Early Competition in Complex Network Industries:

The Case of the Mobile Internet

by

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Abstract

This paper uses the mobile Internet to demonstrate a conceptual framework for understanding how competition, including the emergence of user needs, the products that meet these needs, dominant designs, and firm networks, evolves during the early years of a complex network industry. Complex network industries such as the mobile Internet differ from simple network and non-network industries in that they involve multiple interfaces where standards must be set for each interface in order to ensure compatibility between complementary products and services. This paper represents the products and markets of an industry in terms of product design and customer choice hierarchies respectively where these hierarchies and the network of firms in the new network industry are the result of a "collision" between the hierarchies and firm networks of the existing industries. Although standards define the interfaces between complementary products and services, the existence of these standards and thus the physical connections between the new and existing industries can be considered "gateway" technologies. And this paper draws an analogy between these "gateway" technologies that physically connect the product design hierarchies in the colliding industries and the firms that fill structural holes and thus connect the firm networks of the colliding industries.

1. Introduction

Most business or economic models of technological change emphasize cycles of technological discontinuities, competition between alternative designs, the emergence of dominant designs, and incremental progress [6] [65] [48] [65][1]. In the competition between alternative designs, successful designs satisfy some form of user needs where it is often difficult to recognize these needs before a specific design's success suggests that they exist [15] [70]. The degree of success of a specific design along with other technological, social, and strategic factors impact on the choice of a dominant design [56] [61] [65] where a dominant design can often be defined at multiple levels [62] in a product design hierarchy [5] [16] or in a nested hierarchy of sub-systems [48] [64].

It is widely recognized that these cycles of technological change operate differently in network than in non-network industries [65]. As opposed to a single firm providing for example an automobile through a hierarchy of assembly and part suppliers, multiple firms often provide complementary products and services in network industries where standards define the interfaces between them [18] [19] [22] [35] [43] [44] [53] [56] [61] [65]. Multiple firms must agree to some extent on these interface standards before products and services can be successfully offered [53] [56] and the definitions of these interface standards are considered part of the dominant design for the product or system. Groups of firms often determine these interface standards in official committees, voluntary organizations, or in unofficial coalitions [29] [56] [61] and the existence of network effects increases the importance of installed base and other non-technical factors in the competition between interface standards [22] [29] [54] [56].

[1] Although the literature on the product life cycle [59] [34] also emphasizes dominant designs and incremental change, it does not specify whether there are one or multiple technological discontinuities within a single product life cycle.

We can also distinguish between simple network industries such as music and video players, facsimiles, and modems and more complex network industries such as telecommunication and broadcasting systems and the Internet. While the former products typically involve a single interface, more complex network industries such as telecommunication and broadcasting systems [9] [10] [37] [60] and the Internet [1] [54] may involve tens if not hundreds of different interfaces where different firms and different standard setting groups may focus on different interfaces. The large number of interfaces may cause many different kinds of products or services to emerge that are consumed by different populations of users [57]. The large variety of products and users probably further complicates the analysis of user needs and thus the design of products that will meet these needs [15] [70]. Furthermore, the large number of firms that provide complementary products and services and the large number of standard setting groups that are involved with the many interfaces can also cause firm networks to play a more important role in complex network than in simple network or non-network industries [4] [7] [43] [44] [65] [69].

This paper builds on these and other concepts to provide a conceptual framework for understanding how early competition, including the emergence of user needs, the products that meet these needs, dominant designs, and firm networks, evolves during the early years of a complex network industry. It uses the metaphor “collisions between industries” to describe this framework where the word “collision” reflects the unplanned and unpredictable nature of successful applications and products [15] [70] and of eventual winners [2] [3][6] [63][66] in new industries. It represents the products and markets of individual industries in terms of product design and customer choice hierarchies [16] respectively where these hierarchies and the network of firms in the new network industry are the result of a collision between the hierarchies and firm

networks of the existing industries. Although standards define the interfaces between complementary products and services, the existence of these standards and thus the physical connections between the new and existing industries can be considered "gateway" technologies [18]. This paper draws an analogy between these "gateway" technologies that physically connect the product design hierarchies in the colliding industries and the firms that fill structural holes [12] and thus connect the firm networks of the colliding industries.

This paper uses the mobile Internet to demonstrate this conceptual framework where there is a collision now occurring between the product design and customer hierarchies and firm networks of the mobile phone, the Internet, and other industries (See Figure 1). The difficulties of predicting the first successful products and services and the complexity of the firm networks make the mobile Internet an appropriate network industry to consider. Almost every early analysis of the mobile Internet [8] [11] [38] [55] overemphasized the potential of successful PC Internet applications for the mobile Internet and Western firms did not even consider standards for entertainment applications, which have become the "killer" applications. These errors reflect an overly narrow assessment of the potential applications for the mobile Internet by Western firms, which in retrospect may have been overcome by analyzing how industries are colliding to form the mobile Internet, and how standards are needed for the gateway technologies that connect these industries.

With respect to firm networks, the greater success of Japanese (and Korean) firms than Western service providers is partly due to the differences in the way gateway technologies and the standards for them are chosen in Japan than in the West, which reflect differences in firm networks. NTT DoCoMo and the other Japanese (and Korean) service providers have always had a larger influence on phone specifications and

standards than Western service providers have had [24] [26] [30] and this difference has continued in the determination of "gateway technologies" and the standards for them in the mobile Internet. While Western manufacturers were initially unable to agree on the standards for these gateway technologies in the WAP (Wireless Application Protocol) Forum, Japanese (and Korean) service providers have largely dictated them to their manufacturers and other firms in the Japanese mobile Internet.

The initial failure of Western manufacturers to agree on these standards for gateway technologies and the greater success of Japanese than Western mobile Internet services has also caused Western service providers, particularly large ones, to begin playing a larger role in the determination of gateway technologies and the standards for them in so-called "branded services." For example, Vodafone introduced Vodafone Live! in late 2002 and several other service providers have followed with similar branded services [30]. Thus, it appears that the firm networks in the Western world are beginning to resemble those in Japan (and Korea) where service providers are replacing manufacturers as the central players in the firm networks. This paper first discusses the key concepts followed by the research methodology and the collisions between the mobile phone and each of the other industries shown in Figure 1 and Table 1.

Take in Figure 1 and Table 1

2. Key Concepts

The concept of hierarchies is a central part of the proposed conceptual framework and this concept has been applied by many scholars, beginning with Simon [58] [59] to the field of technological innovation [5] [16] [48] [62]. For our purposes, we can represent the process of translating needs into products in terms of an interaction

between customer choice and product design hierarchies [16] where the interaction also includes the determination of a business model [14] and sales and service channels [2]. In the customer choice hierarchy, firms develop a conceptual framework for how customers evaluate competitive offerings where they divide users and applications into different segments and the problems to be solved in each segment. The product design hierarchy defines the method of problem solving and it includes both alternative designs and sub-problems for both products and processes [16].

Non-network and even simple network industries can be easily analyzed in terms of the evolution of products in these hierarchies where we can draw an analogy between the cyclical model of technological change and movements up and down the hierarchies. Large movements back up the hierarchies can be defined as technological discontinuities and large movements down the hierarchy can be defined as dominant designs [48] [61] [64]. For example, technological discontinuities for music players include cylinders, acoustic discs, electrically-recorded discs, micro-groove discs, stereo discs, cassette tapes, and compact discs [13] [28] [47]. Technological discontinuities for computers include mainframes, mini-computers, personal computers, and personal digital assistants [23] [32] [52] [68]. Ones for semiconductors include germanium and silicon transistors, bipolar integrated circuits (ICs), metal-oxide semiconductor (MOS) ICs, and microprocessor-based ICs [10] [33] [46]. In each of these three industries, large movements back up the hierarchies can be defined as technological discontinuities and large movements down them can be defined as dominant designs [28] [32] [33].

However, it is much more difficult to describe complex network industries such as the Internet in terms of an evolution of products in individual hierarchies of product design and customer choice since the source of these complex network industries is often multiple industries. This paper argues that complex network industries can be

more accurately represented as a collision between the product design and customer choice hierarchies and firm networks of individual industries. For example, the emergence of the Internet can be represented in terms of a collision between the telecommunications, computer, music, video, other entertainment, publishing, news, employment, financial, retail and wholesale trade, and other entertainment, and other industries [1] [39] [54] where many of these individual industries have undergone multiple technological discontinuities (See Figure 2 for a simple representation of this).

Take in Figure 2

It should be pointed out that there is not a clean division between complex network industries and non-network industries. Because many new industries borrow technologies from existing industries, it might be possible to represent the emergence of any new industry in terms of a collision between different technologies[2] and thus a collision between existing industries. However, such a model would be far more complex than one that represents the emergence of new computers, music players, and semiconductors in terms of technological discontinuities and dominant designs and thus movements up and down the product design and customer choice hierarchies. Therefore, any additional explanatory power from a model that uses the technology collision metaphor must be compared to the additional complexity of such a model.

Returning to the proposed framework for complex network industries, the gateway technologies link the product design hierarchies from the colliding industries and thus are part of the hierarchies for each industry. One reason for introducing the concept of a

[2] I am indebted to one reviewer for this idea.

gateway technology is that in a network industry firms must recognize the need for a gateway technology before they can propose standards for them. For example, in 1970s firms had to recognize the need for electronic mail [1] [54] and in the mobile Internet firms had to recognize the need for ringing tones and screen savers before they could propose standards for them.

The emergence of gateway technologies, standards for them, and the products that are compatible with them are impacted by network effects. When there are very strong network effects, products and services in a newly formed product design hierarchy must solve the "startup problem" and create a critical mass of users [53]. There must be a sufficient number of users (critical mass) for them to obtain value from the product either in terms of direct usage (e.g., telephone) or in terms of promoting the existence of complementary products such as hardware and software. In the mobile Internet, a critical mass of users must be created for services that require compatibility between phones, servers, and other devices/media (See Figure 1).

Gateway technologies and the product design hierarchies in which they are a part of impact on firm networks in two ways. First, existing research suggests that firm network structure arises from both the "inherent characteristics of the technologies that populate an industry" and institutional factors [42]. The inherent characteristics of the technologies that populate an industry can be represented by the collision between the product design hierarchies of individual industries while institutional factors include the existing firm networks in the industries that are colliding. Understanding how the new network structure arises may also help us to better understand how the rewiring of networks occurs [71] [72].

Second, these hierarchies also impact on the rules that govern participation in the network where it is generally recognized that centrality in a firm network reflects

competitive strength [42]. In eras of intense technical change there may be a rapid evolution in these rules and thus the structure of firm networks where firms attempt to appropriate the benefits from the gateway technologies. Some firms will fill structural holes [12] and thus obtain "Burt rents" from these non-redundant ties [42]. These structural holes are to firm networks what gateway technologies are to technological systems. Other firms will accrue "Coleman rents" through their membership in an exclusive group where trust and repeated exchange matter [17].

In the Japanese mobile Internet, there is competition between technology providers to supply gateway technologies, between service providers to assemble them, and between other firms to respond to them. Although we can label the latter firms as content providers in the mobile Internet, in actuality they may be retailers, broadcasters, ticket providers, train companies, or any type of firm that is using the mobile Internet as an internal productivity tool. Although outside of Japan phone manufacturers such as Nokia are also competing to both supply and assemble these gateway technologies, phone manufacturers in Japan play a much smaller role in Japan and they largely respond to the decisions on gateway technologies that are made by the service providers.

3. Research Methodology

Between 2000 and 2005, the author gathered data and tested and revised theories on the emergence of the mobile Internet numerous times using the case study approach [21] [73]. The initial research focused on successful content and applications and the reasons for their success. Beginning in 2002, the author began investigating the technologies that are driving the emergence of new content and applications where the ones listed in Table 1 began to emerge from the interviews and published data.

Simultaneously, the author began applying several frameworks of technological change [6] [15] [63] [64] [65] to the mobile Internet where it became clear that these existing frameworks did not address all the concepts relevant to a complex network industry. In 2004, the author began applying the concept of a "collision between industries" to this data.

Published information was found in both English and Japanese 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 at more than ten service providers, ten phone manufacturers, ten firms that are using 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. Since the interviewees asked me not to quote them, I do not do so.

4. Entertainment

Entertainment content such as ringing tones and screen savers played key roles in the creation of a critical mass of mobile Internet users in Japan in 1999/2000, in Korea in 2000, and in Europe and the U.S. in 2003/2004. The success of these ringing tones and screen savers reflects a collision between the customer choice hierarchy of non-mobile entertainment (popularity of music and images) and the product design (lower technological capability of phones than PCs) and customer choice (importance of

personalization) hierarchies of the mobile phone industry. 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, mobile phone). 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. Although many Westerners initially argued that the success of mobile entertainment services reflected unique cultural characteristics of the Japanese market [20] [45], the fact that they have become a multi-billion dollar global business outside of Japan [36] suggests otherwise [30] and the previous success of non-mobile applications of the same content suggests that Westerners could have understood the potential for the mobile entertainment content in the West many years ago.

The success of this mobile entertainment content represented an untapped part of young people's customer choice hierarchy and along with technological improvements in phones drove changes in the Japanese mobile Internet's product design hierarchy for both phones and content in 1999 and 2000 (See top two rows in Table 2). The early success of musical score downloading services where users had copied the music scores onto paper and then re-input them via the keypad caused phone manufacturers to release phones with the MIDI (Musical Instrument Digital Interface) protocol for the direct downloading of ringing tones in late 1999. The early success of screen savers and horoscopes caused phone manufacturers to introduce phones with color displays in late 1999 and early 2000. Both of these changes caused content providers to release color contents and ringing tones based on the MIDI format.

NTT DoCoMo and a few content and technology providers initially made most of the money in this entertainment content in Japan. The success of the subscription-based

entertainment content led to the creation of a critical mass of users and the first rule in the 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 this rule.

Table 3 lists some of the firms that have filled structural holes by providing gateway technologies or handling intellectual property rights in the entertainment applications in the Japanese mobile Internet. NTT DoCoMo made “Burt” rents by filling the structural hole between the mobile phone and entertainment industry with its micro-payment system and also its control of the technological specifications for ringing tones and screen savers. In the micro-payment system, NTT DoCoMo and now most of the world’s service providers collect content fees from subscribers on their monthly bills and pass on a certain percentage of these fees to content providers. Initially, JASRAC (Japanese Society for Rights of Authors and Composers) distributed copyright fees for the ringing tones to the music owners, Faith handled the technical specifications for ringing tones, and Yamaha and Rohm (and later Qualcomm) provided the chips. And large numbers of the early providers of this entertainment content made Coleman rents from through first mover advantages.

Take in Tables 2 and 3

This competitive situation began to change as the second and third largest service providers in Japan copied NTT DoCoMo’s i-mode service and as the continued evolution in the product design and customer choice hierarchies for mobile entertainment content (which are largely driven by technological improvements) has provided opportunities for these other service providers to introduce new services, some

of them before NTT DoCoMo did (See Table 2). J-Phone (become 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 service provider to introduce camera phones and KDDI was the first to introduce 15-second 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 service providers”.

Technological improvements continue to drive changes in the gateway technologies and thus the product design hierarchy for the mobile Internet (See Table 2). Faster and lower power chips, cheaper and larger memory, and faster network speeds have led to higher resolution displays, 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 have had a large effect on content, technology, and service providers. 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 cdma (Code Division Multiple Access) network became capable of delivering 15-second songs in a service called Chaku Uta, KDDI and the music companies took control of the specifications and the ringing tone providers have struggled to obtain access to song rights, which the music companies own. In screen savers, camera phones have enabled users to produce their own screen savers from photographs 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 engines, Macromedia Flash have enabled the screen saver content providers to offer more sophisticated types of screen savers.

The success of these technologies focuses attention on the vertical connections between the basic phone hardware and applications. Partly due to the number of industries and thus applications that are being connected by the mobile Internet, a vertical division of labor is beginning to appear in the phone design in a manner similar to how it has appeared in the PC [15] [43]. Figure 3 shows some of the various layers of software and hardware in the phones and some of their suppliers. Each of these firms has created its own network of alliances and through these alliances is attempting to control the specifications for the gateway technologies and thus fill the structural hole between the hardware and application software.

These technological changes have also impacted on the service providers. In order to respond effectively to them, the managers responsible for mobile Internet services, beginning with NTT DoCoMo and later for the other service providers, 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 product design and customer choice hierarchies and the effect of the technologies just mentioned on the product design hierarchy was becoming increasingly complex and increasingly difficult for these managers to handle internally.

In doing this, we can say that the service providers are changing the rules that govern participation in the network. Table 4 summarizes the evolution of these rules in the network of firms in the Japanese mobile Internet. The latest changes are giving specific content and technology providers the chance to move towards the center of the mobile Internet firm network (See Figure 4). 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 technologies that will be in new phones, the technology providers want to sell their technologies to the service providers and manufacturers, and all of the firms need to know about the impact of new technologies on content quality and thus user satisfaction to do this. Using the language of network theory, firms are trying to reduce the length of the path [71] [72] between themselves and the best source of the information.

Take in Figures 3 and 4 and Table 4

5. General Internet Sites

A second critical mass of users also emerged in 2000 through a collision between the product design hierarchies of the Internet and mobile phone 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 I call push-based Internet mail. With c-HTML, content providers must reformat their PC sites for the size of the mobile phone display. This enabled firms and individuals who could not or did not want to be on NTT DoCoMo's official menu to create their own sites.

Push-based Internet mail is similar to short message services (SMS) [34] except that it is perfectly compatible with the Internet. Like SMS, it is automatically "pushed" to phones after it arrives on a service provider'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, anyone can send this mail from a PC to a phone and the use of embedded URLs (Universal Resource Locators) 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 [49]. Although this positive feedback between mail and browsing also exists in the PC Internet, the small size of the phone's screen and thus the difficulty of doing searches and other browsing on the phone increase the importance of this feedback between mail and browsing on the phone [30].

The number of general Internet sites that have been formatted for the mobile phone increased dramatically in 1999 such that by the end of that year there were more than 10 times as many general Internet sites as official i-mode sites and traffic to the general Internet sites exceeded that of official i-mode sites by September 2000 [49]. While the most popular general Internet sites offer home page creation and mail magazine services, tens of thousands of content providers, retail outlets, manufacturers, and service companies have created sites and mail services for their customers and employees. For example, retail outlets use these services to send discount coupons to registered customers [25], shopping sites use them to send information on specific products that users have registered to receive [29], and firms use them to send information to an employee for example information about a maintenance worker's next project [31].

Using the collision analogy, we can say that c-HTML and push-based Internet mail services act as gateway technologies and NTT DoCoMo has filled a structural hole between phones and general Internet sites by offering them. NTT DoCoMo's early entry, its larger number of subscribers, and network effects enabled it to initially dominate these gateway technologies and fill the structural hole. However, as the markup languages used by all three service providers have begun to converge on XHTML

(Extensible Hyper Text Markup Language), NTT DoCoMo's control of this gateway technology has weakened, the number of redundant ties between the general Internet sites and the mobile phone has increased, and NTT DoCoMo control of this structural hole is disappearing.

Technological change, such as that discussed in the entertainment section, may lead to further changes in the gateway technology and thus enable another firm to fill the structural hole that is associated with this gateway technology. For example, many text sites can be accessed via Java programs, which reduce the downloading time and cost and enable the greater use of graphical images. 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, have been available in some phones since 2005. The diffusion of enterprise applications such as the maintenance one 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.

In the West, the lack of push-based Internet mail and the promotion of site access via the input of a URL have slowed the speed of this collision between general Internet sites and mobile phones. As far as I know, not a single non-Japanese service provider had made such Internet mail services a standard feature as of mid-2006. Although some US service providers made it easy for their users to send an SMS to phones from their own PC as early as 2002 and some European service providers 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 than SMS. The lack of push-based Internet mail services has slowed the growth in mobile shopping [28], retail [25], and enterprise [31] applications [30] and similar arguments can be made for the collisions between

industries that are discussed below because many of them depend on inexpensive push-based Internet mail and site access via the input of a URL.

6. Publishing

The collision between mobile phones, the Internet, and publishing is being driven by the existence of micro-payment systems and gateway technologies that link printed media (e.g., newspapers, magazines, maps, and posters), mobile phones, and the Internet. Micro-payment systems make it easier for newspapers and other traditional providers of print media to charge users subscription fees and thus they provide these firms with a viable business model in the mobile Internet. Relevant gateway technologies include cameras and software that recognizes URLs, mail addresses, and 2D bar codes (called a QR code) where URLs or mail addresses are contained in the 2D bar codes [29]. Some firms are also improving these 2D bar codes by using color to increase the amount of information that can be stored in them or by partially hiding these rather unattractive codes in pictures.

In terms of the collision analogy we can say that the QR codes, bar code recognition software, and the camera act as gateway technologies and both the providers of these technologies and the publishers that use these gateway technologies to link the Internet and the printed media are filling a structural hole between firms in the Internet and the publishing industries. The successful applications will likely reflect the emerging product design and customer choice hierarchies of the mobile Internet, which will be formed through the collision of these hierarchies in printed media and phones. For example, some of the most successful services have integrated the customer hierarchy of fashion magazines (the desire to obtain the latest fashions when you see them in magazines) with the product design hierarchy of Internet-compatible mobile phones (a

function to satisfy this need). NTT DoCoMo claims that the number of accesses to a site doubled on the average following the introduction of a QR code [51]. Similar arguments can be made for services that integrate the customer choice hierarchy of "weekender" magazines (find the restaurant) with the product design hierarchy of Internet-compatible mobile phones (a way to find the restaurant) through maps and a GPS (Globally Positioning System) function [40].

7. Broadcasting

The collision between mobile phones, the Internet, and broadcasting is also being driven by the existence of micro-payment systems and the relevant gateway technologies where here it is those that that link mobile phones, the Internet, and devices like televisions and radios. In addition to simple methods like displaying URLs on television screens and announcing them in radio programs, one gateway technology is the placement in phones of radio or television tuners and the relevant software for automatically connecting users to the relevant sites while they are listening to or watching a program. Phones with analog tuners (both radio and television) have been available since December 2003, phones with digital television tuners were released in late 2005 and digital television services that can be accessed with mobile phones started in April 2006. In the digital television services for mobile phones, users can watch the program, access data, or do both on a split phone screen.

Another method is to link mobile phones with stand-alone televisions and radios via short range wireless technologies such as infrared or Bluetooth. Phones with infrared devices that are compatible with televisions have been available since 2002 and more than 50% of Japanese phones contained these infrared devices by the end of 2004. Java programs can be used as electronic program guides and such programs were pre-loaded

on some phones released by NTT DoCoMo by late 2004.

In terms of the collision analogy, we can say that infrared, Bluetooth, and special Java programs act as gateway technologies between stand-alone televisions, the mobile phone, and the Internet. Both the firms that provide these technologies and the broadcasters that use these technologies to link the Internet and the programming are filling a structural hole between firms in the Internet and the publishing industries. The collision between the product design and customer hierarchies of television programs and mobile phones helps us understand the needs of people while they watch television and the limitations of the phone. Viewers have downloaded ringing tones that are made from program theme songs and screen savers that are based on animated characters or popular actresses and actors in a television program for many years. 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. With the proper gateway technology 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 [29].

8. Point of Sales (POS) and Ticketing Systems

The collision between the mobile phone industry and both point of sale (POS) and ticketing systems started in mid-2004 when NTT DoCoMo released phones that contain smart card functions. Although several other phone-based payment methods have been

tried, it appears that phones containing these smart card functions[3] will be the most successful method in Japan and perhaps elsewhere. The inclusion of these smart card functions in phones enables these functions to act as a gateway technology between phones and existing networks of POS and ticketing systems.

We can also say that this gateway technology has enabled NTT DoCoMo and its partners to fill a structural hole between mobile service providers and firms that use POS and ticketing systems. NTT DoCoMo, JR (Japan Railways) 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 2005, 2.4 million phones containing this smart card had been sold and more than 30,000 stores had readers that could accept payments with these phones [50]. Smart-card functions are now standard features on all NTT DoCoMo phones and are expected to be so on phones from KDDI and Vodafone by the end of 2007.

Several firms including JR and Sony's subsidiary Bit Wallet are transferring their users of smart cards to phones that contain these smart cards. About 26 million cards were used to make about 17 million payments in December 2005. JR built its network of 11 million payment cards from its train users and through alliances with other train lines. Initially riders could only use the cards as train tickets, JR later added the capability to make purchases at stores in and near train stations, and riders have been able to use phones as train tickets on JR's lines since January 2006. Bit Wallet has built its network of 15 million cards and 30,000 stores from existing networks of convenience stores, super markets, fast food restaurants, and other chains [50].

[3] Smart cards contain an IC chip and a very short range (<10 centimeter) antenna that enable them to communicate with the appropriate transmitter.

In terms of the collision metaphor, the popularity of smart cards as train tickets and payments in convenience stores reflects the customer choice hierarchy of commuters and convenience store users and the product design hierarchy of these smart cards. Commuters place a great deal of value on products that enable them to reduce their commuting time and the smart cards (and also placing them in phones) enable them to do so through bypassing the ticket machine and making faster purchases of food, drinks, snacks, and newspapers. By eliminating the need to purchase tickets in stations and reducing check out times in convenience stores the use of these smart cards or phones that contain them increase the capacity of 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 the train and convenience store applications.

9. Discussion

The purpose of this paper was to explore how early competition, including the emergence of user needs, the products that meet these needs, dominant designs, and firm networks, evolves during the early years of a complex network industry. Using the mobile Internet as an example, this paper describes this early evolution in terms of a collision between the product design and customer choice hierarchies and firm networks of existing industries. Gateway technologies physically connect the product design hierarchies, standards define the protocols for them, and the combination of the standards defines a dominant design for the new industry. Firms fill structural holes, which are analogous to gateway technologies, and thus connect the firm networks of the colliding industries.

This paper makes three contributions. First, it helps us better understand the differences between complex network industries and both simple network and non-network industries in terms of how dominant designs emerge. Complex network industries such as the mobile Internet involve multiple interfaces between different industries where the existence of these multiple interfaces makes it very difficult to describe the dominant design for the mobile Internet in terms of a single term. Like the PC Internet, the dominant design for the mobile Internet can be better described in terms of multiple terms that correspond to each gateway technology and the vertical connections (and their standards) between the basic hardware and software applications in a phone.

This has implications for the literature on both dominant designs and standards. The emergence of a dominant design in a complex network industry will involve far more firms and technologies than the emergence of a dominant design in a simple network industry. The existence of these multiple interfaces also increases the possibility that firms will not notice the importance of an interface and its gateway technology before successful products suggest that the interface and gateway technology are important. The difficulty of recognizing the importance of an interface also illuminates some of the problems that standard setting organizations or coalitions of firms face when they attempt to prioritize interfaces and gateway technologies and the setting of standards for them.

Second, this paper helps us better understand how firm networks emerge and evolve and the impact of these firm networks on competition by linking the concepts of gateway technologies, structural holes, and Burt and Coleman rents. For example, the micro-payment system can be thought of as a general gateway technology that enabled mobile phone service providers to fill a structural hole between firms in the mobile

phone and the entertainment industry. NTT DoCoMo's early introduction of this system enabled it to earn Burt rents and its content providers to earn Coleman rents. The former has been reduced as service providers copied NTT DoCoMo's services and the latter has also been reduced through increases in the number of content providers on each service provider's official menu. Other gateway technologies connect specific forms of entertainment such as music, games, and animation/photographs with the mobile phone. There is competition between technology providers to supply them and between content providers to respond to the changes in gateway technologies.

At a higher level, we can say that firms are competing to fill structural holes between the entertainment and mobile phone industries by controlling the way standards are chosen for these gateway technologies. Although the Japanese service providers still largely play this role in the mobile Internet, rapid improvements in technology are causing changes in the way service providers set these standards and thus changes in the rules that govern participation in firm networks. The service providers increasingly rely on information from specific content and technology providers to determine these standards, which may cause the Burt rents to move towards the specific firms that occupy the more "exclusive" positions near the service providers. As opposed to merely "taking orders" from NTT DoCoMo or KDDI, content providers work with those firms that will provide them with the best information about new technologies and how these new technologies can enable new forms of content.

This second contribution suggests that firms should also consider the gateway technologies, the potential standards for them, structural holes, and how the structural holes impact on the structure of firm networks when considering the formation of a new network industry. This is particularly important since previous research [4] [7] [42] [43] [44] [65] [69] has found that a firm's competitiveness is related to its position in firm

networks. Quickly identifying the critical gateway technologies, the potential standards for them, and the way that these gateway technologies interact with structural holes can help firms establish central positions in the firm networks. And because these technologies are part of the product design hierarchy of the new industry, it is essential for firms to understand how insights into the product design and customer choice hierarchies of the new industry can be found by looking at the collisions between the product design and customer choice hierarchies of existing industries.

Third, this paper helps us better understand the emergence and evolution of these product design and customer choice hierarchies and thus the successful products and applications for the new industry. For example, as described in Section 4, the collision between the product design and customer hierarchies in the entertainment and mobile phone industries explains why ringing tones and screen savers have played such an important role in the creation of a critical mass of mobile Internet users all over the world. The success of this entertainment content reflects the collision between the customer hierarchy of non-mobile entertainment (popularity of music and images) and the product design (e.g., lower technological capabilities of phones than PCs) and customer choice (importance of personalization) hierarchies of the mobile phone industry.

Sections 5-8 use the concept of a "collision between product design and customer choice hierarchies of existing industries" to also describe the emergence and evolution of competition in other mobile Internet applications. Because these applications have experienced much less growth than the entertainment ones, Sections 5 – 8 are both an explanation of what is happening and a forecast of what might occur. Future research should explore these applications in more detail. Will the mobile Internet continue to evolve in Japan in the manner described in these sections? How about in other countries

where the mobile Internet has emerged and continues to evolve much more slowly than in Japan?

This third contribution suggests that firms should consider the product design and customer choice hierarchies of the colliding industries when considering the formation of a new network industry. The hierarchies of the colliding industries can provide firms with insights into how competition, in particular the market needs and the characteristics of successful products, will emerge and evolve during the early years of a new network industry. This is particularly important since firms often focus too much on their specific industries and customers and not on all the industries in which the collision is occurring. Hiring managers from these other industries and creating communication forums with them are first steps towards trying to understand the product design and customer choice hierarchies of the colliding industries.

Further research should also attempt to apply these concepts to the emergence of other complex network industries such as the PC Internet. Understanding the origins of new industries is clearly important to policy makers and firms. Business scholars are particularly interested in how competition evolves in a new industry and how this competition evolves differently in network than non-network industries. And understanding how firm networks emerge is important to both business and network scholars.

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Figure 1. Collision Between Mobile Phone, Internet and Other Industries to Form Mobile Internet

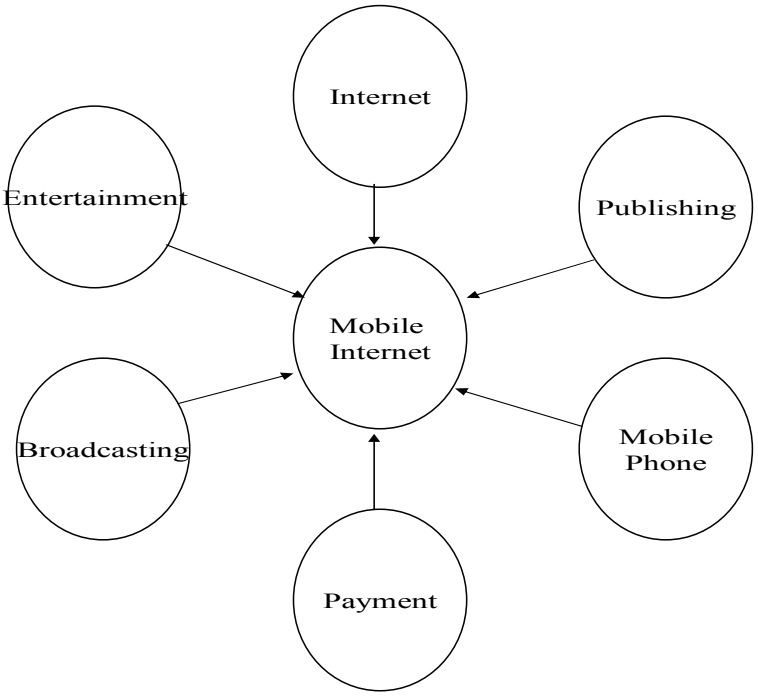

Figure 2. Collision Between Computer Telecommunications, and Other Industries to Form PC Internet

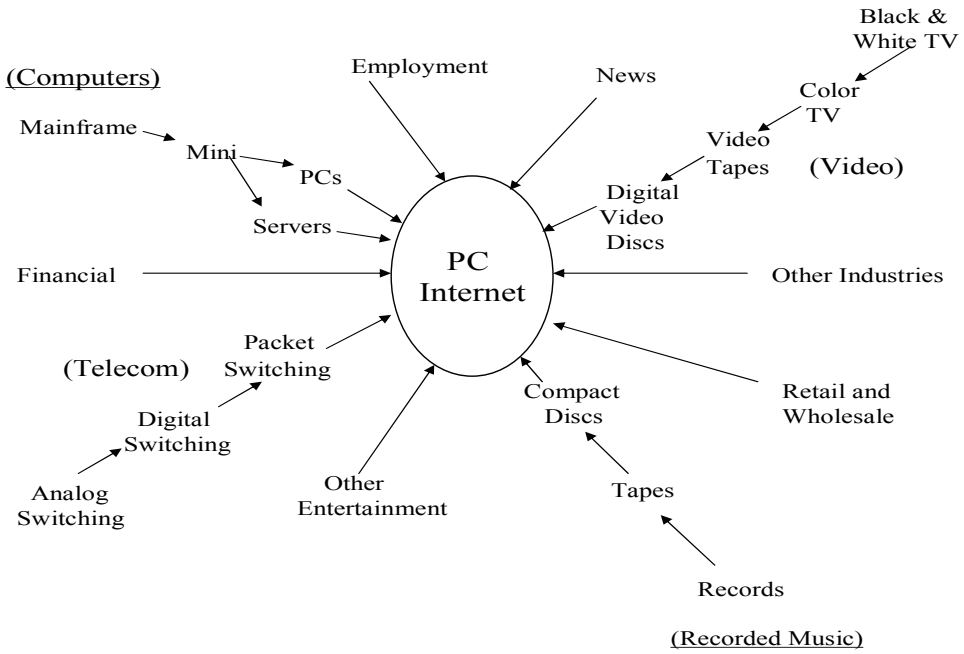

Figure 3. Basic Block Diagram of Software and Hardware in Phones and Key Suppliers/Products in Japan

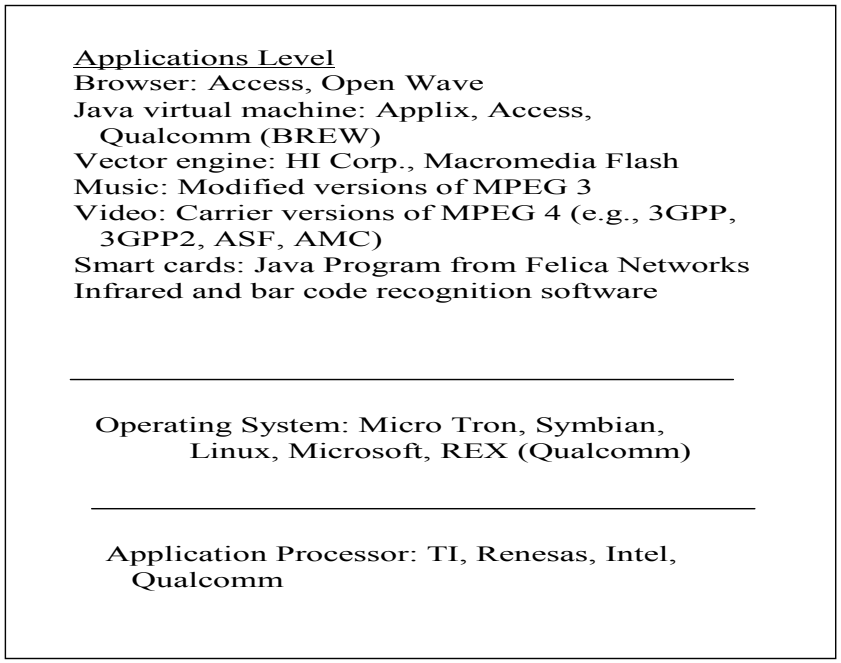

Figure 4. Emerging Network of Firms in Japanese Mobile Internet

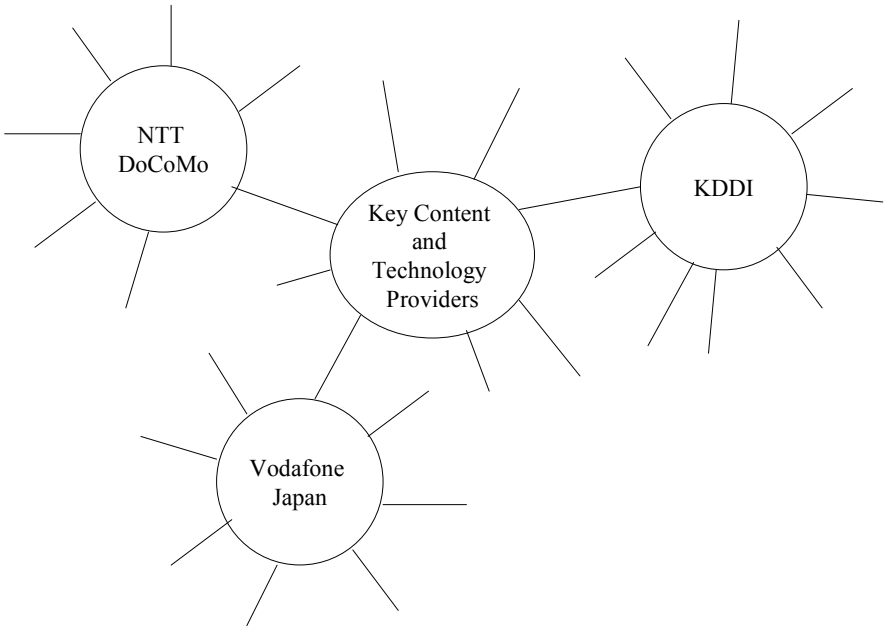

Table 1. Gateway Technologies for Connecting Specific Industries where Standards must be defined for each Gateway Technology

Industry	Product/ Service	Examples of Gateway Technologies		
		For connecting phones and servers		For connecting phones & other devices/ media
		1999-2000	By end of 2005	
General	Wireless infrastructure including packet system, mail/messaging micro-payment system, browser			Not applicable
Entertain-ment	Screen Savers	For animation- and photo-based screen savers	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	For simple ringing tones	1. polyphonic ringing tones 2. lyrics in ringing tones 3. Complete songs	
	Games	For simple games based on c-HTML	More complex games based on thin-client, Vector Graphics (e.g., 3D, Flash)	
General Internet Sites	News	Simple markup language (e.g., c-HTML), Internet mail	More sophisticated markup language (e.g., full browser), Java, Vector Graphics	Cable or wireless connection with PC for exchange of data with other devices.
	Shopping			
	Retail			
	Enterprise			
Publishing	Shopping	Simple markup language, Internet mail	More sophisticated markup language, Java, Vector Graphics	Internal cameras, bar code reading software, URLs embedded in 2D bar codes
	Maps			
Broad-casting	Radio	Simple markup language, Internet mail	More sophisticated markup language, Java, Vector Graphics	Internal radios, infrared, Bluetooth
	Television			Internal televisions, infrared, Bluetooth
POS and Ticketing Systems	Train/concert tickets	Not applicable	Thin client (e.g., Java)	Smart cards and smart card readers
	Retail			

Table 2. Evolution of Product Design and Customer Choice Hierarchies for Mobile Internet-Based Entertainment

Year	Hierarchy	Type of Entertainment		
		Animation/ Pictures	Music	Games
1999-2000	Product Design	Animation or photo-based screen savers	Simple ringing tones	Java-based games.
	Customer Choice	Personalization of phones	Personalization of phones	Portable game players
2001-2004	Product Design	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
	Customer Choice	1. Personalization of phones 2. Picture albums 3. Video albums	Personalization of phones	Portable game players
Current or Near Future	Product Design	Complete songs and videos that are activated by incoming calls		Higher speed processing
	Customer Choice	1.Personalization of phones 2.Portable music and video players		Portable game player and replacement for Playstation

Table 3. Examples of Firms Filling Structural Holes between the Entertainment and Mobile Phone Industries in the Japanese Mobile Internet

Problem	Solution/Standards	Firms/Organizations
Payments for content	Micro-Payment Services	Service Providers
Ringing tones (chords)		
Copyright fees	Distribution of fees	JASRAC
Specifications	Mini-MIDI standard	Faith
	Chips that conform to standard	Yamaha, Qualcomm
Music (including lyrics)		
Copyright fees	Distribution of fees	Music companies and JASRAC
Specifications	Modified MPEG3 standard	Service providers
	Chips that conform to standard	Various manufacturers
Screen Savers & Games		
Simple Animation	GIF	Open
Photos	MPEG Compression	MPEG
Java/BREW	Service provider and manufacturer solutions	Sun, Applix, service providers, Qualcomm
Vector graphics	3G, Flash	HI Corp., Macromedia Flash
Video	Nancy	Noa and Vodafone
	Modified MPEG4	Service providers, various suppliers

Acronyms: JASRAC (Japanese Society for Rights of Authors and Composers); MIDI (Music Instrument Digital Interface); MPEG (Moving Picture Expert Groups)

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 service provider, NTT DoCoMo
From 2001	Work with all three major service providers
From 2002	Work with firms that will provide you with the best information about successful technologies/content