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The Comparison of the Information Technology (IT) Revolution and the Industrial Revolution

—Railway and Internet—

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1 Introduction

The purpose of this paper is comparing the Information Techonology Revolution and the Industrial Revolution and discussing the influences that Information Technology has exerted in society. For this purpose the current analytical span of time in the field of economics or business administration is not long enough. The Kondratieff cycle is the longest analytical cycle, but it is only around 50 years.

Peter Drucker looks briefly at the history of 500 years of technology from Gutenberg's printing press to the IT Revolution in his recent paper (Drucker, 1999). We would like to start from his view of the "Technological Revolution". Drucker insists that all the important technological reforms have evolved in a similar way, and he opposes the general opinion that the IT Revolution should be seen as a special case.

1-1 Printing Press and Railway: Dormancy, Explosion and the Unexpected Use of Technology

The printing press, invented by Gutenberg in 1455, was used for at least fifty or sixty years for printing the same kind of texts that monks had for centuries copied by hand. After that, printing large numbers of copies of various kinds of books, such as Machiavelli's *The Prince* (1514) and Martin Luther's German Bible (1522), the printing revolution swept all over Europe and changed completely its economy and psychology. Both the Reformation and the birth of nation states were influenced by this social change. Drucker comes to the conclusion that the new printing press laid dormant for a couple of decades and suddenly appeared and exploded, and brought a radical change to the European people.

On the other hand, about 40 years passed between the time when James Watt's steam engine was first applied to the cotton industry and the invention of

the steam locomotive and railway. Drucker emphasizes that the railway was the truly revolutionary element of the Industrial Revolution, which not only created a new economic dimension but also changed the mental geography. In just the same way the new technology of steam engine laid dormant for a couple of decades and then also exploded and bore a totally new product.

1-2 The future of the IT Revolution: Social Recognition of the Knowledge Worker

Then what can we say about IT Revolution? According to Drucker the Information Revolution, since the first computers were invented, has only transformed and systematized traditional processes so far. There has been no change in the way major decisions are made in business or government. Fifty years have passed since the first computer was applied to the Internet and e-commerce. In the mental geography of the Internet, distance has been eliminated. Through the Internet and e-commerce there is only one economy and only one market. For the first time, the possibility of new distribution channels has arisen, but it is not certain what products will be created by these new channels. As Drucker is aware that the social recognition of the technologist was necessary for great technological revolutions, he insists the social evaluation of the knowledge worker should be raised.

1-3 The comparison of the IT and Railway Revolutions

Based on the Drucker's views we will examine the future of the IT Revolution and its social influences. Before that we would like to look briefly at the expansion of railways into the Asian districts.

2 The Global Expansion of Railways and Their Social Effects

2-1 Railways in the U.K.: "The Equalizing effect"

After about thirty years since the first railway in the world (Stockton-Darlington Railway, 1825) was constructed, the railway network in the U.K. was almost completed. Trip time was shortened drastically, and the general concept of time, which had been very vague up to then, was unified thanks to the railway timetables. Railway changed the mental geography and created many kinds of new industries. As a result, the life of English people, from aristocrats to the working classes, was changed greatly. One example is the diffusion of mass-tourism.

In 1841 Thomas Cook first organized a day trip between Leicester and Loughborough in Midland by railway. At first, his purpose was to promote the Temperance movement, but he was developing the first commercial travel agency in the world. With the help of Cook's arrangements, many manual workers could enjoy inexpensive short journeys for the first time. The first international exposition held at the Crystal Palace in Hydepark provided him with a big business opportunity.

2-1-1 "The Dangerous Equalizing Effect of the Railway"

The more people traveling by railway, the more opportunities for people to interact with those outside their local communities. Everyone could have fairly equal opportunities to go to the destination of their choice by just buying a certain ticket, and railway stations were in fact the first public buildings large enough for such a variety of people to get together. The railway helped to equalize all people living in the U.K. so much so that the upper classes began to see the railway as dangerous.

2-1-2 Growth of the Railway Network and the Standardization of Gauge

Because English railways were constructed completely by private companies in the 19th century, two additional conditions were necessary so that various lines might be connected as parts of one whole network. The first was to make an adjustment of the fares between different companies possible, and the second is the standardization of the gauge, or distance between the tracks. The London and Birmingham Railway Company took the initiative in setting up the Railway Clearing House in 1842, after which the direction to solve the former became clear. However, as the second condition was central to the management of railway companies, it could not be solved by railway companies themselves. The Gauge Act of 1846 declared that the most widely prevailing gauge at that time, which was 4 feet and 8 1/2 inches (1435 mm), should be the standard. As a result, the broad gauge (7 feet and a quarter inch, 2013 mm) adopted by the Great Western Railway based on the influence of the most famous Engineer of the time, I. K. Brunel, had disappeared by the end of the 19th century.

2-2 Expanding of Railways into the North American Continent

It was widely known that the development of transportation would be very important and necessary to industrialize the North American continent. That is why the first railway in Canada was constructed in the middle of the 1830s, several decades earlier than the Asian colonies. During the same period many lines were built by private railway companies mainly in the eastern coast, and railway-mania in the United States began. In this period state governments had a great influence upon railway development; they lent or supplied land and funds to private enterprises, regulated their management and in some cases made a special treatment with the companies to enable to buy up the lines in a future. The first railway boom, however, came to an end because of the panic in 1837, and a new railway policy in the Federal Government began after that. The Federal Government had a strong will to assist in the construction of the transcontinental railway, which would serve as an artery to connect the eastern industrial capital with the western agricultural regions. The Federal Government supplied huge amounts of land and lent funds to the railway companies, and the Union Pacific Railway, which was the first transcontinental

line, was finished in 1869. By 1860 the total mileage of the U.S. railway amounted to 40,000 km, 2.5 times more than in the U.K. This fact must have been an important factor in the progress of industrialization and the political independence in the U.S., and it must have been one influence in the power transition among industrialized countries after the turn of the 20th century.

2-3 "Railway Imperialism" and India and China

From the viewpoint of so-called "Railway Imperialism" (Davis, 1991) we will consider the roll of railways in Asia.

2-3-1 India and the Coexistence of Different Gauges

In India, the railway construction by the British capitals started at the beginning of the 1850s, several decades earlier than other Asian countries. In 1853 the first railway between Bombay to Thana was constructied by the Great Indian Railway. The total mileage in India is now over 60,000 km, but, because of the coexistence of different gauges, these lines in India could not make a well-organized railway network. The main reasons appear to be as follows:
First, the railway policy of the Government of India fluctuated between the 1850s and the 1880s. When the government protected the investors very carefully, broad gauge (1676 mm) was apt to be adopted, and when the Government of India fell into the financial difficulties and could not afford the luxury of supporting railway companies, a meter gauge (1000 mm) or narrow gauges (610~762 mm) prevailed. Second, the Government of India did not try to unify different gauges; as U.K. government did by the Gauge Act of 1846.

In addition, transports of raw materials from inland to port and of industrial products from port to inland were discounted. This stems from the fact that the Indian railways were based not on the benefits of local economy or political necessity, but on the interests of British investors. That's why we can characterize this as Railway Imperialism.

2-3-2 China: Territorial Undermining by the Great Powers

After the Opium War, great powers and foreign enterprises like Jardine, Matheson and Co., Ltd required from China the right of railway, but were consistently rejected. However, around the end of the 19th century Chinese government changed its attitude and began to recognize the need for modernized transportation. In 1896, Russia received the right to build the East Sino Line, in order to expand the Siberian Railway toward East. After that, many railway lines were constructed by the great powers during the turn of the centuries. In this respect it is also very clear that the railway was not constructed depending on the needs of Chinese people, but instead the railways were used as an important means to exploit the land and resources of China. A situation such as this, can also be suitably for called “Railway Imperialism”.

2-3-3 Japan, Korea and North Easter District of China: “Railway Imperialism” in Japan

Railway construction in Japan is a typical example of how a small country could realize industrialization, grow as a nation state, and advanced into Asia by using the regional network of the railway.

2-3-3-1 The Construction of Domestic Railways

Just after the Meiji Restoration in 1868 some of the influential statesmen in Japan asked a railway for assistance in making a centralized state. Although the Meiji government not only borrowed construction funds from the U.K., but also used its help in all of the design, measurement, construction and operation, it had a strong will to maintain its own initiative, and never permitted foreign governments and enterprises to build a railway directly. In this way the national railway between Tokyo and Kobe was planned. In 1872 the Shinbashi (Tokyo)-Yokohama line was created, and then in 1889 the entire line was completed.

In the 1880s, investment in the railway became a boom and many railway companies were established. The first example of those companies, the Japan Railway Company, used as capital a special bond, which had been issued as a substitute for abolishing the privilege enjoyed by the previous ruling classes. This kind quasi-national and quasi-private railway company contributed greatly to the growth of the railway network in Japan and in 1906 all the lines were bought up by the government.

2-3-3-2 The Military Use of Railway and the Expansion to the Overseas

Railway bureaucracy clung to nationalization even in the middle of the private railway boom because it knew quite well of the railways’ value as effective means to carry soldiers and weapons. In fact, the railway was used effectively in all occasions of war after the Meiji Restoration, such as the South-Eastern War (1877), the Sino-Japanese War (1894-5) and the Russo-Japanese War (1904-5).

The military use of railway led to Railway Imperialism in Korea and China. Railway construction in Korea and in Taiwan was hastened to be adequately ready for the Russo-Japanese War. Japan acquired railway construction rights in the northeastern district of China through victory in the Russo-Japanese War, and the South Manzhou Railway which was completed between Dalian and Changchun in 1908 became the base of an Japan’s aggression in China. This was built and managed by the South Manzhou Railway Company, half of whose total capital of 200,000,000 yen was contributed by the Japanese Government. It owned not only the railway, but also many factories, warehouses, think-tanks, huge amounts of land and so forth. This company was in the center of the Japanese colonialism in China, and comparable with the East India Company of England.

2-3-3-3 The railway network through East Asia

The domestic railway in Japan and the railways in the Korean Peninsula and the East China were tied by the nationalization of the ferryboat between Shimonoseki and Pusan, and formed a big regional railway network through East Asia, which became the most important means to help Japanese imperialism invade China.

2-4 Short Summary

2-4-1 Unexpected Usage of Technology

The railway was expanding even to the Far East within 100 years after its

invention, and brought on great change all over the world. The social influences of the railway, however, were quite different in Europe and in Asia. On the one hand, it promoted industrialization, unified the national market, gave new culture to the people and contributed to human equality in the U.K. and North America. However, in Asia it had an imperialistic function and was the main means of controlling and suppressing the Asian people. We can see the sharp contrast in the attitude toward gauge standardization in India and in the U.K. and it is clear that the technology of the railway was used in quite different ways in the two countries.

2-4-2 Power Transition

The transcontinental railway was one of the necessary conditions for the political and economic independence of the U.S. The first transcontinental railway was, therefore, constructed not unexpectedly during the time of Civil War with warm support from the Federal Government, though the railway in the U.S. in general was furthest removed from the state intervention. It was the railway, together with other factors, that made change the direction of the world history from *Pax Britanica* to *Pax Americana*.

3 IT Revolution

3-1 IT Revolution（1946-95） —From ENIAC to the Internet—

The direct origin of the today's computer is what we call "ENIAC" (Electronic Numerical Integrator And Computer), and was developed by J. Presper Eckert and John Mauchly in the U.S. in 1946. It was a national project that invested $490,000 and the result contained 18,000 vacuum tubes, weighed 30 tons, and used 140 kw of electric power. It was an enormous machine, by today's standards, with a width of 150 feet (45 meters).

ENIAC http://www.unisys.co.jp/ENIAC/eniac01.html

In the 50 years after the birth of ENIAC, until the expansion of the new information technology, or the Internet, computers were used only in a limited range of tasks in which only a small number of computer-programming specialists used computers to calculate technological scientific formulas. Most of the developments of hardware were done to improve the calculation speed. In other words, the computer was limited to the framework of being merely a useful tool to take care of routine office work.

This resembles the history of the development of the railway in that it took 40 years until Watt's steam engine was finally applied to the creation of rail transport. Soon after, society was profoundly changed in a variety of ways.

The birth of the Internet resulted in more people using computers and bringing about the phenomenon that is referred to now as the IT Revolution. We will review the history of the Internet in the following section, comparing it with the birth and expansion of the railway in the Industrial Revolution.

It is said that the direct trigger of the appearance of the Internet was the terrorist bombing of the telephone relay base in Utah State, in 1961. After this event, the U.S. government authorities felt the strong need to make a new communication system that was able to stand up to a nuclear war and began research on the packet communication system.

In 1969, the Pentagon created an experimental network that tied together four computers called ARPANET. In 1973, the first international link was created from ARPANET to University College of London and the Royal Radar Establishment (Norway). However, by 1980 there were only a few hundred closed networks served by a host computer all over the world.

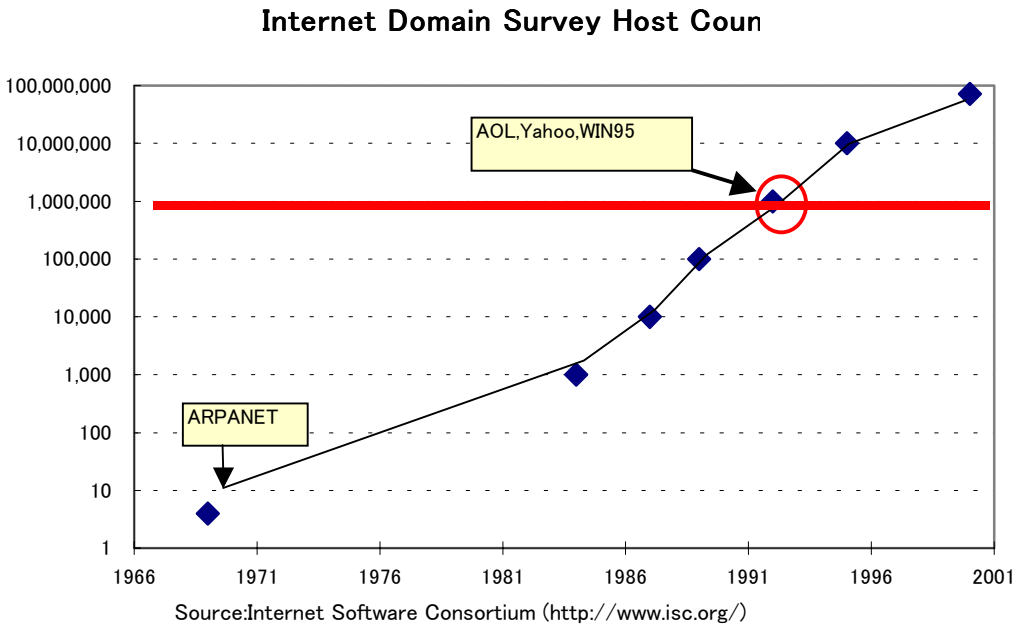
This situation began to develop rapidly due to the TCP/IP protocol that was developed for Unix in the University of California, Berkeley in 1982.

In 1984 the number of computers hosting a network surpassed 1,000 units. It exceeded 10,000 units by 1987, 100,000 units by 1989, and one million units by 1992. The number of the host computer rapidly increased by 10 times in these few years.

However, in those days, the benefits of this network were seen by only parts of the government and universities. It had not reached a stage of usefulness as a means of livelihood, business, medical treatment, education, and such.

The major turning points followed. Browser software was developed in 1993. It was called Mosaic and developed by a student group at Illinois University for the purpose of browsing the WWW. In 1995, AOL started an Internet connection service by using a dial-up connection. Yahoo started the searching service, which serves as the portal (entrance) for Internet users. This is what is called a ‘portal site’. In the same year, 1995, Microsoft sold MS-Windows 95 which triggered a rapid expansion of Internet use all over the world. Due to these influences, in 1995, the total number of host computers in the world increased explosively and broke through the ten million-unit marks. In 2001, the first year of the 21st century, the number of host computers worldwide continue to proliferate has already broken the 100,000,000 mark.

Therefore, we regard 1995, 50 years after the birth of ENIAC, as the year humanity took a major step forward in the innovation of information technology tools. This parallels the Industrial Revolution in which rail transportation appeared several decades after the invention of the steam engine.



3-2 IT Revolution (1995~)

3-2-1 Unexpected Usage

As explained in the previous chapter, computers were originally created as a national project and were developed only for scientific calculation purpose. Later their use expanded to the business world for salary computation and order processing. Before the spread of the Internet, they were highly priced and considered as a tool used only by those that specialized in hardware and programming. Unlike today, computers were not used by a wide range of people for the variety of purposes we see now.

Next, we look at how the expansion of the Internet has influenced our society. Needless to say, we cannot ignore the emergence of unexpected business applications and usage.

For example, the Net Auction system of eBay developed a virtual market by linking people through the Internet. Also, Priceline's Reverse Auction System developed a new business model in which prices decrease gradually by having corporations or suppliers bid for the opportunity to sell a product to the purchaser. Amazon.com developed a system in which one could make an order with just one click after providing personal details during the first purchase. Citibank developed a Net Banking system where the encrypted account information could be reviewed through a browser. Based on today's standard, these Internet businesses are not unusual. However, when these e-businesses were first introduced, they were considered innovative and business model patents were granted in the U.S.

However, what we want to emphasize is that revolutions of this magnitude

have a great impact on human history resulting in an enormous change in life style, the way capitalism functions, and the way countries operate, while originating from seemingly un-extraordinary technologies and not from grandiose political incidents.

3-2-2 Changes in Dominance Positioning

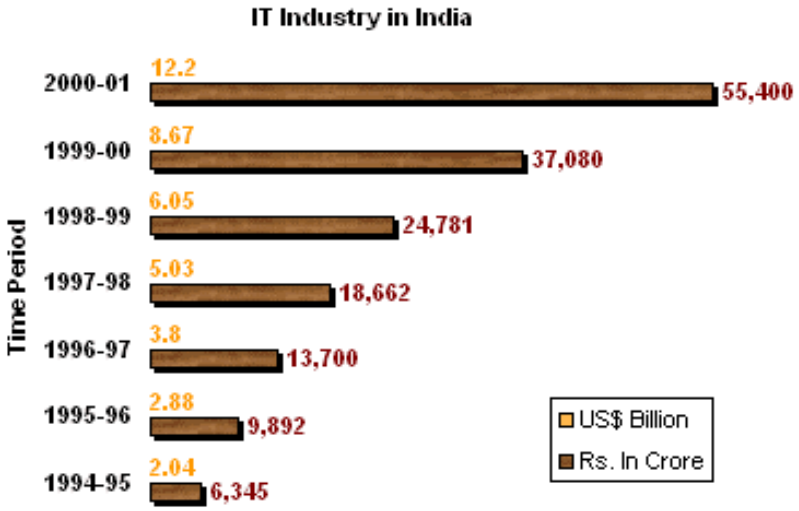
The Internet, which originated in the U.S., now has spread globally. In the "IT Revolution", will only technologies originate in the U.S. keep setting global standards (like the Internet itself)? In other words, will all the IT global standards have to originate from the U.S.? We feel that is not the case.

Furthermore, will local technologies, including business models that are different from the global standards be able to survive the waves of globalization just like the railway did by adapting to change?

In the next section we will cover the issue of whether the country, which invented the technology, will maintain hegemony in the rest of the world. We will discuss cases in India and Japan.

3-2-3 Software Industry in India

IT industry in India, especially the software industry has been receiving a lot of attention in the past several years. In fact, the Indian software industry has been achieving remarkable growth, from $2.7 billion in 1997 to $3.9 billion in '98, $5.7 billion in '99, and $8.3 billion in 2000. More than 185 of *the Fortune* 500 companies outsourced their software requirements to Indian software houses. The formula for IT industry growth in India is to import hardware for software development and then to export the software. How was India able to achieve such growth?



Of course the Indian government has played an important role in this. Tariffs on hardware were abolished in 1991 in order to facilitate software export. Establishing the Software Technology Park (STP) in 1998 and the IT Ministry in 1999 are considered as important factors in the government's role in the growth

of the software industry.

Active lobbying also took place. Some of the activities include NASSCOM, a group in the Indian IT industry, pressuring the Indian government to abolish the tariff on hardware and also to relax other regulations. NASSCOM also pressured the U.S. government to ease restrictions on the issue of visas to Indian IT technicians stationed in the U.S.

Furthermore, in order to receive orders from Japan, Japanese 64 bit fonts were incorporated and a program was implemented at the company level to train employees in Japanese business customs.

However, this is a phenomenon that has frequently happened in the history in other developing countries and is nothing new. What was new in software industry was that it was able to achieve growth without creating infrastructure such as roads and ports that were necessary in the past industrialization.

In addition, the offshore business model holds the key to success in India. As a result of the advancement in information technology, Indian corporations could respond to the orders made by American or Japanese customers rapidly without relocating themselves. Using the time difference wisely, if an American customer requests to make changes to software, changes could be made, while customers were sleeping and it will be available by the next morning. This is a business model using the time difference effectively and making use of the talented and relatively cheap human resources found in India.

It is interesting to note that the global expansion of the IT revolution has provided India with great opportunities after its textile industry was swept away by the Industrial Revolution of Great Britain.

3-2-4 The Mobile Internet in Japan

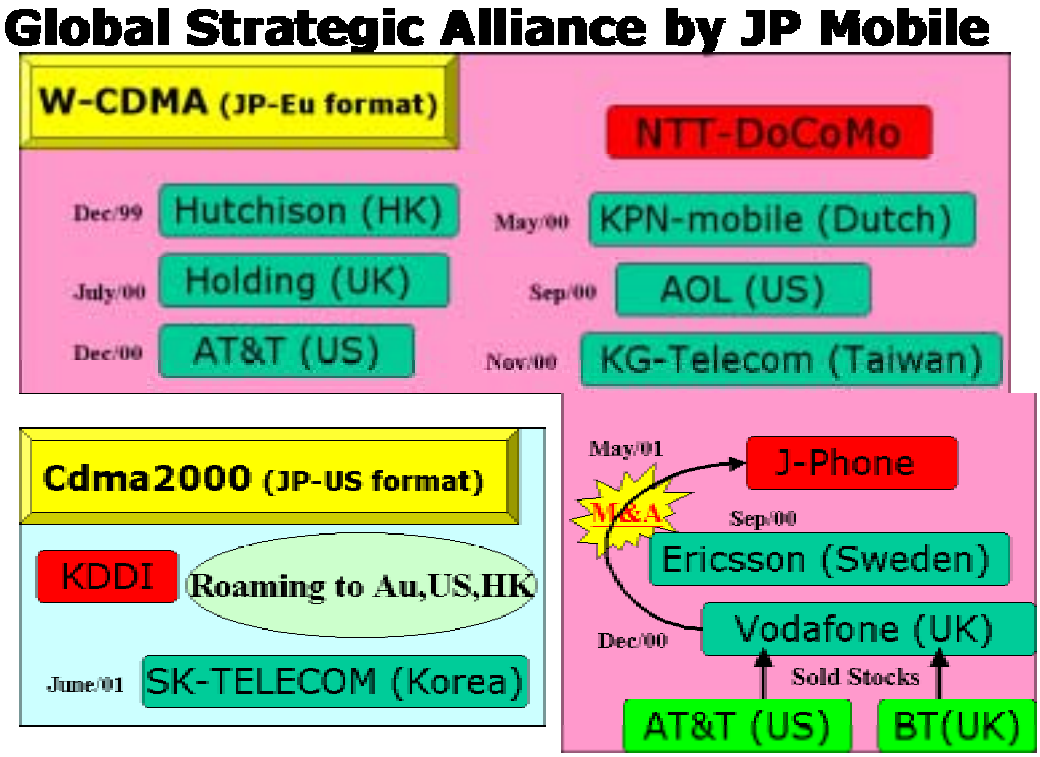
Mobile phones in Japan are achieving tremendous growth. The I-mode of NTT DoCoMo was introduced in February 1999 as the first mobile phone in the world that was able to access the internet. After 2 years, until April 2001, 23 million units of I-mode were sold. There are two other companies that provide the same service in Japan. They are KDDI's Ezweb and J-Phone's J-Sky and they have sold 7.2 million units and 6.7 million units respectively. The total number of units sold, 36.9 million units, is a remarkable figure when considering that the total population of Japan is only 120 million. This is tremendous growth in such a short period of time. All 70 million mobile phones that exist in Japan today are digital, and a half of them is capable of accessing the Internet.

On the other hand, based on the estimate provided by the Japanese government at the end of 2000, 37 million people access the Internet from desktop computers. This number is similar to the number of people who access the Internet through mobile phones. The mobile Internet enables not only e-mail but also other activities such as accessing web sites.

Other activities include checking stock prices, finding out surfing conditions, purchasing plane tickets and engaging in on-line banking. Such usage as

mobile Internet has been expanding and it can be positioned independently from accessing Internet through desktop PCs. The technology that originated in Japan is likely to globalize.

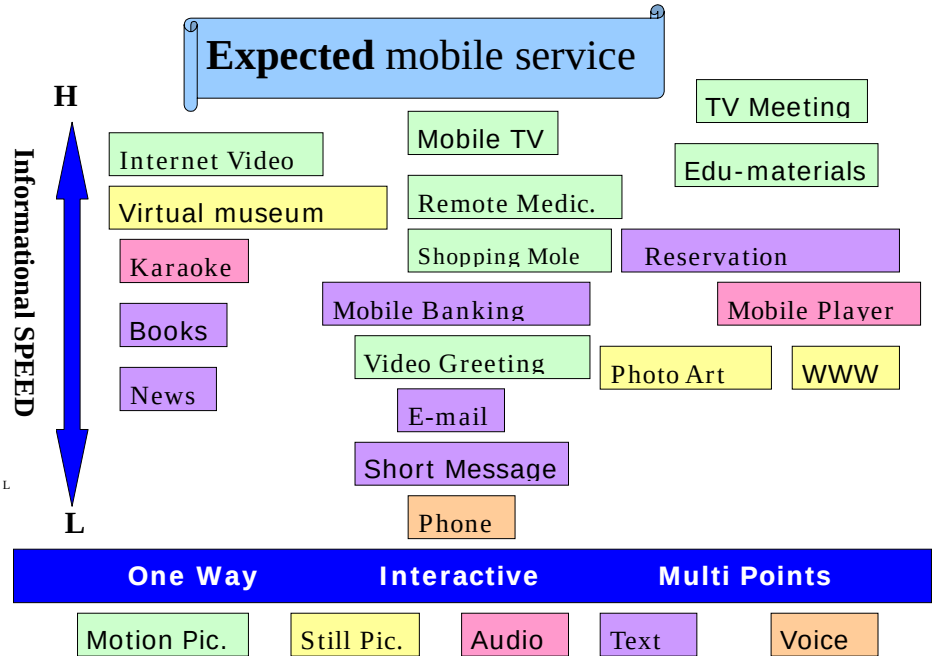
In order to make IMT 2000 a next global standard using W-CDMA



(Japan-Europe format), NTT DoCoMo has been making alliances with Hutchison (Hong Kong) in December 1999, KPN-mobile (Dutch) in May 2000, Holding (U.K.) in July 2000, AOL (U.S.) in September 2000, KG-Telecom (Taiwan) in November 2000, and AT&T (U.S.) in December 2000. KDDI with Cdma2000 (Japan-US format) also made a coalition with SK-TELECOM (Korea) in June 2001, and it will start providing an international roaming service in Australia, the U.S. and Hong Kong. Furthermore, using the next generation W-CDMA, J-Phone has made alliances with Ericsson (Sweden) in September 2000 and Vodafone (U.K.) in December 2000. In May 2001, they became the leading shareholder of Vodafone by purchasing stocks from BT and AT&T.

The next generation of mobile phone will be improved even more with activities such as karaoke and tele-conferencing being possible. A GPS navigation mechanism can also be installed, and if Java is incorporated, mobile ID or e-money can also be implemented.

We feel that the technology of the mobile Internet, which originated from Japan, will be globalize and open up a new page in Internet history.



3-3 Summary

In this chapter, we covered the role the Internet plays in the IT revolution from two perspectives: unexpected usage and change in dominance positioning.

We had three findings. Many people started using computers with the emergence of the Internet; as a result, e-commerce began to take place as well as various applications beyond scientific calculation, which was the original function of computers. Secondly, although technologies such as computers and Internet originated in the U.S., dominance can be shifted to countries other than the U.S., because large quantities of data can now be transmitted in short period of time over long distances.

The second finding describes new business opportunities that were born in India. Economic growth models that are quite different from models that were seen in the past can now be applied. In Japan, the mobile Internet, which can be classified as part of the Internet instead of as telephone service, has created a new market. Based on these case studies, we can state that local models and technologies have the possibility of having an impact on the global economy.

4 Conclusion

In order to understand the essence of technological revolution like the IT revolution, we propose to analyze from a longer time span, perhaps in century units as we do with the printing revolution and the Industrial Revolution.

We noted that the role railways played in the Industrial Revolution and the role the Internet plays in the IT revolution are very similar. To understand the IT revolution, we used the knowledge obtained from the way railways spread. We can state the following three propositions based on our findings:

Proposition number 1 – Dormancy and Explosion

Dramatic growth does not originate from political revolution, but from technology. It may require some time until it takes off. However, once it takes off, it will radically change the world.

Proposition number 2 – Unexpected usage

In the process of transmitting technology, unexpected usage of the technology may be born and it will radically change the life style of people.

Proposition number 3 – Change in Dominance Positioning

Through the process of the transfer of technology, changes in dominance positioning can occur between developed and developing countries

Based on the knowledge acquired in the development of this paper, we plan on carrying out further research on details, which deserve more elaboration.

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