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Abstract:
Japanese telecommunication firms entered the 1990s as major players in the global market. The 1990s coincided with an explosion in global demand for telecommunications products. Japanese firms, however, witnessed a strong decline in global competitiveness over the 1990s. We explore the factors accounting for this change in fortune focusing on the Internet network equipment industry and 2nd generation handsets. The Japanese problem in telecom grew out of weaknesses in: their approach to deregulation, their commitment to relationship contracting in an environment characterized by disruptive technologies, the absence of a supportive environment for start ups, institutional rigidities within NTT, and non-strategic approaches taken towards standard setting.

Keywords: telecommunications, competitiveness, Japan, standards

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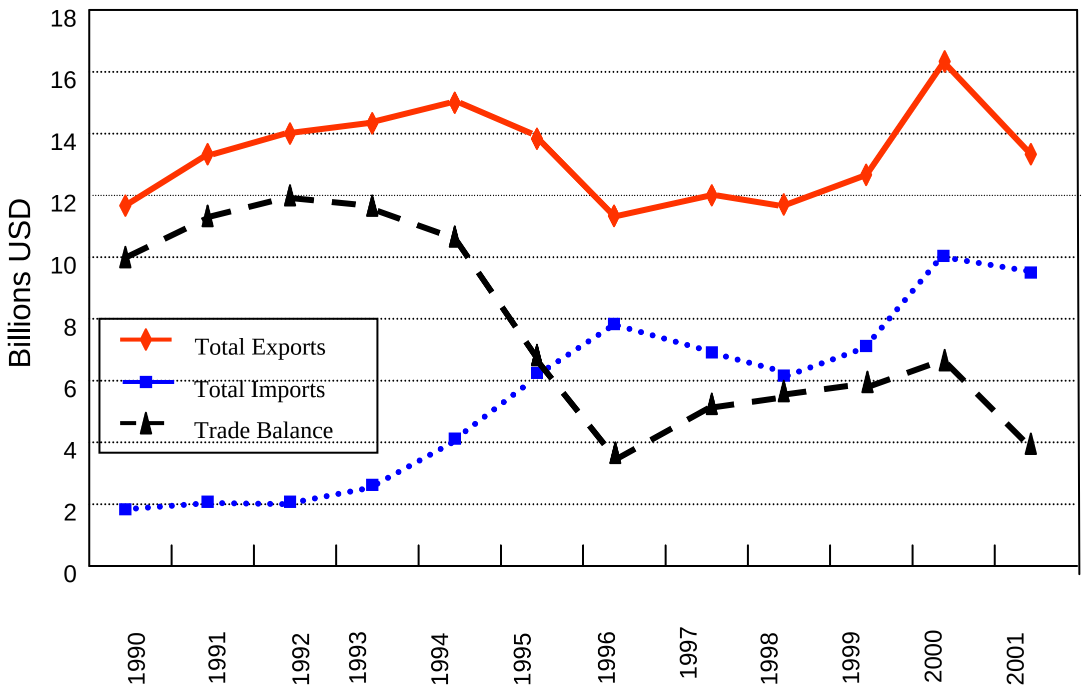
Looking at Japan's current technological assets, it is clear that Japan remains a formidable manufacturing power. Yet, over the last decade, it has retreated from world markets in key Information, Communications, and Telecommunications (ICT) sectors such as semiconductors (the building block of the electronics industry) and the communications sector and in particular the telecommunications sector. This paper analyzes key sources of decline in the telecommunications equipment sector.

Figure 1

Japanese Trade Balance in Telecommunications Equipment



Source: OECD Telecommunications Database. Created by Kenji Kushida, 2004.

There was an explosion of global demand for telecommunication equipment during the 1990's. To get some perspective on this growth, we can examine exports of communications equipment (this is a broader category than just telecommunication equipment, with telecommunication equipment accounting for roughly 21% of total communication exports). Exports of communication equipment from OECD countries increased from 49 billion USD in 1991 to 165 billion in 2001. Communication equipment export growth was 12% per annum in the EU, 11% in the United States and zero in Japan. In 1991, Japan accounted for 27% of total OECD communication equipment exports. By 2001, Japan's share had fallen to 8 % (OECD, 2003a:228-230). In short, Japanese firms did not share much in the increased trade in communication equipment.

If we focus only on the telecommunication equipment balance of trade for Japan from 1990-2001 as shown in Figure 1, we see first that exports rose from roughly 11.7 billion dollars in 1990 to 13.2 billion in 2001. Set against this very modest increase (in view of the growth of world wide demand), we see a dramatic growth of telecommunication equipment imports from roughly 2 billion in 1990 to almost 10 billion dollars in 2001. This growth in imports more than cancels out the rise in exports so that the overall telecommunication trade balance shows a sharp decline from almost 10 billion in 1990 to 4 billion dollars in 2001.

These data provide an incomplete picture of the global market for telecommunications equipment since they do not include production in third countries which rose dramatically in the 1990s. Countries like Mexico, Poland, and the Czech Republic became preferred locations for communication equipment production. Since Japan is generally recognized to have lagged in outsourcing manufacturing especially relative to the U.S., we would expect that if production from third country production sites were included, it would only strengthen the trends described above. An interview with the President of the Japanese division of a major manufacturing outsourcing firm confirms that while all of Japanese manufacturing firms have been slow to outsource manufacturing relative to North American competitors, telecommunications firms have been particularly reluctant. They have chosen to go forward keeping their own manufacturing plants with the exception of NEC.[1]

In response to the developments described above, the then Director-General of Commerce and Information Policy Bureau of the Ministry of Economy, Trade, and Industry (METI) met with top officials at NEC, Hitachi and Fujitsu in December 2002 to urge these companies to consider integrating their telecommunications equipment businesses. The most promising opportunity was to create a "merger among equals" between NEC and Hitachi but the effort failed. Such government interventions are typically reserved for troubled industries perceived to be in crisis. This action to consolidate the domestic industry into a few strong corporations reflected not simply the troubled state of the worldwide telecommunications industry but was also spurred by "a sense of crisis about declining Japanese telecom equipment technology" (Nikkei Weekly, 2003:10). The cost of R&D to compete in telecom has risen so much that Japanese government officials believe that mergers must take place for Japan to be competitive in the future. As one METI official put it in an interview, we are acting because of the "lowering of their competitive power." . As we shall see below, METI has been active in other ways as well in trying to revive Japan's fortunes in telecom.

So concerned are government officials that the Soumusho (Ministry of Public Management, Home Affairs, Post and Telecommunications) has created has two committees – one populated by high level executives and one technical committee - aimed at understanding the causes of the decline and identifying future courses of action to reverse it. There is a lot of "hand wringing" on these committees with some blaming the U.S. for pressuring the Japanese government to break up NTT, seeing its partial breakup as the source of all of Japan's competitive problems in telecom.

How do we account for these dramatic shifts in fortune? That is our task. We will focus on two key areas of global competition: network equipment and mobile phones. We begin with a change in the competitive environment that has had profound reverberations for the development of the ICT sector worldwide. This change was the worldwide movement toward controlled deregulation of the telecommunications sector. First were the various regulatory reforms around the world that led to further liberalization of the sector. Second various technological innovations of the 1990s (including fiber optics, high capacity and high speed hard disk drives and digital subscriber lines) expanded the volume and capacity of communications. Thirdly, and most importantly has been the convergence of the telecommunications and information technology sectors, especially in the mid 1990s with the emergence of the World Wide Web and the browser; this "linked the existing capital stock of computers and communications systems in an open network that significantly increased their utility" (OECD, 2000:56-57).

The U.S. took the lead in these developments. In the 1970s, the arguments for deregulation of regulated industries gathered strength as the ideology of competition received renewed emphasis (Temin, 1987). Since deregulation alone of AT&T could lead to further strengthening of their power, further action was required. It was in this environment that the breakup of the Bell System and the creation of the "Baby Bells" as the cornerstone of a 1982 antitrust settlement took place. Along with AT&T, seven new "regional operating companies" were created. The divestiture ushered in a new era that was augmented by the 1995 decision by AT&T to spin off Lucent, its R&D and manufacturing equipment arm. These reorganizations led to the creation of a more open competitive environment throughout the communications sector, which when combined with other events like the creation of the World Wide Web and wireless radio-based telephony, allowed for the entry of thousands of new competitors in the communications sector. Messerschmitt (2000: 212) estimates that venture capital played more of a role in networked computing than in perhaps any other industry other than biotech. By the late 1980s, provision of telecommunication equipment in the U.S. became open to foreign suppliers and domestic new entries on a scale unknown to the rest of the industrialized world. The regional holding companies and the Bell Operating Companies were energized by their new independence and moved in a variety of innovative directions (Temin, 1987: 345, 362-364).

AT&T, however, struggled to find a new direction and new missions. By 2003, AT&T was but a shell of its former monopoly self and a messy process of "creative destruction" ensued which included over investment in telecommunications in the late 1990s and the subsequent meltdown in the years following. Nevertheless, out of this cauldron, new industries and capabilities were established with American firms emerging stronger than before. The costs for information and information processing dropped dramatically in the late 1990s as did the price of PCs and peripheral equipment and to a lesser extent so did the cost of cellular telephone services. Business to business applications of the new communications capabilities grew rapidly. The Federal Communications Commission played an enabling function for the development of ICT industries through its interpretation of the Telecommunications Act of 1996. They pursued creating competitive telecom environments by adopting policies that opened the local market to different vendors of telephone services and in particular to Internet service providers and builders of data networks.

It was these firms that built the physical links of the Web and enabled E-commerce and enhanced communications capabilities within and across firms (see Hundt, 2000:180). The low cost of connecting firms to the Internet was a critical facilitating factor for the growth of the ICT sector. In the words of the OECD, "the major factor affecting the formation of a mass of users large enough to create sufficient demand pull for other ICT products and services is the level and structure of pricing for Internet access (OECD, 2000:67). Unmetered local telecommunication charges are critical to the promotion of mass usage. The U.S. has had among the lowest averages prices for Internet access along with countries like Finland, Iceland Canada, and Sweden (OECD, 2000:67-69). Important also for building the ICT infrastructure has been the availability and pricing of leased lines for business use; these lines provide the building blocks for the development of business-to-business electronic commerce (OECD, 1999:5). Prices have fallen throughout the advanced countries especially since 1998 in Europe following widespread liberalization of the communications sector. In the period 2000-2002, the United States and the EU had the lowest rates in the world. Comparative data is available for charges for a basket of national leased lines of 2 megabits per second for August 2000. Japan's rates were 50% higher than the OECD average and twice as high as U.S. rates (OECD, 2001: 82-83). Some observers attribute this to the tendency of Japanese regulators to target the development of certain technologies rather than emphasizing lower prices for consumers (Tilton, 2004: 2).

Until 2003-2004, Japan was a consistent outlier when it came to the costs of accessing the Internet and the pricing of leased lines. Despite early public discussion of the coming importance of the convergence between communications and computers, Japan lagged in adopting and applying these new capabilities. Much of that lag can be traced to the failure to deal creatively with the NTT telephone monopoly in Japan. Powerful institutional forces and vested interests contributed to both slow the process of change and shape it in ways that preserved much of NTT's structure and pricing power. Steve Vogel, a close observer of the deregulation process in Japan concludes that, compared to other nations pursuing deregulation of the telecom sector, Japan's Ministry of Post and Telecommunication (MPT) alone deliberately pursued regulatory reform as a means to augment its power (Vogel, 1997, 2000).

It is also striking that one of the major groups adamantly opposing the NTT breakup was the traditional "family" of NTT equipment suppliers, NEC, Hitachi, Fujitsu and Oki Electric. Yet, it is these companies that, long term, would be the most likely major beneficiaries of such a breakup insofar as the changes could be expected to accelerate the creation of an ICT infrastructure and associated products and services. It would appear that the equipment suppliers focused primarily on the disruptions that a breakup might create for their up-to-then guaranteed NTT markets. It is becoming increasingly clear that relationship contracting (long term trust-based relationships among upstream and downstream producers in this case) in Japan, so positively evaluated by some observers, becomes a liability when rapid often discontinuous change is required to take advantage of new opportunities (cf. Dore, 1987:173-191).

The NTT suppliers ignored the long term benefits they might receive from reorienting product lines to compete in worldwide markets. Finally, NTT was Japan's largest employer throughout the 1980s and into the 1990s (291,000 employees in 1989), the world's most valuable company until the early 1990s, the center of Japanese telecom R&D activity, and an engine of national economic growth. Not surprisingly, privatization and breakup had major implications for other institutional actors including the unions, NTT equipment suppliers, the Ministry of Finance and politicians. The unions were particularly active and effective opposing the breakup (Tilton, 2004: 3). Predictably, the forces for inertia were large and strong.

There were also powerful internal institutional rigidities that slowed NTT's support for the emergence of networking technologies in the form of new products and services. NTT researchers didn't see the potential of TCP(Transmission Control Protocol)/IP(Internet Protocol) - layers 4 and 3 of the layered network reference model) and the Ethernet (layers 2 and below of the layered network), in part, because of their ingrained focus on the need for high reliability systems for provision of domestic universal service. This, after all, had been their long- term mandate. We are reminded that under certain conditions, the vaunted quality of Japanese firms can be the enemy of innovation. The Internet, based on packet technology, was a "best effort" network that did not initially match the traditional quality benchmarks [in the network area, these are known as Quality of Service (QoS) benchmarks] provided in universal voice service. In particular, it was in the beginning quite deficient in minimizing delays and in providing sufficient bandwidth guarantees as well as insuring reliability (correctness of data transfer). As a best effort network, the Internet does not guarantee delivery of specific messages and involves retransmission of dropped packets. In the early 2000's, some

3% of all packets sent daily were dropped.[2] Moreover, each packet is delayed by variable and unknown amounts and the bandwidth available to each connection is unpredictable. The traditional "five nines" (99.999%) reliability target of telephone companies was simply not a design requirement for the Internet architects. All this was anathema to the QoS culture of NTT.

The many low QoS and reliability features exhibited by the early Internet are a common feature of disruptive technologies (Christensen, 1997). Many of these same technologies, however, incrementally add new features and improve reliability as one after another of its technical problems gets resolved. High reliability organizations like traditional telephone companies, in particular, have a great deal of difficulty in understanding and responding positively to disruptive technologies with these trajectories because they initially challenge existing value propositions. Moreover, it is the case that to this day, despite major improvements, a number of the aforementioned QoS network problems persist in varying degrees.

In the late 1990s, there were still senior NTT executives who didn't understand TCP/IP. Moreover, most NTT researchers, well into the mid-1990s, still, by and large, preferred Asynchronous Transfer Mode (ATM) technology as their mainstream approach to networking and viewed TCP/IP as an interesting option. Indeed, the IP router was only one of many possible pieces of equipment for building the data network. Many NTT researchers preferred "IP over ATM" as the ideal solution from the point of view of providing high QoS.

It was not a matter, however, of choosing between two new promising technologies. NTT began research on ATM switching in the mid 1980s. ATM was a "competency-enhancing technology" (Anderson and Tushman, 1997:49-50) in that it was a natural extension of the existing public telephone network relying on circuit switching. In circuit switching, distance and duration of connection determine the cost of communication service (Yamashita, 2004:1). Such competency-enhancing technologies are typically easier to incorporate into incumbent organizations and thus they are more attracted to them. NTT predictably wanted to continue to extract high levels of profit from their existing fixed line investments. Moreover, ATM was consistent with the high reliability culture of NTT. The ATM network, like the Internet, uses packet switching except that its packages (called cells) are fixed length and small. It uses a different form of routing based on a unique address within each link. ATM is connection-oriented, meaning that all host-to-host communications requests are provided a connection (fixed route) through the network. That is, it provides a dedicated connection. ATM emphasizes the active configuration of QoS parameters to insure high quality and reliability (Messerschmitt, 2000:507). As such it is a very complex system.

There are two alternative approaches to transmission. The first is to devise complex mechanisms in the core to reduce error; this is the path followed by ATM in the effort to deliver guaranteed QoS. The second is to have terminals located around the network and to engage in retransmission when error occurs; this is the path followed by Internet architects. Table 1 summarizes key differences between ATM and the Internet.

Table 1

ATM	Internet
Evolved from telephony	Data exchange among computers -"elastic" service, strict timing requirement
Human conversation -strict timing requirements -need for guaranteed service	"Smart" end systems -computers can adapt, perform control, error recovery
"Dumb" end systems/ -telephones -complexity inside network	Many link types -different characteristics -uniform service difficult
Based on establishing virtual circuit before sending data; switching based on virtual circuit identifier	Based on sending packets of data without Initially establ ishing a dedicated path. Packets routed based on final destination addresses

Source: Adapted from Kurose and Ross, 2002.: Section 4.1.2 with aid of Ye Xia.

The development of ATM was designed to improve NTT's existing digital switches. Originally designed for voice, NTT officials were convinced ATM could be made to be multipurpose. NTT officials believed in the early 1990s that ATM was the ultimate solution mixing voice and data traffic over fiber. In 1991, Fujitsu became the first company worldwide to offer an ATM switching system that enabled high speed, two way transmission and routing of voice, video and data simultaneously. NTT anticipated replacing the existing current narrow band digital network with the large capacity broadband ATM trunk line network somewhere around the year 2000 (Fransman, 1995: 86,116, 123). NTT officials were confident they were leaders en route to building the new information highway.

Rather than wait and let equipment suppliers take the lead in developing ATM switches, NTT took the initiative and led its suppliers in developing this new technology. This also involved NTT taking the lead in developing the software required for the broadband ISDN services that they expected to be deployed over this network. In this way, NTT thought they would insure that they accumulated and controlled the key competencies required for operating, maintaining and modifying the switch software necessary for providing new services. This was in keeping with NTT's long standing view that it was their job to take the lead in advance of the equipment vendors in developing complex new technologies (Fransman, 1995:115-116,119). Correspondingly, this led equipment vendors to take a passive view and wait for NTT to take the lead when confronting complex technologies. As we shall see shortly, this passivity had disastrous consequences for Japan's emergent network infrastructure industry.

NTT's technical and financial investments in ATM and associated ISDN services were enormous. Fransman (1995:115) reports that NTT spent 2,547 million dollars for R&D in 1993, 4.5% of its revenues; ATM was a top priority in that spending. Nezu (2002:17) reports that NTT's insistence on rolling out ISDN on a nationwide basis (only Germany made a similar mistake) led to a waste of roughly 9 billion dollars of investment-all wiped out by the spread of DSL broadband access which NTT initially resisted (ISDN had roughly one sixth the speed of DSL). NTT pursued this dead end trajectory with the strong support and urging of the Ministry of Post and Telecommunications, buttressed by tax incentives and public money. The early decisions to support a "network build out" of ISDN services made sense in terms of providing an interim technology before fiber optic networks became possible (Kushida:2004:63). The issue is why NTT and MPT persisted in these policies as long as they did.

In 1995, NTT was experimenting with vBNS, a network built on the commercial ATM lines. It was built with a speed of 155 Mb/s and was expanded to 622Mb/s in two years. Those collaborating with NTT aimed for a speed of 2.4 Gb/s. This group concluded at the end of 1997, that it was not feasible to achieve 2.4Gb/s and that it would be more effective to exclude ATM from the network and utilize IP directly over SONET [Synchronous Optical Networking]. SONET is a layer two network technology for communication over optical fiber. It is only at this point that NTT executives began to realize that ATM was not the ultimate end to end solution (Oie, Goto, Konishi and Nishio, 2001:184-185). Especially notable was the strong internal political commitment to ATM. NTT executives didn't want to admit failure even after key engineers in their Basic Research Lab concluded that ATM could not provide the speed possible with TCP/IP over SONET and the Ethernet. In particular, the Network Service Systems group, which made telephone switching systems for ATM, continued to push ATM and lobbied NTT executives to continue supporting it.

In the late 1990s, NTT finally stopped their research on telephone switching units based on ATM. They continue, however, to use ATM as an access network from .0.5Mbps to 622 Mbps and as a backbone network for MPLS service (MPLS is a kind of IP over ATM that provides virtual private network over IP).

TCP/IP and the Ethernet were developed largely by seemingly unimportant graduate students at American universities. Robert Metcalfe, working with David Boggs, a young electrical engineer at Stanford, for example, was working on revising his PhD Dissertation while working at Xerox's Palo Alto Research Centre (PARC) when he invented the Ethernet. NTT personnel were, for the most part, not in these information loops. In the late 1990s, few Japanese graduate students populated the engineering graduate schools of the leading U.S. universities making these contributions. Thus, Japanese firms were less likely to know about the early phase of these developments.

Of course, not all NTT engineers were ignorant of the emergent Internet technology. A small informal group promoting Internet concepts emerged in NTT in the early 1980s.[3] Dr. Shigeki Goto, a research group leader (kacho) at the NTT Research Laboratories, arranged to send a Dr. Okuno to Stanford University. With Ken Murakami as the lead person; the Japanese team finally succeeded in 1988 in connecting the NTT Laboratories Computer Network to the CSNet (Computer Science Net) and ARPANET through CSNET in the U.S. Even this was done informally because at the time NTT was forbidden to engage in overseas activities.

The Internet group operated initially as a "skunkworks" (an informal group flying under the radar of the formal organization). A key step in the process of formal recognition of this group came in 1992 when Shigeki Goto became a department head (bucho). This enabled him to start several Internet projects with the official support of the Director of NTT Software laboratories. Ironically in the late 1980s and early 1990s, despite the resistance to the Internet from most NTT researchers and executives, many of the NTT researchers engaged in ATM-related work, such as those writing software for ATM switching units, came to use TCP/IP as a tool to do their work. The initially small pro-Internet group promoted TCP/IP and the Ethernet as desirable solutions and gradually key researchers were won over. The turning point for them to accept TCP/IP was the arrival of Mosaic in the period 1993-1995. Nevertheless, as we saw above, top NTT executives continued to resist these networking solutions until the late 1990s.[4] One member of the Goto group, Ken Murakami developed a high speed protocol for IP (MAPOS) in 1996-1997 and demonstrated its effectiveness by building a system between Kyoto and Tokyo. He offered it to others at NTT but they were not interested since it "was not ATM." Ironically, he made it available to CISCO and CISCO implemented a version of it on their routers called GSR.

With this background in mind, it is not surprising that the Japanese electronics industry has lagged in the introduction of cutting edge products and services associated with networking. ISDN requires digital switches and many of their researchers were kept busy with the very consuming task of developing all sorts of equipment to allow the telephone lines to handle data. By contrast, TCP/IP requires routers, network interface cards, and sophisticated software such as network configuration management software. TCP/IP protocols are mostly implemented in software, running at both the routers and the user's computers. When one examines the global market for these products, one is struck by the almost complete absence of Japanese vendors (International Data Corporation, 2000). More generally, Western telecommunication companies (e.g., Nortel, Alcatel) have increasingly shifted their activities to software with much of their manufacturing being outsourced. Software now drives most networking functions and allows new features to be added in the field (Delaney, 1999:B8). The advantages include the reduced risk and flexibility that results from reprogramability. Japanese telecom companies have been slow to make the transition from hardware to software. In a Soumusho commissioned survey of Japanese and foreign information communications researchers, respondents were surveyed on the superiority of Japan, the U.S. and Europe in specific information and communication technologies. Respondents saw great Japanese strength in intelligent home appliances, mobile terminals and optical communications. They ranked the Japanese weakest, however, in software, the Internet, content production support, computer systems, and security. In these areas, they acknowledged overwhelming American superiority (Soumusho, 2003:10).

Without a strong domestic market in the networking products associated with TCP/IP and the Ethernet, Japanese electronic firms were unable to build up scale economies that could serve as a platform for competing in international markets. Moreover, Nezu (2002:27) argues that the telephone and telecommunication equipment makers initially were reluctant to develop routers because they were much less profitable than the existing large-scale switching machines used by the telephone companies. By 1995, routers and other protocols they run became sufficiently complex that to compete in this market required a steep learning curve. Even Bell Labs, which tried to build routers competitively in the mid-1990s, had difficulty developing competitive products especially as a result of their lack of expertise on the software side. To compete effectively with Cisco, they would also have had to be able to make network interface cards.[5] All the major national telephone monopolies were slow in recognizing the significance of the Internet and associated products, not the least of which was AT&T (Naughton, 1999:114-117).

In summary, the major Japanese electronic firms were accustomed to relying on NTT to set future technology directions in the field of communications. With NTT being slow to grasp the significance of TCP/IP and the Ethernet, the major electronic firms, not surprisingly, lagged in the development of ICT products and services. We can see this being played out in the behavior of NEC and Fujitsu.

In the early 1990s, Masao Hibino, President and CEO of NEC Magnus Communications, Ltd. was General Manager of Modem Development at NEC and stationed in Silicon Valley. He thought TCP/IP and the Ethernet were important developments and sent information to NEC offices in Tokyo to that effect. They responded, however, that “TCP-IP” wasn’t real communication because it was "connection-less.” In short, without a dedicated connection, they believed that there was no real communication. At this time, he says “NEC people thought ATM delivering ISDN services was the final solution to broadband. Everyone in Japan thought so and we worked with ITU-T (International Telecommunication Union - Telecommunication Standardization Sector) to get each standard approved for ATM.” NEC also had mid-career Industrial Associates at UC Berkeley and these individuals must have been aware of the evolving Internet technology. Such individuals, however, were focused on their careers and reluctant to take the kind of risks that would be entailed by strongly championing a non-mainstream technology.

The same was true of the many Japanese executives stationed in Silicon Valley, some of whom saw the Internet as an important development. Nevertheless, it is also the case that many of the Japanese executives assigned to Silicon Valley had great difficulty penetrating the local knowledge networks. To succeed in Silicon Valley in knowledge acquisition, one needs to develop an exchange relationship in which one give as much as one gets. This is what Eric von Hippel,(1988:76-92) calls informal know-how trading. In addition, as Annalee Saxenian, a knowledgeable observer of Silicon Valley puts it, one also needs to" marinate" in the Silicon Valley culture if one is to be able to draw upon its knowledge. The Japanese assigned to Silicon Valley appear to have been weak in both of these areas.

By 1995-96, NEC executives had begun to realize that the Internet was different from what they had thought. By then, however, they had incurred a substantial investment in ATM switches, both financially and politically and had developed rated products. It was not until 1997-98 that they realized everything should be changed and that ATM was not a solution for broadband. By then, however, it was hard for them to change to TCP/IP products. Hibino believes that had NEC shifted all the people working in ATM to TCP/IP at that time, they would have had a chance to catch up but they didn't. In late 1999, the mobile market was growing rapidly and the number of subscribers to DoCoMo's i-mode was exploding. NEC, accustomed to following NTT's lead, shifted resources including personnel who had worked on ATM over to 2nd generation phones. They thought it would have potential for export markets to China and Europe.

Cisco had already disseminated its products in the market and it was hard for NEC to differentiate their products and find a niche market. At the same time, the hardware and especially the software had become complex. Cisco had proprietary IOS intellectual property based on TCP/IP protocol. To simply copy Cisco products would have led to legal action from Cisco. So in 1997, NEC made the decision to distribute Cisco routers, hubs and switches. The problem, however, was not Cisco's intellectual property rights per se. Japanese vendors could develop their own router codes to get around that. The challenge was posed by the operator's (enterprise's) deployment and familiarity with Cisco's router command interface (CLI). Customers wanted to insure that any new hardware and software had interoperability and compatibility with Cisco products and operations. In particular, Cisco draws competitive strength from the extensive versions of its software that accommodate different legacy systems.

Notwithstanding, NEC continued to work on the technology and sought new combinations so that they were not using pure "routers." The idea was to develop new integrated products (e.g., products that included routing and bridging technologies) that would not run afoul of Cisco's IP. Despite these efforts, in the fall of 2003, NEC was engaged only in domestic production of routers, hubs, and switches. In mid 2003, Cisco was estimated to command roughly 80% of the world market for routers and high end switches for enterprises and Internet providers, the combined markets of which total an estimated 170 billion dollars (Yamazaki, 2000, 2003:50). [6] **Moreover**, Cisco along with Juniper Networks and Redback Networks, all American producers have an 88% market share of the world market for routers for telecom carriers (Nikkei, 2003:3). Cisco's share of the Japanese market, however, was only around 40-50% as many Japanese companies stayed loyal to the products of the domestic electronic companies; they also sought to buy products from Cisco competitors like Juniper Networks.

Seeking to keep pace with the evolving technology, NEC and Hitachi announced plans in December 2003 to jointly develop next generation routers designed for high-speed internet connections to telecom service providers. The total development costs over a three year period were estimated to be about 20 billion yen (180 million dollars) with half the cost to be subsidized by METI (Nikkei, 2003:3). It is remarkable (or perhaps unremarkable) that despite strong foreign and domestic criticism of METI's old style "industrial targeting," it continues to orchestrate and invest in such downstream product development activities.

The situation at Fujitsu was somewhat analogous to NEC but with some variance. In the mid- and late 19909s, Fujitsu had two groups that were relevant for adoption of Internet-related technologies: the Communications Systems Group that focused on sales to the telecom sector and carriers like NTT, and the Computer and Information Processing Group that focused on sales to enterprises. The Communications Systems Group, like NEC, was accustomed to following the direction set by its lead customer, NTT, and thus saw the future as one dominated by ATM delivering ISDN services. As a consequence, it was not open to the Internet's potential. By contrast, the Computer and Information Processing Group, focused on sales to enterprises, was more open to Internet technologies. The problem here was that investment decisions were made for them by top leaders who at the time did not appreciate the potential and ignored the needs of these emergent Internet businesses. So Fujitsu ended up investing heavily in carrier routers but not enterprise routers. In so doing, they abandoned the enterprise global market to Cisco. [7] Fujitsu continued to manufacture a relatively full line of data communication products such as switches and routers and simple equipment such as repeaters and hubs. Most products, however, are designed for the domestic market though there are some modest sales of routers and switches to SE Asia. They do have a leading position in the global market for SONET, including an estimated 28% of the American market (Takemoto, 2004:B3).

In early 2004, it was announced that Fujitsu would stop developing routers by themselves and would distribute routers from outside companies. The overwhelming market share held by Cisco and Juniper and their strong price competitiveness combined with the continued weakness of Fujitsu's telecom equipment business (in the red for 30 billion yen -$272 million- for fiscal year 2003-2004) was undoubtedly a factor in this decision. The bankruptcy of WorldCom, its biggest U.S. customer, had badly hurt their performance in 2002 and 2003 (Takemoto, 2004:B3). Fujitsu will seek to rebuild its telecom business by strengthening the development of low-price servers with router functions, distributing products of other manufacturers and exploring co-development with other large electronic companies (Nikkei, 2004:13).

Unlike in Japan, the existing electronic firms in the U.S. were not dependent on the dominant telephone company for their vision of future technologies. Still, they weren't as fast to grasp the significance of the Internet as were the large number of new venture entries. Cisco moved with incredible speed, using its elevated stock price to acquire start ups that had the desired sets of skills and product lines. Originally they had made only a small part of the router but with the build up of their capabilities through mergers and acquisitions, they could market the whole router. As a result they secured tremendous first mover advantages as discussed above. None of the large vertically integrated Japanese electronic companies (or the big U.S. players like Hewlett Packard or IBM), were capable of that kind of speed.

The pace at which NTT came to recognize the significance of TCP/IP undoubtedly would have accelerated if the conditions had been created for the entry of new firms committed to innovation; they would have put pressure on NTT and would have provided the opportunities for acquisition that were available to Cisco. Even if NTT had speeded up its timetable for recognizing the importance of TCP/IP and the Ethernet, however, what NTT did or did not do would not have mattered as much if the institutional field had been augmented by new electronic firm entries. Such firms would not have been constrained by the traditional mission of "five nines" reliability, nor the commitment to building on existing competencies by using the public telephone network, nor by NTT's past political commitments to ATM. Nationally, the conditions favorable for market entry by new venture startups, however, had not been created.

To be sure, it can be argued that, from the time information about the foundations of the Internet first come to the attention of NTT researchers, to the point in the late 1990s when TCP/IP and the Ethernet became accepted as the de facto standard for networking, NTT made - from an historical perspective - a rather quick adaptation to a discontinuous technology. Prof. Shigeki Goto makes this argument and he certainly is correct.[8] From the perspective of coping effectively with the rapidly changing competitive environment, however, one can make a strong argument that the process of adaptation was very slow.

Of particular relevance is NTT's decision to have the entire ATM network go through the ITU (International Telecommunications Union) standardization process prior to implementation; this consumed a great deal of time. ITU is the international organization within the United Nations System where governments and private sector companies coordinate global telecom networks and services. The Europeans, who traditionally liked to standardize around one technology, have been particularly active in ITU. The ITU has been known for its very slow standardization process whereby protocol suites are discussed at face to face meetings and then put out to review by mail. Each country's representatives can propose the ultimate solution that they would like and this leads to a long iterative process of negotiation and further discussion before a common standard is finally selected. Moreover, to satisfy as many of these constituencies as possible, the solutions have tended to involve complex protocol solutions that are difficult to implement. NTT had long been committed to working with ITU and it was only natural that they would continue to do so with ATM. If researchers/ engineers working on international standards wanted to be promoted at NTT, it was fully expected that they would work with ITU.

.A quite different approach, however, was taken by the IETF (Internet Engineering Task Force) in which Americans have been the most active members. The IETF had its beginnings in 1986 at a meeting in San Diego attended by 21 individuals and has evolved into the principal body engaged in the development of new Internet standard specifications (Malkin et.al., 2001). IETF conducts its discussions mainly by e-mail and the emergent policies are by "rough consensus and running code". What this means is that very often researchers involved in IETF work on a particular problem first, find a solution, and then write a draft version of IETF standard, called an Internet Draft, which is then posted for about 6 months with a Request For Comment (RFC); it may then become a standard. Typically it does not become a standard unless it has been implemented and widely used. Thus, the solution is often in the form of either a prototype or complete working software, so-called "running code." This mode is possible because the main job of researchers involved in IETF is not to write standards. In fact, as we have seen the standard comes after they have already completed their project. Moreover, unlike in ATM, many of the protocols that are standardized at the IETF are simple and can be done by a few people. The simplicity of the Internet architecture and the low expectations of performance (relative to ATM) make this possible.[9]

As a result of these working routines, IETF has been much more responsive to real time market forces in its development of new Internet standard specifications than was ITU in its development of ATM standards. Letting the market place decide the winners, while not without its problems, tends to be a faster process. This case is also instructive for researchers who commonly distinguish between de jure standards created by committees and de facto standards created by markets (Funk, 2002:1; Besen and Farrell:1994). The IETF process shows that a committee-based approach facilitated by online communication and use of "running code" can be a powerful force that is quite in synch with market forces (cf., Shapiro and Varian, 1999). Finally, Japanese researchers played only a minor role in setting IETF's Internet standards in the critical early years (1986-1996). While the number of Japanese attending IETF meetings has grown in recent years, they participate mostly as observers rather than as active members. That is telling in terms of their continuing status as followers rather than leaders.

NTT worked on standardizing the basic protocols of ATM for broadband network from 1985-1989. Yet, major problems remained. Because the paradigm of ATM involved setting up a dedicated connection from a sender to a receiver via a sequence of switches, a great burden was put on the functions of packet switches. Further demands were placed on the packet switches by the growing expectations for faster transmission speed. To get the desired performance consumed a great deal of time and resources. These technical problems combined with the slowness of the ITU committee-based approach to standardization enabled the Internet to become well established as a commercial entity before ATM could be effectively deployed (cf., Messerschmitt, 2000:507). NTT's slow acceptance of the Internet from a market perspective leads us to return to consider the pace at which NTT was deregulated and the extent to which its monopoly power has been dented so that market forces could more strongly determine its strategic directions.

In response to the AT&T breakup and in the context of Japan's push at that time for administrative reform, the Second Provisional Council on Administrative Reform (Rincho) proposed in 1982 that Japan allow competition in all telecommunication service sectors to be achieved through the privatization – meaning break up – of NTT. In 1984, the Japanese Diet passed three telecommunication reform laws that set the process of privatization in motion and established the MPT as the dominant regulator in the sector. Responsibility for price and service regulation shifted from the Diet to the MPT. The MPT chose to micro manage competition in the telecom sector, orchestrating the entry of new competitors by evaluating all price or service changes in terms of their potential impact on the competitive balance (Vogel, 1996:161). In the early years, it favored new entries over NTT and engaged in contentious struggles with NTT particularly with regard to its proposal to break up NTT.

It was not until 1997 – fifteen years after the AT&T breakup – that the final terms of the breakup were announced. They stopped short of the AT&T model and used the newly legalized holding company structure to partially break up the company. NTT was divided into three companies – one long distance and international company and two regional companies within the holding company structure. This meant that NTT would be forced to separate its accounts in ways that minimized the cross subsidization of activities but fell far short of the original goal of breaking up NTT. NTT has continually and effectively used the argument that to grant full independence to its constituent units would dull the firm's overall global competitive position – an ironic argument in view of its poor performance globally.

One effect of the breakup bargain was that the MPT switched from a pro-competition anti-NTT stance to a more NTT protective stance. They worked out the basic agreement on interconnection between competing carriers and NTT's infrastructure based initially on using NTT's historic costs to calculate interconnection charges. The net effect of that was to discourage new entries by keeping those charges high. Despite strong pressure from the U.S. and Japanese constituency arguing for lower access charges, NTT has only grudgingly lowered its rates (they were still 8 times higher than those in the U.S. as late as 1999) and interconnection charges still stood at twice the level of those in the U.S., France, Germany and the U.K. in early 2003 (Carbaugh Jr., 2003:1). Yet, in spring 2003, the Ministry of Public Management, Home Affairs, Posts and Telecommunications, formerly the MPT, announced they planned to raise – not lower – the interconnection rates 12% to compensate for NTT's lower revenue resulting from declines in fixed line usage and to avoid the specter of a WorldCom bankruptcy in Japan. It was widely rumored that the real reason was pressure from NTT-related diet members (Tilton, 2004:4-5).

There are now strong voices in the U.S. criticizing the strategy of forcing the Baby Bells to subsidize their competition by sharing their lines with them; the argument is that this policy inhibits facility-based competition (newcomers lack incentives to build their own infrastructure). Nevertheless, it is widely recognized that lower access charges in Japan would at least in the short term have stimulated competition, boosted demand for the Internet, data networking and other information services and promoted the ICT sector overall much as it did in the U.S. Throughout the 1990s there was no cheap fixed rate Internet service available to Japanese consumers, a major barrier to electronic commerce. It wasn't until 1999 that NTT offered a flat rate Internet service although at the very high price of $100 a month. That price was lowered to 4,000 yen ($36.68 at the then prevailing exchange rate) in the year 2000. In 1998, 6.4% of Japanese households and individuals had access to the Internet while 26.2% had access in the U.S. That gap has been greatly reduced since then as the rates have come down, so that by 2001, 34% had access to the Internet in Japan compared to 50.5% in the U.S. (OECD, 2002:325).

Japan leads the world in access to the Internet via mobile phones. As of March 2004, the number of Internet connection service subscribers via mobile phone reached 69.7 million representing 80% of all mobile phone subscribers Yamashita, 2004:2). These applications thus far have had far less significance for business to business transactions.

Tokyo Metallic Communications Corp. introduced Digital Subscriber Service (DSL) to Japan in late 1999. NTT was committed to Fiber optics (Fiber to the Home-FTTH) as the optimal solution to solving the "last mile" problem and did its best to ignore DSL and when that failed they acted to obstruct the entry of new companies trying to hook up to their backbone. To install DSL, competitors had to enter NTT branch offices and install their own equipment. Without clear rules, it was fairly easy to obstruct such efforts. In early 2000, politicians became concerned that not only was

Japan falling behind the United States and Europe in making broadband service via DSL available to households but Korea had passed them by as well. As a result, rules for competitors accessing NTT branch offices were clarified and the Fair Trade Commission (FTC) also intervened and pressured NTT to make its local loop available to new entrants.

With these changes, new subscribers to DSL exploded so that by September 2002 they reached 4 million and by the end of 2003, they had 10 million (at this time, NTT East and West combined had 37% of the market and Yahoo!BB had and equivalent 36%. [BOB: The %s are not clear to me here]. The resulting competition has led DSL rates to fall to Y2000 ($16.94) a month, the cheapest in the world. It is for this reason that some would claim that real competition in Japan's telecommunication market has just begun (Nezu, 2002:25). By waiting so long, however, the Japanese have given their global competitors a big head start. NTT had failed to realize the potential for DSL as an interim broadband technology before FTTH could be more fully deployed. Like other national monopolies, NTT had long been accustomed to being able to deploy new technologies that met its high standards at a pace it alone decided was appropriate. They had been reluctant to deploy DSL not only because of their commitment to fiber –optic network but because DSL interfered with certain ISDN services. Aggressive new competitors like Yahoo!BB, however, were much more sensitive to potential customer demand and forced their hand. Unlike, FTTH, DSL did not require a large-scale infrastructure investment.

The bright spot for Japan's telecommunications sector has been the success of DoCoMO's i-mode service. DoCoMO, an NTT subsidiary, has brought the Internet to a large base of subscribers. As early as late 2001, the Japanese mobile Internet market had some 46 million subscribers dwarfing equivalent services in the rest of the world. DoCoMo's i-mode in early 2003 had some 70% of the total mobile phone subscribers and an even higher proportion of the income from related services. Following Funk (2002:221), we can characterize Japan's mobile Internet offering as providing great reach (referring to the number of people participating in the sharing of information) but modest richness (referring to the quality, depth and bandwidth of information). DoCoMo's i-mode represented a successful improvisation in combining and reconfiguring existing technologies (e.g. using c-HTML) and a pioneering approach to the mass marketing of mobile Internet to a consumer market with a clever revenue sharing model with content-providing partners. For millions of Japanese consumers, their first (always on) Internet experience was on a mobile Internet service not a desktop. As is well known, entertainment and e-mail are the main applications in Japan followed by news/ weather (including traffic news) and young people are the leading users.

Despite the domestic success of mobile Internet services and i-mode in particular, the irony is that Japanese service providers and handset manufacturers for 2nd generation phones have had very little success in global markets. Moreover, the

Japanese domestic market share has been divided among an amazingly large number of handset makers (NEC, Sharp, Sony, Denso, Fujitsu, Panasonic, Mitsubishi, Casio, Kyocera, Sanyo, Toshiba, Hitachi, Pioneer, and Kenwood). The failure to develop foreign markets in the 1990's led to extraordinary, some would say – "excessive competition" – for domestic market share. All things being equal, the large number of players also limited the market share and profits of any one producer, thereby making it difficult to build a domestic base for the increased economies of scale necessary to compete in global markets.

The dichotomy between the development of sophisticated handsets and an architecture whose platform provides for diverse content and services for the domestic market on the one hand, and weak performance in global markets in the 90s on the other, in part, grows out of an important decision made in 1993. This was NTT's selection of a closed digital standard for its 2nd generation digital cellular phones, known as Personal Digital Cellular (PDC). As Funk (2002:13) points out, global mobile communication standards are relatively open in the sense that they have been typically created in open standard setting processes. This was not the case for PDC, especially from an international perspective. It is a standard for which the only adopting country is Japan and one company, NTT, dominates the standard setting process. This compares to other communication standards for 2nd generation digital cellular phones such as the European-driven GSM, which had seen 120 countries adopting it by the end of 1998, and had broad participation in the standard setting process (Funk:2002:12). What foreign company would want to sign on to the PDC standard for its domestic market when one service provider in Japan (NTT) and its exclusive set of Japanese handset makers had preferential information that gave them considerable market advantage? Nokia and Ericsson did begin to offer PDC handsets in Japan in the late 1990s but that move was designed to enable them break into the Japanese domestic market.

The PDC digital standard for second generation digital cellular phones was largely developed and is still largely controlled by NTT DoCoMo.[10] Standards development for PDC was begun by NTT engineers and that technology and the wireless R&D lab, along with a large number of the key engineers involved, were transferred to DoCoMo when it was established as an NTT subsidiary [BOB: I thought DoCoMo was always an NTT subsidiary??]. NTT DoCoMo, as the service provider, developed the detailed specifications for the standard in cooperation with selected handset manufacturers. The Ministry of Post and Telecommunications (MPT), as it was known at the time, required that the Association of Radio Industry Business ratify the new standard and that DoCoMo publish a set of specifications for the air interface. Other service providers were then able to provide PDC services based on these specifications. Despite this public disclosure, the four major handset manufacturers for DoCoMo – Matsushita, NEC, Mitsubishi and Fujitsu – received more detailed preferential information about the PDC standard that gave them great advantages over their domestic competitors. This quickly enabled them to solve various air interface problems and to develop superior (e.g., lighter) phones than those offered by other phone suppliers. In return, they delayed the sale of their series of highly competitive phones to service providers other than NTT DoCoMo. This, in turn, gave DoCoMo significant advantages over other service providers.

In this environment, DoCoMo has been able to dictate its terms to the handset manufacturers who were willing to accept DoCoMo's leadership because they were guaranteed participation in DoCoMo's dominant share of the domestic market. By contrast, in Europe, key handset manufacturers, Nokia in particular, developed the specifications and had them adopted by the service providers. This difference demonstrates the continued strength of NTT relative to its captive suppliers. Notable is the government complicity in DoCoMo's dominance; the government failed to insure that the public disclosure of the standard specifications for handsets provided by NTT DoCoMo be sufficiently detailed and available to all parties at the same time so as to create a level playing field. This process also can be contrasted to GSM standards in Europe where detailed specifications were made available to all relevant parties in a timely manner.

Japanese carriers such as DoCoMo and Au contract with their vendors to develop distinct phones from the basic hardware and compensate them by guaranteeing high volume sales or in some cases commit to paying a portion of the vendor's R&D costs. European (and American) carriers proceed quite differently. They do not require high levels of customization but instead rely on software for expressing features and other modes of differentiation. European phones are more modular with companies like Nokia developing platform modules (called engines) which can then be used for different models, thereby reaping huge cost savings. This is in sharp contrast to the Japanese handset manufacturers who build every model "from the ground up." Moreover, the same is true for the software in handsets. There are, however, interesting tradeoffs that favor the Japanese handset producers. The European handset makers with their more modular design have the advantage of being able to spin out a lot of variations from a single design. There is, however, a cost associated with that strategy which is that they can not optimize the design of any particular variation and in practice they sacrifice compactness or functionality. This contrasts with the extremely sophisticated Japanese handsets therefore which are more fine tuned and usually more compact and optimized with more advanced functions. The Japanese also have the advantage of many parts suppliers in Japan which supply unique components for camera and precision mechanical components. The outcome of global competition may be determined by the players who can learn more and faster from the others. The Europeans will need to learn to design more of an optimized integral product for very high end or breakthrough products while the Japanese will have to learn modular design for the mass market so they can spin out more variations from a single model thereby reducing costs.[11]

It may seem strange that NTT choose to develop the PDC standard as its own unique solution to the 2nd generation phone standards. To be sure, the PDC standard contains some elements from the U.S. TDMA standard (air interface standard) and some elements of the GSM standards (architecture) though NTT would insist that they developed these elements independently. NTT's failure to anticipate the negative impact of developing a proprietary standard on equipment exports (e.g., handsets, base stations) reflected, in part, the insularity of NTT resulting from its historical mandate to serve the domestic market. It also reflected its status as an engineering-driven company rather than a market-driven company. Whatever the reasons were for adopting the PDC standard, the result was that the Japanese handset manufacturers were kept busy supplying unique (proprietary) phones for the domestic market. NTT continued to upgrade features which kept the R&D staff of the handset manufacturers busy meeting their specifications. As a result, handset makers did not have the resources to develop phones and other telecom equipment that could meet US or European standards. Nor could they build economies of scale based on strong home market sales to penetrate foreign markets.

One can contrast the choices made by NTT with the choices made in Korea. Both countries have highly regulated/protected wireless markets with three carriers, one of which is dominant with more than a 50% market share. Instead of the dominant carrier developing a proprietary standard as did NTT, the Korean carriers, under pressure from the government and feeling less of a need to develop their own standard, were early licensees of Qualcomm of their proprietary Code Division Multiple Access (CDMA) technology. The CDMA standard has become increasingly accepted around the world with some 164 million subscribers by mid 2003. The Korean carriers, as early licensees of Qualcomm, were able to exploit that technology and evolve with it ahead of most others. As a result, companies like Samsung and LG were able to leverage their CDMA experience along with their consumer electronics know how (especially color LCD and camera technology) to take a large and growing share of the worldwide handset industry.

The contrast with the Japanese (NTT's) selection of its own proprietary PDC standard could not be starker.[12] Especially striking is the pride that NTT engineers had in taking a leadership role whether it be a pioneer in developing ISDN or its own PDC standard for 2nd generation phones. As public employees (until the partial breakup in 1997), many felt they truly worked for the advancement of Japan and its citizens. That desire to play a leadership role building only on their own internal capabilities turned out in this case to be a significant liability. It is a great asset to have highly capable engineers and for those engineers to have great pride in their capabilities but the decision to make one's own technology and standards or to cooperate with others in building an international standard is a business decision. Just because you are capable of creating your own technology and standard does not necessarily mean that you should do so. It is increasingly the case, especially in setting worldwide telecommunication standards, that open innovation is a more productive strategy (Chesbrough, 2003). Certainly the explosion of demand for European telecommunication equipment in the 1990s is to be understood in part as an outcome of European company success in collaboratively building and then leveraging the global GSM standard.

To add to the mix, Funk (2002:71-72) speculates what would have happened if Japan had adopted the GSM standard rather than the PDC standard. In all likelihood, Japanese consumers would have benefited since Japan has much more expensive cellular service than European countries. Even more to the point of our focus, however, is the likelihood that the adoption of GSM would have helped Japanese producers of mobile phones and infrastructure participate and compete in the global market. By working on GSM, especially through creating European research labs as Motorola did, they would have developed their own patents and would had access to the patent portfolio of other producers based on an exchange of patents agreement among GSM producers. This agreement allowed the producers involved in developing GSM products and services to move the technology forward much more rapidly. Participating in these arrangements would have made it easer for the Japanese producers to compete in the global market through achieving global economies of scale instead of retreating to their far smaller domestic fortress market, protected by their PDC standard. There is reason to think that Japanese producers would have done particularly well in global infrastructure competition because of their strong technology in frequency spectrum efficiency and low power technology. On the domestic side, Funk (2002:72) concludes "if Japan had adopted an open standard like GSM, they would have been forced to develop a method of competing in the Japanese market that did not depend on control of the standard."

Having learned somewhat from its experiences with the PDC standard, the Japanese government through the MPT encouraged firms to enter the Personal Handy-phone System (PHS) market in the mid-1990s. PHS had the potential to become a global standard in low mobility systems. The MPT used a committee-based standards setting system to develop the communication standard for PHS but they did so without foreign participation. The standard setting process was open to all Japanese manufacturing firms and service providers from the beginning (an improvement over the way the PDC standard was developed) but the MPT delayed the opening of the standard for foreign firms in order to give a competitive advantage to Japanese firms. Not surprisingly, the foreign firms were not interested in participating in a fait accompli and the PHS standard lost all chances of becoming a global standard. Initially the MPT predicted that PHS services would outstrip the growth of cellular phones with new companies like Sharp entering the market. This put further pressure on handset manufacturers for cellular phones to increase their R&D activities to provide better and better handsets (especially the push toward miniaturization). As a result, the already heavy R&D investment required for keeping up with NTT improvements was further augmented, leaving even less scope for investment in the R&D necessary to meet global standards so as to tap foreign markets.

In more recent years, NTT DoCoMo seems to have learned something about the importance of open standards and of combining market pressures with a standards setting committee system. NTT was held responsible for Japan's dramatic decline in its share of global equipment export markets by virtue of its adoption of the proprietary PDC standard. They were, thus, under pressure from the MPT to take a different approach to the development of the 3rd generation standard. As a consequence, DoCoMo participated more fully in developing the global 3rd generation standard, forging an alliance with Nokia and Ericsson that includes acceptance of Japan's W-CDMA technology for outdoor applications in exchange for accepting the GSM network interface.

The Japanese handset manufacturers, however, are still a long ways from building the global platform management and product line strategy based on modularity that has allowed Nokia to become the undisputed leader in global mobile phone markets. To succeed in these markets requires a deft integration of committee-based standard setting activity and global market competition that the Japanese firms have, thus, far found quite elusive. It is naïve to expect that just by developing a more intelligent standards policy (though surely that is needed), Japan would be able to restore its former share of communication equipment exports.

A lot has changed since 1990. Japan played a big role in 1st generation analog phones when competition took place in intermediate goods as the Japanese handset makers successfully sought to supply phones for U.S. and other carriers (e.g., Hitachi and Oki supplied phones to AT&T). The industry has now moved toward a customer driven market where brand plays a dominant role. Sales channels are different and more complex. Japanese cell phone technology in certain respects has evolved in isolation from mainstream developments of other global players. The reason is that the R&D and manufacturing expertise of Japanese handset makers is geared to customized Japanese carrier designs. In short, the phones of each Japanese carrier like DoCoMo and KDDI, have unique proprietary handset designs. These handsets have a more integral architecture (less modular) than European and American produced phones and they rely less on software to express desired features. Without modularity, they bear the heavy costs of designing every new product from the ground up. These factors, combined, constitute a significant though not insurmountable barrier for Japanese handset makers in their efforts to make a strong play for global markets.[13] At the same time, as we have seen earlier, the approach of Japanese handset makers is not without its merits. Their integral designs allow them to optimize specific models to insure more compact and more sophisticated phones with many advanced features. This is particularly appealing at the high end of the market.

Competition is made all the fiercer by the dominant position of Nokia and the rise to prominence of Samsung and LG Electronics. Samsung can now supply relatively high end phones at prices that the Japanese find it hard to match. Moreover, Samsung's brand is now far better known around the world than is that of any Japanese cell phone producer. All these conditions make it quite difficult for Japan to recover its previous share of telecommunication equipment exports. Ten years may have been too long a period to fall behind. On the other hand, Japanese firms have excelled historically in playing catch up. That they will be successful can not be ruled out.

Conclusion:

Basically the decades of the 1980s and 1990s saw a huge opportunity missed with Japan's failure to deregulate telecom and break up NTT's monopoly power. As a result, NTT was able to keep prices high (therefore limiting the spread of the Internet) and to push its own proprietary technologies. This delay severely retarded the development of ICT infrastructure and that, in turn, led to a retarded development of ICT products and services. Institutional rigidity and ill-conceived decisions regarding standard setting have clearly slowed the growth of Japan's ICT sector. The absence of a hospitable environment for new ventures and the constraints imposed by relationship contracting on the large electronic firms in their ties to an NTT committed to ATM technologies slowed the private sector's embrace of the Internet and related networking technologies.

As a result, U.S. and European firms reaped huge first mover advantages in the global network equipment and mobile phone markets and opportunities were opened later for the Koreans as well. In the case of handsets, this is ironic since the Japanese, arguably, have the most sophisticated and content rich handsets along with a pioneering revenue sharing model in their domestic market, and the highest number of subscribers accessing the Internet through wireless connections. Yet, their commitment to a proprietary PDC standard for 2nd generation phones proved a major barrier to translating these advantages into global market sales. Moreover, the dominant (as measured by market share) handset makers favored by DoCoMO were so subordinate to DoCoMO that they had to devote all their resources to building customized models from the ground up. This left them unable to move toward a more modular platform strategy that would yield greater economies of scale and allow them to better compete in global markets. As we move into 3rd generation phones, it is not clear that the dynamics have sufficiently changed or will change in ways that alter the current outcomes in global competition in handsets in which Japanese firms are weak players..

To be sure, the advantages held by Japan's competitors are by no means unassailable in the future. A smaller amount of national real estate, high population density and a small number of major metropolitan areas favors lower rates in Japan than the United States over the long term. This will require, however, a further weakening of NTT power and a willingness of regulators to leave the NTT subsidiaries to some combination of a market fate and international committee-based standard setting. Japanese firms, especially handset manufacturers and infrastructure providers, need to learn to participate more effectively in the international standard-setting process. The weakness they have demonstrated in the past in setting global standards, whether it be a function of poor English capabilities or a naïvité that the best technology will always win, or their insularity, or their own engineering arrogance or a failure to join the shift from a traditional committee-based approach to the more dynamic IETF model or some combination of all of these factors, has put them in a disadvantageous position.

On a different level, the Japanese government also needs to further bolster market forces, something they have shown little taste for since their rapprochement with NTT. In 2003, as mentioned earlier, they raised interconnection rates (the fees NTT is allowed to charge other carriers for accessing its phone lines). In so doing, they of course made it harder for new entries to compete with NTT. However, this is part of a larger problem faced by all advanced countries with a land line infrastructure relying on the Public Switched Telephone Network (PSTN). It is the problem of how to be able to continue delivering universal service without weighing down the leading part of the industry innovating with Internet Protocol (IP). The pattern has been to have the leading edge of the industry subsidize the lagging part, hence the rise in interconnection rates. Nobuo Ikeda (2003) has proposed that in Japan the two parts of NTT be separated with PSTN to be run as a government-owned universal service company to be liquidated in the long run. This would leave the IP part of NTT free to innovate and grow without worrying about cannibalizing land lines or having to subsidize the provision of universal service for land lines. This is a novel solution, already being met by fierce political opposition from vested interests. The Americans face the same problem without a good solution in sight. To date, the Federal Communications Commission has responded to the declining revenue base for universal service (resulting from the loss of revenue by long distance carriers) by increasing the universal service charge for the wireless carriers that are cannibalizing the land line revenues. Again, the problem is one of burdening the innovative elements of the industry with the need to subsidize the declining portion. Whoever finds a workable solution that frees up the IP part of the industry to innovate without weighing it down with a need to subsidize universal service may indeed create a stronger competitive field for its players.

There are larger forces on the horizon that contain the seeds of a Japanese revival. While the U.S. firms are superior to Japanese firms in the conventional PC-centered Internet and related technologies of content, production, and security, many experts predict that the future will be one of ubiquitous networks centered on mobile communications technology. It is here that Japanese firms have significant advantages.

As discussed above, their wireless technology is quite sophisticated. Mobile communications technology requires terminal technology for overcoming restrictions of receiving devices and of terminals; it also requires optical technology for overcoming performance problems. These are areas in which the Japanese are quite strong (Soumusho, 2004:10-11). Wireless networks and ubiquitous computing using cell phones, provide Japanese firms an opportunity to break Cisco's near monopoly on the network equipment business. To be sure, those firms and industries in the U.S. Europe, and Korea that gained large initial advantages, will obviously seek to build on rather than yield them. There are many researchers in the U.S. who believe that the future lies in wireless sensor nets providing the key platform for communication rather than the mobile phone.

In the networking area, although their global market share is very low, Japanese producers have maintained a high level of technology through servicing domestic firms so that should an opportunity occur, they are in a position to capitalize on it. Japanese firms and government officials are exploring possible alliances with Chinese and Korean firms to challenge Cisco's dominant position and were they to unite on setting technology standards, their international clout would be formidable. As one sign of such efforts, in late 2003, seven major Japanese electronic firms including NTT along with the Japanese government announced plans to cooperate with the governments and selected firms in China and Korea to jointly develop "Internet Protocol Version 6 ("IPv6"). IPv6 is the "next generation" protocol to replace the current version Internet Protocol, IP Version 4 ("IPv4"). IPv6 will dramatically expand the number of addresses (identifiers for a computer or device on the IP network) and will be a key to the growth of network uses. IPv6 is such a foundational protocol that numerous protocols need to be developed or changed in order to work with it. These can be written in ways that favor certain competitors. The participating East Asian firms and governments are declaring their efforts to embrace the standard with their products and have committed to lobbying for international standardization around their proposed applications of connections protocols and security software. They have the potential to be a formidable force that will challenge the U.S. companies like Cisco that has had employees making contributions to IETF. The East Asians see Ipv6 as an important opportunity to cut off legacy requirements and in so doing reduce one of Cisco's major advantages. This is the case because IPv6 allows for completely new applications such as consumer electronic devices connected to the net. Such networks do not share the legacy requirements that a corporate network has. Indeed, IPv6 is not compatible with the exising IPv4 protocol. As a result, Cisco's advantage of having compatibility with every device or product ever developed, would be reduced were IPv6 fully deployed. [14]

Japanese producers have a keen interest in influencing these standards since they are already quite strong in the networking of household electric appliances and equipment and want to build on that base in such a way that they are not dependent on protocols that favor Western competitors. With Ipv6 providing an almost infinite number of addresses, an IPv6 address can be assigned to home appliances enabling direct connection between end-user terminals (Yamashita, 2004:3). While the alliances with other East Asians show interesting potential, Japanese firms, even if they are successful, will be forced to share the fruits of their efforts with China and Korea. It is, however, not at all clear that IPv6 will be widely deployed. Despite its creation some 10 years ago, no major deployment has taken place. Its lack of compatibility with IPv4 raises the costs for migration from IPv4 to IPv6. Moreover, especially in light of security issues, the extent of market demand for consumers to remotely access their home appliances is not at all clear. In these kinds of situations, more practical half way solutions often arise to address existing problems..

The respective efforts of Japanese and other Asian firms as well as Cisco to influence IPv6 protocols have the effect of undermining IETF's principle that its participants make contributions as individuals not as corporate representatives. It is no doubt inevitable that this high minded view can not be sustained in an era of intense corporate competition over very large stakes. In the end, shifts in the competitive environment, evolution of key technologies and standards, and the entry of new competitors will greatly challenge Japanese communication equipment firms' efforts to recover their position as key players in global network equipment exports..

Finally, there are those who look for simple explanations for Japan's problems in telecom, relying on conspiracy theory to explain its declining global role. Koichiro Fujii (2003) in his popular book (over 30,000 in sales) "Who Destroyed NTT" is representative of this perspective. He describes the "destructive" consequences of U.S. pressure for the breaking up of NTT and the opening up of opportunities for new entries by cutting interconnection rates. He sees deregulation as a plot by the U.S. to steal technological hegemony from Japan. While it is easy to dismiss such irrational and inflammatory treatments, a softer version of his views resonates with many in the Japanese elite especially among disillusioned NTT executives.

We have instead attributed Japan's problems to a complex set of factors around the management of technology ranging from NTT management making the wrong technology bets on ATM and ISDN, institutional rigidities within NTT, damaging approaches to standards, to a failure to move more strongly to restructure the slow moving monopolistic NTT. For those who believe that if NTT had been still stronger, the outcome would have been better for Japan, one can ask the following question.

Would Japanese consumers have experienced the recent rapid spread of DSL and rapidly falling prices if NTT had been stronger? The answer is clearly no! Most of all Fujii, by focusing on what happened to NTT and its employees, fails to appreciate the consequences of a more rapid restructuring of NTT accompanied by the strong encouragement of new entries and the rapid introduction of new technology. These initiatives would have produced wide benefits for Japan's whole economy and society. AT&T's standing in the U.S. now is but a shell of its former formidable organizational body. Who can deny, however, that the U.S., despite the excesses of the 1990s and resultant over capacity in fiber networks, has emerged much stronger in global telecommunications as a result of the AT&T breakup. Such is the power of "creative destruction" as envisioned by Joseph Schumpeter. It is one of the ironies of industrial evolution that market forces sometimes may lead to better management of technology than government's efforts to micro-manage the process.

Notes:

[1] Interview with Kimio Inagaki, President Jabil Circuit, Japan, 5/8/04.

[2] Lecture by John Chuang, Sept 10, 2001. John Chuang is Professor of Information Management Systems, UC Berkeley.

[3] I am indebted above all for this account of Internet development at NTT to Dr. Shigeki Goto of the School of Science and Engineering, Waseda University and formerly of NTT and Ken Murakami, Senior Research Scientist NTT Laboratories.

[4] This section is based on an interview with Prof. Shigeki Goto, Waseda University, 6/11/03 Tokyo,

[5] I am indebted to Ye Xia, formerly of Bell Labs, for this detail.

[6] This section draws heavily from an interview with Masao Hibino, President and CEO of NEC Magnus Communications Ltd. 10/23/03.

[7] I am indebted to Haruki Koretomo, Chief Scientist, Network Systems Group of Fujitsu Ltd. for this account. 10/22/03

[8] Interview with Goto Shigeki., op.cit.

[9] I am indebted to Ye Xia at University of Florida, Gainesville and Ken Murakami, Senior Research Scientist, NTT Laboratories, for their provision of this description of the workings of IETF and ITU.

[10] This section on PDC, PHS and the 3rd generation global standard draws very heavily from Jeffrey Funk (2002: 70-82, 183-194), an interview with David Hytha, an American executive with long experience in Japan and Director, New Wave Networks, Sept 4, 2003 and feedback from Kenji Kushida, a UC Berkeley Ph.D. student studying DoCoMo.

[11] This section drew heavily from the observations of Kimio Inagaki, President Jabil Circuit, Japan.

[12] I am indebted to Reza Moazzami, a telecom consultant, for his observations on the Koreans, July 7, 2003.

[13] These observations benefited from a dialogue with Kimio Inagaki, President of Jabil Circuit, Japan.

[14] I am indebted again to Kimio Inagaki, President Jabil Circuit, Japan for his insights on this matter.

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