the Japanese market as an example. Value networks involve a larger number of firms, a more complex set of relationships between them, and agreements on a greater number of interface standards than do value chains. Building from this concept of a value network, the paper shows how: (1) agreements on many of these interface standards are enabling connections to be made between the mobile phone and other industries; (2) the resulting products and services often reflect the technological capability of phones and the existing products and services in these "other" industries; (3) each new interface standard requires a new critical mass of users; and (4) a critical mass of users for a new interface standard partly builds from previously created critical masses of users. On a practical level, this paper's analysis adds to a growing list of evidence that the growth in Western mobile Internet markets is nowhere near its potential and that the change from a value chain to a value network requires a different form of standard setting, policy making, and management than are currently used in the mobile phone industry.

1. Introduction

Many scholars have differentiated between value chains and value networks in their descriptions of industry structure. Value chains represent industries in terms of sequences of value-adding activities. They are particularly appropriate for representing manufacturing industries in which the transformation of physical materials through a sequence of manufacturing processes is the critical feature of these industries and the major source of competitive advantage for many of the firms in these industries (Porter, 1980, 1985). On the other hand, the concept of a value network is more appropriate for industries in which a firm's internal processes are less important than the multiple ways in which firms and customers are connected to each other. Such industries include banking, insurance, advertising (Normann & Ramirez, 1994; Weiner, Nohria, Hickman, & Smite, 1997), and of course the Internet (Afuah & Tucci, 2002).

This paper considers how the mobile phone industry is changing from a value chain to a value network. As shown in Fig. 1 and described in great deal elsewhere (Funk, 2002; Funk & Methe, 2001; King & West, 2002; Lehenkari & Miettinen, 2002; Lyytinen & Fomin, 2002; Steinbock, 2003), the establishment of analog and digital air-interface standards such as GSM and CDMA enabled two semi-independent value chains for phones and operators to emerge in the 1990s at the global level. However, the introduction of and expected growth in the mobile Internet has caused a number of scholars to describe how the mobile phone industry can be better represented by a value network than a value chain (Li & Whalley, 2002;

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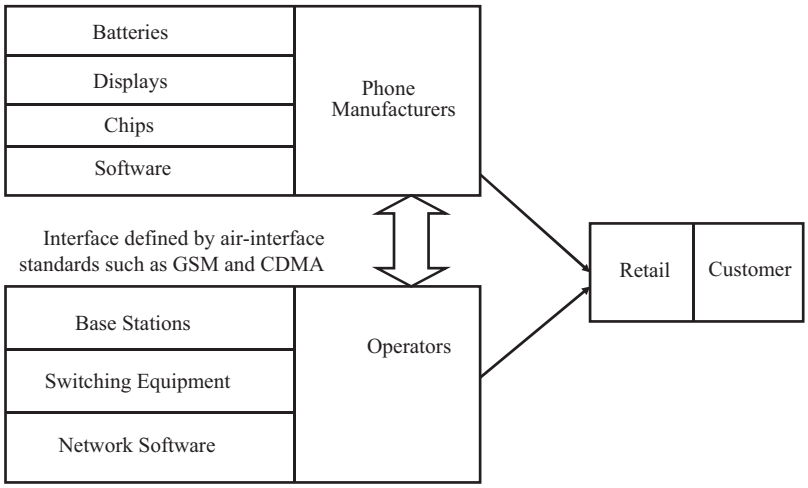

Fig. 1. The "old" value chain for the mobile phone industry. Source: adapted from (Steinbock, 2003; Peppard & Rylander, 2006).

Peppard & Rylander, 2006; Tilson & Lyytinen, 2006). As summarized in Fig. 2, music, animation, video, and game firms are already important parts of the mobile phone industry in most countries and in Japan, the number and diversity of firms are even larger and include publishers, retail outlets, restaurants, transportation, and travel-related companies, broadcasters, other general Internet sites, and any kind of firm that uses the Internet to manage internal operations (Funk, 2007a).

Although the main purpose of this paper is not to explain why growth has occurred more in Japan than elsewhere, the analysis contained within it is consistent with those that attribute Japan's faster growth to its greater use of e-mail, revenue sharing with content providers, and agreements on standards than in the West (Fransman, 2002; Funk, 2004, 2007a; Haas, 2006; Knutsen & Lyytinen, 2005). All of the Japanese operators had made e-mail a standard function on phones by early 2000 (Funk, 2001), they take a portion of mobile commerce revenues only when they collect these revenues for third parties and even then only keep about 10% of these revenues (Funk, 2007a), and they have almost always dictated phone specifications to the phone manufacturers (Funk, 2003), and they now dictate most interface standards to them (Fransman, 2002; Funk, 2007a). The setting of interface standards by Japanese operators is quite different from the decentralized and relatively uncoordinated approach used by Western firms, where more than 1000 relatively independent standard setting committees exist (Tilson & Lyytinen, 2006).

Using the Japanese market as an example, this paper focuses on how: (1) agreements on many interface standards are enabling connections to be made between the mobile phone and other industries; (2) the resulting products and services often reflect the technological capability of phones and the existing products and services in these "other" industries; (3) each new interface standard requires a new critical mass of users; and (4) a critical mass of users for new interface standards often builds from previously created critical masses of users. Agreements on some interface standards enable basic data connections between phones, operators, and content, while other interface standards connect the mobile phone with specific industries. For example, standards for packet, micro-payment (i.e., billing), user authorization, messaging, text-based content, and electronic mail services enable basic data connections between the operators and phones shown in Fig. 1 (Burkhardt, Henn, Hepper, Rintdorff, & Schack, 2002; Natsuno, 2003; Sharma & Nakamura, 2004; Tilson & Lyytinen, 2006), where Fig. 1 can be placed at the center of the value network in Fig. 2 for the mobile phone industry. On the other hand, standards for music, images, video, Java, 3D content rendering, 2D bar codes, short-range wireless techniques, global positioning satellite (GPS), and physical payments have enabled connections between the mobile phone and other industries that surround the mobile phone industry in Fig. 2.

The paper first discusses some key concepts and the research methodology followed by a discussion of how a value network involving the industries in Fig. 2 has emerged in Japan. The industries shown in Fig. 2 were chosen because the connections between each of them and the mobile phone industry have resulted in a value network and these industries are often emphasized in discussions of the mobile Internet in the Japanese press. The paper concludes with a discussion of theoretical and practical issues. With respect to practical issues, this paper's analysis adds to a growing list of evidence (Henten et al., 2004; Funk, 2007a; Haas, 2006; Knutsen & Lyytinen, 2005) that the growth in Western mobile Internet markets is nowhere near their potential and that the change from a value chain to a value network requires a different form of standard setting, policy making, and management than is currently used in the mobile phone industry.

2. Key concepts

It is widely recognized that technological progress can be represented in terms of a cyclical model of technological change (Anderson & Tushman, 1990). Following technological discontinuity, there is competition between alternative

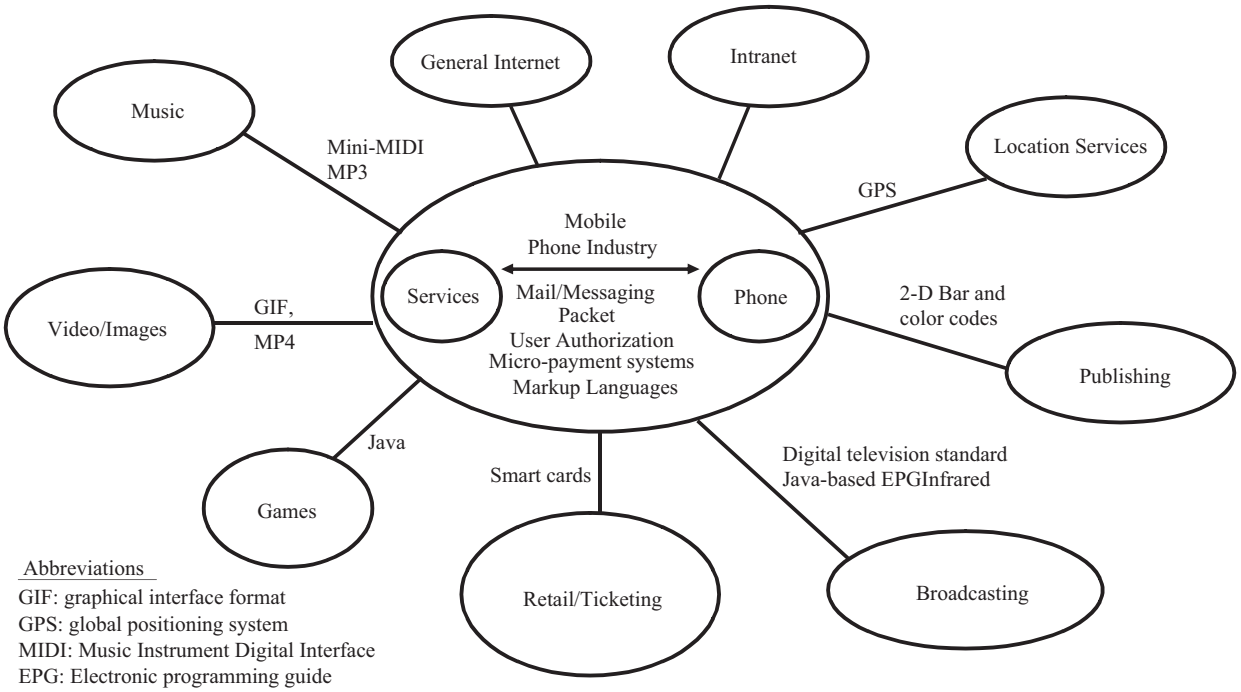

Fig. 2. The emerging value network for the mobile phone industry and some of the interface standards that support the value network.

designs from which a so-called "dominant design" emerges, which is followed by incremental change. The concept of a dominant design plays a particularly important role in network industries (Tushman & Rosenkopf, 1992) in which one or multiple interface standards form the basis of a stable architecture in such an industry (Murmann & Frenken, 2006; Suarez & Utterback, 1995).

For example, the definition of the Wintel standard for personal computers (PCs) occurred well after the first PC was introduced in 1975 (Langlois, 1992) and the definition of the TC/IP and HTML standards occurred long after research on the Internet was started in the late 1960s (Abbate, 1999; Segaller, 1998). The Wintel standard (initially called the IBM PC) emerged from competition between different types of operating systems, microprocessors, and computer architectures in the 1970s (Langlois, 1992). TC/IP also emerged from competition between different standards of which the winning standard was developed by a small group of independent researchers that was funded by the Defense Research Projects Agency (DARPA). Although there were alternative designs, the development of HTML is typically described in terms of one person, Tim Berners-Lee. It was only after the emergence of these basic standards that a decentralized process emerged for setting standards in the 1990s that to a large extent have built new standards on top of the TC/IP and HTML standards (Abbate, 1999; Segaller, 1998), and thus benefited from the existing value network of firms and users.

The concept of a value network is particularly relevant to network industries such as the PC and Internet. Unlike value chains that connect multiple activities both within and between firms (Porter, 1980, 1985), value networks connect multiple buyers and sellers at a single node (Normann & Ramirez, 1994; Weiner et al., 1997). Such a node can be part of a value chain or a larger value network. For example, it is not only that the Internet can be described as one large value network; many individual firms within the Internet are defined as networks of buyers and sellers and thus they can be represented rather more accurately as value networks than value chains. Such firms must often interact with a broad range of buyers, sellers, and providers of complementary products through multiple platforms (Evans, Hagiu, & Schmalensee, 2006). Many Internet sites including portals, search engines, auctions, employment sites, online traders, real-estate sites, and even Amazon.com due to its large alliance program (Afuah & Tucci, 2002) offer such multiple platforms (Evans et al., 2006) and can be considered value networks.

The structure of firm networks is of great interest to scholars. Existing research on firm networks suggests that firm network structure arises from both the "inherent characteristics of the technologies that populate an industry" and institutional factors (Kogut, 2000). Interface standards and the relationships between them can be thought of as the "inherent characteristics of the technologies" that populate the mobile phone industry. Institutional factors that are relevant to this paper are the differences in standard setting approaches between Japan and the rest of the world and in particular the way in which Japanese operators have set the specifications (Funk, 2003), and more recently the interface standards for phones (Fransman, 2002; Funk, 2007a; Haas, 2006; Tilson & Lyytinen, 2006).

An important part of firm network structure is the rules that govern participation in the network (Kogut, 2000). In eras of intense technical change there may be a rapid evolution in these rules and thus the structure of firm networks. Some

firms will fill structural holes (Burt, 1997) between firms and thus obtain "Burt rents" from these non-redundant ties (Kogut, 2000). Other firms will accrue "Coleman rents" through their membership in an exclusive group of firms, where trust and repeated exchange matter (Coleman, 1990).

Another difference between value networks and value chains is the greater existence of network externalities and thus the greater need to create a critical mass of users in value networks. Products for which their value is a function of the number of users are said to exhibit network externalities (Arthur, 1994; Katz & Shapiro, 1985, 1994). The existence of these network externalities can require a critical mass of users to exist before growth will occur. Products for which a critical mass of consumers *never* emerged include the picture phone, AM stereo, digital compact cassettes, and digital audio tape (Grindley, 1995; Rohlfs, 2001; Shapiro & Varian, 1999). More recently the slow growth in mobile browsing outside Japan and Korea suggests that a critical mass of users and sites formatted for the mobile phone has not yet fully emerged in the West (Funk, 2007a).

Creating a critical mass of users can be problematic. It is not just the number of users that constitute a critical mass; it is the relationships between the users that determine whether a critical mass of them has been created. A critical mass of users must define a community of users either in a physical or virtual sense (Rohlfs, 2001). In the early stages of the mobile Internet, a virtual community of ringing tone, screen saver, and game users was needed to support value networks of compatible content, phones, and operator services (Funk, 2007a). In the main body of this paper similar arguments are made for connections between the mobile phone and other industries shown in Fig. 2.

Creating a critical mass of users also requires firms to focus on the right set of market needs and product attributes, which they often not do (Christensen, 1997; von Hippel, 1983). For example, creating interface standards for ringing tones, screen savers, and games required firms to recognize that such needs exist and that such needs could be met with the phone technology available in the late 1990s. This paper's description of an interaction between these needs and product attributes for each of the industry connections shown in Fig. 2 is consistent with a basic interaction between markets and products (Clark, 1985; Murmann & Frenken, 2006; Tushman & Anderson, 1986). The early user needs for each connection in Fig. 2 reflect a combination of the basic needs of mobile phone users and those of the users in the industry being connected to the phone industry. Product attributes include those of phones, operator services, and content all of which must be compatible with the interface standards that connect them.

3. Research methodology

Between 2000 and 2005, the author gathered data and tested and revised theories on the emergence of a value network in the mobile phone industry numerous times using the case study approach (Eisenhardt, 1989). The initial research focused on successful content and applications and the reasons for their success. Beginning in 2002, the author began investigating the technologies and interface standards that are required for new content and applications where those listed in Table 1 began to emerge from the interviews and published data. The author applied the concepts of critical mass, the interaction between markets and products, and value networks to the emergence and evolution of these interface standards.

The author relied on both published information and interviews. Published information was found in both English and Japanese (in particular the Nihon Keizai Shinbun) language newspapers, industry journals, and consulting reports. Between 2000 and 2005, the author interviewed more than 150 participants in the Japanese mobile Internet and somewhat smaller numbers of representatives from foreign companies. Multiple interviews were conducted with managers in more than ten operators, ten phone manufacturers, ten firms that used mobile Intranet systems as an internal productivity tool, 30 technology suppliers, and 100 content providers. A broad definition of content providers is used where it includes retailers, broadcasters, ticket providers, and train companies in addition to the traditional providers of information and entertainment. The research reported in this paper represents only a small part of the data collected in the Japanese interviews. The interviewees asked not to be quoted.

4. Results: entertainment

Entertainment content such as screen savers and ringing tones played key roles in the creation of the first critical mass of mobile Internet users (Fransman, 2002; Funk, 2007a; Haas, 2006), and in the emergence of the initial value network of operators, phone manufacturers, and content and technology providers in Japan in 1999/2000. Beginning with NTT DoCoMo, Japanese operators defined and upgraded the interface standards for screen savers and ringing tones many times. Phones capable of transforming a downloaded graphical interface format (GIF)—compatible picture into a screen saver were available by the spring of 1999 and those capable of downloading ringing tones using a compressed form of the MIDI musical instrument digital interface (MIDI) protocol were available by late 1999 (Takeishi & Lee, 2006). Improvements in chips and displays caused members of the emerging value network for screen savers and ringing tones to continuously modify these interface standards largely through the direction of the operators. These interface standards for screen savers and ringing tones also depended on the existence of more basic interface standards such as packet, micro-payment (i.e., billing), and user authorization that enabled basic data connections between phones and operators (shown in the middle of Fig. 2). Users were charged for these screen savers and ringing tone services in their phone bills from the operators where the operators passed on about 90% of the content fees to the content providers (Funk, 2007a, 2007b; Haas, 2006; Takeishi & Lee, 2006).

Table 1
Examples of interface standards/technologies for connecting the mobile phone industry to specific industries.

Industry	Product/service	Interface standards/technologies		
		For connecting phones and servers		For connecting phones and other devices/media
		1999–2000	By end of 2005	
General	Wireless infrastructure including packet system, mail/messaging micro-payment system, markup language, and user authorization			Not applicable
Entertainment	Screen savers	Graphic interchange format (GIF)	1. Thin-client (e.g., java) and vector graphic—(e.g., 3D, flash) based screen savers 2. #1 plus music or video and/or integration of ringing tunes and screen savers	1. Camera phones for creation of own screen savers 2. Cable or wireless connection with PC for exchange of data with other devices
	Music	Mini-MIDI (music instrument digital interface)	1. Mini-MIDI-ringing tones 2. MP3 for lyrics in ringing tones or complete songs	
	Games	Simple markup language (e.g., c-HTML)	Java and Vector Graphics (e.g., 3D, flash)	
General Internet sites	News Shopping Retail Enterprise	Simple markup language (e.g., c-HTML) Internet mail	More sophisticated markup language (e.g., full browser), java, and vector graphics	Cable or wireless connection with PC for exchange of data with other devices
Publishing	Shopping Maps	Simple markup language (e.g., c-HTML), Internet mail	More sophisticated markup language, Java, and vector graphics	Internal cameras, bar code reading software, and URLs embedded in 2D bar codes
Broadcasting	Radio Television	Simple markup language (e.g., c-HTML), Internet mail	More sophisticated markup language, Java, and vector graphics	Internal radios, infrared, and bluetooth Internal televisions, infrared, and bluetooth
Retail/ticketing	Train tickets Retail	Not applicable	Thin client (e.g., java) and simple markup language (e.g., c-HTML), Internet mail	Smart cards and smart card readers

The success of these ringing tones and screen savers can be explained in terms of the historical needs in the entertainment (popularity of music and images) and mobile phone (importance of personalization) industries and in specific attributes of the mobile phones (lower technological capability of phones than PCs). Young people have for many years placed a large emphasis on music and images and personalizing their appearance (e.g., clothing, jewelry, cosmetics, and hair) and belongings (e.g., handbags, wallets, and mobile phone) than have older people. The technology available in mobile phone networks and handsets in 1999 and 2000 merely restricted these applications for music and images to simple ringing tones and screen savers, at least initially.

NTT DoCoMo and a few content and technology providers initially made most of the money from the growing market for mobile entertainment content in Japan. The success of subscription-based entertainment content led both to the creation of a critical mass of users and the first rule governing participation in the value network of firms in the Japanese mobile Internet: "you have to work with NTT DoCoMo." Content providers wanted to be on its official menu, manufacturers wanted to provide it with phones, and network effects strengthened the emergence of a value network that is governed by this rule. More than 2000 firms were on NTT DoCoMo's official menu (including non-entertainment content) by the end of 2001 (Natsuno, 2003) and this number had reached 8000 by 2007 (Nihon Keizai Shinbun, 2007a).

Table 3 lists some of the firms that initially profited from this value network in terms of the social network theory summarized in Section 2. NTT DoCoMo made "Burt" rents (mostly packet charges) by filling the structural hole between the mobile phone and entertainment industries with its micro-payment system and its control over the phone specifications. Other organizations and firms filled other structural holes between the content providers, music owners, and phone manufacturers. Japanese Society for Rights of Authors and Composers (JASRAC) handled the distribution of copyright fees from the ringing tone providers to the owners of the music compositions, Faith provided the software technology for MIDI, and Yamaha and Rohm (and later Qualcomm) provided the chips that supported Faith's software (Takeishi & Lee, 2006). And large numbers of the early providers of this entertainment content made Coleman rents

Table 2
Evolution of product and market for mobile internet-based entertainment.

Year	Product versus market	Type of entertainment		
		Animation/pictures	Music	Games
1999–2000	Product	Animation or photo-based screen savers	Simple ringing tones	Java-based games.
	Market	Personalization of phones	Personalization of phones	Portable game players
2001–2004	Product	1. Screen savers based on Java, 3D, and/or flash 2. Creation of own screen savers using camera/video phones 3. Video downloads	1. Polyphonic ringing tones 2. Lyrics in ringing tones 3. Complete songs	3D or flash-based technology
	Market	1. Personalization of phones 2. Picture albums 3. Video albums	Personalization of phones	Portable game players
Current or near future	Product	Complete songs and videos that are activated by incoming calls		Higher speed processing
	Market	1. Personalization of phones 2. Portable music and video players		Portable game player

through their membership in an exclusive group, where the most profitable firms occupied top positions on NTT DoCoMo's official menu.

This competitive situation began to change as the second and third largest operators in Japan copied NTT DoCoMo's i-mode service and as the continued improvements in phone technology have provided opportunities for these other operators to introduce new services that are based on new interface standards, some of them before NTT DoCoMo (See Table 2). J-Phone (renamed Vodafone in 2003 and Softbank in 2006) introduced a micro-payment system in December 1999 and KDDI did so in April 2000. J-Phone was the first operator to introduce camera phones and KDDI was the first to introduce 15 s CD-quality songs that could be used as ringing tones. The success of these services caused the network rule to change from "work with NTT DoCoMo" to "work with all three major operators" for most of the services described in this paper.

Technological improvements continue to require changes in the interface standards and thus phones, services, and content (See Table 2). Faster and lower power chips, cheaper and larger memory, higher resolution displays, and faster network speeds have led to higher resolution images, more chords in the ringing tones, higher resolution cameras, larger Java programs, the introduction of Macromedia Flash and 3D engines and their increased performance, and a transition from ringing tunes to music and still photos to video.

These changes are having an increasingly large effect on various firms and the value networks in which they operate. Initially, ringing tone providers merely had to update their ringing tones for the increasing number of chords in new phones and Faith and Yamaha benefited from their roles in updating the specifications. But as KDDI's code division multiple access (cdma) network became capable of delivering 15 s CD-quality songs in a service called Chaku Uta, KDDI increased its control over the interface standards, the music companies used their copyrights to control the songs, and the ringing tone providers have struggled to obtain access to these songs. In the screen savers segment, camera phones have enabled users to produce their own screen savers and suppliers of both camera phone chips and software for managing these photos have filled this structural hole. On the other hand, phones with Java, 3D rendering software, Macromedia Flash have enabled the screen saver content providers to offer more sophisticated types of screen savers (Table 3).

These technological changes have also impacted in other ways on the value networks. In order to respond effectively to these changes, the managers responsible for mobile Internet services, beginning with NTT DoCoMo and later for the other operators, increased their reliance on specific content and technology providers (in many cases specific individuals) for ideas about new content and technologies. They had to rely more on these content and technology providers, because the interaction between the market and products and the effect of the technologies just mentioned on the product was becoming increasingly complex and increasingly difficult for these managers to handle internally.

It can be said that the rules that govern participation in the value network are and probably will continue to change (See Table 4). The latest changes are offering specific content and technology providers, the chance to move towards the center of the mobile Internet value network. The new rule for participation in the network is becoming "work with those firms that will provide you with the latest information about successful technologies and content." The content providers want to obtain early information about the interface standards that will be in new phones, the technology providers want to sell their technologies to the operators and manufacturers in order that their technologies will become interface standards, and all of the firms need to know about the impact of new interface standards on content quality and thus user satisfaction to

Table 3
Examples of firms filling structural holes between the entertainment and mobile phone industries during the early years in the Japanese mobile internet.

Problem	Solution/standards	Firms/organizations
Payments for content	Micro-payment services	Operators
Ringing tones (chords)		
Copyright fees	Distribution of fees	JASRAC
Specifications	Mini-MIDI standard	Faith
	Chips that conform to standard	Yanaha, Qualcomm
Music (including lyrics)		
Copyright fees	Distribution of fees	Music companies and JASRAC
Specifications	Modified MPEG3 standard	Operators
	Chips that conform to standard	Various manufacturers
Screen savers & games		
Simple animation	GIF	Open
Photos	MPEG compression	MPEG
Java/BREW	Operator and manufacturer solutions	Sun, Applix, operators, and Qualcomm
Vector graphics	3G, Flash	HI corporation, Macromedia Flash
Video	Nancy	Noa and Vodafone
	Modified MPEG4	Operators, various suppliers

Acronyms: JASRAC (Japanese society for rights of authors and composers); MIDI (music instrument digital interface); MPEG (moving picture expert groups); GIF (graphical interface format).

Table 4
The evolution of rules that govern participation in the network of firms in the Japanese mobile internet.

Years	Rule
1999–2001	Work with the largest operator, NTT DoCoMo
From 2001	Work with all three major operators
From 2002	Work with firms that will provide you with the best information about successful technologies/content

do this. Using the language of network theory, firms are trying to reduce the length of the path (Watts, 2003; Watts & Strogatz, 1998) between themselves and the best source of the information.

One possible outcome of new firms moving to the center of the mobile Internet value network is the emergence of vertical disintegration (i.e., a more complex value chain) in mobile phones (see Fig. 3). Operating systems, application processors, and various forms of application software are becoming more common on phones and it is possible that open standards for them will emerge and lead to vertical disintegration in phones (Henderson, 2005) in a manner similar to that which has happened in personal computers (Langlois, 1992).

5. Results: general Internet sites

A second critical mass of users also emerged in 2000 that depended on a different set of interface standards than those described in the last section and that enabled connections between mobile phones and a larger number of industries. The technological limitations of the mobile phone required the use of a markup language and mail protocol that are slightly different from their PC Internet versions. NTT DoCoMo chose a simplified form of HTML called c-HTML (compact hyper text markup language) and a type of Internet mail, which are called here push-based Internet mail. With c-HTML, content providers must reformat their PC sites for the size of the mobile phone display. Some firms did this as "official" content providers that were given a place on the i-mode menu and others merely created a universal resource locator (URL) that could be easily accessed via the input of this URL with the keypad.

Push-based Internet mail is similar to short message services (SMS) (Garrard, 1998) except that it is perfectly compatible with the Internet (Knutsen & Lyytinen, 2005). Like SMS, it is automatically "pushed" to phones after it arrives on an operator's servers and it is restricted in size. The mail's arrival on the phone causes the phone to beep and display an icon on the screen. Users merely click on the icon to access the mail and it is not necessary for them to open their mail clients or browsers as most people do when they access mail on their PC. Unlike SMS, it has always been possible to send this mail from a PC to a phone and the use of embedded URLs in this mail has created positive feedback between mail usage and general Internet site access (i.e., browsing) as many individuals, content providers, and other businesses began to include URLs in their mail messages in the year 2000 (Knutsen & Lyytinen, 2005; Natsuno, 2003). Although this positive feedback

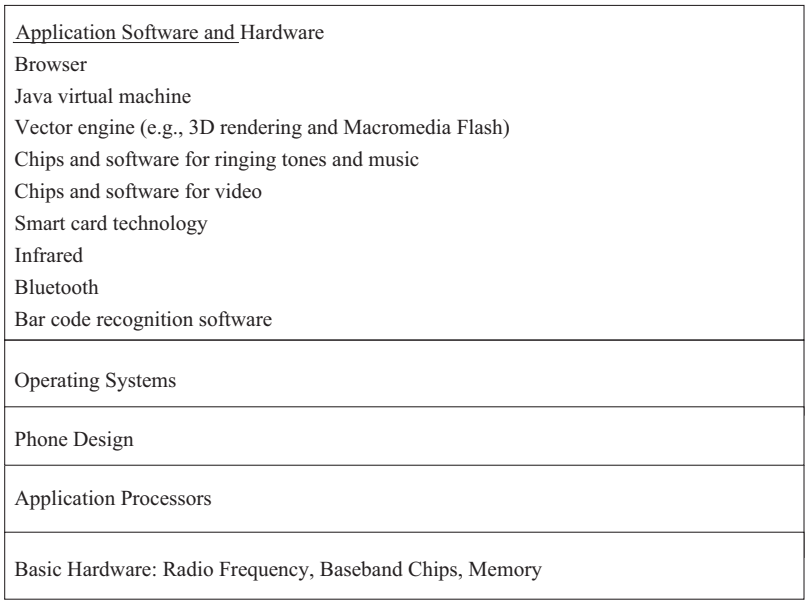

Fig. 3. The emerging vertical disintegration in Japanese mobile phones.

between mail and browsing also exists in the PC Internet, the small size of the phone's screen and thus the difficulty of conducting searches and other browsing on the phone increase the importance of this feedback between mail and browsing (Funk, 2001, 2007a).

The number of general Internet sites that were formatted for the mobile phone increased dramatically in 1999. Although some of these sites were on the official i-mode menu, there were more than 10 times as many general Internet sites than official i-mode sites by the end of 1999. The number of these sites exceeded 40,000 by mid-2001 and traffic to them exceeded that of official i-mode sites by September 2000 (Natsuno, 2003) and was double that of traffic to all the sites on the operators' official menus by the end of 2006 (Nihon Keizai Shinbun, 2007a). Not only can the sum total of these sites be defined as a value network, many of the individual sites operate as value networks in which push-based Internet mail plays a critical role.

For example, Digital Street offers a search engine that had more than 40,000 sites registered by mid-2001 (Natsuno, 2003). PC Internet portals such as Yahoo! Japan and Excite Japan offer mobile Internet portals. Magic Island offers a home page creation service that grew through viral marketing as users included the URLs of their home pages in mail messages. Xavel offers mail magazine services in its Girls Walker portal to almost 10 million subscribers in which thousands of users write the mail and Xavel merely categorizes and ranks the mail magazines. Xavel makes money when users purchase fashion-related products that can be accessed via URLs, which are embedded in the mail messages. Net Price offers products to its almost 10 million mail subscribers for which discounts are offered when multiple individuals make the purchase, which is facilitated by the use of push-based Internet mail (Funk, 2007b). More than eight million of Mixshi's ten million subscribers use their mobile phone to access Mixshi's social networking site (Nihon Keizai Shinbun, 2007b) and KDDI is increasing the uplink speed in order for users to more easily upload videos and other information to such social networking sites and blogs (Nihon Keizai Shinbun, 2007c).

Tens of thousands of other content providers, retail outlets, manufacturers, and service companies have also created sites and mail services for their customers and employees, albeit many of them cannot be defined as a value network by themselves. For example, retail outlets use these mail services to send discount coupons to registered customers, shopping sites use them to send information on specific products for which users have registered to receive (Funk, 2007b), and firms use them to send information to employees, which might for example be information about a maintenance worker's next project (Funk, 2006).

Using the social network theory cited in Section 2, it can be said that NTT DoCoMo has filled a structural hole between phones and general Internet sites by defining the interface standards for push-based Internet mail and c-HTML. NTT DoCoMo's early entry, its larger number of subscribers, and the importance of network effects enabled it to initially dominate the traffic to the general Internet sites. However, as the markup languages used by all three operators have begun to converge on extensible hyper text markup language (XHTML), the number of redundant ties between the general Internet sites and the mobile phone has increased and NTT DoCoMo's control of this structural hole (Burt, 1997) is disappearing.

Technological change, such as that discussed in the entertainment section, may lead to further changes in these interface standards and thus enable other firms to fill the structural hole that is associated with it. For example, many text

sites can be accessed via Java programs, which reduce downloading time and cost and enable the greater use of graphical images and the automatic updating of data on the phone's display. The increased use of graphical images also increases the importance of vector graphic engines such as Macromedia Flash and 3D rendering techniques. Full browsers, which can access regular Internet home pages, are now a standard function on Japanese phones. The diffusion of enterprise applications such as the maintenance example mentioned above is driving the emergence of software that links the mobile phone with existing customer relationship management, sales force automation, or enterprise resource planning software (Funk, 2006).

In the West, the lack of inexpensive push-based Internet mail and the promotion of site access via the input of a URL have slowed the connections between general Internet sites and mobile phones. As far as is known, not a single non-Japanese operator had made such Internet mail services a standard feature on all of its phones as of mid-2007 (Knutsen & Lyytinen, 2005; Sauser, 2007). Although some US operators made it easy for their users to send an SMS to phones from their own PC as early as 2002 and some European operators had done so by late 2004, it would be much easier for users, both business and non-business, firms, and content providers to use Internet mail (particularly inexpensive mail) than SMS (Knutsen & Lyytinen, 2005). The lack of inexpensive push-based Internet mail services has probably slowed the growth in mobile shopping, retail, and enterprise applications and similar arguments can be made for the services and interface standards that are discussed below. Growth in many of the services discussed below depends on the existence of inexpensive push-based Internet mail and site access via the input of a URL or at the minimum build off of the critical mass of general Internet sites that were created by the existence of push-based Internet mail and site access via the input of a URL.

6. Results: publishing

A critical mass of two-dimensional (2D) bar code users has recently emerged in Japan and it can be said that these 2D bar codes (see them illustrated in Wikipedia, 2007a) have enabled connections to be made between the mobile phone and publishing industries (see Fig. 2). First offered by Denso (it calls them QR codes) for logistics applications, 2D bar codes can now be found in a wide variety of printed material such as newspapers, magazines, maps, posters, and even restaurant menus. Simply by using a camera phone to photograph the 2D bar code or by using an internal bar code reader, software in the phone recognizes the URLs that are embedded in these codes and automatically connects the phone to the relevant Internet site.

The large number of newspapers, magazines, retail outlets, restaurants, and other firms that created mobile sites for the reasons discussed in the last two sections provided a ready market for 2D bar codes and thus facilitated the creation of a critical mass of users for them. For example, many newspapers and magazines had started mobile sites that depended on the operator's micro-payment systems to collect subscription fees from users. Retail outlets and restaurants had started mobile sites in order to distribute discount coupons where mail services played a critical role in distributing them. The availability of 2D bar codes merely provided another way to attract more visitors to their sites and to strengthen their value networks.

Furthermore, firms such as Color Zip Japan have introduced a new form of interface standard between the mobile phone and publishing industries that is called "color codes." Up to 17.1 billion different types of color codes (each representing a different URL) can be embedded in a color picture (Nikkei Ryutsu Shinbun, 2007a) thus, eliminating the need for unattractive 2D bar codes and perhaps the space they consume in printed matter. As of April 2007, Color Zip Japan had licensed its color codes to 170 firms (Nikkei Ryutsu Shinbun, 2007b) and more than 200,000 of these codes were in use (Nikkei Ryutsu Shinbun, 2007c).

In terms of the social network theory discussed earlier, it is contended here that firms such as Denso and Color Zip Japan are filling a structural hole between the mobile phone and publishing industries and they are creating their own value networks. It can also be contended that the successful applications for these 2D bar codes can to some extent be explained in terms of an interaction between historical needs in the publishing industry and the product attributes of the phones. For example, some of the most successful applications of this interface standard have integrated the needs of fashion magazine readers (the desire to obtain the latest fashions seen in magazines) with the key attributes of Internet-compatible mobile phones (a function to satisfy this need). An advertiser in such magazines can potentially receive much faster feedback on its advertisement from a user clicking on a 2D bar code than from trying to estimate the number of visits to a retail outlet that were caused by a specific advertisement.

7. Results: location-based services

A critical mass of location-based services has also emerged in Japan where formats for global positioning services (GPS) and maps have enabled connections between phones and these services. Through the use of Qualcomm's GPS technology, KDDI was able to offer successful services much earlier than the other operators have been able to accomplish. Critical aspects of these services include voice and visual (on the phone's screen) directions and a combination of assisted GPS (Hjelm, 2002) and on-phone processing to locate the satellites and provide location coordinates to the phone (Funk, 2004). By March, 2004 more than 500 firms provided GPS phones to more than 50,000 of their employees in order to improve internal productivity (e.g., sales, maintenance, delivery and other workers) (Funk, 2006). There were also more than

7,50,000 subscribers at the end of March 2006 to KDDI's navigation service for consumers called "EZ Navi-Walk" (Nihon Keizai Shinbun, 2006) and there were hundreds of sites in which these navigation services could be used.

Like the discussion of the 2D bar codes, the large number of map, hotel reservation, restaurant guide, real estate, and retail outlets that created mobile sites for the reasons discussed in sections four and five have provided a ready market for location-based services and thus facilitated the creation of a critical mass of users for them. For example, map providers started mobile sites in 2000 that depended on the operator's micro-payment systems to collect subscription fees from users. The number of subscribers to map sites increased as the resolution of the mobile phone display was improved. Providers of hotel reservation, restaurant guide, and real-estate services and also retail outlets started mobile sites as a critical mass of browsers emerged in 2000 for the reasons cited in Section 5. Many of these firms began to link up with map providers as the resolution of color displays and thus the quality of the maps improved. KDDI's GPS services merely provide additional value to the users of these sites and thus it was relatively easy for KDDI to create a critical mass of GPS users.

GPS and the combination of GPS and 2D bar codes impact on the value networks of KDDI, map providers, and other content sites including those discussed in the last section. In terms of the social network theory discussed earlier, KDDI's GPS service and the services from map providers are filling a structural hole between the mobile phone and the physical locations of retail outlets, restaurants, and other firms. Furthermore, the ability to include links to maps and KDDI's GPS service in the 2D bar codes enables these 2D bar codes to help connect phones with physical locations, fill this structural hole, and expand the number of ways that firms can construct value networks.

8. Results: retail and ticketing systems

A critical mass of "wallet phones" has also emerged in Japan and these wallet phones have enabled connections to be made between the mobile phone and retail/ticketing industries (see Fig. 2). The "smart cards" (Wikipedia, 2007b) in these wallet phones contain a small antenna and microprocessor that enable connections between the phone and both point-of-sale (POS) and ticketing systems. These functions were first available in the so-called smart contactless IC cards. Bit Wallet (a subsidiary of Sony) was the first Japanese firm in Japan to offer such smart cards as a form of pre-paid electronic money and Bit Wallet's technology was subsequently licensed by Japan Railways (JR) East, NTT DoCoMo, and other firms. Bit Wallet created a critical mass of users and readers for its smart card technology in a small shopping area of Tokyo called Osaki. Growth accelerated as JR East (in Tokyo) installed readers in most of its train stations in Tokyo in 2001. NTT DoCoMo first released phones in 2004 that contain Bit Wallet's smart card technology, JR East made its readers compatible with these phones in January 2006, and Bit Wallet's smart card technology is now embedded in most new Japanese phones (as of mid-2007).

In terms of the social network theory discussed earlier, Wallet phones have enabled NTT DoCoMo and its partners to fill a structural hole between mobile phones and firms that use POS and ticketing systems. NTT DoCoMo, JR East, and Sony established a firm called Felica Networks that is producing the smart card chips for phones and applications for them; these Java-based applications can be downloaded onto phones via the mobile phone networks. At the end of March 2007, 28 million Japanese owned a wallet phone and this figure was expected to reach 40 million by the end of March 2008 (Nihon Keizai Shinbun, 2007d). 2.6 million of these users had also registered to use their phone as a credit card (Nihon Keizai Shinbun, 2007e), thus, expanding the capabilities of wallet phones from pre-paid to post paid and 390,000 subscribers had registered to use their phone as a train ticket by early 2007 (Nikkei Ryutsu Shinbun, 2007d).

Firms such as JR and Bit Wallet are now trying to transfer their users of smart cards to wallet phones in order to provide more convenience to these users and to expand their value networks. At the end of March 2007, there were about 57 million smart cards (Nihon Keizai Shinbun, 2007f) and about 80,000 readers (Nihon Keizai Shinbun, 2007g) in use. It is forecasted that 680 billion Yen (US$ 5.67 Billion) in purchases would be made with these cards or wallet phones in 2007 (Nihon Keizai Shinbun, 2007e). JR built its value network of 20 million card users and 12,300 readers from its network of train users, licenses to other train lines, and alliances with kiosks and other stores in or near train stations. Initially riders could only use the cards as train tickets and JR later added the capability of making purchases with smart cards and wallet phones. Bit Wallet has built its value network of 49,000 stores from existing networks of convenience stores, super markets, fast food restaurants, and other chains and its network of 29 million card users from customers of these businesses (Nihon Keizai Shinbun, 2007f, g).

JR, Bit Wallet, and other firms are encouraging their smart card users to change to wallet phones in order that they can provide more convenience to their users and to expand their value networks. Money can be downloaded onto phones anywhere a signal is available, while downloading money onto smart cards is limited to train stations and some banks. Firms also hope consumers will use the phone as a point card, subscribe to their mail services, and access their sites via URLs in this mail or through general browsing so that these firms can more easily develop one-to-one relationships with consumers and alliances with other firms. For example, in one service mail is generated when a user passes through a specific train station that he/she has registered on the relevant menu. Such applications would build on the critical mass of mail users and web browsers that are described in previous sections.

In terms of the interaction between markets and products, the popularity of smart cards and wallet phones as train tickets and as a method of payment in convenience stores reflects the needs of commuters, train companies, and convenience store users and the product attributes of phones. Commuters place a great deal of value on products that

enable them to reduce their commuting time and the smart cards and wallet phones enable them to do so through bypassing the ticket machine and through making faster purchases of food, drinks, snacks, and newspapers in kiosks or convenience stores. By eliminating the need to purchase tickets in stations and by reducing check out times in convenience stores the use of these smart cards or wallet phones also facilitates the flow of users through train stations and convenience stores. Contrast these applications with traditional credit card applications like purchases in department stores and restaurants where users and the department stores and restaurants are less concerned with saving a few minutes than in train and convenience store applications.

9. Results: broadcasting

It is not clear whether a critical mass of users has yet emerged for interface standards that link the mobile phone with broadcasting-related services. Phones with analog tuners (both radio and television) were first offered in December 2003 and digital television services (called One-Seg in Japan) that can be accessed with mobile phones were started in April 2006. With digital television services for mobile phones, users can watch the program, access data, or do both on a split phone screen. The number of Japanese owning a so-called One-Seg phone passed the five million mark in March 2007 and this figure was expected to pass the ten million mark by August 2007. According to one survey of Japanese that had purchased these phones, 53% of respondents said they watched TV on the phone at least once a month (Nihon Keizai Shinbun, 2007h). However, the programs are currently free and it is not clear whether the additional viewing time of mobile users will significantly increase the advertising fees for the broadcasters, whether users would be willing to pay for programs and if so how much, or to what extent users will download content or other data that is related to a program on a split screen.

Another approach is to link mobile phones with stand-alone televisions and radios. This can be done by broadcasters announcing their home pages, showing them on a television screen, or through interface standards such as infrared or Bluetooth. Phones with infrared devices have been available since 2002 and more than 50% of Japanese phones contained these infrared devices by the end of 2004. These phones can be used as a remote-control device for a television or other device (radio, CD player, and karaoke machine). In addition, it is possible to use Java programs as electronic program guides where not only the program schedules but also online information about the programs is displayed on the phone's screen, while the user is watching stand-alone television. Available online information about a program is automatically displayed as the user changes channels in the Java program. Such Java programs have been pre-loaded on some phones from NTT DoCoMo since late 2004 and other Java programs can be downloaded from the Internet onto mobile phones.

The protocols for all of these technologies can be thought of as interface standards. Although agreements on the protocols for digital television for mobile phones and infrared technology have already been determined, competition between various types of Java programs for electronic programming guides and other methods of connecting phones with stand-alone televisions are still ongoing. In terms of social network theory, both the firms that provide such interface standards/technologies and the broadcasters that use these technologies to link the Internet and television programs are trying to fill a structural hole between firms in the Internet and the broadcasting industries and to expand existing or create new value networks.

In terms of the interaction between markets and products, the markets for existing television programs and broadcasting-related mobile Internet services helps in understanding the potential evolution of these applications. For many years, Japanese users have been downloading ringing tones that are made from program theme songs or screen savers that are based on animated characters or popular actors and actresses in a television program. Revenues for these broadcasting sites have depended on the micro-payment systems and interface standards that are described in section four of this paper.

Viewers are also starting to participate in game, sports, and talk shows via voting and to order products or access information that is discussed in these or other types of television programs. For example, Tokyo Broadcasting Systems had 170,000 viewers visit its mobile internet site during a quiz game in October 2005 (Nihon Keizai Shinbun, 2007i). With the proper type of interface standard in place, viewers might select a specific program ending for the television program or purchase the ending that is not shown in the program as a video downloaded over the mobile phone network. They might purchase sports tickets or access sport data while watching a sporting event. They might purchase clothing, cosmetics, or perfume used by actresses in a program, or they might access a map of a restaurant or other place that is shown in the program (Funk, 2007b). Like the 2D bar codes, location-based services, and wallet phones, creating a critical mass of users for broadcasting-related interface standards will probably build from existing mobile sites and user behavior.

10. Discussion

The structure of the mobile phone industry is currently changing from a value chain to a value network. Until recently the structure of the industry could best be described in terms of two relatively independent value chains for phone manufacturers and operators. With the addition of Internet compatibility and other functions, however, the structure of the mobile phone industry is gradually changing to a value network in which firms from a broad set of industries are interacting in the supply of a broad range of mobile Internet-related services. Furthermore, many of the individual firms

within this value network can themselves be represented more accurately as value networks than value chains. This includes many operators, phone manufacturers, providers of the technologies that constitute an interface standard, and content providers. For example, providers of 2D bar codes, color codes, electronic programming guides, smart cards, and java programs can be analyzed more effectively as value networks than as value chains partly due to the network effects associated with their products. On the content side, portals, search engines, mobile shopping sites, social networking sites, newspapers, magazines, restaurant guides, train companies, convenience stores, and broadcasters can in many cases be more accurately represented as value networks than as value chains also partly due to the network effects associated with their users, sites, and/or sponsors.

The differences between value networks and value chains have at least seven implications for the mobile phone industry. First, value networks involve a larger number of firms and a more complex set of relationships between them. This is why network scholars have introduced the concepts of structural holes (Burt, 1997), Burt and Coleman rents, and the rules that govern participation in the network (Kogut, 2000). Although these concepts had little meaning when the mobile phone industry primarily involved component suppliers to the phone manufacturers and infrastructure suppliers to the operators, they are becoming useful for understanding how competition is evolving in a Japanese mobile phone industry that consists of tens of thousands of firms. The narrow focus of the Western press on a small number of firms in the mobile phone industry reflects both the limited growth in the Western mobile Internet markets and the realization by this small number of Western firms that they are both striving to be at the center of these still emerging value networks and to determine the rules that will govern participation in them.

Secondly, the change from a value chain to a value network has important strategic implications for firms in the mobile phone industry. Although this really involves a paper in its own right, understanding network effects, creating a critical mass of users, and managing so-called "multi-sided" platforms are much more important issues in a value network than in a value chain. In particular, firms can use multi-sided platforms to deal with different types of buyers and sellers through different pricing structures and information sharing arrangements (Evans et al., 2006).

Thirdly, the change from value chains to value networks makes the issue of critical mass much more complex. Instead of once creating a critical mass of users and firms in for example compact discs or in an analog air-interface standard for mobile phones, the growth in the Japanese mobile Internet has involved the creation of a critical mass of users multiple times and the evolution of the overall value network for the Japanese mobile Internet reflects the creation of these critical masses for specific interface standards. This interpretation is consistent with other papers (Funk, 2001, 2007a; Knutsen & Lyytinen, 2005) that have concluded that the greater growth in the Japanese than Western mobile Internet markets is due to the creation of a critical mass of users in both entertainment content (which depends on micro-payment services) and in services and content that depend on inexpensive e-mail.

Furthermore, a critical mass of users in more advanced services that depend on other interface standards has often been built on top of these two critical masses of users and the evolution of the overall value network for the Japanese mobile Internet reflects the creation of critical masses of users for new interface standards. For example, a value network of firms that support 2D bar codes partly grew from the value network of firms that depend on the operator's micro-payment services for revenues (e.g., newspapers and magazines) and from the value network of firms that distribute discount coupons with push-based Internet mail (e.g., retail outlets and restaurant guides). The value network of firms that support GPS grew from the value network of firms that support these 2D bar codes (restaurant guide, real estate, and retail outlets) and that depend on the micro-payment systems (map providers). The value network of firms that support smart cards partly grew from the value networks of trains and convenience stores and it is now becoming a value network of firms that support so-called "wallet" phones. Many of these firms (e.g., retail outlets) support a move from smart cards to wallet phones because they hope to use push-based Internet mail, browsing, and other functions of the phone in order to build off of and expand their existing value networks in the mobile phone industry.

The way in which new value networks build from old ones and a critical mass of users for a new interface standard partly builds from previously created critical masses of users explains a great deal about why the growth in mobile Internet services has been so slow in the West. For example, while Japanese content providers merely considered whether adding 2D bar codes would increase the number of visitors/revenues to their already somewhat successful sites, many Western content providers are still considering whether they should even offer a mobile site or not. This discourages Western service operators from pushing standards for 2D bar codes and Western manufacturers from adding 2D bar code readers to phones.

Fourthly, the resulting products and services for the new interface standards that connect the mobile phone and other industries often reflect the products and services that were used in the other industries and the technological capability of phones. This can better understanding of how new value networks may emerge. For example, the success of ringing tones and screen savers can be explained in terms of the historical needs in the entertainment (popularity of music and images) industry and in the initial technological limitations of the phone. The most successful applications for 2D bar codes reflect the needs of fashion magazine readers (the desire to obtain the latest fashions when you see them in magazines) with the key attributes of Internet-compatible mobile phones (a function to satisfy this need). The popularity of smart cards and wallet phones as train tickets and as a method of payment in convenience stores reflects the greater needs for convenient payments in these than in other more traditional credit card applications (e.g., restaurants and hotels) and the key attributes of Internet-compatible mobile phones.

Fifthly, building from the above implications, the change from a value chain to a value network suggests that the current methods of measuring "progress" in the mobile phone industry are completely inadequate. Progress in the industry is often

measured in terms of the percent of mobile operator revenues from data as opposed to voice where most of this so-called "progress" is from the diffusion of SMS. Such a measure ignores the mobile commerce revenues from other firms in not only entertainment content but also in non-entertainment mobile commerce, which exceeded $5 Billion in 2004 in Japan (Funk, 2007b), or from the predicted $5.7 billion market for electronic payments with smart cards/wallet phones in 2007. The fact that these markets are never reported in the Western press or in analyses of the Western mobile Internet markets (Hibberd, 2007; Tilson & Lyytinen, 2006; Wu, 2007) suggest that they are very small or do not exist at all. According to one source, peer-to-peer messaging represented 67% and entertainment content (which is also delivered primarily with SMS) represented 21% of industry data revenues in 2006 where data revenues only represented 13.5% of total revenues in the global mobile phone industry (Hibberd, 2007). SMS was initially ignored by the operators and phone manufacturers, it is still largely based on 15-year-old technology (Garrard, 1998), and the recent updates in SMS technology, which enable third parties to send ringing tones, screen savers, and games, can hardly be described as earth shattering.

Consider where the PC Internet would be if progress were only defined in terms of the percent of fixed-line operator revenues from data as opposed to voice? This is not done because policy makers, academics, and firms realized very early that the PC Internet represented something much more important than merely an extension of the telephone industry. Now it is time to do the same thing in the mobile phone industry. Just as a beginning was made to measure progress for the PC Internet in terms of other signifiers such as the amount of business-to-business (B2B) and B2C commerce beginning in the late 1990s, a similar process needs to be undertaken in the mobile phone industry. Academics concerned with the mobile phone industry need to come up with better measures of progress within it and hold the industry accountable for them. I believe that doing this will cause telecommunications policy and information systems personnel to realize that "what is not happening but could happen in the mobile phone industry" is much more interesting than "what is actually happening" in that industry. In some sense, the benefits of the mobile Internet extend far beyond the boundaries of any single firm and exist primarily in the value networks of firms.

Sixthly, interface standards play a key role in these value networks and many of them are highly interdependent. For example, operator-defined interface standards for markup languages, mobile mail, and URLs in mobile mail facilitated easy browsing in operator-defined menus and connections between phones and general Internet sites in Japan. Other operator-defined-interface standards and the availability of micro-payment services have enabled users to download ringing tones, screen savers, and games while browsing through these operator-defined menus. Agreements on standards for 2D bar codes enable phones to interact with printed material and for users to connect to mobile Internet sites that were previously established because of the agreement on markup languages. Other standards enable phones to interact with radios, televisions, location-based services, ticket wickets, and cash registers.

The interdependencies between these interface standards and the need to create a critical mass of users for each of them complicates the standard method of setting. Although air-interface standards in the mobile phone industry have historically been developed in decentralized committees of manufacturers, this has not occurred during the early years of many industries. The basic PC and Internet standards were created by small numbers of engineers that created entirely new architectures and business models. Even the air-interface technologies for the first wireless systems were created during the first half of the 20th century by small numbers of engineers in firms such as Marconi, Motorola, Ericsson, and AT&T. Seen in this light, the coordination of standard setting by individual Japanese operators such as NTT DoCoMo, KDDI, or Softbank (formerly Vodafone) is not unusual and is highly consistent with models of technological change (Tushman & Anderson, 1986). For example, it is highly unlikely that firms could have successfully created working standards for operating systems, microprocessors, and application software in decentralized committees for the first personal computer or for any of the PCs released in the 1970s.

Having said this, however, leaving the standard setting to Western mobile phone operators may not lead to the desired outcome, partly because Western operators have pursued a very closed approach (Wu, 2007). This reflects the path-dependent nature of standard setting, policies, and economic growth. Part of the difference between the West and Japan is that Japanese operators introduced a fairly open approach before they understood the extent to which users would pay for mail/messaging and simple entertainment content. For Western operators, the crucial lesson from the Japanese mobile Internet is that money can be made from mail and specific types of entertainment content and they need to control the interface standards and the revenue streams in order to maximize their profits. Introducing inexpensive mail services, sharing more revenue with third parties, and enabling more firms to participate in their services contradict these basic strategies.

Seventhly, building from the other implications, policy makers need to become involved with these issues. Economists have long recognized that economic growth requires policy makers to set the right rules in various industries. An inability to agree on standards and the existence of closed systems are issues that policy makers have dealt with before and can probably deal with again. Academics can assist this process by conducting further research on the mobile Internet including the structure of the industry, the potential revenue streams, and the processes of standard setting.

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