

The Japanese Wireless Telecommunications Industry:

INNOVATION, ORGANIZATIONAL STRUCTURES,
AND GOVERNMENT POLICY

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I. INTRODUCTION

Wireless telecommunications are revolutionizing communication. People can communicate with one another from anywhere, and vast information resources are becoming increasingly accessible anytime, anywhere. As wireless telecommunications technology improves, the future holds countless possibilities and opportunities to enhance people's lives and methods of work. Japan's wireless telecommunications industry has recently become the focus of international attention in discussions about cellular telephone industries and wireless telecommunications.¹ Most such discussions and analyses of Japan's wireless telecommunications industry tend to focus on three major points, and the objective of our study is to explain these points.

First, Japan's cellular internet connection services enjoy a market size, profitability, and diversity and sophistication of content yet to be seen anywhere else in the world. Second, the technological sophistication of handsets currently only available in Japan surpasses handsets in all other wireless telecommunications markets. Third, NTT Docomo, the dominant cellular telecommunications company in Japan, has enjoyed wild domestic success and profits.

These three points become relevant to almost all studies of wireless telecommunications due to the following reason: Japan has had a closed, self-contained domestic industry until now, but with the imminent global adoption of a next-generation global telecommunications standard, the Japanese service providers and handset manufacturers are poising themselves to enter global wireless telecommunications markets. This is likely to change global competitive landscapes significantly, and there is widespread speculation about how wireless telecommunications markets will change in the future.

The widespread attention given to Japan's wireless telecommunications industry is significant both in studying the Japanese economy and in examining global wireless telecommunications. First, it is surprising for a Japanese industry to pioneer new technology, such as cellular internet connection services. Most previous examples of Japanese industries that became internationally successful owed their competitiveness to technological prominence in improving the manufacturing of products along existing designs – *process innovation* – rather than through innovation in content.² In other words, we now see Japan taking a different type of technological leadership. Second, in examining global wireless telecom-

¹ Popular media, exemplified by all major newspapers and magazines such as the *Economist*, *Business Week*, *Newsweek* and *Time* have all written about the sophistication and future potential of Japan's wireless handsets and services. Furthermore, seminars at Stanford University with presentations by important figures in the Japanese wireless industry have been packed beyond capacity.

² Aoki, Masahiko, *Towards a Comparative Institutional Analysis* (Cambridge: MIT Press, 2001), IV-17.

munications, we see a shift in the location of technological leadership in this industry. Until recently, Europe has been the main focal point of wireless telecommunications, with firms such as Nokia and Ericsson dominating handset manufacturing, and European service providers setting the standards for cellular service. Now, technological advances beyond all those in other areas of the world can be seen in the Japanese wireless telecommunications industry.

To explain these three observations, we must divide our explanation into *how* and *why*. More specifically, we must examine *how* the industry developed to cause these observations, and *why* it was able to develop in these ways. To answer *how* the industry developed, we will trace the development of Japan's wireless telecommunications industry. In explaining *why* the industry was able to develop as it did, we look at previous studies of industries producing innovation. For the Japanese automobile industry, process innovation leading to technologically advanced manufacturing has often been attributed to organizational factors such as the *kanban system* and supplier *keiretsu* organizations.³ Radical innovation in computer designs have been attributed to properties of the design structure of computers, and rapid innovation in Silicon Valley has been attributed to broad organizational structures in the region. Therefore, we apply three theories explaining innovation to determine whether, and if so how, the organizational structure of Japan's wireless telecom industry sheds light on the question of why the developments we observe were able to occur.

In this paper, we first conduct an overview of the current state and development of Japan's wireless telecom industry. Next, we will briefly present three theoretical frameworks attempting to explain relationships between system design, organizational structures, and different types of innovation. Following this we will synthesize the theories to create an explanatory narrative to understand how the industry developed to create the observations we examine.

II. THE THREE OBSERVATIONS

First, let us expand on the three key observations to establish an idea of the type of developments we attempt to explain. The first observation is the high level of development in cellular internet connections services. Each cellular service provider in Japan offers an internet connection service allowing subscribers to use internet e-mail compatible with all conventional internet e-mail,⁴ browse world-wide-web sites with content optimized for cellular phones, and download various type of data, such as photos, music, or small programs, to be saved in the phone itself. Internet e-mail allows subscribers to communicate with anyone, anywhere, at any time to any other device compatible with e-mail, such as computer users overseas or cell phones in delivery trucks. Access to world-wide-web pages allows subscribers to gather a wide variety of information ranging from local maps and directions to news and train schedules, and allowing reservations of tickets and bank transactions to be made from anywhere at any time. Finally, the ability to download various types of data in handsets leads us to an examination of handsets.

The second observation is the sophistication of Japan's handsets. Cellular handsets in Japan have been the lightest and smallest in the world since 1996, and are the first, and so far only, handsets to incorporate a number of advanced technologies. Those include 65,000 color active matrix TFT displays,⁵ integrated digital cameras, radios, mp3 players, as well as designs that allow handsets to be directly inserted into PC-Card slots to function as wireless modems in notebook computers.⁶ Handsets with integrated digital cameras allow digital photos to be sent as e-mail attachments to other handsets or computers. Integrated mp3 players allow users to download music from the internet or other devices, insert headphones into a handset, still smaller and lighter than many non-Japanese handsets, and use the device as a phone, portable music player,

³ Aoki, Masahiko, *Information, Incentives, and Bargaining in the Japanese Economy* (Great Britain: Cambridge University Press, 1988), 22, 25.

⁴ Internet e-mail refers to the type of e-mail used by almost all users e-mailing via computers.

⁵ This is roughly the quality of higher-end notebook computer displays.

⁶ As of this writing, Japan is the only country with handsets incorporating these elements.

and web-browser.⁷ Furthermore, incoming-call melodies in Japanese handsets have developed to the point that 16-tone chords using FM sourcing are standard features – meaning that sound quality is close to an FM radio-broadcast without the static – and large selections of melodies are downloadable from internet sites, also allowing users to create their own sound files.

The third observation, dominance of NTT Docomo, is dramatic. Spun out of the former telecommunications monopoly, NTT, as an unprofitable division, it became the top market capitalized company on Japanese stock markets in February, 2000. Its operating profits grew to 686 billion yen⁸ in nine years, and with the exception of one year, it has consistently had a market share of over 50 percent in a rapidly expanding market.

III. DEVELOPMENT OF THE JAPANESE TELECOMMUNICATIONS INDUSTRY

We divide the history of Japan's wireless telecommunications industry into three periods, corresponding to major systemic changes in the industry.

The Current Period — 1999 until late 2001

-The Industry

The Japanese wireless telecommunications market enjoys a large market size both in terms of subscribers as a proportion of the population,

as well as in terms of the sheer number of subscribers. Three service providers with nationwide networks compete under two standards. There are a large number of handset manufacturers, with most large consumer electronics companies producing cellular handsets.

As of January 2001, approximately 50 percent of the Japanese population used some form of cellular phone.⁹ As a percentage of the population, Japan had the second largest usage among the G-8 countries and the second largest absolute number of subscribers in the world in January, 2000.¹⁰

The three main service providers are NTT Docomo, KDDI, and J-phone. NTT Docomo became the largest market capitalized firm in Japan in February 2000, and has remained in that position since. It consistently holds approximately 60 percent of the market share, and is clearly the dominant player in the industry. KDDI is the fourth largest communications firm in the world following NTT, AT&T, and Deutsch Telecom, with a market share of approximately 25 percent.¹¹ J-phone has a market share of approximately 16 percent.¹² The two cellular network standards used by these three service providers are PDC and CDMAOne. Adopted only in Japan, PDC is used by NTT Docomo and J-phone, and is incompatible with all other standards used in the world. CDMAOne, on the other hand, used by KDDI, is a global standard, one of the many standards adopted in areas such as North and South America, parts of Europe, China, Korea, the Philippines, and Russia.¹³

⁷ The technological sophistication of Japanese handset is especially impressive when compared directly with standard models manufactured by foreign manufacturers in the Japanese market. Competing in the same market, one might expect foreign manufacturers to match commercially successful designs introduced by domestic manufacturers. As of January 2001, Nokia and Ericsson's handsets had monochrome, 60-character displays, and were capable of producing 4-tone harmonies. At the same time, Sony's handset had approximately twice the screen size with a 65,000 color TFT display, was capable of 16-tone harmonies, sported an integrated mp3 player, and was capable of running Java applets. One might still argue that the foreign handsets were competing on different design grounds. Ericsson's advertising campaign did stress design, with the phrase "Simple beauty from Sweden." However, the handsets are significantly larger and heavier than domestic handsets, and consumers generally regard them as somewhat stylish but impractical for anything except voice communication. (Premium Newsletter, *Mobile Media Japan*, Vol. 1 (January, 2001): 14 <<http://www.mobilemediajapan.com>> (accessed 5 April, 2001))

⁸ \$5.5 billion at an exchange rate of 1 USD = 125 Yen

⁹ population figures from the Statistics Bureau of Japan <http://www.stat.go.jp/english/e_cen_en.htm> and total market figures from <www.mobilemediajapan.com>

¹⁰ Policy Report, Ministry of Posts and Telecommunications, 2000. <<http://www.mpt.go.jp/policyreports/japanese/papers/h12/1-index.html>>

¹¹ Tsuyama, Keiko, *NTT & KDDI Dounaru Tsushin Gyokai* (Tokyo: Nihon jitsugyou shuppan sha, 2000), 12.

¹² Yahoo Finance, <<http://sg.biz.yahoo.com/010406/15/m62s.html>>

-Handsets

Almost all major Japanese consumer electronics companies, such as Matsushita, NEC, Mitsubishi, Sony, and Fujitsu produce cellular handsets.¹⁴ The leading global handset manufacturers, Ericsson, Nokia, and Motorola have also recently entered the Japanese handset market.¹⁵ These handset manufacturers operate on contracts with service providers, who buy the handsets outright, then market them under their own distribution channels. Therefore, service providers have the option of absorbing handset costs when consumers subscribe to their service. Each service provider has a different set of manufacturers providing handsets for their service, although many manufacturers make handsets for multiple providers. In other words, a consumer subscribing to NTT Docomo's service can choose from one set of handsets, manufactured by a certain set of manufacturers, while a KDDI or J-phone subscriber faces a different set of handsets to choose from. Manufacturers such as NEC make handsets for all three services, while Sony offers handsets only for Docomo and KDDI, and companies such as Sanyo manufacture handsets solely for KDDI's service.

Service providers and handset manufacturers work together closely. Service providers have extensive R&D labs that actively play a role in handset development.¹⁶ Providers often pass patents and information to manufacturers and jointly develop products – color display handsets being a prominent example of such joint development.¹⁷ NTT Docomo has the most extensive R&D lab and effectively controls the PDC standard because its predecessor, the tele-

communications monopoly NTT, developed the standard. In many cases, Docomo holds the details of a technology, and manufacturers develop handsets according to unidirectional information passed down from Docomo.¹⁸ Docomo has a "mobile technology division" whose purpose is to ascertain whether the wishes of Docomo project divisions are technologically feasible, and then request manufacturers to make handsets according to its specifications. Handsets taking advantage of Docomo's internet connection service, i-mode, were manufactured in this fashion, with Docomo developing the technology and sending specifications and orders to manufacturers.¹⁹

Service providers, especially Docomo, can also wield power over handset manufacturers. Manufacturers are required to obtain permission from Docomo to sell the same handsets ordered by Docomo to other providers. In April of 1999, Japan's Fair Trade Commission issued a warning to Docomo for purposefully delaying permission by several months to ensure that handsets for its own service remained a technological step ahead of its competitors' handsets.²⁰ Furthermore, Docomo has been known to alter its specifications, forcing manufacturers to adjust their products, causing delays in shipping the same handsets to other providers.²¹ Whether other providers also exert this type of influence over handset manufacturers, and if so, to what extent they do, is unclear.²² Furthermore, the difference in the set of manufacturers between service providers suggests the existence of more than simply contractual relationships. In a pattern often seen in Japanese industries, previous relationships and relationships through shareholder groupings may play a role in determining

¹³ Shinohara, Isao, *Docomo ga sekai wo seisuru hi* (Tokyo: Toyo keizai shinpo sha, 2000), data page 8.

¹⁴ The complete list of domestic handset manufacturers is quite extensive, and is the following: NEC, Sharp, Sony, Denso, Fujitsu, Panasonic, Mitsubishi, Casio, Kyocera, Sanyo, Toshiba, Hitachi, Panasonic, Pioneer, Kenwood.

¹⁵ As of October, 2000, Nokia had approximately 30% of the global market, Motorola had 15%, and Ericsson had 11% (Nakagawa, Masahiro, "Keitai Denwa secta ni kansuru kyousou kankyou bunseki repoto," *Kokusai kyousouryoku kenkyu kai* 7 (2000).

¹⁶ Ohoshi Koji, the previous president and current chairman of Docomo claims that Docomo's R&D labs are the most extensive wireless cellular R&D labs in the world, while KDDI's R&D labs are widely acclaimed for their R&D in satellite telecommunications. (Yuasa, Izumi, *NTT Docomo no chousen* (Tokyo: Kousho bou, 2000), 74)

¹⁷ Yuasa, *NTT Docomo no chousen*, 167.

¹⁸ Yuasa, *NTT Docomo no chousen*, 167.

¹⁹ Matsunaga, Mari, *I-mode Jiken* (Tokyo: Kadokawa shoten, 2000), 154.

²⁰ Yuasa, *NTT Docomo no chousen*, 167.

²¹ Yuasa, *NTT Docomo no chousen*, 167.

the service providers to which manufacturers sell handsets.

-Cellular internet connection services

As of April 2001, approximately half of all Japanese cellular users subscribed to one of the services offered by the three providers, with the market growing by over 36 million people in two years.²³ Docomo's i-mode service has approximately 64 percent of the market share, while EZWeb from KDDI has 19 percent, and J-sky from J-phone has 17 percent.

There are two standards used for these internet connection services. HTML²⁴ variants are used by Docomo and J-phone, while WAP²⁵ is employed by KDDI. I-mode and J-sky both use proprietary, simplified versions of the HTML language, with a number of additional features that take advantage of handsets. The two services differ slightly in their implementations of HTML. They were originally designed to be mutually exclusive, but each provider has recently been adding converter applications to access each other's content. Docomo's language, Compact HTML, has more features than J-phone's implementation of HTML, termed MML (Mobile Markup Language), and several versions of Compact HTML have been released as the capability of handsets has improved. Improvements include larger screen sizes, the addition and subsequent improvement of color displays, and the incorporation of a version of Java.²⁶ I-mode phones can now run Java applets written in a proprietary form of Java, unsurprisingly named by Docomo as i-java. WAP, employed by KDDI's EZWeb is an international standard for mobile applications using HDML (Handheld Device Markup Language), and is incompatible with HTML. The amount of content written in HDML is dwarfed by the simplified HTML content.²⁷

In each service, the portal²⁸ is a menu system constructed by the provider, rather than being a general search engine, and users cannot change the portal. The menu provides easy access to "recommended," or "official" sites. Content providers apply and pay to become official sites listed in the menu system, and providers examine content before giving approval. For official sites requiring membership or usage fees, the amount charged appears on the monthly bill from the service provider.²⁹ However, the cellular internet connections services are not closed systems. The steps needed to access a screen allowing users to manually enter addresses are neither complicated nor difficult, and major third-party search engines such as *yahoo*, *google*, and *excite* have released mobile versions for all three services.

Development of the Japanese wireless telecommunications industry — 1980s-1999

-The Industry

An examination of the development of the Japanese wireless telecommunications industry should start in 1985, when the national telecommunications monopoly was privatized to create NTT (Nippon Telephone and Telegraph), a private company with certain monopoly rights such as the last mile for telephone networks. This privatization was the result of the first of many "NTT laws" enacted by what was then the Ministry of Posts and Telecommunications. In 1987, analog wireless cellular service was launched, using the PDC format developed by NTT. This PDC format was a proprietary format used only in Japan, and until global standards were adopted, the Japanese wireless telecommunications industry was completely isolated from developments in wireless markets in other parts of the world. Also in 1987, DDI and IDO entered the tele-

²² Most information is about NTT Docomo, and with its dominant market share, Docomo can be expected to have more clout, but its actions are also scrutinized more carefully by all observers.

²³ For information, see <<http://www.mobilemediajapan.com>>

²⁴ HTML (Hyper Text Markup Language) is the coding language used in internet web pages.

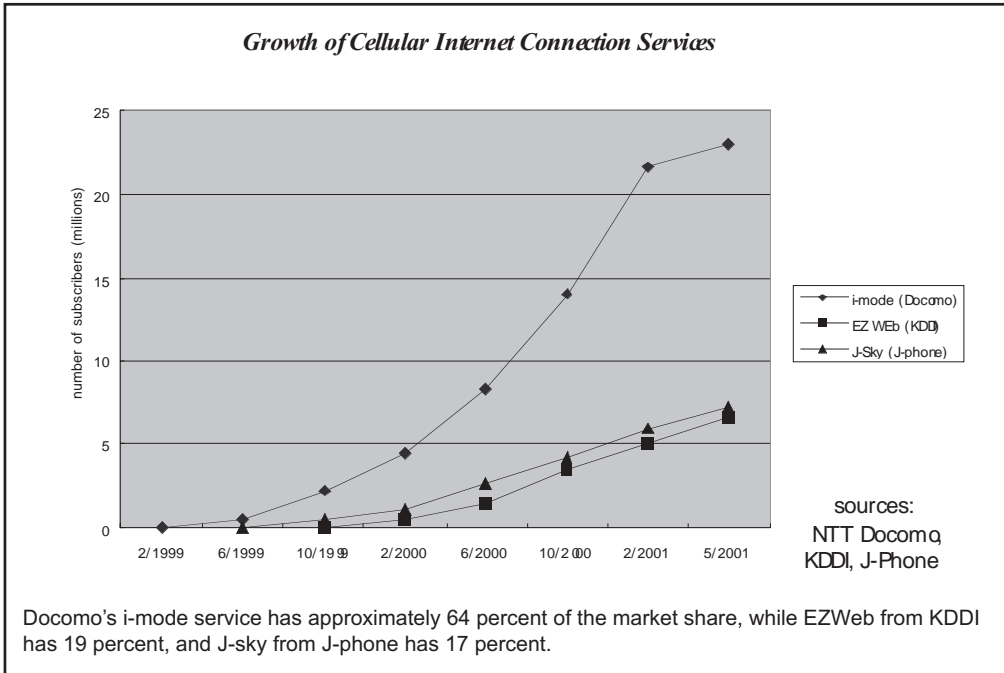
²⁵ Wireless Application Protocol

²⁶ Java is a coding language allowing small applications to be downloaded from a central source and executed locally, without requiring a connection to the central source once it downloaded.

²⁷ Shinohara, *Docomo ga sekai wo seisuru hi*, 49.

²⁸ The "web page" equivalent shown first every time the cellular internet connection is activated.

²⁹ Yuasa, *NTT Docomo no chousen*, 96.



communications market as a result of deregulation in 1985. In 1991, NTT introduced the first model of its “Mova” series with a dramatic reduction in entry price, and the cellular market size grew to just over one percent of the population for the first time. In 1992, as a result of another “NTT law” in 1990, the cellular division of NTT was spun out, creating NTT Docomo. Even at this time, the Japanese cellular industry was lagging far behind that of other countries. Service prices were four to five times more expensive, and the market size still remained only slightly more than one percent of the population.³⁰ By 1994 Docomo had undertaken aggressive price cuts in entry and monthly fees, and had abolished expensive deposit fees for handsets, which were on a rental basis. Between 1993 and 1994, the number of subscribers doubled from 2 million to 4 million users. Finally, in 1993, the digital cellular network was introduced, improving sound quality.

The year 1994 was a watershed in the industry’s development. A series of deregulations changed the industry structure significantly. First, competitors in the cellular industry emerged – Tokyo Digital Phone (later

to become part of J-phone) and Tsuka Cellular (later consolidated into KDDI). Second, the manufacture of handsets was liberalized, allowing service providers to purchase handsets from external sources. Finally, handsets could be sold to customers outright rather than having to be leased. These developments were identical to earlier deregulations of land-line telecommunications, in which competition was introduced, telephone leasing was abolished, and manufacturing was liberalized.³¹ Growth in demand began to accelerate, and the installed user base increased by more than a factor of two.

Furthermore, in late 1994, the industry’s current retail structure and district company organization was established. First, largely as a response to how the newly entered competitors successfully organized their retail networks, Docomo revamped its sales network. Primary demand was unexpectedly from retail consumers rather than business users, which Docomo had originally targeted – legacy of NTT business practices. The sales network was altered from a small number of directly controlled sales units, again legacy of NTT, to outsourced sales units. Two hundred

³⁰ Ohoshi, Koji, *Docomo Kyuseichou no Keiei* (Tokyo: Diamond sha, 2000), 1-2.

³¹ Ohoshi, *Docomo Kyuseichou no Keiei*, 3.

forty specialty stores were established within that year in the Kanto region, and large electronics and discount stores were allowed to sell subscriptions and handsets.³² By July 2000, over ten thousand retail channels had been established, including specialty and general electronics stores. Second, Docomo divided itself into nine district companies to micro-manage sales, advertising, and regional management tasks according to local conditions.³³ Top-level management from the central company were placed at the head of each district company to integrate management.³⁴ Since the competitors were already divided into districts, as will be examined in depth later, this restructuring by Docomo essentially established the current district structures.

Price wars began in 1994, and in 1995, introductory fees were abolished and monthly fees were further reduced. Handset costs were often almost completely absorbed by service providers, and consumers usually expected to pay less than a tenth of the price for handsets that might have otherwise cost more than \$100. In 1996, non-voice application began to proliferate as short message systems became popular and the *Pocketboard* mentioned earlier was introduced. Between 1993 and 1996, the market expanded by a factor of two or more every year, starting at 2 million users in 1993, reaching 21 million in 1996.

In 1997, Docomo began operations with ALADIN, the integrated information system mentioned earlier when examining retail. The system was designed with a modular architecture to effectively cope with exploding demand. The largest open client/server network in 1997, it combined user, sales, branch, and customer balance information, along with telephone number allocations into one database, which was then accessible to the service order center, network service center, routers and billing and accounting divisions. In 1999, Docomo introduced i-mode, and a national network using the CDMAOne standard was completed. At this point, in our analytical divisions of the industry's development, the tran-

sition was made to a period of mainstream non-voice communications and multiple domestic standards.

“THE ENTRANCE OF JAPANESE SERVICE PROVIDERS AND HANDSET MANUFACTURERS IN GLOBAL WIRELESS TELECOMMUNICATIONS MARKETS IS CAUSING WIDESPREAD SPECULATION ABOUT HOW THE MARKET WILL CHANGE IN THE FUTURE.”

-Proliferation and Consolidation

In focusing on the development of service providers, we see a trend of proliferation followed by consolidation from the inception of wireless services to the current industry organization. In 1985, when NTT was privatized, the Ministry of Post and Telecommunications divided Japan into nine districts in a policy identical to previous telecommunications policy. When competition was allowed in 1992, the policy restricted entry to only one new carrier in addition to NTT per district. When IDO and DDI Cellular established themselves as competitors in the cellular market, they were forced to divide themselves between districts. IDO established itself in the Tokyo and Tokai region under the name Tokyo Digital Phone (the Pacific coastal region between Tokyo and Osaka) to concentrate on service to Tokyo, and DDI took everywhere else, concentrating on cities such as Osaka in Western Japan, under the name Tsuka Cellular.³⁵

In 1991, when the Ministry of Post and Telecommunications adopted a digital cellular network, it loosened restrictions on competition, allowing three carriers in addition to NTT per district. By 1996, Tokyo, Osaka, Nagoya, and major metropolitan areas had four competing service providers — Tsuka Cellular, Digital Phone, IDO, and NTT Docomo. The rest of the nation had three competitors,

³² Ohoshi, *Docomo Kyuseichou no Keiei*, 132.

³³ Ohoshi, *Docomo Kyuseichou no Keiei*, 138.

³⁴ Ohoshi, *Docomo Kyuseichou no Keiei*, 140.

³⁵ Tsuyama, *NTT & KDDI Dounaru Tsushin Gyokai*, 81.

Docomo, Digital Tsuka, and DDI.³⁶ Thus Docomo was the only carrier with a nation-wide network under same name. Others providers had contracts with other networks allowing roaming, but predictably, this proliferation of carriers with different service areas led to consumer confusion.

In late 1996, the Ministry of Post and Telecommunications announced that for the next generation wireless standard, IMT-2000, only three providers could compete in each district.³⁷ It may be noted that this time, NTT was not specified in the legislation. Following this announcement, widespread consolidation began to occur in the industry. In the spring of 1997, DDI and IDO joined hands, establishing a unified national network. In 1998, they introduced a competing standard with faster speeds, CDMAOne, completing a national network in April 1999.³⁸ In 1999, another unified national provider, J-phone was established when Digital Phone and Digital Tsuka (confusingly, a different company from Tsuka) merged. This was a result of the purchase of Nissan's shares by Nippon Telecom, who held majority stakes in Digital Phone and jointly owned Digital Tsuka with Nissan.³⁹ Finally, in late 2000, DDI and IDO joined a major telecommunications company, KDD, which held Tsuka, consolidating into KDDI, standardizing its brand nationally as "au" for CDMAOne service, and retaining Tsuka for PDC service. Thus by January 2001, the Japanese industry had consolidated into three nationally unified carriers operating under three brand names.

-Handsets

The development of handsets in Japan was rapid, and the industry underwent a major structural change in 1994. Initially, all handsets were manufactured by NTT, which we can assume was closely cooperating with a selected manufacturer on terms similar to an OEM contract. In 1987, when the analog service began, handsets weighed 2 kg, and were known as "shoulder phones."⁴⁰ In 1990, the smallest and lightest cellphone in Japan at the time, *Handiphone mini* was introduced. In 1991, further

miniaturization resulted in the *Mova*, weighing 220 grams. As mentioned earlier, handset manufacturing was liberalized in 1994, and any manufacturer could be contracted in production. In 1995, the Digital Mova series was introduced, becoming the smallest and lightest handset in the world in 1996. By this time, the number of manufacturers and varieties of handsets had exploded. In 1997, color handsets were introduced, and handsets were as light as 75 grams. Up to this point, the development of handsets could be characterized by miniaturization and functionality improvement. From 1997 on, as data transfer became an option, handsets with radical design departures began to appear. Handsets that mimicked PC cards were introduced in 1999, and in 2000, handsets with mp3 players and radios were introduced. By 2001, handsets with digital cameras and models with connectivity to Nintendo Gameboys and automobile GPS systems had been introduced.

-Internet connection services

Development of the internet connection services, which revealed unforeseen demand, shifted the global center of gravity of innovation in telecommunication service to Japan. The story of how the pioneering i-mode developed has been widely publicized, but sources documenting development of EZWeb and J-sky are scarce. However, the other services were following the footsteps of a model already proven to be successful. Therefore, our main interest is the development of i-mode.

I-mode developed as an in-house venture under strong presidential directives, working outside the established organizational norms of NTT Docomo. In late 1996 or early 1997, seeing the impending saturation of the voice-based communications market, the president of NTT Docomo at the time, Ohoshi Koji, appointed an engineer, Enoki Keiichi, to lead a new project to enable some form of successful non-voice communications application. Enoki was not only given unlimited financial and R&D resources, but also free rein over hiring

³⁶ Tsuyama, *NTT & KDDI Dounaru Tsushin Gyokai*, 80.

³⁷ Policy Report, Ministry of Post and Telecommunications, 1997. <<http://www.mpt.go.jp/policyreports/japanese/papers/index-98wp.html>> (accessed 5 May 2001).

³⁸ Tsuyama, *NTT & KDDI Dounaru Tsushin Gyokai*, 84.

³⁹ Yuasa, *NTT Docomo no chousen*, 76.

⁴⁰ Motorola had already succeeded in 1985 in manufacturing "handset" style cellular phones that were much smaller and lighter than these "shoulder phones." (Ohoshi, *Docomo Kyuseichou no Keiei*, 126.)

personnel. In establishing a team, he hired several key people from outside the NTT group – a radical departure from NTT’s historical record and corporate culture. McKinsey consultants were also hired, another departure from Japanese corporate culture in general, especially for the conservative NTT group. The McKinsey consultants were a significant force driving the initial establishment of a conceptual framework for the service.⁴¹

Enoki was a strong leader, making several pivotal decisions that contributed to the wide success of i-mode. First, in 1997 he chose to adopt a simplified form of HTML rather than WAP, despite the fact that Docomo was scheduled to join the international “WAP forum” later that year.⁴² His rationale was that at the time, WAP protocol had not yet been established as a widely used standard, and that an HTML-based language could tap into the installed base of HTML pages and users familiar with HTML. This adoption of HTML on a basic level was one factor many people cited as “user-friendly” when they created content, and was probably one of the major factors contributing to the explosion of i-mode enabled pages immediately after its release. Second, among researchers and managers he hired from outside the NTT group, one of the key figures was a successful magazine editor, Matsunaga Mari, who established several policies for i-mode that successfully targeted mass consumers. First, Matsunaga set an extremely low price for i-mode subscription. Despite adamant opposition from McKinsey consultants and many engineers, she set the basic monthly fee at 300 yen,⁴³ the same price as monthly magazines. Her rationale was that if the price allowed i-mode to be as accessible as magazines on a magazine stand, people could easily initially subscribe out of curiosity. This pricing scheme is also a widely recognized causal factor for the explosion of i-mode subscribers that rapidly established a large installed base. Second, Matsunaga chose to create a proprietary menu as the portal, allowing Docomo to choose easily viewed content rather than simply relying on a search engine portal for people to roam

freely. Once again, McKinsey consultants and several engineers advised against this move.⁴⁴ However, in hindsight, since the level of diffusion of computers and the internet in Japan is low vis-à-vis many developed nations, a great proportion of i-mode users are unfamiliar with these technologies, making this menu system a widely acknowledged factor contributing to the success of i-mode.

Ezweb was introduced in April, 1999, and J-sky was introduced in December, 1999. They took advantage of an already cultivated market, and documentation about their development is unavailable. Their growth has been rapid, as seen in the chart earlier, but i-mode still dominates the internet connection service market.

Issues for the near future – 2001 ~

Analog cellular networks are known as first generation; digital networks are second generation; and in late 2001, third generation cellular networks, commonly known as IMT-2000 (International Mobile Telecommunications Standard 2000) are scheduled to begin service. The International Telecommunications Union (ITU) based in Geneva, Switzerland, composed of 189 member states and 650 industry members, which decides on many global standards, chose three global standards for the third generation service. When successfully implemented, third generation services are expected to offer 30 to 200 times faster throughput speeds⁴⁵ while using bandwidth more efficiently, creating potential for a broad variety of applications and uses.

Two major third generation standards approved by ITU, Wideband CDMA (W-CDMA) and CDMA 2000, are battling to become the dominant global third generation standard. These two standards will initially be incompatible with one another, but they can be expected to eventually attain mutual compatibility, since the ITU approval of both was because both were based on CDMA encoding and displayed potential for compatibility.⁴⁶ W-CDMA was developed by NTT Docomo, and CDMA 2000

⁴¹ Matsunaga, *I-mode Jiken*, 28.

⁴² Matsunaga, *I-mode Jiken*, 144.

⁴³ \$2.40 at an exchange rate of 1 USD = 125 yen

⁴⁴ Matsunaga, *I-mode Jiken*, 75.

⁴⁵ Second generation services offer a throughput of 10 kilobits per second, while third generation services are expected to offer between 384 kilobits per second to 2 megabits per second (*The road to IMT 2000*, International Telecommunications Union. <http://www.itu.int/imt/what_is/roadto/index.html> (accessed 5 May, 2001).

⁴⁶ Yuasa, *NTT Docomo no chousen*, 49.

was developed by Qualcomm of the US. The battle of global standards is being waged because the wider the acceptance of one standard, the larger the market to which service providers have access.

In Japan, W-CDMA will be adopted by NTT Docomo and J-phone, with Docomo planning to begin test service in late 2001, and J-phone beginning service the next year. KDDI, which is now using CDMAOne, a less developed form of CDMA2000, considered a 2.5 generation standard, since its transmission speeds are faster than first generation, but slower than third generation standards, is expected to maintain its CDMA One network while gradually phasing into CDMA 2000. As of spring 2001, a majority of service providers have pledged adoption of W-CDMA in Japan, Europe, parts of Southeast Asia, and parts of North America, while major providers in North America, China, and other parts of Southeast Asia have pledged adoption of CDMA 2000.

The adoption of a global standard by all service providers signifies entrance of the Japanese wireless telecommunications industry into global markets. Japanese service providers will be in a position to directly compete against service providers in other parts of the world using their technological and organizational expertise. NTT Docomo, which is expected to have technological advantages over other service providers using the W-CDMA standard, since they were mainly responsible for its development, has been expanding its presence throughout the world in preparation for this convergence. It has purchased shares of major wireless providers such as AT&T Wireless in the US, the Hutchison Telephone company in Hong Kong, Hutchison 3G UK of Great Britain, KG Telecom of Taiwan, KPN mobile of the Netherlands, and Telecom Italia Mobile. It has also begun sending managers to Hong Kong.⁴⁷ The specifics on how Docomo expects to profit from tie-ups with foreign firms are still unclear. At the same time, foreign service providers will have access to Japanese markets beyond providing capital and strategic advice, such as Vodafone has begun doing for J-phone.

For Japanese handset manufacturers, a common global standard increases their potential mar-

ket several times. While the Japanese domestic standard was isolated, the main thrust of their R&D was directed towards PDC format handsets, and their product line for other standards, sold in other parts of the world, was sparse. However, with W-CDMA, the main thrust of their R&D efforts are applicable to global markets, and since they have been working closely with Docomo, their implementation of W-CDMA is expected to be technologically sophisticated. Several manufacturers have openly declared their intent to capture a large portion of the global market shares currently enjoyed by Ericsson and Nokia.⁴⁸ At the same time, foreign manufacturers can enter the Japanese market with their flagship products, rather than reengineering handsets for the PDC format. Along with the three large globally dominant firms, low-cost, low-end handsets from Taiwan and Korea can be expected to compete on Japanese markets as well.

The globalization of handset markets may erode a large portion of the power held by Japanese handset providers, especially NTT Docomo, over handset manufacturers. While Japan's market was in isolation, the incentive to work with the dominant provider was large, but if manufacturers have access to larger markets than Japan, they may gain bargaining power vis-à-vis Docomo, threatening to sell products to only competitors if they are confident in other markets. With increased competition among service providers, offering fewer popular handset models would be a severe disadvantage for Docomo. Therefore, handset manufacturers may be expected to gain more autonomy.

For software content providers, depending on the type of standard adopted for third-generation devices, the convergence of domestic and global markets may increase initial business chances, but also entails high-level competition. Since Japanese content providers will have already had substantial experience creating content for cellular handsets, they may be expected to have superior implementation in the short run, since they may be on the third or fourth version of releases. However, content accessible anywhere in the world may not be an advantage until business models can be established allowing payment from users of other ser-

⁴⁷ General report, NTT Docomo. <<http://www.nttdocomo.co.jp/new/contents/01/whatnew0129.html>> (accessed 6 May, 2001).

⁴⁸ "Matsushita...Sony set to take Ericsson, Nokia 3G handset share," News release. <http://www.mformobile.com/default.asp?Redirect=main.asp?pk=12591> (accessed 6 May, 2001).

⁴⁹ Baldwin, Clarkiss Y. and Kim B. Clark, *Design Rules*, (Cambridge: MIT Press, 2000), 12.

vices in other countries, which may not work in the same manner as Japan. Furthermore, without local patent or intellectual property rights, the likelihood of a similar or reverse-engineered service appearing in different countries is possible. Finally, large global content providers can be expected to move into the Japanese market in the fashion of yahoo or ebay. However, these implications from convergence do not necessarily affect service providers' monopoly over the portal, using menu systems.

IV. THEORIES

Baldwin and Clark

In Design Rules, Baldwin and Clark develop a highly sophisticated theoretical framework exploring modularity and its effects on organizational and industrial evolution. They are, at the broadest level, trying to formulate a theory of how design modularity is conducive to innovation. The core of their argument is essentially as follows: *Modularity in the design of a system opens new paths for system design as a whole.*⁴⁹ *This will cause an explosion in the number of designs, potentially entailing a radical change in the market value of the entire system.*⁵⁰ The mechanism causing an explosion of designs and subsequent change in market value is "a decentralized search by many designers for valuable options."⁵¹

Langlois and Robertson

The main argument Langlois and Robertson present in Firms, Markets, and Economic Change is essentially as follows: *For generating innovative concepts under conditions of extreme uncertainty, large numbers of teams working independently are better than large, vertically integrated firms that internalize change. However, large, centralized firms do have*

advantages in implementing new technologies. In this framework, uncertainty is defined as conditions in which the product and process technologies are evolving, with the nature and size of markets yet to be determined.⁵² Langlois and Robertson extend Baldwin and Clark's theory, adding the dimension of *implementation of innovation.*

Aoki

Aoki, in Towards a Comparative Institutional Analysis, creates a theoretical framework identifying organizational structures observed in major industrial models. Prominent models include the vertical hierarchies in the "American model" of production, horizontal hierarchies in Japanese production models, and decentralized industry clusters observed in Silicon Valley. Aoki maps information flows between different components within organizational structures, arguing that each type of organization is best suited to deal with environments with specific types of uncertainty. Aoki extends the previous two theories, which only deal with radical conceptual innovation, by including information flows in his analysis. In Aoki's framework, tacit information sharing seen in Japanese-style horizontal hierarchies is best suited for *process innovation*, where design trajectories are known.

V. ANALYSIS

Theories

Now that we have introduced empirical evidence and three theories of technological development, we are ready to create an explanatory historical narrative of to Japan's wireless telecommunications industry.

⁵⁰ Baldwin and Clark, Design Rules, 245.

⁵¹ Baldwin and Clark, Design Rules, 14.

⁵² Langlois and Robertson, Firms, Markets and Economic Change : A Dynamic Theory of Business Institutions, (New York: Routledge, 1995), 149.

In the 1980s the Japanese wireless telecommunications industry was founded when the PDC format was adopted and spectrum was allocated to NTT. The PDC format, incompatible with all other standards in the world, isolated Japan's cellular industry from global competition.

From the 1980s to 1999, Japan's wireless services and handsets underwent rapid process innovation, catching up to and subsequently surpassing international competition within the same design trajectories. During the period from the 1980s to 1994, we observe the following. Japan's wireless telecommunications industry remained at a comparatively backward state of development vis-à-vis other wireless telecommunications industries until the early 1990s. As seen earlier, service was expensive, coverage was poor, and handsets developed from larger models optimized for cars to smaller "handset" devices, but were technologically less developed vis-à-vis models in global markets. In 1993, the digital network was established nationally, and by 1994, the gap had closed significantly – service prices had decreased significantly but were still higher, service coverage had improved substantially, but was not without significant gaps, and handsets had become dramatically smaller, but were not yet the smallest in the world. In sum, during this period, infrastructure was established and designs were fundamentally altered to align design trajectories with the rest of the world, allowing incremental improvement and mass production.

Using the theories, we can explain these developments as the effective implementation of innovation due to vertical integration. During this period, most of the innovation was from abroad. NTT Docomo looked at services and handsets in other parts of the world, incorporating similar business models and designs into its service and handsets. The organization of Japan's wireless telecommunica-

tions industry offered the following advantages. First, innovation could be implemented rapidly due to the high level of vertical integration, as explained by Langlois and Robertson. Second, Aoki's framework explains how the vertical hierarchy allowed rapid implementation of centralized decisions from the top down, and that the organization was conducive to incremental improvement and mass production.

From 1994 until 1999, we observe that the gap closed between global cellular service markets and Japan's market, and

"THE GLOBALIZATION OF HANDSET MARKETS MAY ERODE A LARGE PORTION OF THE POWER HELD BY JAPANESE HANDSET PROVIDERS, ESPECIALLY NTT DOCOMO, OVER HANDSET MANUFACTURERS".

that Japanese handsets surpassed international competition in terms of miniaturization and sophistication. Service prices in Japan were lowered to similar levels as other cellular markets, and service functionality caught up to cellular industries in other countries, with seamless area coverage and new features such as short messaging systems. In 1996, a Japanese handset became the world's smallest handset, and by 1997, the standard Japanese handset size was smaller than models manufactured by globally dominant handset manufacturers. Pointers, menus, and complex ringing melodies were introduced in Japanese handsets, becoming standard features before many global manufacturers had even introduced such features. The number of handset designs had increased, and as seen earlier, the market value of the entire cellular service system rose dramatically.

These developments can be explained as process innovation that occurred more rapidly in Japan than in the rest of the

⁵³ As mentioned earlier, the automobile and semiconductor industries, along with sectors such as consumer electronics are prominent examples.

beginning to pioneer in services and embark on new handset design trajectories. The Japanese wireless telecommunications industry was first to experience the proliferation of internet sites, high level of subscription, and extensive utilization of internet e-mail, although later short messaging systems began to proliferate worldwide, and a functional cellular internet connection service was offered in Finland.⁵⁴ Handset designs began to diverge vis-à-vis the rest of the world with the introduction of the aforementioned digital cameras, mp3 players, and PC card functionality seen only in Japan.

The development of cellular internet connection services can be explained as fairly radical innovation, while improvements in handsets are rapid process innovation combined with more radical recombinations of technology. In all three theories, the cellular internet connection service is a radical innovation, explained by a decentralization of the locus of decision-making. Baldwin and Clark articulate this decentralization as modularity, while in Langlois and Robertson's theory, the organization of this system is close to innovative networks, or Silicon Valley clustering, in Aoki's terms. The departure of the design trajectory in handsets is explained by Langlois and Robertson's theory as the rapid implementation of innovations⁵⁵ made possible with keiretsu networks. Using Aoki's framework, we extend this explanation by showing that the combination of relational and non-relational contracting is conducive not only to rapid process innovation but also to potentially more radical innovation.⁵⁶ These developments – radical innovation and a departure of design trajectories – is uncommon among Japan industries competing globally.

The dominance of Docomo can be explained to a degree by examining the

change in its organizational structure and the network effects it captured. First, we have seen that Docomo changed its organizational structure when handset manufacturing was liberalized to create an organizational form most conducive to rapid process innovation. Had Docomo continued to sell handsets under its own name through OEM relationships with one or two handset manufacturers, it is likely that Docomo would have lost its competitive edge in handset sophistication, since process innovation would not have been as rapid. Second, in applying the experience of the US Hi-Fi Stereo industry to Japan, we have seen that Docomo successfully took advantage of network effects to create positive feedback loops, attracting and retaining subscribers as new services were introduced.

VI. ANSWERING THE INITIAL QUESTIONS

Thus we are now in a position to take the contemporary observations made about Japan's wireless telecommunications industry and explain the development in the following manner. In the most simplified explanation, the three key observations – pioneering cellular internet connection services, technologically developed handsets, and Docomo's dominance – are the result of three distinct phases of development. First, in an environment where design trajectories were known, basic infrastructure was rapidly installed and design trajectories were aligned with other wireless telecommunications industries worldwide. This could be accomplished effectively due to high levels of vertical integration. Second, rapid and accelerating process innovation resulted in Japan's cellular services and handsets rapidly catching up to global

⁵⁴ "The Wireless Wars," *International Herald Tribune*, 4 December 2000, insert, p. 1.

⁵⁵ In this case we refer to innovations from other industries, such as mp3 players and small digital cameras.

⁵⁶ The suppliers keiretsu allows joint development and the rapid implementation of innovations, with Sony's incorporation of mp3 players into its handset being an example. The potential for new relationships with an IA-IE organization also allows more radical innovation, such as Kyocera cameras being implemented into Sanyo handsets although the companies are not part of keiretsu organizations.

standards, with handsets subsequently surpassing globally dominant handset models. Rapid process innovation was largely a function of a degree of vertical disintegration and keiretsu organizations, and Docomo's retention of dominance was partly due to its corresponding vertical disintegration. Third, cellular internet connection services introduced radical innovation into the industry, and handset designs departed from global design trajectories as faster process innovation and more radical innovation occurred. Radical innovation in an environment of extreme uncertainty was due to adoption of a system decentralizing the locus of decision-making, and the departure in handset design trajectories was possible with an organizational structure combining relational and non-relational contracting. As innovations were introduced, Docomo was able to capitalize on network effects to secure its dominant position.

In sum, organizational structures maximizing advantages of development given the environmental uncertainty gave rise to successful cellular internet connection services and highly advanced handsets, and Docomo remained dominant by adapting organizational structures and capturing network effects.

Policy

Let us now examine the effects of policy on development of the Japanese wireless telecommunications industry. As has already been firmly established, development of the industry initially lagged behind other industrialized nations, but by the time of convergence with global markets, process innovation has overtaken the rest of the world, and development is on a trajectory of radical innovation.

Through the narrative of development we constructed in the previous section, we used theories explaining innovation to examine *why* these developments could occur. We found that the organizational structures in various areas of the Japanese wireless industry maximized advantages of development given the type of environmental uncertainty. It is now our task to examine *how policy affected* the creation of those organizational structures. Since we have already seen the various government policies in our early historical overview of the industry, we now reassemble them to obtain a cohesive picture of how they affected the organizational structures.

First, the Ministry of Posts and Telecommunications (MPT) created an isolated domestic market with a vertically integrated monopoly. By approving a proprietary standard and allocating wavelength spectrum only to NTT, the Japanese market was later isolated from potential foreign competition. Furthermore, the telecommunications industry consisted of a monopoly, which was not broken up until after a digital network was implemented nationally. However, it is difficult to claim that policy *created* this configuration. In the nascent stages of wireless communications, it was not expected that services would develop in the current fashion, and benefits of standardization across countries and regions were unrecognized.⁵⁷ Telecommunication in almost all countries in the world also started as government monopolies. Therefore, having a proprietary domestic standard and a vertically integrated telecommunications monopoly was more of a global norm than a policy outcome.⁵⁸

However, given that the basic industry structure and global isolation were a

⁵⁷ In the early stages of wireless telecommunications, when cellular phones were "automobile phones" and took up the entire trunk of a car, the market was considered to have an extremely limited capacity, potential benefits from standardizing formats were never conceived. (Kano, Sadahiko, "Technical innovations, standardization and regional comparison – a case study in mobile communications," *Telecommunications Policy* (2000), 312. <<http://www.elsevier.com/locate/telpol>>)

⁵⁸ The US and European telecommunications companies all started out as government monopolies, and first-generation analog standards were different in each region. (Kano, "Technical innovations, standardization and regional comparison – a case study in mobile communications," 310.)

global norm, the timing for adoption of a digital net work took advantage of the industry structure. The MPT adopted a digital network *before* it introduced competition into the service provider market. Adoption of the digital network at this time took advantage of the vertically integrated, monopolistic nature of the industry, since the entire industry was able to implement this structural innovation⁵⁹ rapidly. As seen earlier, contrasting this centralized shift to a digital network is the experience of the US cellular service industry, in which half the service providers still use analog networks, preventing the spread of high-performance non-voice communications. Whether this timing was intentional or not is unclear, and is beyond the scope of this paper.

Second, MPT policy changed the industry structure in 1994, introducing competition and allowing vertical disintegration. In introducing competition into the cellular service market, the MPT allowed four providers per district. This level of competition is rare in other parts of the world,⁶⁰ effectively shifting the industry from a monopoly to an arena of intense competition. Faced with this intense competition, NTT Docomo engaged in extensive restructuring of its capabilities, implementing a network-integrated functional hierarchy structure. At the same time that competition in the service provider market was introduced, liberalization of handset manufacturing directly created the less vertically-integrated suppliers keiretsu organizations. Since relational contracting began to fade only in the late 1990s, the creation of suppliers keiretsu was a naturally expected outcome from liberalizing handsets. In the realm of handset manufacturing, consumer electronics companies entering the handset manufacturing business already had networks of suppliers keiretsu. Thus with the

introduction of competition and the liberalization of handset manufacturing, policy created an environment and an industry structure conducive to rapid process innovation.

Third, adoption of IMT 2000 and the subsequent limiting of competition, decreasing the number of service providers to three per district, precipitated the unification of carriers into nationally unified providers. This prepared the industry for global competition from a national standpoint, since R&D efforts would be consolidated and small, regional carriers that might become likely candidates for foreign takeovers would be part of a large, nationally unified company.

Finally, the MPT did not step in to regulate non-voice communications at all. Given that the experience of development in the computer industry and Silicon Valley were essentially free of government intervention aside from investment and bankruptcy laws conducive to startup ventures, it seems that decentralized, modular systems can develop effectively without policy initiatives. Therefore, inaction on the part of the MPT in this case aided development of the organizational structural of internet connection services, best adapted in environments of extreme uncertainty.

Thus, through action or inaction, intentional or not, we find that government policy was, in fact, greatly responsible for creating the organizational structures that we concluded maximized advantages of development given the type of environmental uncertainty.

VII. CONCLUSION

In this paper, we examined Japan's wireless telecommunications industry, which has recently been receiving international atten-

⁵⁹ Recall that *structural* innovation, as defined by Langlois and Robertson, indicate an innovation requiring all other components to be altered when implementing the innovation, contrasting an *autonomous* innovation, where innovation can be implemented into each component independently. Since changing cellular networks from analog to cellular require changes in all broadcasting hardware as well as handsets and software operating the entire system, it is structural innovation.

⁶⁰ Tsuyama, *NTT & KDDI Dounaru Tsushin Gyokai*, 83.

tion, but which has not been analyzed at an academic level. By rigorously applying three theories of innovation to explain the development of this industry, we found how organizational structures have contributed to the three most commonly made observations, and the role policies played in shaping those organizational structures.

As third generation networks are introduced globally, wireless telecommunications

will further change how we live and how we work. Rapid and extensive change in the industry on a global scale is widely predicted and anticipated within the next decade. This study provides a basic understanding of this industry in its first decade of significance, and a way to think about this industry that will become the basis for how we understand a significant portion of our world as it changes our lives in the future.

This essay is a modified version of an undergraduate honors thesis that received the Firestone Medal for Excellence in Research in the field of East Asian Studies in 2001.

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