Dynamics of Market and Strategy for Competitive Advantage
in Japanese Mobile Industry

by

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M.E., Electronic Engineering, University of Tokyo, 1994
B.E., Electronic Engineering, University of Tokyo, 1992

Submitted to the Alfred P. Sloan School of Management
in Partial Fulfillment of the Requirements for the Degree of

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Massachusetts Institute of Technology

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Yoshitaka Hiramoto

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ABSTRACT

The objective of this thesis is to analyze the dynamics of the mobile industry and propose tools that will help create robust strategies to establish competitive advantage. In the mobile industry, competition is so keen that it is extremely difficult for mobile operators to maintain their competitive advantage for a long time. Therefore mobile operators need a clear view of the industry in order to develop strategies that will help them survive the keen competition. The tools proposed in this thesis should provide insights into the dynamics of the mobile industry.

First, two concepts, “Double clockspeed” and “Three phases within system generation,” are introduced. Not only must mobile operators improve their current systems but they must also keep in mind the need to migrate to the next-generation system. Therefore these companies should take into consideration double clockspeed as it relates to the clockspeed of system generation, and the clockspeed of service. On the other hand, an analysis of the mobile industry shows that there are three phases, “Initial Phase”, “Differentiation Phase”, and “Commodity Phase,” within the system generation, and the dynamics of the mobile industry change according to the length and timing of these phases. These two concepts are extremely important for understanding the dynamics of the mobile industry.

Then, a dynamics model of the Japanese mobile industry is proposed, based on the market analysis and the introduced two concepts. This dynamics model is based on the concepts of System Dynamics, which will help us understand the complexity of the mobile industry.

Finally, the proposed dynamics model is applied to the current Japanese mobile industry, and possible scenarios for each mobile operator are analyzed. In addition, possible scenarios of mobile operators versus wireless LAN systems are also investigated, since these systems could become a disruptive technology in the near future, and mobile operators will need to create robust strategies to compete against them.

Thesis Supervisor: Henry Birdseye Weil
Title: Senior Lecturer, MIT Sloan School of Management
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I would like to express sincere gratitude to my thesis supervisor, Dr. Henry Birdseye Weil, for the helpful and professional manner in which he guided me through the remarkable achievement.

I would like to thank my friend, Mr. Satoru Iwasaki, for helping me to deepen my understanding of the system dynamics model.

Last but not least, I would like to thank my dearest wife, Kayo, and my beloved children, Mayu and Taiki, for their kind support throughout my studies at MIT— with my sincere gratitude. All of my happiness goes with you always.
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</table>
1.1. **Environment of the World Mobile Industry**

The worldwide mobile communications industry is growing so rapidly that today the number of subscribers to mobile systems worldwide has reached 1.3 billion as of December 2003\(^1\). In developed countries, the penetration rate is more than 50%; indeed, the growth of the mobile industry may even be growing saturated. In Taiwan, for instance, the penetration rate has already exceeded 100%. On the other hand, however, in developing countries the mobile industry is still expanding rapidly. In particular the growth of the Chinese mobile industry is dramatic. In spite of its present low penetration rate (about 20%), China still has the largest number of subscribers and will certainly be the dominant market in the near future. Tables 1-1 and 1-2 show the number of subscribers per county and per mobile operator, respectively.

Because growth in the number of subscribers is slowing gradually, mobile operators in developed countries have begun to shift their strategy from increasing the user base to improving system capability. In other words, these companies intend to add value to their systems in order to create other revenue sources.

Since 1999, when NTT DoCoMo, the dominant mobile operator in Japan, launched

\(^1\) Source: *GSM Association*
the world's first mobile Internet service, the demand for mobile multimedia services became stimulated all over the world. Recently, many mobile operators have begun to introduce new mobile systems called third generation systems (3G). The new systems have much greater capability for data communications than the existing second generation systems (2G), and they enable mobile operators to provide sophisticated mobile multimedia services.

Table 1-1. Number of subscribers per country

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>No. of subscribers</th>
<th>Penetration rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>China</td>
<td>259,459,400</td>
<td>19.9%</td>
</tr>
<tr>
<td>2</td>
<td>U.S.A.</td>
<td>142,458,000</td>
<td>50.1%</td>
</tr>
<tr>
<td>3</td>
<td>Japan</td>
<td>79,787,200</td>
<td>62.7%</td>
</tr>
<tr>
<td>4</td>
<td>Germany</td>
<td>61,597,800</td>
<td>73.7%</td>
</tr>
<tr>
<td>5</td>
<td>Italy</td>
<td>55,812,300</td>
<td>96.6%</td>
</tr>
<tr>
<td>6</td>
<td>The United Kingdom</td>
<td>51,583,700</td>
<td>86.0%</td>
</tr>
<tr>
<td>7</td>
<td>Brazil</td>
<td>42,969,380</td>
<td>24.1%</td>
</tr>
<tr>
<td>8</td>
<td>France</td>
<td>38,878,200</td>
<td>64.7%</td>
</tr>
<tr>
<td>9</td>
<td>Spain</td>
<td>36,566,300</td>
<td>91.1%</td>
</tr>
<tr>
<td>10</td>
<td>Russia</td>
<td>34,766,200</td>
<td>24.1%</td>
</tr>
<tr>
<td>11</td>
<td>Korea</td>
<td>33,591,630</td>
<td>68.6%</td>
</tr>
<tr>
<td>12</td>
<td>Mexico</td>
<td>29,587,800</td>
<td>28.2%</td>
</tr>
<tr>
<td>13</td>
<td>Turkey</td>
<td>29,055,400</td>
<td>42.4%</td>
</tr>
<tr>
<td>14</td>
<td>Taiwan</td>
<td>25,928,910</td>
<td>114.1%</td>
</tr>
<tr>
<td>15</td>
<td>Thailand</td>
<td>22,619,560</td>
<td>35.8%</td>
</tr>
</tbody>
</table>

Source: EMC

Table 1-2. Number of subscribers per mobile operator

<table>
<thead>
<tr>
<th>Rank</th>
<th>Mobile operator</th>
<th>No. of subscribers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>China Mobile (China)</td>
<td>164,907,500</td>
</tr>
<tr>
<td>2</td>
<td>China Unicom (China)</td>
<td>94,551,900</td>
</tr>
<tr>
<td>3</td>
<td>NTT DoCoMo (Japan)</td>
<td>45,365,900</td>
</tr>
<tr>
<td>4</td>
<td>Verizon Wireless (U.S.A.)</td>
<td>37,148,300</td>
</tr>
<tr>
<td>5</td>
<td>TIM (Italy)</td>
<td>26,432,000</td>
</tr>
<tr>
<td>6</td>
<td>T-Mobile (Germany)</td>
<td>26,103,600</td>
</tr>
<tr>
<td>7</td>
<td>Cingular Wireless (U.S.A.)</td>
<td>23,017,400</td>
</tr>
<tr>
<td>8</td>
<td>Radiomovil Dipsa (Mexico)</td>
<td>22,855,900</td>
</tr>
<tr>
<td>9</td>
<td>Vodafone D2 (Germany)</td>
<td>22,435,700</td>
</tr>
<tr>
<td>10</td>
<td>AT&amp;T Wireless (U.S.A.)</td>
<td>21,835,400</td>
</tr>
<tr>
<td>11</td>
<td>Telefonica Moviles (Spain)</td>
<td>19,380,200</td>
</tr>
<tr>
<td>12</td>
<td>Vodafone Omnitel (Italy)</td>
<td>19,184,100</td>
</tr>
<tr>
<td>13</td>
<td>Turkcell (Turkey)</td>
<td>19,041,200</td>
</tr>
<tr>
<td>14</td>
<td>Orange France (France)</td>
<td>18,661,300</td>
</tr>
<tr>
<td>15</td>
<td>SK Telecom (Korea)</td>
<td>18,13,000</td>
</tr>
</tbody>
</table>

Source: EMC
1.2. **Objective of the Thesis**

The objective of this thesis is to analyze the dynamics of the mobile industry and propose tools that will help create robust strategies to establish competitive advantage. In the mobile industry, competition is so keen that it is extremely difficult for mobile operators to maintain their competitive advantage, and many struggle to introduce innovative functions and services in order to improve their competitive position. Furthermore, mobile operators must continually work on the next-generation system in order to expand their business opportunities. Therefore mobile operators need a clear view of the industry in order to develop strategies that will help them survive the keen competition. The tools proposed in this thesis should provide insights into the dynamics of the mobile industry.

This thesis focuses on the Japanese mobile industry, since Japan leads the mobile market and has been at the cutting edge of innovative technologies and services, including mobile Internet services, camera-embedded handsets, and 3G systems. All three mobile operators in Japan realize large profits from the expanding mobile market and aggressively invest in creating more innovative functions and services. Although the Japanese mobile industry may be unique, the recent explosive growth of mobile Internet services and camera-embedded handsets worldwide is proof that Japan is the leader of the worldwide mobile industry. Therefore the tools in this thesis should be applicable to the mobile industries in other countries.
1.3 Thesis Structure

This thesis consists of six chapters, as shown in Figure 1-1.

![Diagram of thesis structure]

In chapter 2, I investigate the Japanese mobile industry. The industry is analyzed using on Michael Porter’s Five Forces model (Porter, 1985), and then the strategies of each mobile operator are summarized. In this chapter, the market share of new subscribers is often used for analysis. The number of subscribers in the Japanese mobile industry is so large that the market share of each mobile operator is relatively stable. In contrast, the market share of new
subscribers fluctuates and the leading mobile operator often changes. Since the market share of new subscribers directly reflects the results of mobile operators’ strategies, it is an extremely useful metric to analyze the mobile industry.

In chapter 3, two concepts—“Double clockspeed” and “Three phases within system generation”—are introduced. Not only must mobile operators improve their current systems but they must also keep in mind the need to migrate to the next-generation system. Therefore these companies should take into consideration double clockspeed as it relates to the clockspeed of system generation, and the clockspeed of service.

An analysis of the mobile industry shows that there are three phases—Initial Phase, Differentiation Phase, and Commodity Phase—within the system generation, and the dynamics of the mobile industry change according to the length and timing of these phases.

These two concepts are extremely important for understanding the dynamics of the mobile industry.

In chapter 4, a dynamics model of the Japanese mobile industry is proposed, based on the market analysis conducted in chapter 2 and the two concepts introduced in chapter 3. This dynamics model is based on the concepts of System Dynamics (Sterman, 2000), which will help us understand the complexity of the mobile industry.

Finally, in chapter 5, the dynamics model proposed in chapter 4 is applied to the current Japanese mobile industry, and possible scenarios for each mobile operator are outlined and analyzed. In addition, possible scenarios of mobile operators versus wireless LAN systems are also investigated, since these systems could become a disruptive technology in the near future, and mobile operators will need to create robust strategies to compete against them.
CHAPTER 2

The Japanese Mobile Industry

2.1 Overview

With a population of 127.5 million, Japan has the world's second largest economy in terms of gross domestic product (GDP). Also, its telecommunications market is the world's second largest (by revenue) after the U.S. The number of mobile subscribers has also expanded over the past decade, now reaching more than 80 million, with a penetration rate of over 60% as of January 2004 (see Figure 2-1). In March 2000, the number of mobile subscribers exceeded fixed-line subscribers for the first time (Foong and Mitsuyama, 2003).

Source: Telecommunications Carriers Association

Figure 2-1. Growth in the number of subscribers in the Japanese mobile industry
2.1.1 Components of the Japanese Mobile Industry

At present there are four mobile operators: NTT DoCoMo, au (ei-yu), Tu-Ka and Vodafone; there are also four mobile systems: PDC (Personal Digital Communications), cdmaOne (code division multiple access One), cdma2000 1x, and W-CDMA (Wideband Code Division Multiple Access) (see Table 2-1). NTT DoCoMo is the dominant mobile operator with a market share of about 57%; PDC, which offers the Japanese standard 2G system, is the dominant system with market share of about 77.5%. Both au and Tu-Ka are subsidiaries of KDDI Group.

Table 2-1. Market share in the Japanese mobile industry

<table>
<thead>
<tr>
<th></th>
<th>PDC</th>
<th>cdmaOne</th>
<th>cdma2000</th>
<th>W-CDMA</th>
<th>Total</th>
<th>Share (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DoCoMo</td>
<td>43.4</td>
<td>0.0</td>
<td>0.0</td>
<td>1.8</td>
<td>45.3</td>
<td>56.9</td>
</tr>
<tr>
<td>au</td>
<td>0.0</td>
<td>4.2</td>
<td>11.7</td>
<td>0.0</td>
<td>15.9</td>
<td>20.0</td>
</tr>
<tr>
<td>Tu-ka</td>
<td>3.6</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>3.6</td>
<td>4.6</td>
</tr>
<tr>
<td>Vodafone</td>
<td>14.6</td>
<td>0.0</td>
<td>0.0</td>
<td>0.1</td>
<td>14.7</td>
<td>18.5</td>
</tr>
<tr>
<td>Total</td>
<td>61.8</td>
<td>4.2</td>
<td>11.7</td>
<td>1.9</td>
<td>79.7</td>
<td>100.0</td>
</tr>
<tr>
<td>Share (%)</td>
<td>77.5</td>
<td>5.3</td>
<td>14.7</td>
<td>2.5</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Source: Telecommunications Carriers Association

In the mobile industry, mobile operators migrate from one system to another, that is, from the first generation system (1G), to the second generation system (2G), as the technology evolves, in order to improve the performance of their mobile systems. The time-line of system generation is illustrated in Figure 2-2 and the systems supported by each mobile operator are shown in Table 2-2.
1979～ | 1993～ | 2001～ | 2010～
---|---|---|---
1G system | 2G system | 3G system | 4G system

<table>
<thead>
<tr>
<th>Standard</th>
<th>No</th>
<th>Japanese Standard</th>
<th>Global Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service</td>
<td>Voice</td>
<td>Low speed data (≈64kbps)</td>
<td>High speed data (≈384kbps)</td>
</tr>
</tbody>
</table>

**Figure 2-2. Migration of system generations**

| Table 2-2. Mobile systems supported by Japanese mobile operators |
|---|---|---|---|
| Mobile operator | 1G system | 2G system | 3G system |
| NTT DoCoMo | Hi-cap | PDC | W-CDMA |
| au (*) | Hi-cap / TACS | cdmaOne (PDC) | cdma2000 |
| Tu-Ka | | PDC | |
| Vodafone | | PDC | W-CDMA |

(*) DDI and IDO merged and formed au in 2000.

*Source: Websites of NTT DoCoMo, KDDI Group, and Vodafone*

In 1979 Nippon Telegraph and Telephone Public Corporation (presently Nippon Telegraph and Telephone Corporation (NTT), the parent corporation of NTT DoCoMo) developed and launched the first Japanese 1G system, Hi-cap, based on analog technology, as a car phone service. Although there was no standard for the 1G system, a PDC system was adopted as the Japanese standard for the 2G system, and NTT DoCoMo launched it in 1993. Thanks to the digital technology of the 2G system, the popular features of mobile systems such as size, weight, battery lifetime of mobile handsets, voice quality, and security were considerably improved compared with the 1G system. The improved performance of the 2G system gradually attracted more and more subscribers, and the number of 1G subscribers has
continued to decrease until the last 1G system, TACS, was closed in 2000 (Foong and Mitsuyama, 2003).

In 1999 mobile operators introduced an improved 2G system called 2.5G system, which enabled mobile operators to provide a low-speed data transmission service, a mobile Internet service such as NTT DoCoMo’s i-mode.

In 2001 NTT DoCoMo launched the world’s first 3G system, W-CDMA system, whose most distinctive feature is high-speed data transmission. Its competitors, au and Vodafone, soon caught up and they too launched 3G systems in 2001 and 2002, respectively. At present, all mobile operators are migrating from the 2G to the 3G system. Indeed, NTT DoCoMo plans to introduce its 4G system in 2010.

2.1.2 Regulation of the Industry

The Ministry of Public Management, Home Affairs, Post and Telecommunications (MPHPT) is the regulatory body for the Japanese telecommunications industry and responsible for leading the information-communications market. When Nippon Telegraph and Telephone Public Corporation launched the first 1G system in 1979, the company was owned by the Japanese government and had a monopoly on the Japanese domestic telecommunications market including the mobile market. Since 1985, when Nippon Telegraph and Telephone Public Corporation was privatized and NTT was incorporated, MPHPT has liberalized the Japanese telecommunications industry, so that today Japan is one of most liberalized markets in the Asia and Pacific regions.
In 1989 DDI Group and IDO Group, which merged and formed au in 2000, launched their service and the first real competition was introduced into the Japanese mobile market. Furthermore, in 1994 Tu-Ka Group and Digitalphone Group (presently Vodafone) entered the market and competition became even more intense.

In 1994 the mobile handset market took off. From that point on, subscribers have bought their own mobile handsets in addition to leasing them from mobile operators as in the past. Owing to keen competition among mobile handset vendors, each one seeks to provide cheaper and more attractive handsets to subscribers.

In contrast to the governments of European countries, the Japanese government protects mobile operators in order to maintain the dramatic expansion of the Japanese mobile industry. This is especially apparent in the number of players and the license fee.

2.1.3 Number of Players

The mobile industry is distinctive because the government will give licenses to only a limited number of mobile operators owing to limited frequency resources. Mobile operators utilize the licensed frequency band exclusively to provide mobile services. At present, the Japanese government has given mobile service licenses to a relatively small number of mobile operator groups—NTT DoCoMo, KDDI Group (i.e., au and Tu-Ka), and Vodafone.

The population covered by each operator in Japan, about 42 million, is almost the same as that of the U.S. and more than twice as many as European countries (see Table 2-3). Since population is a good approximation of the potential mobile market, it can be said that competition among mobile operators in the European mobile industry is much keener than in
the Japanese mobile industry. Therefore, only three Japanese mobile operators enjoy the major share of the expanding and profitable Japanese mobile market, as Figure 2-1 showed.

<table>
<thead>
<tr>
<th>Country</th>
<th>Population (million, in 2003)</th>
<th>Number of mobile operators</th>
<th>Population per mobile operator (million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>1,304</td>
<td>4</td>
<td>326.0</td>
</tr>
<tr>
<td>Japan</td>
<td>127</td>
<td>3</td>
<td>42.3</td>
</tr>
<tr>
<td>Korea</td>
<td>47</td>
<td>3</td>
<td>15.7</td>
</tr>
<tr>
<td>Taiwan</td>
<td>22</td>
<td>6</td>
<td>3.7</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>7</td>
<td>6</td>
<td>1.2</td>
</tr>
<tr>
<td>The United Kingdom</td>
<td>59</td>
<td>5</td>
<td>11.8</td>
</tr>
<tr>
<td>France</td>
<td>60</td>
<td>3</td>
<td>20.0</td>
</tr>
<tr>
<td>Germany</td>
<td>82</td>
<td>4</td>
<td>20.5</td>
</tr>
<tr>
<td>Italy</td>
<td>57</td>
<td>3</td>
<td>19.0</td>
</tr>
<tr>
<td>Spain</td>
<td>41</td>
<td>3</td>
<td>13.7</td>
</tr>
<tr>
<td>U.S.A.</td>
<td>294</td>
<td>7</td>
<td>42.0</td>
</tr>
</tbody>
</table>

*Source: The UN, Gartner Research*

All mobile operators earn considerable income from the profitable mobile market (see Table 2-4), and they reinvest that profit back into improving their mobile systems in order to differentiate their services from competitors. This is one reason why Japan’s mobile services are the most innovative in the world. In comparison, the population per mobile operator in Hong Kong is just 1.2 million, about one-fortieth that of Japan. This makes the mobile market in Hong Kong a commodity, and it is extremely difficult for mobile operators to earn sufficient income to invest in creating new and innovative services.
### Table 2-4. Financial data of Japanese mobile operators

<table>
<thead>
<tr>
<th></th>
<th>NTT DoCoMo</th>
<th>au</th>
<th>Tu-Ka</th>
<th>Vodafone</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of subscribers</td>
<td>43,861</td>
<td>14,049</td>
<td>3,783</td>
<td>13,963</td>
</tr>
<tr>
<td>(thousand)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Market share (%)</td>
<td>58.0</td>
<td>18.5</td>
<td>5.0</td>
<td>18.5</td>
</tr>
<tr>
<td>Operating Revenue</td>
<td>43,700</td>
<td>14,700</td>
<td>2,900</td>
<td>13,200</td>
</tr>
<tr>
<td>Operating Income</td>
<td>9,600</td>
<td>480</td>
<td>54</td>
<td>2,210</td>
</tr>
</tbody>
</table>

(*) Fiscal Year 2002 ended March 31 in 2003 (million dollar)

Source: Websites of NTT DoCoMo, KDDI Group, and Vodafone

### 2.1.4 License Fees

The Japanese government gave 3G licenses to the three major mobile operators without charging a fee; in comparison, most European governments raised huge amounts of money by auctioning licenses. For instance, in 2000 the German government raised more than €55 billion by auctioning six 3G licenses to four existing mobile operators and two new entrants. However, in 2000 the capital market began to deteriorate rapidly, and the two new entrants had to give up their 3G business (Stuart and Bhalla, 2003). In contrast, mobile operators in Japan can concentrate their investments on their 3G networks, and NTT DoCoMo was the world’s first operator to launch 3G service.

### 2.1.5 Japanese Mobile Subscribers

Japanese mobile subscribers are extremely demanding. During the 1990s they were sensitive to issues of size, weight, and battery lifetime of mobile handsets. For instance, owing to customer demand, the weight of handsets was reduced from 250g to 60g. However, since 1999, when mobile Internet services were launched, subscriber preferences have shifted from outward hardware concerns to inward “function” concerns. Thus, the relatively large handset
now available, which features a larger display, is popular because it is easier for subscribers to browse websites and read or write e-mails. Furthermore, at present almost all mobile handsets are equipped with digital cameras and some have Global Positioning Systems (GPS) that offer site location services. The continual demands of subscribers for new functions makes Japanese mobile handsets the most innovative in the world.

### 2.2 Structure of the Japanese Mobile Industry

I have analyzed the structure of the Japanese mobile industry using Porter's Five Forces model (Porter, 1985). The results are shown in Figure 2-3.

![Diagram of the Japanese mobile industry structure](image)

**New Entrants**
- Threat of New Entrants: **Low**
  - Hard to enter because of license

**Industry Competition**
- Intensity of Rivalry: **High**
  - Two competitors (KDDI group, Vodafone)

**Suppliers**
- Bargaining Power of Suppliers: **Low-Medium**
  - Large subscriber base
  - DoCoMo makes specification

**Buyers**
- Bargaining Power of Buyers: **High**
  - Commodity

**Substitutes**
- Threat of Substitutes: **Medium**
  - PHS System
  - Wireless LAN System

Source: Author, 2004 (derived from Porter, 1985)

**Figure 2-3. Structure of the Japanese mobile industry**
2.2.1 Substitutes

Because it is extremely expensive to deploy systems all over the country, it is equally hard for other companies to provide services as a comparable substitute. Recently, wireless LAN systems based on Wi-Fi in public places, such as coffee shops, airports, and hotels have expanded dramatically (Dodd, 2002). Because mobile systems have certain advantages over wireless LAN systems, such as mobility and larger service area, the wireless LAN systems are considered complementary systems rather than viable substitute systems. However, standardization of the new wireless LAN systems, based on the 802.16e and 802.20 standards, will continue to improve mobility and coverage performance, and wireless LAN systems could be a highly disruptive technology for mobile systems. A discussion in greater detail is given in Section 2.4.2.

2.2.2 New Entrants

As explained earlier, the Japanese government gives licenses only to a limited number of mobile operators owing to limited frequency resources (see Figure 2-4). This makes it even more difficult for other companies to enter the industry. At present, MPHPT is considering giving additional 3G licenses to mobile operators that will deploy systems based on TD-CDMA (Time Division-Code Division Multiple Access), a 3G standard (Nikkei, 2003). IP mobile began its field trials of TD-CDMA system in April 2003, and Softbank has also applied for a license for field trials. In addition, other companies, such as NTT Communications and Cable and Wireless IDC, intend to enter this market. However the frequency band for TD-CDMA systems is limited to only 15 MHz (from 2.010GHz to 2.025GHz), which is much
narrower than that used for existing 3G systems (90MHz). Since the capacity of mobile systems largely depends on frequency bandwidth, it is almost impossible for new entrants to compete with existing mobile operators. NTT Communications is considering the TD-CDMA system as a complementary system to the Wi-Fi system it already provides.

![Diagram showing frequency allocation among Japanese mobile operators]

**Source:** Nikkei Communications

**Figure 2-4. Frequency allocation among Japanese mobile operators**

### 2.2.3 Competition

There are three major players in the Japanese mobile industry—NTT DoCoMo, KDDI Group, and Vodafone. Although NTT DoCoMo is the dominant mobile operator, with market share of about 57%, its competitive position has recently deteriorated and competition in the industry has become much keener. In fact, based on the semiannual accounting of market share of new subscribers from April 2003 to September 2003, **au** won first place. The competitors also have a large number of subscribers and earn a great deal of income. Even if one mobile operator establishes a competitive advantage, the ability of other competitors to
catch up is so strong that it is virtually impossible for any mobile operator to maintain a dominant competitive position for very long.

2.2.4 Suppliers

NTT DoCoMo has adopted a multi-vendor strategy for suppliers, which is one of its distinctive features. NTT DoCoMo selects a number of vendors, say five, from a large number of proposals by domestic and foreign vendors. The vendors that are chosen produce NTT DoCoMo-specific mobile handsets and network equipment based on technical specifications supplied by NTT DoCoMo in order to create innovative value for its mobile services. NTT DoCoMo’s bargaining power with its suppliers is extremely strong because the suppliers want to establish a close relationship with NTT DoCoMo owing to its dominant market share. Additionally, NTT DoCoMo can control prices by making vendors compete with each other.

In contrast, the other competitors’ strategies with their suppliers are completely deferent from NTT DoCoMo. They do not have an R&D department that can produce specifications for a mobile system and then simply purchase the entire system from a single vendor. It is difficult for competitors to change vendors because they have already invested large amounts of money into the purchase of equipment from the vendor in order to provide mobile services, so the switching cost is very high. However, the suppliers’ bargaining power is not high, since they also desire to maintain a close relationship with the operators because of their large subscriber bases. In particular, Vodafone is strong in this area because of its worldwide subscriber base. Furthermore, these operators may have the advantage of equipment price, since their vendors are international companies (e.g., Motorola and Ericsson),
and they may provide equipment at a lower price than NTT DoCoMo’s vendors because of economies of scale.

2.2.5 Buyers

Recently, competition among mobile operators has become keen, and it is extremely difficult for them to differentiate their mobile handsets or their services from those of competitors. This makes mobile handsets a commodity. The bargaining power of subscribers is so strong that mobile operators have to pay sales incentives for mobile handsets to selling partners. Subscribers can buy new handsets at prices lower than the regular price.

2.2.6 Other Factors

In addition to the five forces, Regulation and Complementary Assets also play important roles in determining the structure of the industry.

Regulations

As discussed in Section 2.1.3, MPHPT has the authority to determine the number of operators by controlling the number of licenses. Needless to say, the number of operators has a major impact on the structure of the industry. At present, MPHPT is considering increasing the number of mobile operators, which will change the structure of the Japanese mobile industry in the near future.
Complementary Assets

Complementary assets are crucial for mobile operators to enhance their products and services portfolios and to establish a competitive position (Hax, 2001). For example, a content provider for NTT DoCoMo's i-mode service plays an important role in improving the company's competitiveness. Since NTT DoCoMo launched i-mode service in February 1999, the number of i-mode service users had increased sharply, reaching about 38 million by March 2003—only four years from launch (see Figure 2-5). Although NTT DoCoMo operates the official site in cooperation with many content providers, the number of voluntary sites that are not operated by NTT DoCoMo has increased sharply to rival the official site (Natsuno, 2003) (see Figure 2-6).

Source: Telecommunications Carriers Association

Figure 2-5. Growth of NTT DoCoMo's subscribers and i-mode users
Figure 2-6. Number of i-mode voluntary sites

The i-mode users and i-mode sites form a positive feedback loop. In other words, a sharp increase in the number of i-mode users encourages content providers to provide more content for the i-mode system; at the same time, a rapid increase in the number of i-mode sites attracts more users to i-mode service. As a result, i-mode has become a de facto standard. In fact, NTT DoCoMo's semiannual accounting of market share of new subscribers from April to September 2000 exceeded 70%.

2.2.7 Current Industry Structure

As analyzed above, the Japanese mobile industry is exclusive because the threat of substitutes and new entrants is not high. However, mobile operators should consider strategies for dealing with substitutes and new entrants because emerging technologies, such as Wi-Fi and TD-CDMA, could be a disruptive technology in some subscriber segments. Also,
competition among mobile operators is keen, and the bargaining power of subscribers is strong. Therefore mobile operators must make every effort to differentiate themselves from their competitors in order to acquire a larger share of the market.

2.3 Mobile Operators in Japan

2.3.1 NTT DoCoMo

At present, NTT DoCoMo is the dominant mobile operator with a market share of about 57%. NTT DoCoMo's core competency comes primarily from its strong brand and its well-known research and development capability.

**Brand**

Before 1989, when competition was first introduced into the Japanese mobile market, NTT monopolized the Japanese mobile industry and thus established strong brand recognition as "NTT." When NTT DoCoMo was split off from NTT in 1992, the new company took over not just the mobile business but also the valuable brand name "NTT" as part of its corporate name. At the time, mobile services were much more expensive than they are today, and mobile handsets were status symbols. Consequently, subscribers tended to choose the most well-known brand, namely, NTT DoCoMo, and this contributed to maintaining the dominant market share even after the introduction of competition, as shown in Figure 2-7.
Recently, however, NTT DoCoMo's brand advantage has deteriorated, for two reasons. First, the penetration rate today is 60% and most new subscribers are young people who are much more sensitive to price than status or brand. Second, competitors are expanding their subscriber base and establishing their own strong brand. Therefore the value of NTT DoCoMo's brand compared with that of competitors has decreased.

**R&D Capability**

NTT Group is one of few operators in the world with a large R&D organization, and in 1992, NTT DoCoMo assumed that R&D capability as it relates to mobile systems. The number of R&D staff and R&D costs have continued to increase, reaching 1,100 and $1,000 million, respectively, in 2001.

R&D capability is crucial for enabling NTT DoCoMo to maintain its competitive advantage in the highly competitive Japanese mobile industry. In terms of the 2G system, NTT
DoCoMo’s PDC system was adopted as the Japanese standard. As the system developer, NTT DoCoMo launched the service in 1993—more than a year earlier than its competitors—which gave a first-mover advantage to NTT DoCoMo. Moreover, NTT DoCoMo quickly developed and released attractive, smaller-sized handsets which also helped differentiate the company from its competitors. In terms of the 3G system, the W-CDMA technology that NTT DoCoMo developed has also been adopted as a world standard, which enabled NTT DoCoMo to launch its 3G system first. At present, NTT DoCoMo is researching and developing a new 4G system which the company expects to launch in 2010.

NTT DoCoMo also develops specifications for mobile handsets and equipment, which has enabled the company to add value to its mobile network and to differentiate its services from its competitors.

Recently, however, NTT DoCoMo’s competitiveness has deteriorated and au has steadily gained market share since 2000, as shown in Figure 2-7.

2.3.2 au

In 2000 two mobile operators, DDI and IDO, merged to form au, and today au is the second-largest mobile operator in Japan. In order to compete with NTT DoCoMo, au has executed two strategies: (1) differentiating its services from NTT DoCoMo’s by adopting a different mobile system, and (2) attracting new subscribers, namely young people, by offering lower prices than NTT DoCoMo.
Differentiation from NTT DoCoMo

In 1997, DDI and IDO made a strategic change of direction related to their mobile businesses—they decided to adopt the second Japanese 2G standard, cdmaOne, and launch that service jointly even though they had already launched the 2G service in 1994, thus requiring a double investment in 2G systems. They did this because they thought it would be impossible to catch up with NTT DoCoMo if they had to depend solely on the technology that NTT DoCoMo had developed. In 2003 au discontinued its PDC service and migrated to the cdmaOne system. Also, for its 3G system au adopted the cdma2000 system, which is compatible with cdmaOne. Interestingly, NTT DoCoMo and Vodafone decided to adopt the W-CDMA system, and at one point there was some risk that cdmaOne would be a minority system in the Japanese 3G market.

In 2001 NTT DoCoMo and au both launched their 3G services. However, since that time, NTT DoCoMo has struggled to gain more subscribers because its W-CDMA system is incompatible with the PDC system (which au decided to discontinue). In spite of W-CDMA’s excellent peak data rate, the problems with size, weight, battery lifetime, and service areas made it difficult to induce existing 2G subscribers to migrate to the W-CDMA system. On the other hand, by taking advantage of cdma2000’s backward compatibility with cdmaOne, au is successfully migrating its subscribers from 2G to 3G, and at present au dominates the 3G service market.

Low Price

Because au adopted the cdma2000 system, which is compatible with its 2G system, it is now able to migrate to the 3G system without a large investment in a new network system.
This has enabled au to use its profits to subsidize price reductions that give it an extremely competitive advantage over competitors.

In order to attract new subscribers, especially young people, in 2000, au began offering a “Student Discount,” which is a 50% discount for both basic monthly charges and calling charges. Since then, au’s share of new subscribers has increased steadily, and in 2003 au moved past NTT DoCoMo into top place.

In 2002 au launched a discount on packet communication charges. To explain: since 1999, when Japanese mobile operators introduced mobile Internet services, the demand for data communications over mobile networks has increased and the users of these services are keenly aware of the data communication charges. In fact, recently young people have coined a new word, “Pack-Shi”, or “Packet Death,” which is how they refer to data communication charges that are much higher than they expected, and they cannot afford to pay the bill. au’s Packet Discount offers a discount of more than 60%—from ¥0.27/packet to ¥0.1/packet (1 packet is 128 byte), if the subscriber pays a fixed monthly charge of ¥1,200. This discount is extremely attractive for users who utilize mobile Internet services on a daily basis, and since its introduction au’s share of new subscribers has increased (see Figure 2-8).
Figure 2-8. Market share after the introduction of au’s Packet Discount

2.3.3 Vodafone

Vodafone has twice gone through a change of brand name. In 1999, three digital phone companies and six digital Tu-Ka companies merged and launched the new brand, J-Phone. Then in 2003, J-Phone changed its corporate name to Vodafone after several equity purchases by Vodafone between 2000 and 2001. Although Vodafone has a well-known brand name throughout the world, it is not popular in Japan. Therefore Vodafone has had difficulty establishing a brand reputation.

Vodafone is famous for the world’s first camera-embedded handsets introduced in 2000. They became popular immediately after launch, and the number of camera-embedded handsets has increased sharply. At present, the camera function is a key characteristic that forms the dominant design of mobile handsets, and today most new handsets have digital
camera functions. Until 2002, when its competitors finally introduced camera-embedded handsets, Vodafone had increased its market share of new subscribers by about 10% (as shown in Figure 2-7).

As shown in Table 2-5, Vodafone is far behind its competitors in the 3G business. The company launched its 3G system in 2002, more than a year after its competitors had already introduced a 3G system. Furthermore, subscribers have not been attracted to Vodafone’s 3G service because of limited handset availability. At present, Vodafone has difficulty differentiating its services from its competitors’ in both the 2G and 3G businesses.

<table>
<thead>
<tr>
<th>Table 2-5. Number of 3G service subscribers in the Japanese mobile industry</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>No. of subscribers (thousand)</td>
</tr>
<tr>
<td>Share</td>
</tr>
</tbody>
</table>

(as of February 2004)

Source: Telecommunications Carriers Association

2.4 Other Substitutes

2.4.1 PHS

Personal Handyphone System (PHS) services were launched in 1995 as a low-price alternative to mobile services. There are three PHS operators, NTT DoCoMo, DDI Pocket (a subsidiary of KDDI Group), and Astel. Although the number of subscribers to PHS increased sharply until 1997, reaching about 7 million, since that time it had gradually decreased, falling to about 5 million in 2003 (see Figure 2-9).
Source: Telecommunications Carriers Association

Figure 2-9. Number of subscribers in PHS systems

At the beginning of its launch, PHS had some advantages over mobile systems, such as voice quality, data rate, and charges. However, recently those advantages have deteriorated because of performance improvements and price reductions among the major mobile services. In fact, PHS failed to capture a substantial share of the expanding wireless market. Also, unfortunately, PHS has an undesirable brand image based on lower performance and lower price. Most subscribers do not want to use such a handsets, because of their value as status symbols, as described in Section 2.3.1. Recently, however, the number of subscribers has stabilized about 5 million. This means that PHS has captured a niche group of subscribers who are attracted to PHS's data communications capability and cheaper charges.

2.4.2 Wireless LAN system

Recently, wireless LAN systems in public places have expanded and users can take advantage of high-speed data transmission services in coffee shops, airports, and hotels (Dodd,
Although at present a typical wireless LAN system is based on the global standard, IEEE 802.11b called "Wi-Fi", other standards have also been established, as shown in Table 2-6. Further improvements, such as QoS (802.11e), Security (802.11i) and Higher Speed (802.11n), will also become available in the near future.

**Table 2-6. Wireless LAN systems based on IEEE 802.11**

<table>
<thead>
<tr>
<th>Aspect</th>
<th>802.11b (Wi-Fi)</th>
<th>802.11g</th>
<th>802.11a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency Band</td>
<td>2.4GHz</td>
<td>2.4GHz</td>
<td>5GHz</td>
</tr>
<tr>
<td>Modulation</td>
<td>DSSS/CCK</td>
<td>DSSS/CCK/OFDM</td>
<td>OFDM</td>
</tr>
<tr>
<td>Frame Rate</td>
<td>11Mbps</td>
<td>54Mbps</td>
<td>54Mbps</td>
</tr>
<tr>
<td>Access Control</td>
<td>CSMA/CA</td>
<td>CSMA/CA</td>
<td>CSMA/CA</td>
</tr>
<tr>
<td>Standard Approval</td>
<td>September 1999</td>
<td>June 2003</td>
<td>September 1999</td>
</tr>
</tbody>
</table>

DSSS: Direct Sequence Spread Spectrum  
CCK: Complementary Code Keying  
OFDM: Orthogonal Frequency Division Multiplexing  
CSMA/CA: Carrier Sense Multiple Access with Collision Avoidance

*Source: Nikkei Communications*

The differences between wireless LAN systems and mobile systems are shown in Table 2-7. Wireless LAN systems have some advantages of higher peak data rate and lower price, while mobile systems surpass them at mobility, service area and security.

**Table 2-7. Differences between wireless LAN systems and mobile systems**

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Wireless LAN system(*1)</th>
<th>Mobile system(*2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak data rate</td>
<td>11Mbps</td>
<td>2.4Mbps</td>
</tr>
<tr>
<td>Charge</td>
<td>Monthly fee: ¥1,600</td>
<td>Monthly fee: ¥1,200</td>
</tr>
<tr>
<td></td>
<td>Data: Free</td>
<td>Data: ¥0.1/128byte</td>
</tr>
<tr>
<td>Mobility</td>
<td>Not supported</td>
<td>Supports mobile environment (car, train)</td>
</tr>
<tr>
<td>Service area</td>
<td>639 Hotspots (cafes, airports, hotels etc.)</td>
<td>Almost 100% of population coverage</td>
</tr>
<tr>
<td>Security</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>License</td>
<td>Not required</td>
<td>Required</td>
</tr>
</tbody>
</table>

(*1) "Hotspot" service provided by NTT Communications  
(*2) au’s mobile services

*Source: NTT Communications and KDDI Group websites*
Recently, standards for wireless LAN systems with mobile capability have progressed (see Table 2-8), and improvements in data communications capability, i.e., peak data rate, are shown in Figure 2-10. Since mobile systems have the advantages of mobility and a wider service area over wireless LAN systems, mobile operators tend to underestimate the performance of wireless LAN systems. However, a wireless LAN system could become a disruptive technology, that is, one that currently resides under the low end of the market's demand for performance but may progress substantially due to sustaining technologies (Christensen, 1997). Indeed, with respect to mobility and service areas, the performance of 802.16e and 802.20 will probably improve to the extent that it becomes comparable to that of mobile systems.

**Table 2-8. Wireless LAN systems with mobile capability**

<table>
<thead>
<tr>
<th>Technology</th>
<th>802.16e</th>
<th>802.20</th>
<th>Mobile 3G system (Reference)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhancement of 802.16a (FWA)</td>
<td>-Optimized for mobility</td>
<td>-Not support real time service such as voice</td>
<td>W-CDMA</td>
</tr>
<tr>
<td>Frequency Band</td>
<td>2-6GHz Licensed Band</td>
<td>Lower than 3.5GHz Licensed Band</td>
<td>cdma2000 etc.</td>
</tr>
<tr>
<td>Cover Area from Base Station</td>
<td>A few miles</td>
<td>A few miles</td>
<td>Lower than 2.7GHz Licensed Band</td>
</tr>
<tr>
<td>Peak Data Rate</td>
<td>A few Mbps</td>
<td>A few Mbps</td>
<td>A few Mbps</td>
</tr>
</tbody>
</table>

FWA: Fixed Wireless Access

*Source: NTT Comware Technology*
Source: Author, 2004

**Figure 2-10. Improvement of data communications capability**

With regard to peak data rate, the performance of wireless LAN systems and mobile systems will come close to each other, as shown in Figure 2-10. Therefore mobile operators should create robust strategies to meet the competition from emerging wireless LAN systems. Among mobile operators, only NTT DoCoMo has launched a wireless LAN system, called “Mzone,” in 2002.

### 2.5 Summary

In this chapter, I analyzed the Japanese mobile industry, making the following points:

**Overview**

- The Japanese government protects mobile operators in order to maintain drastic expansion of the mobile industry, especially regarding the number of players and the license fee.
Continual demand from subscribers for innovations and new functions has made the Japanese mobile industry the most innovative in the world.

**Structure**

- Substitutes and new entrants, such as Wi-Fi and TD-CDMA, could become disruptive technologies in some subscriber segments.
- Competition in the mobile industry is so keen, and the ability of competitors to catch up is so strong, that it is impossible for a single mobile operator to maintain its competitive position for a long time.
- Complementary assets are key for enabling mobile operators to enhance their products and services portfolios and to establish a strong competitive position.

**Mobile Operators**

- NTT DoCoMo’s core competency comes primarily from its strong brand and R&D capabilities. However, recently its brand has diminished somewhat among users.
- **au** has two major strategies: (1) differentiate itself from competitors by adopting a different mobile system, and (2) attract new subscribers by offering a lower price than its competitors.
- Although Vodafone is famous for launching the world’s first camera-embedded handset, at present the company has difficulty differentiating its services from its competitors in both the 2G and 3G services.

**Substitutes**

- The PHS system has failed to capture major market share in the expanding wireless market because of performance improvements and price reductions among the major mobile
services, and because of a perceived undesirable brand image. However, this system has captured a stable niche group of subscribers.

- Although a mobile system has some advantages over a wireless LAN system, the performance of both systems will become very similar in the near future, and a wireless LAN system could be a disruptive technology for a mobile system.
3.1 Overview

In this chapter, I will introduce two new concepts: “double clockspeed” and “the three phases of system generation.” An analysis of the mobile industry shows that there are three phases during system generation for systems such as the 1G system and 2G system: the “Initial Phase,” the “Differentiation Phase,” and the “Commodity Phase,” and the dynamics of the mobile industry change according to the length and timing of these phases. Therefore an understanding of these two concepts is extremely important when describing and understanding the dynamics of the mobile industry.

3.2 Double Clockspeed

“Clockspeed” is defined as the rate of evolution of new products as a result of better technologies. Each industry has its own clockspeed (Fine, 1998). For example, the clockspeed of the computer industry is so fast that new products appear within six months after the release of previous products. In contrast, the airplane industry is so slow that the interval between new
product releases ranges from 10 to 20 years. Table 3-1 shows the clockspeeds of various industries.

Table 3-1. Clockspeeds for sample industries

<table>
<thead>
<tr>
<th>Industry</th>
<th>Product Tech Clockspeed</th>
<th>Process Tech Clockspeed</th>
<th>Organization Clockspeed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FAST CLOCKSPEED INDUSTRIES</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal Computers</td>
<td>&lt; 6 months</td>
<td>2-4 years</td>
<td>2-4 years</td>
</tr>
<tr>
<td>Computer-aided Software engineering</td>
<td>6 months</td>
<td>2-4 years</td>
<td>2-4 years</td>
</tr>
<tr>
<td>Athletic Footwear</td>
<td>&lt; 1 year</td>
<td>5-15 years</td>
<td>5-15 years</td>
</tr>
<tr>
<td>Semiconductors</td>
<td>1-2 years</td>
<td>2-3 years</td>
<td>3-10 years</td>
</tr>
<tr>
<td><strong>MEDIUM CLOCKSPEED INDUSTRIES</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bicycles</td>
<td>4-6 years</td>
<td>10-15 years</td>
<td>20-25 years</td>
</tr>
<tr>
<td>Automobiles</td>
<td>4-6 years</td>
<td>4-6 years</td>
<td>10-15 years</td>
</tr>
<tr>
<td>Computer Operating Systems</td>
<td>5-10 years</td>
<td>5-10 years</td>
<td>5-10 years</td>
</tr>
<tr>
<td>Agriculture</td>
<td>3-8 years</td>
<td>5-10 years</td>
<td>8-10 years</td>
</tr>
<tr>
<td>Machine Tools</td>
<td>6-10 years</td>
<td>6-10 years</td>
<td>10-15 years</td>
</tr>
<tr>
<td>Pharmaceuticals</td>
<td>7-15 years</td>
<td>10-20 years</td>
<td>5-10 years</td>
</tr>
<tr>
<td><strong>SLOW CLOCKSPEED INDUSTRIES</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aircraft (commercial)</td>
<td>10-20 years</td>
<td>5-30 years</td>
<td>20-30 years</td>
</tr>
<tr>
<td>Steel</td>
<td>20-40 years</td>
<td>10-20 years</td>
<td>50-100 years</td>
</tr>
<tr>
<td>Aircraft (military)</td>
<td>20-30 years</td>
<td>5-30 years</td>
<td>2-3 years</td>
</tr>
<tr>
<td>Shipbuilding</td>
<td>25-35 years</td>
<td>5-30 years</td>
<td>10-30 years</td>
</tr>
<tr>
<td>Petrochemicals</td>
<td>10-20 years</td>
<td>20-40 years</td>
<td>20-40 years</td>
</tr>
<tr>
<td>Paper</td>
<td>10-20 years</td>
<td>20-40 years</td>
<td>20-40 years</td>
</tr>
<tr>
<td>Diamond mining</td>
<td>Centuries</td>
<td>25-50 years</td>
<td>50-100 years</td>
</tr>
</tbody>
</table>

*Source: Fine, 1998*

For the mobile industry, the situation is more complicated. As explained in Chapter 2, mobile operators migrate from one generation system to another, and within a system they must continually introduce new services in order to differentiate themselves from their competitors. It is apparent, then, that the mobile industry has two types of clockspeed— the “clockspeed of service” and the “clockspeed of system generation,” as shown in Figure 3-1.
Mobile operators must take both these clockspeed types into consideration when creating new strategies.

(*) Assumption: Clockspeed of system generation = 10 years; Clockspeed of service = 1 year

Source: Author, 2004

Figure 3-1. Two types of clockspeed in the mobile industry

3.2.1 Clockspeed of System Generation

System generation in the mobile industry has a slow clockspeed—approximately ten years—similar to the airplane industry, owing to the complexity of mobile systems (Lyytinen and Fomin, 2002). In actuality, in Japan the interval between the 1G and 2G systems was 14 years, and between the 2G and 3G systems was eight years. Lyytinen and Fomin offer two reasons for this slow clockspeed. First, if the timing of mobile system development is too early, the risk of failing to implement the required functionality is too high because a large number of problems have to be solved in order to make the new system feasible. The other reason is that it
takes time for markets to cope with and learn to manage the services enabled by the new
generation system. The authors also noted that the timing should not be delayed until too late
when the competing technological option has become mature. While their analysis was based
primarily on the 1G system, the recent introduction of 3G systems suggests that the mobile
industry must also take other factors into consideration, such as the standardization process,
regulations, amount of investment required, and capacity. These are discussed briefly below.

**Standardization Process**

As discussed in Chapter 2, while there was no standard among 1G systems, the recent
3G systems are based on global standards approved by an international standards body, the
International Telecommunications Union (ITU). Since many mobile operators and vendors
worldwide participate in the standardization process, it takes much longer to achieve
consensus.

**Regulation**

Also discussed in Chapter 2, the Japanese government gave 3G licenses to mobile
operators without charge, while most European governments charged mobile operators huge
fees for licenses made available at auction. While NTT DoCoMo was able to launch its 3G
system first by taking advantage of the free license, most European mobile operators could not
afford to invest in 3G networks due to the huge license fee. In 2003, about two years after NTT
DoCoMo’s launch, European mobile operators finally began to plan and launch their own 3G
systems. However, the speed of migration is expected to be slow due to a shortage of mobile
handsets (Stuart and Bhalla, 2003).
**Investment**

One of the primary factors preventing mobile operators from launching the next-generation system was the large amount of money required to introduce the existing generation system. Mobile operators are hesitant to invest in another generation system even before they have earned sufficient profit to recoup the huge initial investment, since the introduction of a next-generation system is likely to decimate their existing subscriber base.

**Capacity**

A strong incentive for mobile operators to introduce a next-generation system is the lack of system capacity in the present system because of an increase in the number of subscribers (Gawer and Cusumano, 2002). Every mobile system has limits to its capacity owing to the limits of the licensed frequency band. Therefore mobile operators have to acquire more capacity by introducing the next-generation system in order to meet increased market demand.

The factors just described above determine the timing of a next-generation system launch and the clockspeed of system generation fluctuates because of the effects of these factors.

### 3.2.2 Clockspeed of Service

With the introduction of a next-generation system, mobile operators acquire the potential for many innovative services thanks to the new capabilities offered by the new system. Since it is almost impossible for mobile operators to provide all of the possible innovative
services at the outset of a new system launch, mobile operators often release new services periodically over short periods of time. In Japan, typically new-model mobile handsets are released twice a year, just in time for the bonus sales battles in June and December. Thus, the service clockspeed of mobile systems is fast, about 6 months, similar to the computer industry. As I discussed in Chapter 2, competition in the Japanese mobile industry is keen. Therefore mobile operators need to release new services as soon as possible in order to differentiate themselves from their competitors.

3.3 The Three Phases of System Generation

An analysis of the mobile industry shows that there are three phases—Initial, Differentiation, and Commodity—within systems such as the 1G system and 2G system, and that the dynamics of the mobile industry is changing according to the length and timing of the phases (see Figure 3-2).

During the Initial Phase and Differentiation Phase, the potential for innovative services is high thanks to the new capabilities provided by the next-generation system; conversely, price sensitivity among subscribers is relatively low because mobile operators can attract them by providing new services. During the Commodity Phase, however, the potential for innovative services is low and mobile operators have difficulty differentiating their services from other competitors. This leads the mobile market to commodity and the price sensitivity of subscribers accelerates rapidly. Furthermore, during the Initial Phase and Commodity Phase, the system generation clockspeed has a large effect on the industry dynamics. For example, the
lack of system capacity caused by an increased number of subscribers often inspires mobile operators to migrate to the next-generation system, like NTT DoCoMo migrated from the 2G system to the 3G system. Therefore, the factors that determine system generation clockspeed also affect the dynamics of the mobile industry. In the following sections each phase is explained in more detail.

![Graph showing phases within the system generation](source: Author, 2004)

**Figure 3-2. Phases within the system generation**

### 3.3.1 Initial Phase

The Initial Phase is defined as the period beginning when the first mover introduces the next-generation system to when all mobile operators introduce the system. Typically, this phase is short because competitors make every effort to catch up with the first mover as
quickly as possible in order to prevent it from dominating the new market created by the next-generation system.

Needless to say, the performance difference between the existing system and the next-generation system is an important factor prompting mobile operators to migrate to the next-generation system quickly and effectively, because they can easily attract existing subscribers to the new systems by introducing innovative services (Yi, 2001). However, the migration process from the 2G system to the 3G system in the Japanese and Korean mobile industries shows that compatibility of the next-generation system with the existing system is crucial. The migration path from 2G to 3G, as defined by ITU, is shown in Figure 3-3 (Redman et al., 2002). Based on IS-41 core network, the cdma2000 system is compatible with the cdmaOne system, while based on the GSM MAP core network, the W-CDMA system is compatible with the GSM system.
In the Japanese mobile industry, NTT DoCoMo and Vodafone adopted W-CDMA as their 3G systems, but it is not compatible with their current 2G systems, the PDC system. Meanwhile, au decided to adopt the cdma2000 system, which is compatible with its 2G system.

These situations characterize the competitive environment as a standards war between a "revolution" strategy and an "evolution" strategy, as shown in Figure 3-4. NTT DoCoMo and Vodafone had no choice but to select a "revolution" strategy because their 2G systems were not compatible with any of the 3G systems. Thus it is easy to understand why they did not choose the cdma2000 system but instead chose the W-CDMA system—because the W-CDMA system is compatible with the GSM system, which is the dominant 2G system in the world, and there
is a high probability that the W-CDMA system will be the dominant 3G system in the near future. In contrast, au adopted an “evolution” strategy, in large part because its 2G system is compatible with the cdma2000 system.

au’s Technology

<table>
<thead>
<tr>
<th>Compatible</th>
<th>Incompatible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rival Evolutions</td>
<td>Evolution versus Revolution</td>
</tr>
<tr>
<td>Revolution versus Evolution</td>
<td>Rival Revolutions</td>
</tr>
</tbody>
</table>

Source: Shapiro and Varian, 1999

Figure 3-4. Standards war of Japanese 3G systems

The number of subscribers to 3G systems is shown in Figure 3-5. While the number of au subscribers has increased sharply since the launch of its 3G system, reaching more than 10 million, the number of subscribers to NTT DoCoMo’s and Vodafone’s 3G systems is just beginning to take off. This figure clearly shows that compatibility plays an important role when mobile operators migrate to next-generation systems. By taking advantage of compatibility, au is able to attract subscribers to its 3G system without making them incur significant switching costs. In other words, since subscribers of au’s 3G system can access
both of 2G and 3G systems, qualities such as mobile handset functions and service areas do not deteriorate after subscribers shift to a 3G system. In fact, most of au’s subscribers are shifting to a 3G system without realizing they have migrated to the next-generation system.

![Graph showing the number of subscribers to 3G systems.](image)

*Source: Telecommunications Carriers Association*

**Figure 3-5. Number of subscribers to 3G systems**

On the other hand, the cost to subscribers for switching from the PDC system to the W-CDMA system is extremely high. Since NTT DoCoMo and Vodafone had to construct their 3G systems from scratch, at the beginning of commercial launch the population coverage was not nearly as wide (NTT DoCoMo, 22% and Vodafone, 70%), as that of their 2G systems which approaches almost 100%. By December 2003, population coverage of NTT DoCoMo’s W-CDMA system had reached 98%. This means that it took more than two years to expand its service area nationwide in order to be comparable to the service area of the 2G system.
Also, at the time, the utility factors of the 3G system’s handsets—size, weight, and battery lifetime—were much lower than those of 2G system handsets. Therefore the switching costs for subscribers, i.e., performance deterioration in some key aspects, were so high that even the innovative features provided by W-CDMA’s sophisticated technology, such as high-speed data transmission, could not attract the majority of 2G system subscribers to the 3G system.

Migration from 2G to 3G in the Korean mobile industry showed similar results. Today, all three Korean mobile operators are successfully migrating to 3G systems because there is compatibility (Song, 2003).

Needless to say, a first mover has many advantages. It can establish a dominant advantage over its competitors in the emerging market created by the next-generation system before competitors introduce their systems. Additionally, the first mover can accumulate know-how about the next-generation system through their experience and via feedback from users, which enables the company to improve its next-generation system and increase its advantages. However, as explained in Section 3.2.1, there are several problems that have to be resolved in order to make the new system feasible. Therefore, if a first mover introduces its next-generation system too early, defects may occur, and the reputation of the company may deteriorate to some extent.

3.3.2 Differentiation Phase

The Differentiation Phase is defined as the period beginning when all mobile operators introduce their next-generation systems to when all handsets and services of all
mobile operators become similar. In this phase, mobile operators release various kinds of new functions and services periodically over a short period of time—namely, the clockspeed of service. However, only a few of the new functions and services are so attractive that they become popular and enable mobile operators to increase their market share. For example, NTT DoCoMo’s market share of new subscribers was increased by 20% after the launch of its innovative service, i-mode, while Vodafone captured 10% of market share by releasing camera-embedded handsets (see Figure 3-6).

![Market share chart](image)

*Source: Telecommunications Carriers Association*

*Figure 3-6. Market share after release of innovative services*

By analyzing the market share of new subscribers, the dynamics of the mobile industry (see Figure 3-7) can be observed. By taking the advantage as a first mover, the mobile operator that releases an innovative service first can rapidly increase its market share for a brief period. However, that increase of market share inspires competitors to catch up with the first
move, and then all mobile operators begin to release the same or similar services. At this point, the service becomes embedded in the dominant design of mobile handsets and becomes a commodity (Utterback, 1994). Finally, the first mover loses its competitive advantage and is forced to return to the previous position before the new service was released.

\[ \text{equilibrium} \]

\[ \text{First mover's loss of advantage} \]

\[ \text{Emergence of dominant design} \]

\[ \text{First mover's release of an innovative service} \]

\[ \text{Increase of first mover's market share} \]

\[ \text{Competitors' catch-up} \]

*Source: Author, 2004*

**Figure 3-7. Dynamics of the mobile industry**

(A) **Vodafone’s Camera-embedded Handset**

In 2000, Vodafone released the world’s first camera-embedded handsets. It soon became very popular, enabling Vodafone to increase its market share of new subscribers by about 10%. Competitors tried to catch up as soon as possible, and in 2002 both NTT DoCoMo and au released their camera-embedded handsets—about two years from the date of
Vodafone’s launch. At that time, the digital camera function was embedded as part of the “dominant design” of mobile handsets, and since then most new-model mobile handsets have this function. After that, Vodafone’s competitive advantage deteriorated and its market share began to decline. This shows that the diffusion rate of an innovative service is determined based on two key factors—“Performance Improvement” and “Network Effects,” and this diffusion rate and “Delay of Catch-up” affect the amount of captured value thanks to the service.

**Performance Improvement**

The amount of performance improvement that a new technology can offer over any previous technology can have a major effect on the diffusion rate (Hall, 2003). Although mobile services and digital cameras were very popular when Vodafone released the first camera-embedded handsets in 2000, Vodafone not only added the digital camera function to the handsets but also created its innovative service called “Sha-mail,” which allows users to attach photos to e-mail using their mobile handsets. Sha-mail offers much more value for users than just the sum of the value of each mobile service plus the digital camera function; indeed, to a large extent this service changed the way users utilize mobile services. Among young people it has become popular to take pictures and send e-mails with photos by using the mobile handsets. Sha-mail service has contributed to the rapid increase of camera-embedded handsets right from the beginning of its launch.
Network Effects

The value of Sha-mail service to users is dependent on the extent to which it is adopted by other users, because the service is used to communicate with other users. This “network effect” creates a strong positive feedback. In other words, an increase in the number of Sha-mail users adds value to the service, and the increased value attracts more users to the service. The network effect also contributes to a faster diffusion rate for Sha-mail. And once competitors catch up with the first mover, the network effect also contributes to the rapid diffusion rate of competitors. The followers do not have to spend nearly as much effort promoting the new services or increasing user awareness of the new service. In addition, the first-mover’s large user base adds considerable value to the followers’ services right from the beginning of their launch.

Figure 3-8 shows the diffusion of camera-embedded handsets. Although NTT DoCoMo released its handsets about two years after Vodafone, NTT DoCoMo achieved much quicker diffusion by taking advantage of the network effects that had already been established by Vodafone’s user base. Although Sha-mail could be a disruptive technology in the Japanese mobile industry, the exclusive and large market enjoyed by NTT DoCoMo and au gave them the opportunity to catch up with Vodafone. Clearly, the network effect works to prevent mobile operators from maintaining a competitive advantage for very long.
Source: Websites of NTT DoCoMo and Vodafone

**Figure 3-8. Diffusion of camera-embedded handsets**

**Delay of Catch-up**

The delays encountered by competitors when attempting to catch up with the market frontrunner, i.e., the period of time from the first mover’s launch of a new service to the competitors’ launch of a new service, also impacts the value captured by the first mover. Since a mobile handset and a digital camera were two of the most popular portable electronic products when Vodafone released the first camera-embedded handsets in 2000, the concept of merging these two functions was not innovative. However, Vodafone created an excellent business model by providing Sha-mail service, which accelerated the diffusion through a strong network effect. In fact, it took about two years for Vodafone’s competitors to catch up with it. In particular, the dominant company, NTT DoCoMo, which was preoccupied with the development of W-CDMA in order to provide more sophisticated services such as a video
telephony service, seemed to have been taken off guard initially (Foong and Mitsuyama, 2003). As a result, Vodafone enjoyed a lengthy competitive advantage of about two years.

(B) NTT DoCoMo’s i-mode

As discussed in Section 2.2.6, complementary assets made a major contribution to the success of NTT DoCoMo’s i-mode service. The mobile Internet technology that NTT DoCoMo created was not so unique that it was difficult for the company to maintain its competitive advantage by just implementing the technology. In fact, its competitors also launched similar services in the same year when NTT DoCoMo introduced i-mode. Therefore, in order to capture the value of i-mode, NTT DoCoMo accelerated the diffusion rate through the network effect of complementary assets in pursuit of “critical mass” (Rogers, 1995), because the company did not have the first-mover advantage like Vodafone’s camera-embedded handsets. In other words, if one looks at Figure 3-9, NTT DoCoMo sought to position itself in the “Asset Owner” sector of the Making-Money Matrix by attracting content providers, i.e., complementary assets, to the i-mode business faster than its competitors.
Complementary Assets

<table>
<thead>
<tr>
<th>Freely Available</th>
<th>Tightly Held</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inventors Dream</td>
<td>It Depends</td>
</tr>
<tr>
<td>Outsource</td>
<td>Joint Ventures</td>
</tr>
</tbody>
</table>

Uniqueness

<table>
<thead>
<tr>
<th>Easy to maintain</th>
<th>Hard to maintain</th>
</tr>
</thead>
<tbody>
<tr>
<td>No-one</td>
<td>Speed to Market a Prerogative</td>
</tr>
<tr>
<td>Asset Owner</td>
<td>NTT DoCoMo’s i-mode Vulnerable to Competition</td>
</tr>
</tbody>
</table>

Source: Moser, 2004

Figure 3-9. NTT DoCoMo’s strategy in the Making-Money Matrix

NTT DoCoMo’s fundamental strategy for attracting content providers was to “lower the barriers to entry,” and several key factors are discussed below.

Nonparticipation in content business

Although NTT DoCoMo could have entered and profited from the content business, the company opted to continue its customary role in the mobile business. This is because content providers might have hesitated to enter the i-mode business since they knew it would be difficult to compete with NTT DoCoMo because of its overwhelming advantage as the provider of i-mode services. Although NTT DoCoMo did not capture value in the content business, the company successfully captured much more value in the mobile business by expanding its market size in collaboration with content providers (see Figure 3-10).
Figure 3-10. Expansion of market size in collaboration with content providers

Standards

In order to make it easier for content providers to create contents for i-mode services, NTT DoCoMo adopted as many de facto standards as possible. For instance, the company adopted Compact HTML for constructing content in the Internet domain. This compatible version of HTML enables content providers to easily modify their existing websites so that mobile subscribers can access them, thereby leading to low barriers to entry. Additionally, NTT DoCoMo adopted the Graphical Interchange Format (GIF) for i-mode's graphic data format, which is widely used on the Internet. This enabled content providers to easily incorporate their existing graphics into their i-mode contents (Natsuno, 2003).
Billing Service

NTT DoCoMo offers a billing and collection service to content providers. All Internet service charges from NTT DoCoMo’s official sites are collected by NTT DoCoMo, and the company receives a 9% fee from content providers for this service (Dodd, 2002). Because it is difficult for content providers to establish a reliable system for bill collecting, this service is a strong motivation for content providers to join the i-mode business.

By managing the above key factors, NTT DoCoMo is successfully attracting content providers to its i-mode business and accelerating diffusion though the network effect, as shown in Figure 3-11. In other words, NTT DoCoMo successfully crossed the gap between “Early Adopters” and “Early Majority” with in the “Technology Adoption Life Cycle” and at present is reaching “Laggards” (Moore, 1999). Although there was no first-mover advantage, NTT DoCoMo is diffusing its mobile Internet services much faster than its competitors.

Source: Telecommunications Carriers Association

Figure 3-11. Number of mobile Internet users in the Japanese mobile industry
Furthermore NTT DoCoMo created a new revenue source, namely data traffic, as shown in Figure 3-12. Since 1997, the Average Revenue Per User (ARPU) of voice services has steadily declined because of price reductions owing to the keen competition among mobile operators. However, since 1999, when NTT DoCoMo launched its i-mode service, the ARPU of data traffic has steadily increased, which makes the total ARPU relatively stable at approximately ¥8,000. As a result, NTT DoCoMo has captured a huge amount of value with its i-mode service by realizing an increase in market size and market share as well as the new revenue source, thanks to complementary assets.

![Graph showing ARPU of NTT DoCoMo](#)

*Source: NTT DoCoMo website.*

**Figure 3-12. ARPU of NTT DoCoMo**

The competitive advantage of NTT DoCoMo's i-mode was vulnerable and has continued to deteriorate since 2000, as shown in Figure 3-6, because its competitors have
caught up with NTT DoCoMo by obtaining complementary assets, namely, a variety of contents. Thus, NTT DoCoMo’s position today is shifting from the “Asset Owner” sector to the “No-one” sector in the Making-Money Matrix illustrated in Figure 3-9. For this reason, NTT DoCoMo must create and capture another innovative value in order to recover its competitive position in the Japanese mobile industry.

3.3.3 Commodity Phase

The Commodity Phase is defined as the period beginning when all mobile handsets and the services of all mobile operators become similar to when all mobile operators complete the migration to next-generation systems. Recently, the Japanese mobile market for the 2.5G system entered the Commodity Phase, and mobile operators are now unable to differentiate their services from their competitors. In fact, all three operators released camera-embedded handsets offering 100+ mega-pixels at virtually the same time in May 2003. In addition, subscribers are becoming more sensitive to charges, which is why au’s market share, which offers data communication service at the lowest price, has increased recently.

Furthermore, in this phase mobile operators have to consider timing when launching a next-generation system. Timing is affected by the key factors that were explained earlier in Section 3.2.1. There are two main reasons why mobile operators migrate to the next-generation system: Performance Improvement, and Capacity Shortage.
Performance Improvement

In the Commodity Phase, there are few or no differences among the services offered by mobile operators, and the mobile industry has begun to shift into a price war because the services have become established commodities. Some operators who dislike such an unprofitable war may soon migrate to the next-generation system in order to capture another revenue source provided by the new performance of the next-generation system.

Capacity Shortage

In the Commodity Phase, the number of subscribers and the amount of data transmitted over mobile systems may increase through the network effects of products and services. Furthermore, a reduction of calling charges caused by a price war may also increase data traffic, which accelerates the shortage of capacity. Therefore, mobile operators who are faced with a capacity shortage must consider migration to the next-generation system in order to acquire additional system capacity. For this reason, the first mover may be the largest mobile operator in the mobile industry. Based on movements made by the first mover, the followers must also consider migration to the next-generation system in order to prevent the first mover from dominating the emerging market.

3.3.4 The Phase Concept

The phase concept is summarized in Table 3-2. The industry environment and key issues differ from phase to phase, and the dynamics of the mobile industry change according to the length and timing of each phase. Therefore mobile operators should pay careful attention to the phase concept when creating their strategies.
Table 3-2. Phase Concepts

<table>
<thead>
<tr>
<th></th>
<th>Initial Phase</th>
<th>Differentiation Phase</th>
<th>Commodity Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Definition</strong></td>
<td>From: the first mover introduces the next-generation system</td>
<td>From: all mobile operators introduce the next-generation system</td>
<td>From: all handsets and services of all mobile operators become similar</td>
</tr>
<tr>
<td></td>
<td>To: all mobile operators introduce the next-generation systems</td>
<td>To: all handsets and services of all mobile operators become similar</td>
<td>To: all mobile operators complete the migration to the next-generation systems</td>
</tr>
<tr>
<td><strong>Potential for innovative services</strong></td>
<td>High Sophisticated technology of the next-generation system</td>
<td>High Sophisticated technology of the next-generation system</td>
<td>Low Lack of new technologies</td>
</tr>
<tr>
<td><strong>Subscribers’ Price Sensitivity</strong></td>
<td>Medium Attractiveness of innovative services</td>
<td>Medium Attractiveness of innovative services</td>
<td>High Commodity</td>
</tr>
<tr>
<td><strong>Key issues</strong></td>
<td>- First mover advantage</td>
<td>- Dynamics of the mobile industry</td>
<td>- Pricing strategy</td>
</tr>
<tr>
<td></td>
<td>- Smooth migration from the previous system (Compatibility)</td>
<td>- Diffusion rate (Performance improvement, Network effect)</td>
<td>- Timing to migrate to the next-generation system</td>
</tr>
<tr>
<td></td>
<td>- Performance difference from the previous system</td>
<td>- Delay of catch-up</td>
<td>(Performance improvement, Capacity shortage)</td>
</tr>
</tbody>
</table>

Source: Author, 2004

3.4 Summary

In this chapter, two new concepts, “Double clockspeed” and “The three phases of system generation” were introduced. These two concepts are extremely important if one wishes to describe the dynamics of the mobile industry precisely. The following points were made:

- Not only technological factors but other factors such as standardization, regulation, investment, and capacity determine the timing of a next-generation system launch. These factors cause the clockspeed of system generation to fluctuate.

- In the Initial Phase, compatibility of the next-generation system with the existing system is crucial. This determines how successfully a mobile operator can migrate to the next-generation system.
• In the Differentiation Phase, the dynamics of the mobile industry, as shown in Figure 3-7, are observed.

• The diffusion rate of an innovative service is determined based on “Performance Improvement” and “Network Effects,” and this diffusion rate and the associated “Delay of Catch-up” affect the amount of captured value gained from the service. However, this network effect also contributes to the diffusion rate of competitors, which prevents a mobile operator from maintaining its competitive advantage for a long time.

• Complementary assets play an important role for a mobile operator seeking to establish competitive advantage. NTT DoCoMo diffused its i-mode service far more successfully than its competitors did with their services, because NTT DoCoMo attracted content providers (i.e., a complementary asset) to its i-mode business.

• In the Commodity Phase, mobile operators tend to migrate to the next-generation system for two reasons: performance improvement and capacity shortage.
4.1 Overview

In this chapter, I propose a dynamics model for the Japanese mobile industry, based on the market analysis described in Chapter 2 and the newly introduced concepts of “double clockspeed” and the “three phases of system generation” discussed in Chapter 3.

This dynamics model is based on the concepts of system dynamics modeling, which helps to understand the complexity of the mobile industry (Sterman, 2000). First, I introduce the basic model, which represents the typical dynamics of the mobile industry. Then the model is modified to reflect the impact of the three phases—Initial, Differentiation and Commodity—within the system generation.

4.2 Basic Model

The basic model has three modules: (1) source of attractiveness, (2) core market dynamics, and (3) profit feedback, as shown in Figure 4-1.
**Source of Attractiveness**: Mobile operators strive to improve the attractiveness of their mobile systems in order to differentiate themselves from competitors and to increase their market share. Thus mobile operators add new functions to their networks or reduce charges in order to attract new subscribers to their services.

**Core market dynamics**: By improving the attractiveness of mobile systems, the dynamics of the mobile industry are stimulated. While the first mover can increase its subscriber base through strong positive feedback created by the network effects, after a while, as competitors catch up, the first mover’s competitive advantage is reduced.

**Profit feedback**: The mobile operators’ actions, namely source of attractiveness, and core market dynamics, determine the profit earned by a mobile operator. For instance, improved functions may increase ARPU and the number of subscribers, which contribute to increased revenue; conversely, investment in network capacity caused by increased traffic can
increase costs. Furthermore, mobile operators feed back their profits to the source of attractiveness in order to continually differentiate themselves from their competitors and maintain their competitive positions.

The conceptual model of the mobile industry is shown in Figure 4-2. In the following sections, the dynamics of each module are explained in detail.

![Diagram of conceptual model of the mobile industry]

*Source: Author, 2004*

**Figure 4-2. Conceptual model of the mobile industry**
4.2.1 Source of Attractiveness

Mobile operators strive to improve the attractiveness of their mobile systems in order to differentiate themselves from competitors and increase their market share. Gartner Research Group proposes five factors of attractiveness, the so-called “five Cs”—Coverage, Cost, Capacity, Capability, and Clarity—as the key factors influencing subscribers when selecting a mobile operator (Skvarla, 2003).

I have recategorized and renamed these five factors into four factors called Service Area, Price, Function, and Quality in order to make them more intuitive based on the analysis of the mobile market.

Service Area (Coverage)

The history of the Japanese wireless industry shows that the service area is one of the most important factors considered by potential subscribers. The population coverage of the 2.5G systems in Japan is almost 100%, and mobile subscribers take for granted that they can use their mobile service anywhere, even in rural or underground areas.

For this reason, au is migrating to the 3G system far more successfully than its competitors, as explained in Section 3.3.1. PHS systems also have not been popular for the same reason, as explained in Section 2.4.1.

In addition mobile operators have recently begun to provide international roaming services. For example, by taking advantage of Vodafone’s worldwide networks, it can provide international roaming, which enables its subscribers to use their mobile handsets in 85
countries. However, the need for an international roaming service is smaller in Japan than in other developed countries because Japan is an island country and few Japanese go abroad.

**Price (Cost)**

Because at present the majority of potential new subscribers are young people who are sensitive to price, price is an important consideration when seeking to attract new subscribers to a mobile operator’s systems. Since 1999, when Japanese mobile operators first introduced mobile Internet services, the demand for data communications over the mobile networks has increased, and users of these services are concerned about data communication charges. Furthermore, 3G systems, which provide mobile multimedia services such as video downloading, are stimulating the demand for a reduction in the price of data communications services.

**Function (Capability)**

“Function” is further divided into three parts: handset functions, such as an embedded digital camera; network services, such as call waiting and caller ID; and platform services, such as mobile Internet. The physical characteristics of handsets, such as size, weight, and battery lifetime, are included in the “handset functions” sub-category; the content of the platform services are not included in this category but are dealt with in the core market dynamics module as one of the network effects.

**Quality (Capacity and Clarity)**

System capacity is directly related to the quality of a service. If the capacity is insufficient and the system becomes overloaded, the successful call connection rate decreases and voice clarity and effective data rate deteriorate. Therefore mobile operators have to
monitor the quality of their services and confirm whether the actual quality meets the expected service level, because an increase in the number of subscribers may cause a deterioration in the service level. Today subscribers expect to make or receive calls anytime. Thus a deterioration of service can quickly damage a mobile operator’s reputation.

These four factors comprise the Source of Attractiveness module in the dynamics model of the mobile industry, as shown in Figure 4-3.

![Source of attractiveness diagram](image)

*Source: Author, 2004

**Figure 4-3. Source of attractiveness**

### 4.2.2 Core Market Dynamics

The conceptual model of the “Core Market Dynamics” module is shown in Figure 4-4. It begins when a mobile operator, typically a first mover, improves its “source of attractiveness” through new functions and price reductions, which increases attractiveness. Then “attractiveness” and “number of users” create a strong positive feedback loop as a result of network effects. In other words, attractiveness attracts new subscribers to the company’s
system, while an increased number of subscribers improves the attractiveness of the system. However, once competitors catch up, they introduce similar functions or reduce the price. The source of attractiveness also improves the attractiveness of competitors’ systems, and the subscriber base of the first mover also adds value to the competitors through network effects. At this point, the balancing loop created by “Competitors’ Catch-up” becomes dominant, and the first-mover’s advantage begins to deteriorate. The sample output of a first mover’s market share in this model is illustrated in Figure 4-5. While at the beginning of the attractiveness cycle, the first-mover’s market share had increased rapidly, once the competitors catch up (time = 4 quarters) the market share declines sharply.

Source: Author, 2004

Figure 4-4. Conceptual model of the “Core Market Dynamics” module
4.2.3 Applying the Model to a Hypothetical Market

In order to analyze the dynamics of the mobile industry, this dynamics model of the core market dynamics module was applied to a hypothetical market, as illustrated in Figure 4-6. The variable equations are given in Appendix 1, and the assumptions are as follows:

1) number of competitors is one.

2) initial number of subscribers for both operators is 100.

3) first mover always goes ahead and competitor catches up.

It should be noted that in the real mobile industry, assumption (3) is not true because followers sometimes overreact to the first-mover’s action. For example, some followers may offer a lower price than the first mover in order to go ahead of the first mover. However, this model
can still be used for such a situation by interchanging the first mover with the competitor at the
time of the competitor’s catch-up.

Source: Author, 2004

Figure 4-6. Dynamics model of core market dynamics

In the following sections, the key market dynamics factors—performance
improvement, network effects and delay of catch-up—are analyzed using this dynamics
model.
Performance Improvement

The results of the performance improvement simulation, namely increased attractiveness, are shown in Figures 4-7 and 4-8. "Attractiveness100" means that attractiveness is improved by 100 at the point of time = 0 quarter; "Attractiveness200" and "Attractiveness300" are defined in the same way. Peak market share and number of subscribers as of time = 12 quarter (i.e., three years from the increase of attractiveness) are shown in Table 4-1. The added performance improvement contributes to increased market share and number of subscribers.

Source: Author, 2004

Figure 4-7. Simulation result of performance improvement (Number of subscribers)
Figure 4-8. Simulation result of performance improvement (Market share)

Table 4-1. Comparison of results (performance improvement)

<table>
<thead>
<tr>
<th></th>
<th>Peak market share</th>
<th>Number of subscribers (as of time = 12 quarter)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attractiveness300</td>
<td>91.3%</td>
<td>9,270</td>
</tr>
<tr>
<td>Attractiveness200</td>
<td>88.0%</td>
<td>6,390</td>
</tr>
<tr>
<td>Attractiveness100</td>
<td>80.7%</td>
<td>3,510</td>
</tr>
</tbody>
</table>

Source: Author, 2004

Network Effects

There are two types of network effects—“Internal network effects” and “External network effects.” Internal network effects are the effects from a operator’s own subscriber base, as represented by the arrow from “Number of subscribers #1” to “Attractiveness #1” and the
arrow from “Number of subscribers #2” to “Attractiveness #2” in Figure 4-6. External network effects are the effects from the competitors’ subscriber bases, represented by the arrow from “Number of subscribers #2” to “Attractiveness #1” and the arrow from “Number of subscribers #1” to “Attractiveness #2”. The “network effect rate” is defined as the rate of attractiveness increase per subscriber. External network effects make it extremely difficult for a first mover to maintain competitive advantage for a long time, as described in Section 3.3.2.

The results of a simulation of network effects are shown in Figures 4-9 and 4-10. “External NE Rate10” means that the external network effect rate is set at 0.10, and “External NE Rate05” and “External NE Rate01” are defined in the same way. Market share and number of subscribers as of time = 12 quarter are shown in Table 4-2. As the external network effect rate becomes higher, the number of subscribers increases, but the market share decreases more sharply as competitors catch up. In other words, when the external network effect rate is low, the diffusion rate is not high because the external network effects from competitors have small effect, but the operator can maintain its competitive advantage for a relatively long time.
Figure 4-9. Simulation result of network effects (Number of subscribers)

Figure 4-10. Simulation result of network effects (Market share)
Table 4-2. Comparison of results (Network effects)

<table>
<thead>
<tr>
<th></th>
<th>Market share (as of time = 12 quarter)</th>
<th>Number of subscribers (as of time = 12 quarter)</th>
</tr>
</thead>
<tbody>
<tr>
<td>External NE Rate10</td>
<td>53.5%</td>
<td>3,510</td>
</tr>
<tr>
<td>External NE Rate05</td>
<td>56.8%</td>
<td>2,870</td>
</tr>
<tr>
<td>External NE Rate01</td>
<td>61.2%</td>
<td>2,520</td>
</tr>
</tbody>
</table>

*Source: Author, 2004*

In terms of internal network effects, complementary assets play an extremely important role. For instance, the internal network effects of NTT DoCoMo’s i-mode service are illustrated in detail in Figure 4-11. The increase in number of users not only attracts new content providers to the i-mode business but also stimulates existing content providers to add new content or improve their existing content. This adds considerable value to the i-mode service and increases its attractiveness. In addition, an increase of users also stimulates handset vendors to provide a variety of handsets equipped with the i-mode function instead of other mobile handsets not so equipped, which also improves the attractiveness of i-mode service.

*Source: Author, 2004*

Figure 4-11. Internal network effects of NTT DoCoMo’s i-mode service
However these two factors—amount of content and variety of handsets—do not increase the attractiveness of competitors’ comparable mobile Internet services because those mobile operators have adopted different standards for their mobile Internet services, and there is no compatibility among them. This means that the users of competitors’ mobile Internet services cannot access the content provided by i-mode service.

On the other hand, the number of mobile e-mail users increases the attractiveness of competitors’ mobile Internet services because the users can exchange e-mails with other users who have other mobile operators’ handsets thanks to unified standards for e-mail.

As a result, in terms of mobile Internet services, the internal network effect rate is much higher than the external network effect rate owing to the amount of content and the variety of handsets. This is why NTT DoCoMo was able to maintain its competitive advantage for a relatively long time, even though there it had no first-mover advantage. NTT DoCoMo reinforced its internal network effect by successfully attracting content providers to its i-mode business.

**Delay of catch-up**

The results of simulation related to delay of catch-up are shown in Figures 4-12 and 4-13. “Delay1” means that competitors’ catch-up is delayed for one quarter from the first-mover’s original action, and “Delay4” and “Delay8” are defined similarly. Peak market share and number of subscribers as of time = 12 quarter, are shown in Table 4-3. The results are similar to those of network effects. As the delay becomes longer, a first mover can acquire
higher market share, but the number of subscribers increases less sharply because the external network effects from its competitors are also delayed.

\[ \text{Number of Subscribers #1} \]

Source: Author, 2004

Figure 4-12. Simulation result of delay of catch-up (Number of subscribers)

\[ \text{Market Share} \]

Source: Author, 2004

Figure 4-13. Simulation result of delay of catch-up (Market share)
Table 4-3. Comparison of results (Delay of catch-up)

<table>
<thead>
<tr>
<th></th>
<th>Peak market share</th>
<th>Number of subscribers (as of time = 12 quarter)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delay8</td>
<td>86.4%</td>
<td>2,740</td>
</tr>
<tr>
<td>Delay4</td>
<td>80.7%</td>
<td>3,510</td>
</tr>
<tr>
<td>Delay1</td>
<td>65.6%</td>
<td>4,450</td>
</tr>
</tbody>
</table>

Source: Author, 2004

4.2.4 Profit Feedback

The “Profit Feedback” module is relatively intuitive. In this section, the route from “Price” to “ARPU” and the route from “Required Capacity” to “Investment in Capacity” are explained in detail.

Route from Price to ARPU

The relation between price and ARPU is illustrated in Figure 4-14. Price reduction does not necessarily cause a decrease of ARPU because price reduction may stimulate subscribers to use mobile services even more, which may contribute to an increase of ARPU. Figure 4-15 gives an example of au’s ARPU. Although au introduced a discount service for packet communication charges, this service attracted subscribers to data communications services and contributed to an increase of ARPU.

Source: Author, 2004

Figure 4-14. Route from Price to ARPU
Route from Required Capacity to Investment in Capacity

Telecommunications operators typically invest huge amounts of money in a high-capacity network at the beginning of a service launch. Recently, however, mobile operators have invested relatively smaller amounts of money in a lower-capacity network and then increased their capacity as data traffic increases. Thus, mobile operators can increase system capacity by activating another licensed frequency band or by increasing the density of base stations. NTT DoCoMo plans to develop and install economical equipment, such as compact base stations and Multi-drop Optical Feeder (MOF) in order to expand its service area more efficiently.\(^2\)

\(^2\) Source: *NTT DoCoMo website*
4.3 Dynamics Models of the Three Phases of System Generation

4.3.1 Model of the Initial Phase

A dynamics model of the Initial Phase is illustrated in Figure 4-16. A large amount of initial investment is required to construct the new system, which reduces profit. In terms of source of attractiveness, service area and functions—especially handset characteristics such as size and weight—are important factors, while quality is not as critical because the system has enough capacity to support the required traffic. Key factors in this phase are discussed below.

Source: Author, 2004

Figure 4-16. Dynamics model of the Initial Phase
Compatibility

As described in Section 3.3.1, compatibility of the new system with the existing system is the most crucial factor for migrating to the new system successfully. If the initial investment is low because compatibility is already established, the mobile operator can feed back a large amount of profit to the source of attractiveness. Furthermore, the operator can concentrate on improving functions based on the new capability provided by the new system and therefore establish competitive advantage. In contrast, mobile operators whose new systems are not compatible with their existing systems will struggle to expand the service area and improve the characteristics of handsets to be comparable with the mature performance of the existing systems.

Price

Price is an important factor for attracting subscribers to new systems, since most subscribers are sensitive to price. For example, NTT DoCoMo set a lower data communication charge for its 3G service called FOMA (Freedom Of Mobile multimedia Access) than the charge for its 2G service, PDC (see Table 4-4). Without the “Packet Pack” discount, the packet communication charge for FOMA is ¥0.2/packet, which is two-thirds of the charge for the PDC system; it can be reduced to ¥0.02/packet by applying the Packet Pack discount. FOMA’s ARPU is shown in Figure 4-17. NTT DoCoMo has successfully attracted heavy data-communications users to its FOMA system and increased ARPU to a large extent.
Table 4-4. Data communication charges for FOMA

<table>
<thead>
<tr>
<th>PDC</th>
<th>Max data rate</th>
<th>Monthly Charge</th>
<th>Packet Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOMA</td>
<td>Receive 28.8kbps</td>
<td>300 Yen</td>
<td>0.3 Yen/Packet (400 Packet Free)</td>
</tr>
<tr>
<td></td>
<td>Send 28.8kbps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Packet Pack</td>
<td>150 Yen</td>
<td>0.2 Yen/Packet</td>
<td></td>
</tr>
<tr>
<td>Packet Pack 20</td>
<td>150 Yen + 2000 Yen</td>
<td>0.1 Yen/Packet (Free up to 2000 Yen)</td>
<td></td>
</tr>
<tr>
<td>Packet Pack 40</td>
<td>150 Yen + 4000 Yen</td>
<td>0.05 Yen/Packet (Free up to 4000 Yen)</td>
<td></td>
</tr>
<tr>
<td>Packet Pack 80</td>
<td>150 Yen + 8000 Yen</td>
<td>0.02 Yen/Packet (Free up to 8000 Yen)</td>
<td></td>
</tr>
</tbody>
</table>

Source: NTT DoCoMo website

![Graph showing ARPU (Yen) over time](graph.png)

Source: NTT DoCoMo website

Figure 4-17. FOMA’s ARPU

4.3.2 Model of the Differentiation Phase

In this phase, the service areas and handset characteristics have become similar. Therefore function and price are the important factors for attracting new subscribers to mobile systems. A dynamics model for this phase is shown in Figure 4-18, and the equations for variables are given in Appendix 2.
Figure 4-18. Dynamics model of the Differentiation Phase

The results of the simulation are shown in Figures 4-19, 4-20, and 4-21. "Profit function rate" is the rate of feedback from profit to function, while "Profit price rate" is the rate of feedback from profit to price.
"Number of Subscribers #1": PP Rate00 and PF Rate20 people
"Number of Subscribers #1": PP Rate10 and PF Rate10 people
"Number of Subscribers #1": PP Rate20 and PF Rate00 people

Source: Author, 2004

Figure 4-19. Results of simulation: number of subscribers

"PP Rate10 and PF Rate10" means that profit price rate is set at 0.10 and profit function rate is also set at 0.10. "PP Rate00 and PF Rate20" and "PP Rate20 and PF Rate00" are defined in the same way. When profit is fed back only to price, the mobile operator can acquire a larger subscriber base but earn less profit because the company has to invest more money in capacity in order to meet the demand for sharply increased capacity. In other words, the balancing loop shown in Figure 4-22 decreases profit to a large extent.
Figure 4-20. Results of simulation: Profit

Figure 4-21. Results of simulation: Capacity
Source: Author, 2004

Figure 4-22. Balancing loop of capacity investment
Function and price have a close relationship. For example, it is impossible for NTT DoCoMo to provide a music downloading service over its PDC system because a piece of pop music typically has 4Mbytes of data and its packet communication charge is about ¥9,000, or about $90. Therefore when mobile operators plan to introduce new services, the charges must also be considered. Conversely, when mobile operators plan to reduce the price, they should introduce new services in order to stimulate subscribers to utilize mobile services more in order to maintain the ARPU level. In 2002, au launched its innovative service called "Chaku-Uta", which allows users to download songs in their original format and use these songs as the ringer tone on their mobile handsets. This service was offered shortly after au introduced its Packet Discount in 2002. This service quickly became popular and au promptly saw an increase in its data traffic per subscriber (see Figure 4-23).

Source: KDDI Group website

Figure 4-23. Number of packets per user per day
Thus, in the Differentiation Phase, mobile operators have to take both function and price into consideration when developing strategies.

4.3.3 Model of the Commodity Phase

A dynamics model of the Commodity Phase is shown in Figure 4-24. In this phase the potential for new functions is extremely low, which increases the demand for the next-generation system both to avoid a desperate price war and to acquire new capability to provide innovative services. On the other hand, the price reduction caused by being in a commodity market may increase Minutes Of Use (MOU) and this accelerates the shortage of potential new capacity. Furthermore, this shortage of capacity deteriorates the quality of services, that is, the successful call connection rate decreases and voice clarity and effective data rate also deteriorate. This decreases attractiveness of service to a large extent. Therefore a shortage of potential capacity also motivates mobile operators to migrate to the next-generation system in order to acquire additional system capacity.
Source: Author, 2004

Figure 4-24. Dynamics model for Commodity Phase

4.4 Summary

In this chapter, a dynamics model of the Japanese mobile industry was proposed, and the following points were discussed.
The basic model is divided into three modules: “Source of attractiveness”, “Core market dynamics” and “Profit feedback.”

**Source of attractiveness**

- Source of attractiveness has four factors, “Service area”, “Price”, “Function,” and “Quality”.

**Core market dynamics**

- Performance improvement contributes to acquiring added market share as well as increasing the number of subscribers.

- When the external network effect is low, the diffusion rate is not high but the operator can maintain its competitive advantage for a long time. Delay of catch-up has the same characteristics. As the delay becomes longer, a first mover can acquire higher market share but the number of subscribers increases less sharply. Therefore the mobile operator that intends to improve its competitive position should pursue innovative functions that have a low external network effect or that it is extremely difficult for competitors to imitate, even though it makes the diffusion rate of the function low.

**Profit feedback**

- The source of attractiveness and the core market dynamics determine the profit a mobile operator can earn, and this profit is fed back to the source of attractiveness in order to continually improve the mobile operator’s competitive advantage.
The basic model is modified to reflect the impact of the three phases.

**Initial Phase**

- Service area and function, especially the characteristics of handsets such as size and weight, are important factors when considering source of attractiveness.
- Compatibility of the new system with the existing system is a critical factor. The mobile operator whose system is compatible can feed back a large amount of profit to the source of attractiveness and can concentrate on improving functions based on the new capability provided by the new system.

**Differentiation Phase**

- Function and price are important factors when considering source of attractiveness.
- When profit is fed back mainly to price, the mobile operator can acquire a larger subscriber base but will earn less profit. This is mainly because the company has to invest significant amounts of money in capacity in order to meet demands for required capacity which are increasing sharply.
- Since function and price have a close relationship, mobile operators have to take both into consideration when developing strategies.

**Commodity Phase**

- A shortage of new functions increases demand for the next-generation system in order to avoid price wars and acquire new capability to provide innovative services.
- A shortage of potential capacity also motivates mobile operators to migrate to the next-generation systems in order to acquire additional system capacity.
5.1 Overview

In this chapter, the dynamics model proposed in Chapter 4 is applied to the current Japanese mobile industry and possible scenarios for each mobile operator are developed and analyzed.

At present all three major operators have begun to provide 3G services, and the industry is shifting from the Initial Phase to the Differentiation Phase within the 3G system. Although NTT DoCoMo is the dominant mobile operator, it can also be said that au leads the Japanese mobile industry if one considers these factors: successful migration to the 3G system, first introduction of the new 3.5G system, and first introduction of a flat-rate data communication charge.

Successful Migration to 3G system

As described in Section 3.3.1, au has been most successful at migrating to the 3G system thanks to the compatibility of its 2G system with its 3G system. At present au dominates the 3G market in Japan.
First introduction of 3.5G system

In 2003, au introduced a new technology, "EV-DO" (EVolution-Data Only), which is called the 3.5G system. This technology improves the peak data rate up to 2.4Mbps, which is about 17 times higher than the rate of the cdma2000 system and about six times higher than that of the W-CDMA system. This has enabled au to provide more sophisticated mobile multimedia services.

First introduction of flat-rate data communication charge

At the same time as EV-DO was launched, au also introduced a flat-rate data communication charge for the new 3.5G system. This had a huge impact on the Japanese mobile industry.

In the following sections, possible scenarios for au are analyzed first, followed by scenarios for its competitors, NTT DoCoMo and Vodafone. Furthermore, possible scenarios of the mobile operators against wireless LAN systems are also analyzed, since these systems could be a disruptive technology in the near future.

5.2 Scenarios for au

At present, the Japanese mobile industry is moving from the Initial Phase to the Differentiation Phase within the 3G system. Price and Function are the key factors for improving the attractiveness of the mobile systems. Therefore two scenarios related to these factors are analyzed in the following sections.
5.2.1 Scenario for Improvement of Functions

*au* launched its 3.5G system known as EV-DO in 2003. Based on this technology the performance of data communications has improved up to 2.4Mbps, which enabled *au* to offer more sophisticated mobile multimedia services such as "EZChannel," a program distribution service that enables users to enjoy a variety of heavy multimedia content (3 Mbps or less) as if they were TV or magazines.

NTT DoCoMo is also developing its own 3.5G system, called HSDPA (High Speed Downlink Packet Access), and plans to introduce it in 2005, about two years after *au*’s launch of its 3.5G system. The HSDPA technology improves the performance of data communications up to 14.2Mbps, which is about six times better than *au*’s 3.5G system (see Figure 5-1). Throughout the Japanese broadband industry, operators are struggling to improve the peak data rate in order to attract users to their services because users are extremely sensitive to the peak data rate even though the average data rate has not improved much. Therefore, after NTT DoCoMo launches its 3.5G service in 2005, the attractiveness of *au*’s 3.5G system will diminish to a large extent.
5.2.2. Scenario for Price Reduction

When launching its EV-DO service, au also introduced a flat-rate data communication charge for the service. However, the flat-rate charge is a “Pandora’s box” for the industry because mobile systems have severe bottlenecks—radio transmission—and it is far more difficult to improve the capacity of mobile systems than that of fixed-line systems.

au’s introduction of a flat-rate charge had such an impact on the Japanese mobile industry that the rules of the game had to be redefined. Capacity became a much more important factor if an operator hoped to lead the competition. The flat-rate charge not only attracts more users to an operator’s service but it also encourages users to utilize mobile multimedia services more, and such use leads to a dramatic increase in data communication demand. Therefore mobile operators have to invest in capacity improvements in order to meet the increasing demand. If they did not, then the resulting decline in service quality might very
well deteriorate the mobile operator’s reputation, and the company would then lose competitive advantage.

In order to catch up with au, NTT DoCoMo announced that in June 2004 it too would introduce a flat-rate data communication charge, at a price even lower than au’s, which will be only six months from au’s launch of its flat-rate charge[^3].

### 5.2.3 Analysis of the Two Scenarios

These two scenarios were analyzed using the dynamics model proposed in Chapter 4. The key parameters were set as shown in Table 5-1, and the results of the simulations are shown in Figures 5-2, 5-3, 5-4, and 5-5.

<table>
<thead>
<tr>
<th>Scenario for function improvement</th>
<th>Profit function rate</th>
<th>Profit price rate</th>
<th>Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>0.0</td>
<td>8 quarters (2 years)</td>
<td></td>
</tr>
<tr>
<td>Scenario for price reduction</td>
<td>0.0</td>
<td>0.2</td>
<td>1 quarters (3 months)</td>
</tr>
</tbody>
</table>

*Source: Author, 2004*

[^3]: Source: NTT DoCoMo website
Figure 5-2. Simulation results of au’s scenario: number of subscribers

Figure 5-3. Simulation results of au’s scenario: Profit
Source: Author, 2004

Figure 5-4. Simulation results of au’s scenario: Capacity

Source: Author, 2004

Figure 5-5. Simulation results of au’s scenario: Market share
Based on the results of the simulations, au should adopt a function improvement strategy, for the following reasons, discussed below: clockspeed of system generation, system capacity, competitive advantage, and advantage of 3.5G system.

**Clockspeed of system generation:** As shown in Figure 5-4, au needs to improve its capacity rapidly in order to meet expanding demand for data communications caused by the increased number of subscribers and MOU, especially if au adopts a price reduction strategy. This strategy hastens the clockspeed of system generation, since the capacity of the system is limited. Therefore au may not earn enough profit from its 3G system to justify the enormous investment already put into it. In the worst case, if the required capacity reaches its limits before au introduces a 4G system, au will have to stop taking on new subscribers.

**System capacity:** The introduction of a flat-rate charge changes the rules of the game, and the crucial factor for winning the keen competition is shifting from price to capacity. At present au has the advantage of capacity, since the number of its subscribers is less than half that of NTT DoCoMo. However, the advantage continues to decrease as the au’s market share increases. Furthermore, NTT DoCoMo may have the advantage of capacity in the technological aspect because the company has a major R&D capability. Therefore it is uncertain whether au can establish the competitive advantage of capacity.

**Competitive advantage:** Although au’s introduction of the flat-rate charge had a large impact on NTT DoCoMo, it should take only six months for NTT DoCoMo to catch up with au. The delay of catch-up regarding price reduction is much shorter than that of function improvement. As shown in Figure 5-5, au can maintain its competitive advantage for a longer
time if the company adopts a function improvement strategy. Therefore au should focus on
function improvement in order to increase its market share against the dominant company, NTT DoCoMo.

**Advantage of 3.5G system:** Because at present au is the only mobile operator to launch a 3.5G system, the company should create innovative services that make full use of the new capabilities provided by the system. The HSDPA system which NTT DoCoMo plans to introduce has a much higher capability for data communications than EV-DO, and users are sensitive to such performance differences. Therefore au needs to establish its competitive advantage in the new 3.5G system market before NTT DoCoMo’s launch of its own 3.5G system.

5.3 **Scenarios for NTT DoCoMo**

NTT DoCoMo should also pursue a “function improvement” strategy because the fast clockspeed of system generation, and system capacity, are grave issues for NTT DoCoMo. The company has invested a much larger amount of money in constructing its 3G system, W-CDMA system, from scratch. Additionally, system capacity is a severe problem since NTT DoCoMo has the largest user base. However, NTT DoCoMo is the dominant mobile operator in Japan and still has many advantages, such as HSDPA, a dominant user base, and dominant W-CDMA, even though the company has given up first place in market share of new subscribers to au some time ago.
5.3.1 HSDPA

As described in Section 5.2.1, NTT DoCoMo plans to introduce HSDPA, which has a much higher data communications capability than EV-DO, au’s 3.5G system. Therefore, after the launch of HSDPA, NTT DoCoMo may gain a competitive advantage over au in the 3.5G system market. However, a high data rate does not itself add much value to users, and NTT DoCoMo will need to introduce innovative services that take advantage of the new capabilities provided by HSDPA. By combining the high data rate with a flat-rate charge, NTT DoCoMo should be able to create a mobile multimedia service that can handle large amounts of data transmission.

5.3.2 Dominant User Base

NTT DoCoMo is the dominant mobile operator with a market share of about 57%, and it maintains competitive advantage by controlling its existing user base. This large user base is extremely favorable for reinforcing network effects. For example, when i-mode service was launched, NTT DoCoMo used its large user base to reinforce the network effects and diffuse the service much more rapidly than could its competitors.

In terms of 3G services, the videophone is one possible service that could create another competitive advantage for NTT DoCoMo, because this service is greatly affected by the network effect. Furthermore, although NTT DoCoMo launched its videophone service when it launched its 3G system, au has no plan to introduce it. Therefore the success of videophone service should enable NTT DoCoMo to establish a sustainable competitive
advantage over au. The number of NTT DoCoMo videophone users has already begun to expand (see Figure 5-6).

![Graph showing the number of videophone users from 2003/4 to 2003/9.](source: NTT DoCoMo website)

**Figure 5-6. Number of videophone users**

In addition, a market survey shows that half of mobile users want to use their mobile handsets with a videophone function in the near future. Although the videophone service changes the way mobile handsets are used, and the switching cost for users is high, the dominant user base could enable NTT DoCoMo to accelerate the positive feedback loop through network effects and establish a competitive advantage over its competitors.

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4 *Source: japan.internet.com*
5.3.3 Dominant W-CDMA

Although at present cdma2000 is the dominant 3G system, W-CDMA will surpass it to become the dominant 3G system in the near future. This will occur because GSM is the dominant 2G system with a 70% share worldwide\textsuperscript{5}, and GSM is compatible with W-CDMA. Therefore most mobile operators that provide GSM services are likely to adopt W-CDMA as their 3G systems. Although the launch of 3G system was delayed in European countries because of huge license fees, recently mobile operators have began to launch the system anyway. For example, Vodafone introduced its 3G service for corporate customers in seven major European countries, including the UK, Germany, and Italy in February 2004, and it plans to launch a commercial service in October 2004. T-Mobile, the second-largest mobile operator in Germany, also plans to launch its 3G service in April 2004\textsuperscript{6}.

The worldwide dominance of W-CDMA will provide NTT DoCoMo with not only a wide service area for international roaming services but also a large potential of innovative services. In other words, NTT DoCoMo can easily import innovative technologies or services related W-CDMA from a large number of foreign countries. Conversely, NTT DoCoMo can also license new technologies or services to many foreign mobile operators, like i-mode service in 2G system. This will provide another attractive revenue source for NTT DoCoMo.

Furthermore, the dominance of W-CDMA will also help NTT DoCoMo to establish a

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\textsuperscript{5} Source: GSM Association

cost advantage because network equipment and mobile handsets will be cheaper than for its competitors that provide cdma2000 systems, thanks to economies of scale.

5.4 Scenarios for Vodafone

As explained in Section 2.3.3, at present Vodafone has difficulty differentiating its services from its competitors in both the 2G and 3G businesses. Although Vodafone has already launched its 3G service, the company still concentrates mostly on its 2G service, unlike its competitors. However, it has failed to establish a competitive advantage even in the 2G business.

Based on the application of the dynamics model to its situation, I believe Vodafone should pursue a “function improvement” strategy and improve its 3G service in order to prevent its competitors from dominating the 3G market. Vodafone must shift its resources to the 3G business in order to catch up with its competitors as quickly as possible.

Another possible scenario is for Vodafone to remain in its 2G business and pursue a price reduction strategy. At present, there is no key application that requires the high-speed data communications provided by 3G systems, and most subscribers utilize their mobile handsets mainly for voice calls and low-speed data communication services like e-mail. Therefore the 2G system has enough capability to meet the requirements of most users.

In addition, Vodafone already has a nationwide network and can develop new mobile handsets at low cost because the 2G technology is already mature. Based on this strategy, Vodafone can provide voice and low-speed data communications services at a much lower
price than its competitors who have to invest large amounts of money in a 3G system network and development of the new technology and services.

This strategy is similar to one undertaken by Hutchison in the UK mobile industry. Hutchison is a new mobile operator whose first system is a 3G system. By taking advantage of not owning a 2G system, the company is expanding its 3G system efficiently, which enables the company to provide its service at a lower price than its competitors. In particular, Hutchison is trying to attract new customers with a low charge for voice service in order to expand its customer base (Stuart and Bhalla, 2003). Although the number of subscribers as of December 2003 was one-quarter of the original goal, the number has begun to grow rapidly thanks to the improvement of service areas and the introduction of new handsets.\(^7\)

Having outlined Hutchison's scenario, however, I believe their strategy is too risky for Vodafone, because it might establish an undesirable brand image, if it is perceived to have a low-performance and low-price mobile service like a PHS service. Furthermore, unlike Hutchison, Vodafone has already had a large user base of 18.5 million subscribers. Therefore Vodafone should pursue a strategy that encourages this large user base to migrate to 3G service by creating innovative functions and services that are available via its 3G system.

5.5 Undesirable Scenarios for Mobile Operators

As described above, all of three major mobile operators should adopt the function improvement strategy. However, there is a possibility that some mobile operators will pursue a different strategy, the price reduction strategy. These situations characterize the competitive environment as a war between the function improvement and the price reduction as shown in Figure 5-7. In this section, it is assumed that NTT DoCoMo adopts the function improvement strategy and au selects the price reduction strategy. For example, when NTT DoCoMo launches HSDPA, au may reduce charges in order to compensate the difference of performance between HSDPA and EV-DO, au’s 3.5G system. In this case, however, NTT DoCoMo should not change its strategy to the price reduction and shift into a desperate price war but seek to position itself in the “Function versus Price” sector for the following reasons.

au’s Strategy

Source: Author, 2004

Figure 5-7. War between function improvement and price reduction
**Fast clockspeed of system generation:** As discussed in Section 5.2.3, a price reduction strategy hastens the clockspeed of system generation. Therefore NTT DoCoMo may not earn enough profit from its 3G system to justify the enormous investment already put into it, if NTT DoCoMo changes its strategy to the price reduction.

**Sustainability of strategy:** au has to improve its system capacity rapidly in order to meet drastically expanding demand for data communications. Therefore a price reduction strategy may not be sustainable, since the capacity of the system is limited. Although NTT DoCoMo may lose a portion of market share for a period of time, its advantage over au may be improved as au’s competitive advantage of price is deteriorated. On the other hand, NTT DoCoMo should concentrate its R&D capability on the improvement of function and system capacity. The introduction of a flat-rate charge changes the rule of the game and the crucial factor for winning the keen competition is shifting from price to capacity. Thus, the innovative technology to improve the system capacity will provide NTT DoCoMo with the sustainable competitive advantage under the new rules.

**HSDPA:** The HSDPA system which NTT DoCoMo plans to introduce has a much higher capability for data communications than EV-DO, au’s 3.5G system. Therefore, after the launch of HSDPA, NTT DoCoMo may gain a competitive advantage over au in the 3.5G system market and should be able to create innovative mobile multimedia services that can handle large amounts of data transmission.
5.6 Scenarios Involving Wireless LAN Systems

As described in Section 2.4.2, the performance of wireless LAN systems continues to become more satisfactory, and these systems could become a disruptive technology for mobile systems. Therefore mobile operators should create robust strategies to deal with emerging wireless LAN systems. There are two possible scenarios against wireless LAN systems: Convergence and Differentiation.

5.6.1 Convergence Scenario

Wireless LAN systems enjoy the advantages of a high peak data rate and lower charges than mobile systems; conversely, mobile systems surpass wireless LAN systems in the characteristics of mobility, wide service areas, and security. Therefore a system that will converge a mobile system and a wireless LAN system should add considerable value to users. In fact, at ITU such a convergence system has been defined as “Systems Beyond 3G” (SB3G) (see Figure 5-8). The convergence system that integrates multiple wireless systems via an IP network is located between 3G and 4G systems.
An example of such a convergence system is given in Figure 5-9. Handsets have the capability to handle both a mobile system and a Wi-Fi system, and can access both systems. In a mobile system service area, users can utilize typical mobile services, while in the service areas of Wi-Fi systems (hotspots), users can utilize broadband services at the low flat rate. In the hotspots, users can make voice calls based on Voice over IP (VoIP) technology and enjoy real mobile multimedia services, such as music and video downloading. Nokia and Motorola plan to commercialize handsets that are capable of these tasks in 2004 (Nikkei, 2004). However, such a system may reduce the ARPU because in the hotspots the cheap flat rate is applied instead of the expensive calling charge for mobile systems.
5.6.2 Differentiation Scenario

In the convergence scenario there was some risk of ARPU reduction, so another possible scenario would be to differentiate mobile systems from Wi-Fi systems and compete against each other directly. Using this strategy, mobile operators should reinforce their advantages and improve their disadvantages in order to highlight the differences in performance. However, the comparison of important characteristics (summarized in Table 5-2) shows it is difficult for mobile operators to differentiate their systems from wireless LAN systems in every aspect. At present many standards related to wireless LAN systems are going through a process of standardization, and each system has its strengths. Therefore the overall performance of a converged system of several wireless LAN systems might be comparable to a mobile system, and the converged system could be a substitute system for a mobile system. Although at present it is difficult to precisely estimate the performance of the emerging
wireless LAN systems, it is likely that these systems will take a portion of market share away from the mobile systems, just as the PHS systems did.

<table>
<thead>
<tr>
<th>Aspect</th>
<th>cdma2000 (2.4Mbps (EV-DO))</th>
<th>W-CDMA (14.2Mbps (HSDPA))</th>
<th>Wireless LAN (100Mbps (802.11n))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak data rate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Charge</td>
<td>Expensive</td>
<td>Expensive</td>
<td>Cheap-Expensive (*)</td>
</tr>
<tr>
<td>Mobility</td>
<td>Supported</td>
<td>Supported</td>
<td>Supported (802.16e or 802.20)</td>
</tr>
<tr>
<td>Service area</td>
<td>Nationwide</td>
<td>Nationwide</td>
<td>Nationwide (802.16e or 802.20)</td>
</tr>
<tr>
<td>Security</td>
<td>High</td>
<td>High</td>
<td>High (802.11i)</td>
</tr>
</tbody>
</table>

(*) Charge depends on the systems. The new systems such as 802.16e may be more expensive than current Wi-Fi systems.

Source: Author, 2004

5.6.3 Analysis of Possible Scenarios

Even though the convergence scenario carries some risk of ARPU reduction, mobile operators should adopt this strategy for the following reasons.

Value for Users

Mobile operators should pursue such a strategy in order to maximize value for users and to establish competitive advantage. In this sense, the convergence of mobile systems and wireless LAN systems should add considerable value to users. In addition, since competitors may also adopt the convergence strategy, mobile operators should enter this emerging market as soon as possible in order to establish competitive advantage. Because emerging wireless LAN systems have great potential to provide innovative services, the convergence system should provide mobile operators with many opportunities to differentiate themselves from their competitors and to establish sustainable competitive advantages.
Prevention of a Differentiation Scenario

Although there are many uncertainties surrounding the emerging wireless LAN systems, there is some possibility that they will become substitute systems for mobile systems and take away market share and revenue from mobile operators. Therefore mobile operators must take actions to reduce these risks. The convergence of mobile systems and wireless LAN systems will provide mobile operators with knowledge and experience about wireless LAN systems so that mobile operators can create robust strategies to deal with wireless LAN systems. Furthermore, the convergence strategy will make the wireless LAN systems complementary rather than substitutes for mobile systems, which may prevent the differentiation scenario from taking place.

In 2002, KDDI (the parent company of au) and Cisco succeeded in establishing IP-based seamless communications between their 3G systems and a wireless LAN system in a moving environment. NTT DoCoMo launched its commercial wireless LAN system called “Mzone” in 2002. Clearly, some mobile operators consider convergence as one of their future scenarios.

5.6.4 Undesirable Scenarios Against Wireless LAN Systems

As described above, mobile operators should adopt the convergence strategy. Some mobile operators may deploy their own wireless LNA systems, while some may establish close

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8 Source: KDDI Group website
relationships with wireless LAN operators most of which are fixed-line operators. However, fixed-line operators who have no relationship with mobile operators may adopt the differentiation strategy in order to enter the expanding and profitable mobile industry. In this case, mobile operators will be forced to shift into a war between convergence systems and improved wireless LAN systems (See Figure 5-10).

![Diagram showing Fixed-line Operator's Strategy]

- **Fixed-line Operator's Strategy**
  - **Differentiation**
    - Substitute Systems
  - **Convergence**
    - N.A.
    - (*) Fixed-line operators do not have mobile systems
    - Complementary Systems
  - Mobile Operator's Strategy
    - Convergence versus Wireless LAN

*Source: Author, 2004*

**Figure 5-10. War between convergence systems and wireless LAN systems**

Although the performance of the emerging wireless LAN systems is uncertain, there are some risks that they will become substitute systems for mobile systems or convergence systems and take away market share and revenue from mobile operators. One of possible scenarios for mobile operators to reduce these risks is to aggressively enter the wireless LAN industry in order to create another revenue source. Since the emerging wireless LAN systems,
based on the 802.16e and 802.20 standards, require the licensed frequency band, mobile
operators should not only deploy wireless LAN systems but also make a contribution to the
commercialization of new wireless LAN systems such as field trials in order to be given the
license to provide their services by the government.

5.7 Summary

In this chapter, the dynamics model was applied to the current Japanese mobile
industry and possible scenarios for each mobile operator were analyzed. The points that were
discussed are the following.

au’s strategy

au should adopt a function improvement strategy for the following reasons:

- The “price reduction” strategy hastens system generation clockspeed, which prevents au
  from earning sufficient profit from its 3G system to justify its huge investment in the
  system.

- Although the introduction of flat-rate charge will change the rules of the game, and the
  crucial factor for winning the competition is to shift from price to capacity, it is uncertain
  whether au can establish a competitive advantage in terms of capacity.

- Because the delay of catch-up for the price reduction strategy is short, au cannot maintain
  its competitive advantage for a long time.
• **au** should create innovative services that make full use of new capabilities provided by its 3.5G system and help it to establish competitive advantage in the new 3.5G system market before NTT DoCoMo launches its 3.5G system.

**NTT DoCoMo’s strategy**

NTT DoCoMo should also pursue a **function improvement strategy**. This company is the dominant mobile operator and still has many advantages that should enable it to catch up with **au**. These are discussed below.

• Since NTT DoCoMo’s 3.5G system has a higher capability for data communications than **au**’s, NTT DoCoMo will likely establish competitive advantage over **au** after it launches its 3.5G system.

• NTT DoCoMo can establish competitive advantage by controlling its existing large user base. In particular, this user base is extremely favorable for reinforcing network effects. The company’s videophone service is one possible service that should create another competitive advantage for NTT DoCoMo.

• W-CDMA will be the dominant 3G system in the near future, which should provide many advantages for NTT DoCoMo, such as an opportunity to import innovative services, a new revenue source from licensing new technologies to foreign mobile operators, and cost advantages based on economies of scale.

**Vodafone’s Strategy**

Vodafone should also pursue a **function improvement strategy**, for the following reasons.
• Vodafone should shift its resources from the 2G business to the 3G business in order to catch up with its competitors as quickly as possible.

• Although one other possible scenario is to remain in the 2G business and pursue a price reduction strategy, I believe this strategy is too risky because the company may in fact inadvertently establish an undesirable brand image of a low-performance and low-price mobile service, similar to the PHS system.

**Strategy Against Wireless LAN systems**

Mobile operators should adopt the convergence strategy, even though this strategy has some risk of ARPU reduction, for the following reasons.

• Mobile operators should maximize their value to users in order to establish competitive advantages. Since emerging wireless LAN systems have great potential to provide innovative services, a convergence system should give mobile operators many opportunities to establish sustainable competitive advantages.

• The convergence strategy will provide mobile operators with knowledge and experience about wireless LAN systems so that they can create robust strategies to deal with the competitive threat of wireless LAN systems.

• The convergence strategy will mitigate the possibility of wireless LAN systems becoming substitutes, and instead make them complementary to mobile systems, which may prevent a differentiation strategy from ever taking place.

• Fixed-line operators who have no relationship with mobile operator may adopt the differentiation strategy. In this case, mobile operators should aggressively enter the wireless LAN industry in order to create another revenue source.
In this thesis, the dynamics of the mobile industry were analyzed and a dynamics model was proposed for the Japanese mobile industry as a tool to identify and create robust strategies for mobile operators seeking to establish competitive advantage. In the mobile industry competition is so keen that it is extremely difficult for a mobile operator to maintain its competitive advantage for a long time. They struggle to continually introduce innovative functions and services in order to improve their competitive position. Furthermore, mobile operators must consider migration to the next-generation system in order to expand their business opportunities. Ultimately, therefore, mobile operators must have a clear view of the industry and be in a position to develop robust strategies that will enable them to survive keen competition. The dynamics model proposed in this thesis should provide insights into the dynamics of the mobile industry.

In order to more precisely describe the dynamics of the mobile industry, two new concepts were introduced: Double clockspeed and the three phases of system generation.

The clockspeed of system generation is far more important, since it has a major impact on mobile operators' strategies. Not only technological factors but others such as standardization, regulation, investment, and capacity determine the clockspeed of system
generation. Therefore mobile operators must take these factors into consideration when developing strategies.

In regard to the three phases of system generation, the dynamics of the mobile industry changes according to the length and timing of these phases. Therefore mobile operators need a clear understanding of the phases in order to make appropriate decisions.

In the Initial Phase, compatibility of the next-generation system with the existing system is the key factor for successfully migrating to the new system. Therefore mobile operators should pursue this advantage. However, the standards for a 4G system must be global ones, and it may be difficult for develop a 4G system that is compatible with all the existing 3G systems. In other words, some mobile operators may be unable to develop this advantage. In such a case, a mobile operator should establish close relationships with handset vendors in order to provide compatible handsets that will enable users to access both the existing system and the new system when it is launched. These compatible handsets may offset the disadvantage of incompatibility.

In the Differentiation Phase, the amount of captured value of a new service is determined by Performance Improvement, Network Effects, and Delay of Catch-up. However, network effects will also contribute to the diffusion rate of competitors, and this may prevent a mobile operator from maintaining a lengthy competitive advantage.

Performance improvement contributes to acquiring the market share as well as increasing the number of subscribers. On the other hand, the effects of the external network effect and the delay of catch-up are different from those of performance improvement. In other words, when the external network effect is low or when the delay is long, the diffusion rate is
not high, but a mobile operator can still maintain competitive advantage for a long time. Therefore mobile operators need to understand these factors when creating strategies. The mobile operators that pursue a high diffusion rate should create innovative services whose external network effect is high and delay of catch-up is short, while mobile operators that pursue competitive advantage should introduce new services whose external network effect is low and delay of catch-up is long.

In the **Commodity Phase** mobile operators plan to migrate to the next-generation system for two reasons, Performance Improvement and Capacity Shortage. However, the introduction of a flat-rate charge will probably greatly increase the required capacity. Therefore, capacity shortage may be the dominant reason for future migration to the next-generation system.

Based on the proposed dynamics model, I analyzed the current Japanese mobile industry. All of three major mobile operators should adopt the function improvement strategy. However **au**’s introduction of a flat-rate charge has had such an impact on the Japanese mobile industry that the rules of game must be redefined. Therefore mobile operators will need to create robust strategies that will enable them to win the keen competition under the new rules.

Mobile operators should also create appropriate strategies to deal with emerging wireless LAN systems, since these systems could become a disruptive technology for mobile systems. Based on the analysis of wireless LAN systems, mobile operators should pursue the **convergence strategy** in order to identify opportunities for establishing sustainable competitive advantages and to prevent wireless LAN systems from becoming substitutes for mobile systems.
Although the proposed model analyzes the Japanese mobile industry, its dynamics are not limited to the Japanese mobile industry but can apply generally, so that the model should be applicable to mobile systems in the future or in other countries. Future technology innovations will make higher-band frequencies available to mobile systems and next-generation systems will be introduced one after another. The concepts and models proposed in this thesis offer a clear view of the dynamics of the mobile industry not only for the present but also for the future.

The government has strong power to control the mobile industry and it can decide on the number of players, license fees, and regulations. Therefore the government should also have a clear view of the dynamics of the mobile industry. If there are too many players, the mobile operators will not earn sufficient profit to feed back to their sources of attractiveness. The industry may lose leverage to expand, and innovative technologies and services may be more difficult to develop. For this reason, the government must have a clear vision and understanding in order to accelerate expansion of the profitable mobile industry.
APPENDICES
Appendix 1

Equation for variables in core market dynamics module

(01) \[ \text{"Attractiveness #1"} = \text{Source of Attractiveness} + \text{"Number of Subscribers #1"} \times \text{Internal network effect rate} + \text{"Number of Subscribers #2"} \times \text{External network effect rate} \times \text{Switch} \]
Units: 1

(02) \[ \text{"Attractiveness #2"} = \text{Delay of source} + \text{"Number of Subscribers #2"} \times \text{Internal network effect rate} + \text{"Number of Subscribers #1"} \times \text{External network effect rate} \times \text{Switch} \]
Units: 1

(03) \[ \text{Delay} = 4 \]
Units: Quarter

(04) \[ \text{Delay of source} = \text{DELAY FIXED(Source of Attractiveness, Delay, 0)} \]
Units: 1

(05) \[ \text{External network effect rate} = 0.1 \]
Units: 1/people

(06) \[ \text{FINAL TIME} = 20 \]
Units: Quarter
The final time for the simulation.

(07) \[ \text{INITIAL TIME} = 0 \]
Units: Quarter
The initial time for the simulation.

(08) \[ \text{Internal network effect rate} = 0.1 \]
Units: 1/people

(09) \[ \text{Market Share} = \frac{\text{"Number of Subscribers #1"}}{\left(\text{"Number of Subscribers #1"} + \text{"Number of Subscribers #2"} \right)} \]
Units: 1

(10) \[ \text{"Net number of subscribers #1"} = \text{"Attractiveness #1"} \times \text{Subscriber increase rate} \]
Units: people/Quarter

(11) \[ \text{"Net number of subscribers #2"} = \text{"Attractiveness #2"} \times \text{Subscriber increase rate} \]
Units: people/Quarter
(12) "Number of Subscribers #1" = INTEG ("Net number of subscribers #1", 100)
Units: people

(13) "Number of Subscribers #2" = INTEG ("Net number of subscribers #2", 100)
Units: people

(14) SAVEPER = TIME STEP
Units: Quarter [0,?]  
The frequency with which output is stored.

(15) Source of Attractiveness = 100
Units: 1

(16) Subscriber increase rate = 1
Units: people/Quarter

(17) Switch = PULSE (Delay, 40)
Units: 1

(18) TIME STEP = 1
Units: Quarter [0,?]
The time step for the simulation.
Appendix 2

Equation for variables in the dynamics model for Differentiation Phase

(01) \[ \text{ARPU} = \text{MOU} \times \text{Price} \]
Units: dollar/people/Quarter

(02) \[ \text{"Attractiveness } \#1\text{"} = \text{Function attractiveness rate} \times \text{SQRT(}\text{Function}) + \text{Price attractiveness rate}/\text{Price} + \text{"Number of Subscribers } \#1\text{"} \times \text{Internal network effect rate} + \text{"Number of Subscribers } \#2\text{"} \times \text{External network effect rate} \]
Units: 1

(03) \[ \text{"Attractiveness } \#2\text{"} = \text{Function attractiveness rate} \times \text{SQRT(}\text{Delay of function}) + \text{Price attractiveness rate}/\text{Delay of price} + \text{"Number of Subscribers } \#2\text{"} \times \text{Internal network effect rate} + \text{"Number of Subscribers } \#1\text{"} \times \text{External network effect rate} \]
Units: 1

(04) \[ \text{Capacity} = \text{INTEG (Net capacity,200000)} \]
Units: min/Quarter

(05) \[ \text{Capacity Investment} = \text{Capacity investment cost} \times \text{Net capacity} \]
Units: dollar/Quarter

(06) \[ \text{Capacity investment cost} = 0.3 \]
Units: dollar/Quarter/min

(07) \[ \text{Delay} = 2 \]
Units: Quarter

(08) \[ \text{Delay of capacity investment} = 1 \]
Units: Quarter

(09) \[ \text{Delay of function} = \text{DELAY FIXED(}\text{Function, Delay , 100 }\text{)} \]
Units: 1

(10) \[ \text{Delay of price} = \text{DELAY FIXED(}\text{Price, Delay , 1}\text{)} \]
Units: dollar/min

(11) \[ \text{External network effect rate} = 0.05 \]
Units: 1/people
(12) FINAL TIME = 20
Units: Quarter
The final time for the simulation.

(13) Function= INTEG (Net function,100)
Units: 1

(14) Function attractiveness rate=1
Units: 1

(15) Function Investment=MAX( Profit*Profit function rate, 0 )
Units: dollar/Quarter

(16) Function investment rate=0.01
Units: 1/dollar

(17) Function MOU rate=1
Units: min/people/Quarter

(18) INITIAL TIME = 0
Units: Quarter
The initial time for the simulation.

(19) Internal network effect rate=0.1
Units: 1/people

(20) Market Share="Number of Subscribers #1"/("Number of Subscribers #1"+"Number of Subscribers #2")
Units: 1

(21) MOU=Price MOU rate/Price+SQRTr(Function)*Function MOU rate
Units: min/people/Quarter

(22) Net capacity=MAX((Required capacity-Capacity)/Delay of capacity investment, 0 )
Units: min/Quarter

(23) Net function=Function Investment*Function investment rate
Units: 1/Quarter

(24) "Net number of subscribers #1"="Attractiveness #1"*Subscriber increase rate
Units: people/Quarter

(25) "Net number of subscribers #2"="Attractiveness #2"*Subscriber increase rate
Units: people/Quarter
(26) Net price = -MAX( Profit price rate*Profit/Capacity, 0 )
Units: dollar/min/Quarter

(27) "Number of Subscribers #1" = INTEG ("Net number of subscribers #1",100)
Units: people

(28) "Number of Subscribers #2" = INTEG ("Net number of subscribers #2",100)
Units: people

(29) Price = INTEG (Net price,1)
Units: dollar/min

(30) Price attractiveness rate = 100
Units: dollar/min

(31) Price MOU rate = 400
Units: dollar/people/Quarter

(32) Profit = ARPU"Number of Subscribers #1"-Capacity Investment
Units: dollar/Quarter

(33) Profit after function investment = Profit-Function Investment
Units: dollar/Quarter

(34) Profit function rate = 0.1
Units: 1

(35) Profit price rate = 0.1
Units: 1/Quarter

(36) Required capacity = MOU"Number of Subscribers #1"
Units: min/Quarter

(37) SAVEPER = TIME STEP
Units: Quarter [0,?]  
The frequency with which output is stored.

(38) Subscriber increase rate = 1
Units: people/Quarter

(39) TIME STEP = 1
Units: Quarter [0,?]
The time step for the simulation.
Terminology

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1G</td>
<td>First generation systems</td>
</tr>
<tr>
<td>2G</td>
<td>Second generation systems</td>
</tr>
<tr>
<td>3G</td>
<td>Third generation systems</td>
</tr>
<tr>
<td>4G</td>
<td>Forth generation systems</td>
</tr>
<tr>
<td>ARPU</td>
<td>Average Revenue Per User</td>
</tr>
<tr>
<td>cdmaOne</td>
<td>code division multiple access One</td>
</tr>
<tr>
<td>EV-DO</td>
<td>EVolution-Data Only</td>
</tr>
<tr>
<td>FOMA</td>
<td>Freedom Of Mobile multimedia Access</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Positioning Systems</td>
</tr>
<tr>
<td>HSDPA</td>
<td>High Speed Downlink Packet Access</td>
</tr>
<tr>
<td>ITU</td>
<td>International Telecommunications Union</td>
</tr>
<tr>
<td>MOU</td>
<td>Minutes Of Use</td>
</tr>
<tr>
<td>MPHPT</td>
<td>The Ministry of Public Management, Home Affairs, Post and Telecommunications</td>
</tr>
<tr>
<td>MSS</td>
<td>Mobile Satellite Service</td>
</tr>
<tr>
<td>NTT</td>
<td>Nippon Telegraph and Telephone Corporation</td>
</tr>
<tr>
<td>PDC</td>
<td>Personal Digital Communications</td>
</tr>
<tr>
<td>PHS</td>
<td>Personal Handyphone System</td>
</tr>
<tr>
<td>SB3G</td>
<td>Systems Beyond 3G</td>
</tr>
<tr>
<td>TD-CDMA</td>
<td>Time Division-Code Division Multiple Access</td>
</tr>
<tr>
<td>VoIP</td>
<td>Voice over IP</td>
</tr>
<tr>
<td>W-CDMA</td>
<td>Wideband Code Division Multiple Access</td>
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References


*Nikkei Communications*, No. 404, December 8, 2003.


