Migration Strategies for Competitive Advantage of Mobile Network Operators

by

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M.E., Electrical Engineering, the University of Tokyo, 1992
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Submitted to the Alfred P. Sloan School of Management
in Partial Fulfillment of the Requirement for the Degree of

Master of Science in the Management of Technology

at the

Massachusetts Institute of Technology

June 2003

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ABSTRACT

Innovation in platform industries, including mobile telecommunications, has a great impact on societies and economies; hence a migration from an existing platform to the subsequent one should be progressed under careful forecasting, weighed scenarios and strategies that encompass a broad view. This thesis analyzes why mobile network operators are struggling to move from the second generation (2G) and its derivatives to the third generation (3G) technologies and proposes migration strategies, which allow them to sustain their competitive advantage. First, a migration model is proposed as a reinforcing loop model composed of two dynamics, “Platform Migration” caused by a shortage of network capacity, and “Service Innovation” triggered by a decline in ARPU (Average Revenue Per User). Platform migration is an implementation process for new platform technologies and can be categorized into Revolution-type and Evolution-type. After these two schemes have been evaluated through case studies, Collaboration-type migration, an enhanced Evolution-type, is proposed for future, technically diversified situations. Service Innovation is a process for creating new profitable services to give further revenue growth. Empirical analysis clarifies that mental breakthrough management is a common approach in the mobile industry and proposes that a mixture of corporate, partner and market initiatives be adopted for diversified customer preference.

This thesis then proposes the following strategies for future successful migration: first, mobile network operators should drive the migration cycle powerfully, concentrating on successive service innovation dynamics for their revenue growth and the next platform migration. Second, they should choose migration schemes carefully according to their level of technology leadership, value chain leadership and investment capability. Finally, service platform should be considered for realization of innovative services with Partnership Dynamics.

Thesis Supervisor: Michael A. Cusumano
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Acknowledgement

My thesis project in this MIT Management of Technology Program is just the corpus of my ten-year experiences in the business society. Professors and friends in MIT Sloan School gave me the broader perspectives and the opportunities to enhance my talents of from an engineer to a business leader for my next ten years. I would really appreciate this wonderful program and acknowledge the following individuals:

*Professor Michael A. Cusumano* for his remarkable directions to my thesis project during his busy schedule

*Dr. Keiji Tachikawa*, CEO and Chairman of NTT DoCoMo Inc., for his giving me a great opportunity to join MIT Sloan School

*Mr. Shiro Tsuda*, Senior Executive Vice President of NTT DoCoMo Inc, for his showing me a great leadership of DoCoMo’s 3G launching and giving me opportunities and directions

*Mr. Kiyoshi Tokuhiro, Mr. Kei Irie and Mr. Kyaji Murakami*, Executive Managers of NTT DoCoMo Inc. for their kind supports from 3G project to this MIT Sloan School

*Mr. Joo Hyung chul of SK Telecom, Mr. Hans Hauser of T-mobile and Mr. Kari Marttinen of TeliaSonera*, for great suggestions and information for my thesis project.

*Mr. Kazuaki Yoshizawa, Dr. Atushi Murase, Dr. Hendrik Berndt, Mr. Yoshiyuki Yasuda, Mr. Makoto Kijima, Mr. Futoshi Kikuchi, Mr. Hozumi Tamura, Mr. Hiroshi Nakamura, Mr. Tomohiko Ozaki, and Mr. Ken Takahashi*, Executive Managers of NTT DoCoMo Inc. for a number of suggestions and directions for my thesis project.

*Mr. David Weber*, for his great coordination and work for MOTs.

Finally my acknowledgement of great thanks to my loving wife, *Kanako*, and my daughter, *Hinano*, for supporting my life in Boston. Rest of my life goes with you.

Boston, Massachusetts
May 2003
# Table of Contents

ABSTRACT .............................................................................................................................................. 2

ACKNOWLEDGEMENT ............................................................................................................................... 3

TABLE OF CONTENTS .......................................................................................................................... 4

LIST OF FIGURES .................................................................................................................................. 8

LIST OF TABLES .................................................................................................................................. 11

1. INTRODUCTION AND MOTIVATION .......................................................................................... 12
   1.1. BITTER TRAILS TO THE THIRD GENERATION MOBILE TECHNOLOGIES ......................... 12
   1.2. TRAFFIC BUSINESS IS MAINSTREAM ............................................................................ 14
   1.3. OBJECTIVE AND OVERVIEW OF THE THESIS ............................................................... 15

2. MIGRATION IN MOBILE TELECOMMUNICATIONS INDUSTRY .............................................. 18
   2.1. OVERVIEWS ......................................................................................................................... 18
   2.2. MARKET TRENDS .................................................................................................................. 18
       2.2.1. Market Scale and Penetration .................................................................................... 18
       2.2.2. ARPU and MOU .......................................................................................................... 19
   2.3. TECHNOLOGY TRENDS ....................................................................................................... 22
       2.3.1. Mobile Telecom Platform .......................................................................................... 22
       2.3.2. Platform Innovations for the Efficient Use of Radio Spectrum .................................. 23
       2.3.3. Spectrum Allocation ..................................................................................................... 26
       2.3.4. Platform Innovations for the Mobile Services ............................................................... 27
       2.3.5. Third Generation Mobile Technologies (3G) ................................................................. 28
       2.3.6. Migration Paths from 2G to 3G .................................................................................... 30
   2.4. MIGRATION PROCESS IN THE MOBILE INDUSTRY ...................................................... 31
       2.4.1. Migration Process as Discontinuity .............................................................................. 31
       2.4.2. Two Dynamics in Migration Process ............................................................................ 32
       2.4.3. Migration Model in the Mobile Industry ......................................................................... 34
   2.5. SUMMARY .............................................................................................................................. 36

3. PLATFORM MIGRATION DYNAMICS ......................................................................................... 37
   3.1. OVERVIEWS .......................................................................................................................... 37
   3.2. TRIGGERS IN PLATFORM MIGRATION DYNAMICS .......................................................... 37
4.2.1. Reversal of ARPU Decline ................................................................. 71
4.2.2. Platform Migration Cost ................................................................. 72
4.3. SERVICE INNOVATION DYNAMICS ............................................. 74
   4.3.1. Dynamics for Future Investment Capability .................................. 74
   4.3.2. Service Innovation Dynamics ....................................................... 74
4.4. ANALYTICAL FRAMEWORK FOR THE SERVICE INNOVATION PROCESS ................................................. 77
4.5. CASE ANALYSIS OF SMS BREAKTHROUGH.................................... 78
   4.5.1. ARPU Decline in the European Market ........................................ 78
   4.5.2. Background to SMS ................................................................. 79
   4.5.3. Breakthrough Management ....................................................... 81
4.6. CASE ANALYSIS OF I-MODE BREAKTHROUGH ......................... 82
   4.6.1. ARPU Decline before i-mode ................................................... 82
   4.6.2. Trial and Lessons before i-mode ................................................ 83
   4.6.3. Breakthrough Management ....................................................... 84
4.7. LESSONS FROM THE CASE STUDIES .......................................... 85
   4.7.1. Mental Breakthrough from Internet Services ............................... 85
   4.7.2. Profitability Capture ................................................................. 86
   4.7.3. Implications and recommendations ........................................... 87
4.8. SERVICE INNOVATION MODEL .................................................... 88
4.9. IMPLICATION OF 3G MIGRATION IN THE EUROPEAN MARKET ............ 89
4.10. SUMMARY ...................................................................................... 91

5. FUTURE DIRECTIONS IN MOBILE TELECOMMUNICATION INDUSTRY .......... 92
5.1. OVERVIEWS ...................................................................................... 92
5.2. ROADMAP TO THE FUTURE MOBILE SERVICES ..................... 92
   5.2.1. Overviews ................................................................................... 92
   5.2.2. Customer Preference and Service Dynamics ................................ 93
   5.2.3. Technology Dynamics beyond the Third Generation ................... 94
   5.2.4. Regulatory Dynamics and Industry Structure .............................. 97
   5.2.5. Corporate Strategies Dynamics in Mobile Value Chain .................. 100
   5.2.6. Summary ................................................................................... 102
5.3. PLATFORM MIGRATION FOR BEYOND THE THIRD GENERATION (B3G) .......... 103
   5.3.1. Overviews ................................................................................... 103
   5.3.2. Assumed Migration Scenario to B3G .......................................... 103
   5.3.3. Migration Cycle for B3G ........................................................... 104
5.3.4. Collaboration-type Migration ................................................................. 105
5.3.5. Recommended Process for Collaboration-type Migration ...................... 106
5.3.6. Summary ................................................................................................. 107

5.4.  Measuring the Technical Performance of Mobile Operators..................... 108

5.4.1. Overviews ............................................................................................... 108
5.4.2. Required Technical Competencies for Mobile Network Operators .......... 108
5.4.3. Measuring R&D Performance for Platform Innovation ......................... 109
5.4.4. R&D Expenditure .................................................................................... 110
5.4.5. Standardization Process ......................................................................... 111
5.4.6. Contributions to the Standardization Bodies ........................................... 112
5.4.7. Essential IPR .......................................................................................... 114
5.4.8. Correlation between Contributions and EIPR ........................................ 115
5.4.9. Summary ................................................................................................. 116

6.  Future Migration Strategies for Competitive Advantage ......................... 117

6.1.  Overviews ................................................................................................. 117
6.2.  Driving Migration Process by Successive Service Innovation.................... 118
6.3.  Strategies for Future Platform Migration .................................................... 120

6.3.1. How to Choose among the Platform Migration Schemes ....................... 120
6.3.2. Advanced Process Management .............................................................. 122
6.3.3. More Creativity for the R&D Facility Owner .......................................... 125

6.4.  Strategies for Service Innovation Dynamics ............................................. 125

6.4.1. Overview for Future Service Innovation Approach ................................ 125
6.4.2. Service Platform Concept ..................................................................... 126
6.4.3. Service Innovation Model by Partnership Dynamics ............................ 128
6.4.4. Organizational Perspective ..................................................................... 130
6.4.5. Business Perspective ............................................................................. 130

7.  Conclusion .................................................................................................... 131

APPENDIX 1 .................................................................................................... 135

APPENDIX 2 .................................................................................................... 142

TERMINOLOGIES ........................................................................................... 143

REFERENCE .................................................................................................... 145
List of Figures

Figure 1-1 NTT DoCoMo Stock Price Fluctuation ................................................................. 13
Figure 1-2 Thesis Structure .................................................................................................. 17
Figure 2-1 Number of Subscribers and Penetration in the Mobile Market ....................... 19
Figure 2-2 Forecast of Voice ARPU and Voice Service Revenues in U.S. Market .............. 20
Figure 2-3 MOU Increase and ARPU Decline in U.S. Market ............................................. 21
Figure 2-4 Mobile Telecom Platform .................................................................................. 22
Figure 2-5 Functional Model of Mobile Service Platform .................................................... 23
Figure 2-6 Three Multiple Access Technologies ................................................................ 24
Figure 2-7 Channels per Unit Bandwidth in 1G and 2G Systems ......................................... 25
Figure 2-8 Instance of Additional Spectrum for Capacity Increase ...................................... 26
Figure 2-9 Defined Options for IMT-2000 Radio Interface .................................................... 29
Figure 2-10 Network Configuration of 3G ........................................................................... 29
Figure 2-11 Migration Paths to 3G ....................................................................................... 30
Figure 2-12 4D Classification in Telecom Industry ............................................................... 31
Figure 2-13 Growth of Customers in Mobile Platforms ....................................................... 32
Figure 2-14 Combination of Platform and Service Wave in Mobile Migration ................... 33
Figure 2-15 Two Dynamics in Mobile Migration .................................................................. 34
Figure 2-16 Migration Dynamics Model in the Mobile Communications Industry ............. 35
Figure 3-1 Triggers of Platform Migration .......................................................................... 38
Figure 3-2 Backward Compatibility in Two Migration Schemes ......................................... 39
Figure 3-3 Revolution-type and Evolution-type ................................................................. 40
Figure 3-4 Upgrade from GSM platform to GPRS platform ................................................ 41
Figure 3-5 Platform Migration Model .................................................................................. 42
Figure 3-6 4C as Critical Factors in Platform Migration ....................................................... 43
Figure 3-7 Customer Growth and Coverage Expansion in Vodafone GSM ....................... 49
Figure 3-8 Customer Growth and Coverage Expansion in DoCoMo PDC ......................... 51
Figure 3-9 Customer Growth and Coverage Expansion in SK Telecom ............................. 56
Figure 3-10 Customer Growth and Coverage Expansion in au CDMA2000 1x .................. 58
Figure 3-11 KDDI Spectrum Usage ...................................................................................... 59
Figure 3-12 Three Evaluation Criteria for Entry to Platform Migration ............................... 62
Figure 3-13 Recommended Approach to Revolution-type Migration .................................. 65
Figure 3-14 4C Operation Model for Successful Platform Migration ................................. 67
Figure 3-15 Three Evaluation Criteria in NTT DoCoMo’s 3G Migration .............................. 69
| Figure 4-1 Service Innovation Dynamics | 75 |
| Figure 4-2 Analytical Framework for the Service Innovation Process | 77 |
| Figure 4-3 ARPU Comparison Q3 2002 | 79 |
| Figure 4-4 Voice and Data ARPU Comparison Q3 2002 | 80 |
| Figure 4-5 Data ARPU Growth in the European Market | 81 |
| Figure 4-6 SMS Breakthrough Management | 82 |
| Figure 4-7 ARPU Decline in DoCoMo | 83 |
| Figure 4-8 i-mode Breakthrough Management | 84 |
| Figure 4-9 i-mode Service Configuration | 85 |
| Figure 4-10 Service Innovation Model for Content Services | 89 |
| Figure 4-11 Time-contiguous Platform Migration in UMTS Migration | 90 |
| Figure 5-1 Two Directions in the Mobile Service Innovation | 93 |
| Figure 5-2 ITU-R Vision of Beyond 3G | 94 |
| Figure 5-3 Network Configuration of B3G | 96 |
| Figure 5-4 Evolution of the Mobile Terminals by Bioelectronics | 97 |
| Figure 5-5 Horizontal Integration in the Mobile Industry | 98 |
| Figure 5-6 Relationship with Public Network Operators | 99 |
| Figure 5-7 Two Types of Leadership in the Mobile Value Chain | 101 |
| Figure 5-8 Migration Cycle in 3G and B3G | 104 |
| Figure 5-9 Comparisons of Complete Migration and Collaboration-type Migration | 105 |
| Figure 5-10 Collaboration-type Migration Process | 107 |
| Figure 5-11 Capabilities for Technology Leadership | 108 |
| Figure 5-12 Measures of Technology Leadership of Mobile Network Operators | 110 |
| Figure 5-13 R&D Expenditure in the Mobile Industry | 111 |
| Figure 5-14 Standardization Process | 112 |
| Figure 5-15 the Third Generation Partnership Project (3GPP) | 113 |
| Figure 5-16 Contributions to TSG-RAN from 1999 to 2002 | 113 |
| Figure 5-17 Essential IPR for UMTS | 115 |
| Figure 5-18 Correlation between Number of Contributions and Essential IPR | 115 |
| Figure 6-1 Multiple Waves of Service Innovation on a Platform | 118 |
| Figure 6-2 Successive Service Innovation | 119 |
| Figure 6-3 Logical Tree for Scheme Decision | 120 |
| Figure 6-4 Process Management for the Migration Process | 123 |
| Figure 6-5 Development for Process Management | 124 |
| Figure 6-6 Service Platform for Mobile Network Operators | 127 |
Figure 6-7 Partnership Dynamics Model for Service Innovation ............................................... 129
Figure A-1 Mechanism of ARPU ......................................................................................... 136
Figure A-2 Simulation model for Analysis of ARPU Decline .............................................. 137
Figure A-3 ARPU Decline (Investment Ratio = 1% to 3%) ................................................... 138
Figure A-4 Price Reduction in Call Charge (Investment Ratio = 1% to 3%) ......................... 138
Figure A-5 MOU Growth (Investment Ratio = 1% to 3%) .................................................... 139
Figure A-6 Revenue Growth (Investment Ratio = 1% to 3%) .............................................. 139
List of Tables

Table 2-1 Requirement of the IMT-2000 Radio Transmission Speed.................................................. 28
Table 3-1 Cause of Traffic Growth for Platform Migration................................................................... 38
Table 3-2 Features and Instances of two Migration Schemes.............................................................. 41
Table 3-3 Three Specifications for the 2G Wireless Interface..............................................................47
Table 3-4 Analysis of cases of Vodafone and NTT DoCoMo..............................................................52
Table 4-1 3G Spectrum Auction Cost.................................................................................................73
Table 4-2 Service Innovation Resulting from Mental Breakthrough.....................................................76
Table 4-3 DoCoMo’s Trial of Data Services before i-mode ...................................................................84
Table 5-1 Possible Wireless Interface Specifications...........................................................................95
1. Introduction and Motivation

Deregulation of telecom industry in the 1990s has promoted rapid growth of the market, innovations in wireless technologies and restructuring of the value chain. During this decade, mobile network operators also experienced a number of migrations\(^1\) in technology, services, ways of working, etc, resulting from innovations and aimed at providing a better communication environment to the customers.

Failure to handle such migration well causes instability of corporate finance, customer churn and loss of opportunities, while successful migration leads to further growth. Therefore a successful migration scenario is one of the most important corporate strategies for mobile operators\(^2\) to sustain their competitive advantages in the marketplace.

1.1. Bitter Trails to the Third Generation Mobile Technologies

The third generation mobile technologies, called 3G, have been expected to provide a big worldwide surge of economic growth after IT bubble burst. However, many mobile network operators throughout the world have been struggling to introduce these cutting-edge technologies into their networks, although several years have passed since specifications became stable in the International Telecommunication Union (ITU) in 2000. NTT DoCoMo, the Japanese leading mobile operator, launched the world’s first 3G service in May 2001. But its trail to success has been hard going on the way. New platform

\(^{1}\) “\textit{Migration}” is a general word, and not usually used as a synonym for change. However, in this research, it is used as a word like change and transition because of its frequent reference in the mobile industry. In addition, this migration includes a migration in both technology and business structure.

\(^{2}\) There are some ways to describe the mobile telecommunication network operators: mobile carriers, mobile service providers and so on. This research adopts “\textit{mobile network operators} (sometimes \textit{mobile operators} for the simplification)”, while it adopts “\textit{mobile vendors}” for describing manufacturers in the mobile industry.
technologies, which have no backward compatibility with its 2G technologies, force
DoCoMo to improve service qualities of its network infrastructure and handsets and to
grope to more attractive services, while those technologies have a much higher
performance than the previous one. In particular, its decision to downgrade the status from
a commercial service to an introductory service in the first four months caused much
disappointment both to the market and to its shareholders. This means that expectations for
3G from the market had been too high, as can be seen in its stock price fluctuation around
2001 as shown in Figure 1-1.

Even now the small coverage and lack of maturity of the handsets prevent DoCoMo from
seizing the opportunities. In Europe, heavy payouts resulting from 3G license auctions put
the European mobile network operators in a bad financial situation and have also prevented
them starting their 3G services. These events illustrate how difficult successful migrations
can be and how big an impact the failure in such transitions has on the market.

Figure 1-1 NTT DoCoMo Stock Price Fluctuation
1.2. Traffic Business is Mainstream

Migration to the next platform is an unavoidable event for mobile network operators, since the evolved platform is essential to acquire further traffic increase and revenue growth. Generally it is very clear that the mainstream of telecommunication operators is “Traffic Business”. This means that they should pursue not only the expansion of market scale but also the innovation of new services that will encourage their customers to use the network more frequently. In particular, traffic business in mobile telecommunications is quite profitable because mobile terminals have become commodity items in this decade. Moreover, portability will lead to various kinds of personal communication that will contribute directly to traffic growth. Therefore, mobile network operators continue to pursue the traffic business as their mainstream interest, while they are diversifying their business models.

Recent trend of using Average Revenue Per Users (ARPU) and Minutes Of Use (MOU) as financial criteria of mobile network operators indicates this point clearly. Historically, pressure from the market for reductions in call-charges has lead to an increase of MOU and to a decline in ARPU. This means that mobile network operators need to extent their network capacity efficiently and create further sources of revenue. Therefore, migration to a new platform for the efficient accommodation of customers and provide new services generating further traffic is inevitable for mobile network operators.
1.3. Objective and Overview of the Thesis

The purpose of this thesis is to clarify migration mechanisms from the viewpoints of business management. Empirical analyses of successful migrations in the past show some key factors to be managed in the migration process. And, referring to the analyses, this thesis illustrates the current migration problems in 3G and proposes the future migration strategies for mobile network operators to sustain their competitive advantage (Thesis structure is shown in Figure 1-2).

In Chapter 2, first of all, “Platform Migration” and “Service Innovation” are defined as two critical dynamics in mobile migration. During the last decade, the mobile industry has experienced several migrations from analog platforms to 3G platforms. Such changes in platform technologies are defined as platform migrations. Platform migrations focused on relative technology improvements such as higher capacity and enhanced capabilities. Another important dynamics is service innovation between two successive platforms. The trigger of service innovation is ARPU decline. Mobile network operators are pursuing new types of service in order to hold back ARPU decline and stimulate revenue growth. At the end of this chapter, it is proposed that the successful migration process should be thought as a powerful reinforcing loop led by these two continuous dynamics.

In Chapter 3, empirical analyses of platform migrations in the past reveal capacity shortage as one of the critical triggers of migration process and illustrate two migration schemes characterized as “Revolution-type” and “Evolution-type”. Additionally, four critical factors are introduced for the analysis of these two types, and case studies for Vodafone, NTT DoCoMo, SK Telecom and KDDI, which involve the remarkable features of platform
migration, are examined. At the end of this chapter, I propose a successful model.

In Chapter 4, mechanism of service innovation dynamics is clarified. Specific cases of service innovation include the short message service (SMS) and i-mode service. Both services arose from innovations after the platforms had been defined. I will extract some principles from these two cases and clarify a service innovation model.

In Chapter 5, in order to foresee the future migration, the roadmap to the future mobile services is discussed by means of some dynamics. Then, referring to this roadmap analysis, Collaboration-type migration, enhanced Evolution-type migration, is proposed as the future platform migration scheme. In the rest of this chapter, the current technical performances of mobile network operators are measured. This research focuses particularly on R&D expenditure and contributions to standardization bodies in making new specifications, because standardization activities have been quite important for mobile network operators for roaming and interconnectivity.

Finally, in Chapter 6, I will propose a set of strategies are proposed for mobile network operators to sustain their competitive advantages in future migration processes. First, mobile network operators should drive the migration cycle, concentrating on successive service innovations. Next, they should evaluate their current level of technology leadership, value chain leadership and investment capability in order to choose the type of its appropriate migration from four schemes. In the end, mobile operators should create new profitable services on the service platforms with the partnership dynamics.
Chapter 1: Introduction and Motivation

Chapter 2: Migration in Mobile Industry
1) Market Trends & Technology Trends
2) Migration Process: Reinforcing Feedback Loop
   - Platform Migration Dynamics
   - Service Innovation Dynamics

Chapter 3: Platform Migration Dynamics
1) TRIGGER: Capacity Shortage
2) Revolution-type & Evolution-type
3) 4C Analytical Framework
   - Capability, Coverage, Cost, Complementary Assets
4) Case Studies
   - Revolution-type: Vodafone, DoCoMo
   - Evolution-type: SK Telecom, KDDI
5) Lesson from Case Studies
   - Technology Leadership
   - Value Chain Leadership
   - Investment Capability
6) Implication to Japanese 3G

Chapter 4: Service Innovation Dynamics
1) TRIGGER: Decline in ARPU
2) Mental Breakthrough Management
3) Push & Pull Model
4) Case Studies
   - Short Message Service (SMS)
   - Mobile Content Service (i-mode)
5) Lesson from Case Studies
   - Source of future profitable service
     Partnership & Toolkits
     Technology Leadership
6) Implication to European 3G

Chapter 5: Future Directions in Mobile Industry
- Technology Roadmap
  1) Future Customer Preference
  2) "All in Mobile" & "Mobile in All"
  3) Convergence Network

- Future Platform Migration
  - Collaboration-type

- Technical Performance
  1) R&D Expenditure
  2) Contributions
  3) Essential IPR

Chapter 6: Future Migration Strategies for Competitive Advantage
- Migration Process Driven by Successive Service Innovation
  - Cumulative traffic by "Mobile in All"

- Platform Migration
  1) Choice of 4 Schemes
  2) Process Management

- Service Innovation
  1) Service Platform
  2) Partnership Dynamics

Figure 1-2 Thesis Structure
2. Migration in Mobile Telecommunications Industry

2.1. Overviews
In this chapter, the mechanism of the migration process is clarified from a perspective of business management. In the beginning of the chapter, the market and technology trends are introduced. Then, considering these tendencies, the migration process is proposed. The migration process can be defined as a reinforcing feedback loop composed mainly of two powerful dynamics, namely “Platform Migration” and “Service Innovation” These two dynamics have their own distinct features and have emerged continuously from the past. In introducing these two processes, it is proposed that, from business perspective, the migration process should be thought of not in terms of a linear model but of a powerful reinforcing model, as explained at the end of this chapter.

2.2. Market Trends
2.2.1. Market Scale and Penetration
During this decade, the worldwide mobile market has grown rapidly, and the total number of subscribers reached around 1,170 millions\(^3\) on Dec. 2002. The several technological and service innovations in the mobile industry encourage the customers to use the mobile services frequently year by year. But the recent growth of the markets in U.S., Europe and Japan becomes slower and shows signs of the saturation, while the worldwide growth will keep the current pace for a while. In particular, the penetration ratio in the European market reached more than 60\% as shown in Figure 2-1. These tendencies indicate mobile operators need to not only pursue the market expansion but also explore the new sources of the traffic growth.

\(^3\) Source: GSM Association (GSMA) Report on Feb.2003
Figure 2-1 Number of Subscribers and Penetration in the Mobile Market

2.2.2. ARPU and MOU

Recent trend in using Average Revenue Per Users (ARPU) and Minutes Of Use (MOU) as the financial criteria in the mobile market illustrates that point clearly. ARPU shows the average monthly bill per subscriber. That is, the growth in ARPU directly shows the total revenue of mobile network operators, even if the number of users stays constant. ARPU can also be used as a measure of current traffic trends (Gruber, 1999). MOU signifies how long customers use wireless telephony during a month. This can be used as a measure of traffic growth for mobile network operators. The recent trend and the forecast in U.S. ARPU, according to UBS Warburg, are shown in Figure 2-2. Fierce competition in the market forces mobile operators to reduce the call charges. This behavior can be seen as decline in
ARPU (See Appendix 1). Reduction of the call charge encourages the low-end users to enter the services. In the end, total revenues from voice service will switch from increasing to declining, because of the excessive reduction of call charge and ARPU decline.

![Figure 2-2 Forecast of Voice ARPU and Voice Service Revenues in U.S. Market](chart.png)

**Figure 2-2 Forecast of Voice ARPU and Voice Service Revenues in U.S. Market**

On the other hand, MOU has a contrastive feature to ARPU. A variety of mobile services and reduction of call charges will encourage the customers to use the mobile platform so frequently. Then, the traffic will increase according to their use as shown in Figure 2-3.
Figure 2-3 MOU Increase and ARPU Decline in U.S. Market

Source: UBS Warburg, 2002
2.3. Technology Trends
2.3.1. Mobile Telecom Platform

Recent diversification in customer preference has led mobile system to be modulized. In particular, the success in content services such as i-mode, Japanese mobile Internet access, has let the mobile operators to focus on three areas: the technology platform, a new business model, and unique content (Gawer and Cusumano, 2000). This means that the mobile platform should satisfy common capabilities in response to various requirements, while a variety of content will be representative of not only existing mobile services but also future mobile applications. Considering this modularization of the mobile industry, I propose that the mobile industry structure be composed of several layers, namely Terminal layer, Platform layer, Adaptation layer and Service Applications layer as shown in Figure 2-4.

In actual network configuration, each layer corresponds to a particular network element as shown in Figure 2-5. The platform layer guarantees customers’ connectivity, which is the most important role in telecommunication services.

This study seeks mainly to clarify the innovation and implementation model of this platform layer. This layer is just composed of the wireless interface, radio access network
(RAN) and core network (CN). Some critical functions such as authentication of customers, billing, copyright management and information transfer should also be deployed in this layer. The adaptation layer comprises gateway servers or a set of service-oriented equipment to ensure connection between the mobile platform and service application entities. This layer can be transferred from one platform to the next platform and build up flexibly according to each service application. The service applications layer is, in this study, considered a group of items of content and service entities. As customer preferences become more diversified, the entities in this layer will also increase.

2.3.2. Platform Innovations for the Efficient Use of Radio Spectrum

Mobile technology innovations have emerged in order to improve the network capacity. In the respect, enhanced multiple access and voice compression algorithm are critical and complementary technologies each other. Firstly, multiplexing technologies are among the most important technologies in the wireless interface. Within a service area, mobile network operators want to allow as many customers as possible to use their network. They achieve this through multiple access
technologies. The significant point about multiplexing is how much spectrum and capacity may be allocated to one user efficiently. Generally speaking, if a large bandwidth can be deployed for one user, that user can enjoy high-speed transmission. However, mobile network operators need to appreciate the trade-off between higher capacity and higher transmission speed.

There are mainly three types of multiple accesses, namely FDMA (Frequency Division Multiple Access), TDMA (Time Division Multiple Access) and CDMA (Code Division Multiple Access) as shown in Figure 2-6. FDMA is a technology that allocates each communication channel its own specific frequency. TDMA works by dividing communication at one frequency into a number of time slots, each of which corresponds to one communication channel (Kuwahara, 1992).

![Figure 2-6 Three Multiple Access Technologies](image)

The other technology is voice compression algorithms. Whether based on CDMA or TDMA, all digital systems need to encode the analog waveforms of speech into a bit stream. Although many kinds of digital coding technology have been proposed for cell phone services, the common aim is to produce the lowest possible bit rate while maintaining acceptable sound quality. Because computing power is increasing continuously, newer
phones and networks are capable of using more advanced compression.

The generations in mobile platform have been concerned closely with these two technologies (See Appendix 2). Migration from the first generation mobile systems (1G), based on analog-based technologies, to the second generation mobile systems (2G), digital-based technologies, emerged mainly for capacity increase to deal with future traffic growth. Mixed with TDMA technology, many designs of Compression and Decompression (CODEC) have been proposed. The number of communication channels per unit bandwidth is one of evaluation criteria of system capacity as shown in Figure 2-7. Personal Digital Cellular (PDC), Japanese 2G technologies, adopts two kinds of voice compression algorithm, that is full rate (FR) and half rate (HR). PCD-HR realizes a remarkable channel efficiency of 0.24 channels per kHz.

![Figure 2-7 Channels per Unit Bandwidth in 1G and 2G Systems](source: The Essential Guide to Telecommunications)
2.3.3. Spectrum Allocation

The more attractive a mobile service is, the more its total traffic will increase. As mentioned in Section 2.2.2, Minutes of use (MOU) is increasing year by year, because the call charge reduction and the provision of data services match the recent customer preferences. On this point, spectrum allocation is one of the most critical issues for increasing the network capacity. Since each frequency band has specific features, mobile network negotiate carefully to obtain additional spectrum. With different bands for the same cellular service, the system should consider supporting handover and roaming between two frequency bands as shown in Figure 2-8.

![Figure 2-8 Instance of Additional Spectrum for Capacity Increase](image)

The allocation of spectrum is administered at both national and international levels. Basically the International Telecommunications Union (ITU) arranges international spectrum allocation for common global technologies such as satellite and mobile services. In particular, recent globalization in mobile services has encouraged the ITU to ask countries to use the same frequency bands for any new technology. Basically the ITU has stated that each country is free to select the spectrum to be used for 3G, because devices for roaming services will be simpler to manufacture if they operate at the same frequencies worldwide (Dodd, 2001). Therefore many countries, particularly those adopting Universal Mobile Telecommunications System (UMTS), one of the 3G specifications, are planning to use the 2GHz band for their 3G services (Dornan, 2001).
2.3.4. Platform Innovations for the Mobile Services

The other factor for mobile technology innovations is based on the new technologies from the aspect of services. Traditional telecom services have been network services such as call waiting, call forwarding and voice storage. However the recent diversification in the customer preferences forces the mobile operators to pursue new functions for new services (Lyytinen and Fomin, 2002). For instances, global roaming and Short Message Service (SMS) are key technologies in GSM. In particular, sophisticated roaming function was highly required, because the customers moved over the borders and they wanted to use their cell phones outside their home country. Furthermore, Nordic Mobile Telecommunications (NMT), one of the first generation mobile technologies, was limited to the Nordic area. Those factors strongly accelerated the make-up of GSM specifications. In the respect, not only the wireless interface but also the core network was designed for these mobile services and standardized by regional standardization bodies (Hillebrand, 2002).

As a result of the rapid growth, some regional parties that had developed the digital technologies challenged to enhance their platforms for higher data transmission. These derivatives, called 2.5G, were mainly based on packet technology, because it was able to provide both push and pull environments and also ensure the efficient use of radio interface by using the statistical multiplexing effect. In the European Telecommunications Standards Institute (ETSI), mobile network operators and vendors proposed sets of specifications and finally established the General Packet Radio System (GPRS) in 1999 (Hoffman, 2003). In Japan, NTT DoCoMo launched PDC-based Personal Digital Cellular-Packet (PDC-P) system in 1997, which would be platform for i-mode service launched in 1999. In United States, a packet service called Packet-One was launched commercially in 1999, based on
the cdmaOne system, compliant to Interim Standard-95 (IS-95) standardized in American National Standard Institute (ANSI).

2.3.5. Third Generation Mobile Technologies (3G)  
Foreseeing the future growth of the mobile market, the International Telecommunications Union (ITU) investigated global standardization for the third generation mobile technologies (3G), called International Mobile Telecommunications 2000 (IMT-2000). ITU set the standardization schedule for completing detail specifications by Dec 1999 and clarified requirements for the IMT-2000 radio transmission system to provide multimedia services in various environments as shown below Table 2-1.

<table>
<thead>
<tr>
<th>Table 2-1 Requirement of the IMT-2000 Radio Transmission Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indoor</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>Transmission Speed (kbps)</td>
</tr>
</tbody>
</table>

(Source: ITU-R Recommendation)

In an attempt to establish a unique standardized radio interface, ITU led the study of protocols, identifiers, services, voice coding and network architecture, striving to achieve a consensus among the number of organizations involved, such as mobile network operators and vendors. Nations, regions and organizations were required to propose a radio interfaces, and finally several tentative specifications were proposed to ITU, as derivatives of regional second generation technologies. Efforts were made simultaneously in some parties such as the third generation partnership project (3GPP), and the third generation partnership project 2 (3GPP2), to build consensus among the competing advocates. In the end, five optional interfaces were standardized in May 2000 as shown in Figure 2-9.
As a result, 3GPP adopted W-CDMA (IMT-2000 CDMA Direct Spread) for its wireless interface and radio access network (RAN), and an evolved-GSM core network (CN) as its IMT-2000 package, while 3GPP2 accepted CDMA2000 (IMT-2000 CDMA Multicarrier) for RAN and an evolved ANSI IS-41 CN as its package as shown in Figure 2-10.
2.3.6. Migration Paths from 2G to 3G

As technologies have become more complicated, migration paths in mobile technologies have become diversified. Although the aim of standardization is to agree a unique specification for global roaming and the reduction of network costs, industry standards are difficult to be established. Standards are based on partly the technological investigation and partly the result of a political harmonization. Standardization endeavors to maintain a focus on the technology, to enter into an industry-wide agreement that reduces time to market and ensures product compatibility. However as mentioned above, when technology trends are driven by several parties, the direction of standardization becomes complicated. As each 3G technology have some compatibility with 2G/2.5G specifications, complex migration paths have emerged as shown in Figure 2-11 (Redman et al, 2002).

![Figure 2-11 Migration Paths to 3G](image-url)
2.4. Migration Process in the Mobile Industry
2.4.1. Migration Process as Discontinuity

Many studies have been undertaken in order to classify this kind of technology innovation. One study showed four types of innovation process, namely disruption, discontinuity, displacement and distraction, called the 4-D classification as shown in Figure 2-12 (Christensen, Anthony and Roth, 2001).

**Figure 2-12 4D Classification in Telecom Industry**

Based on this classification, migration can be categorized as a discontinuity process. That is, this change is a “radically sustaining innovation for better technical performance that either meets or exceeds the current needs of the market”. In respect to platform migration, incumbents have often applied such innovation. Additionally, migration in the mobile industry might have been defined as a technological replacement of the platform. However, this recognition is not enough from the business perspective. Considering sustainable growth of mobile operators, I strongly recommend that migration should be thought as a reinforcing feedback loop composed of technology innovation, service innovation and investment in the next innovation. This research focuses on illustration of the migration mechanism and then proposes successful strategies for mobile network operators.
2.4.2. Two Dynamics in Migration Process

When we consider the migration process, it can be seen that there are two notable dynamics, that is, “Platform Migration” and “Service Innovation”. This section suggests that these two elements have their own clockspeeds and features.

Over the last twenty years, the mobile industry has experienced several platform migrations, which are well known as the progression of mobile technology generations from 1G to 3G (Tachikawa, 2002). Since it is inefficient for mobile network operators to own several different types of network system simultaneously, they always move to replace the existing platform with the next one. Moreover, from this perspective, the platform migration process can also be described as a mixture of two processes of technology implementation and customer transfer. Therefore a growth in the number of subscribers is a feature of platform migration as shown in Figure 2-13.

![Figure 2-13 Growth of Customers in Mobile Platforms](image)

Figure 2-13 Growth of Customers in Mobile Platforms
On the other hand, we should not overlook the existence of service innovation between successive platforms. As mentioned in Chapter 1, the traffic business is mainstream for mobile network operators and they should pursue traffic increase. Since platform migration by itself does not contribute to traffic growth so well, mobile operators need to create some attractive services on the new platform in order to encourage their customers to use the network environment more frequently. In addition they should exploit the potential performance of the new platform in terms of services. For instances, Short Message Service (SMS) in GSM and i-mode service, the Japanese mobile Internet access service, are innovative services and bridge across 2G/2.5G and 3G as shown in Figure 2-14.

![Figure 2-14 Combination of Platform and Service Wave in Mobile Migration](image)

These new services have encouraged the customers to use mobile platform for voice telephony, text-based messaging service and content downloading. They lead directly to revenue growth as well as traffic growth, even though the operators will be faced with pressure from the market for price reductions. In summary, we have to consider that the migration process is composed of two processes: platform innovation and service
innovation, as shown in Figure 2-15.

2.4.3. Migration Model in the Mobile Industry

As mentioned in Section 2.3, this section proposes the migration model should take the form of a powerful reinforcing feedback loop as shown in Figure 2-16. This means that, while mobile network operators pursue traffic growth and further revenue, they also innovate new technologies and services sequentially. Traffic growth arising from new services leads to spectrum shortage, just same as a shortage of network capacity. In consequence, mobile network operators need to investigate new platform technologies for acquiring new spectrum and making efficient use of spectrum that they already owned. This is the stimulus for the platform innovation part.

As mentioned previously, platform migration is composed of technology implementation and the transfer of customers to the next platform. Simultaneously, mobile operators are faced with the pressure of market-driven price reductions. Price reductions also reduce ARPU directly. The requirement for recollection of the investment in the previous platform migration forces mobile operators to create new services to stimulate traffic growth. Traffic
growth leads to capacity shortage, which in turn means spectrum shortage. Occasionally, additional spectrum is allocated to mobile network operators when they implement new wireless technologies. In addition, mobile network operators have tried to investigate new technologies for the efficient use of spectrum and to add some new functions such as global mobility, Internet Protocol and so on. These technology innovations encourage mobile network operators to migrate their existing platforms to the next ones.

In summary, platform innovations arose due to shortages of capacity, and service innovations led by ARPU reduction drive this migration cycle continuously. This is the migration mechanism in the mobile communications industry.

Figure 2-16 Migration Dynamics Model in the Mobile Communications Industry
2.5. Summary

In this chapter, the migration model is clarified. The points are the following:

- The market saturation will confront the European, the US and the Japanese mobile operators. The market trends illustrate that their MOU (Minute Of Use) is still increasing. But the ARPU (Average Revenue Per User) is declining gradually, because of price reduction in the fierce competition.

- The technical platform, called mobile platform, has been innovated by the two market requirements: “efficient use of the radio spectrum” and “additional functions for the new mobile services”. The generations in mobile platform have been concerned closely with these wireless technology innovations. As the technologies have become more complicated, the migration paths, which are transition from the existing generation technology to the next one, in mobile technologies have become diversified.

Referring to these two trends, this chapter clarified the migration process.

- The migration process in the mobile industry can be defined, according to 4-D classification scheme by Christensen et al., as discontinuity event, managed by incumbent companies such as mobile network operators.

- The migration model is a reinforcing feedback model, rotated powerfully by two dynamics: “Platform Migration” caused by a shortage of network capacity, and “Service Innovation” triggered by a decline in ARPU (Average Revenue Per User).

In Chapter 3, platform migration dynamics is analyzed and defined more clearly from case studies. Service innovation dynamics will be also clarified in Chapter 4 with proposed analytical framework.
3. Platform Migration Dynamics

3.1. Overviews
The key issue in this chapter is to clarify the mechanisms of platform migration dynamics. Firstly, the empirical analysis about platform migrations in the past indicates consistent triggers, namely capacity shortage and function enhancement. Next, two kinds of migration scheme, known as the Revolution-type and the Evolution-type, are explained. Additionally, an analytical framework of 4C (Capability, Coverage, Cost and Complementary Assets) is proposed and applied to four specific cases relating to Vodafone, NTT DoCoMo, SK Telecom and KDDI. Referring to these case studies, three key factors, namely technology leadership, value chain leadership and investment capability, are illustrated as criteria to entry platform migration process.

3.2. Triggers in Platform Migration Dynamics
Platform migration means the replacement of an existing network system with the next generation and the transfer of customers to the next platform. There are two consistent triggers for platform migration as shown in Figure 3-1. One is capacity increase, to cater for traffic growth, and the other is deployment of new network functions, to support future new services. Historically an increase in capacity is more important than new function deployment, because radio frequencies are a limited resource. In this case, capacity means network capacity, which is how many customers can transfer information simultaneously. Capacity shortage is also quite a severe problem for mobile network operators, because the capacity determines the actual market share. Additionally operators have to stop their sales of handsets, if they are faced with a capacity shortage. In Table 3-1, historical causes of traffic growth leading to platform migrations are shown.
Table 3-1 Cause of Traffic Growth for Platform Migration

<table>
<thead>
<tr>
<th>Platform Migration</th>
<th>Cause of Traffic Growth</th>
<th>Innovative Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>1G to 2G</td>
<td>Voice Telephony</td>
<td>Cell Phone Service</td>
</tr>
<tr>
<td>2G/2.5G to 3G</td>
<td>Small Data Traffic</td>
<td>SMS, i-mode</td>
</tr>
<tr>
<td>3G to B3G</td>
<td>Rich data content</td>
<td>MMS, Moving Picture</td>
</tr>
</tbody>
</table>

For the migration from 1G to 2G, voice telephony was the main mobile service and traffic increased with market growth. After this, data services have been the triggers to accelerate platform migration from 2G to 2.5G and from 2.5G to 3G.

The other trigger for platform migration is the deployment of new functions. That is, the anticipation of new services requires new functions in the mobile infrastructure. As mentioned in Section 2.3.4, the global roaming function was one of the triggers for establishment of GSM specifications.
3.3. Platform Migration Model
3.3.1. Backward Compatibility

This section categorizes the past migrations into two types, namely the Revolution-type and the Evolution-type, from an empirical analysis. Compatibility between the existing platform and the next platform is a critical factor as shown in Figure 3-2.

In this analysis, backward-compatibility means that legacies of existing network equipment can be used in the next platform. In addition, wireless interface compatibility, meaning the same as handset compatibility, is also important. That is, handsets for the next platform can be used for common services such as voice telephony or data transmission for existing services in the existing platform. Therefore, following cases are not backward compatible: PDC with GSM, GSM with AMPS and PDC with IMT-2000. If mobile operators are able to provide dual-mode or tri-mode handsets that support these different wireless interfaces, their customers will be able to enjoy the same environment as the backward compatibility.

![Figure 3-2 Backward Compatibility in Two Migration Schemes](image)

(a) Revolution-type Migration

(b) Evolution-type Migration

Figure 3-2 Backward Compatibility in Two Migration Schemes
3.3.2. Revolution-type Platform Migration

Revolution-type migration occurs when the existing and new platforms have no compatibility, as shown in Figure 3-3. For instance, the latest case is the migration path from PDC to IMT-2000 DS-CDMA in the Japanese market. Study group of 3GPP proposed that the wireless interface of IMT-2000/UMTS would be W-CDMA and core network (CN) would be an evolved GSM Network. Enhanced GSM CN and PDC CN are almost entirely different, from network architecture to protocol. This means that neither the wireless interface nor the core network have any compatibility. Another case is from CDMA2000 1x to IMT-2000 DS-CDMA in the near future in Korea (Song, 2002).

3.3.3. Evolution-type Platform Migration

This type of migration allows operators to transfer legacy network resources to the next platform. Examples of Evolution-type migration paths are the natural paths from GSM to GPRS/UMTS, from PDC to PDC-P and from cdmaOne to CDMA2000 1x. In particular, the cdmaOne and CDMA2000 series are specifications strategically developed by Qualcomm. Mobile network operators owning CDMA2000 have only to install new channel cards in the base station equipment, software upgrades at the base station controller...
and mobile switching center, and a packet core backbone to carry traffic. Infrastructure costs are clearly lower than with the Revolution-type and the speed of implementation and coverage expansion are also faster.

Table 3-2 Features and Instances of two Migration Schemes

<table>
<thead>
<tr>
<th>Revolution-type</th>
<th>Evolution-type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newly Implemented</td>
<td>Partially Used Network Legacies</td>
</tr>
<tr>
<td>Required Standardization</td>
<td>Including Normal Upgrade</td>
</tr>
<tr>
<td></td>
<td>(Including software upgrade)</td>
</tr>
<tr>
<td></td>
<td>Backward Compatibility</td>
</tr>
<tr>
<td>NMT (1G) to GSM (2G)</td>
<td>GSM (2G) to GPRS (2.5G) to UMTS (3G)</td>
</tr>
<tr>
<td>TACS (1G) to GSM (2G)</td>
<td>PDC (2G) to PDC-P (2.5G)</td>
</tr>
<tr>
<td>PDC (2G) to cdmaOne (2G)</td>
<td>cdmaOne (2G) to CDMA2000 1x (2.5G)</td>
</tr>
<tr>
<td>PDC (2G) to IMT-2000/UMTS (3G)</td>
<td>CDMA2000 1x (2G) to CDMA2000 EVDO (3G)</td>
</tr>
</tbody>
</table>

The technical features in Evolution-type migration can be described as the up-grade of hardware and software, in terms of using various items of legacy network equipment and terminals. For instances, GPRS, 2.5G follow-on GSM, allows mobile network operators to use many items of legacies of GSM network equipment as shown in Figure 3-4

![Figure 3-4 Upgrade from GSM platform to GPRS platform](image-url)
3.3.4. Platform Migration Model

These two schemes are not mutually exclusive, as is demonstrated in Figure 3-5. However, external and internal strategic requirements are dominant factors for mobile network operators in deciding which scheme will be applied. In particular, the development process and government policies are critical factors. A Rough analysis shows that Evolution-type migration is easier to be constructed than Revolution-type, but occasionally pressures from outside may not allow mobile network operators to choose the Evolution-type. In any case, mobile network operators need to demonstrate leadership for their own success in these migrations. Therefore, corporate decisions and preparation planning from a long-term view are quite important.

![Platform Migration Model](image)

**Figure 3-5 Platform Migration Model**
3.4. 4C Framework for Platform Migration

For analyzing these two schemes, four analytical factors, which help to clarify the features of these two migration schemes, are proposed. Then, the fundamental implementation model is clarified in the rest of this section. After the advantages of Evolution-type migration have been shown, a set of tactics and strategies for successful migration in the future are suggested. In particular, that is how to drive Revolution-type successfully.

3.4.1. 4C Factors for Platform Migration

Some research studies have shown the users re-select their mobile network operators in terms of coverage, cost, capacity, capability and clarity (Skvaria, 2002). Historically, these factors are quite critical for mobile voice telephony. Considering the past migrations of mobile platform, I have rearranged these and now propose four elements as critical factors for the migration process, namely, capability, coverage, cost, and complementary assets as shown in Figure 3-6.

![Figure 3-6 4C as Critical Factors in Platform Migration](image-url)
3.4.2. Capability
Capability is one of the fundamental factors for migration. Basically, one of the critical
capabilities is transmission speed over the radio interfaces. That is different from wired
interfaces, since it is limited by the cell size and features of bandwidth allocated to the
mobile services. Another critical capability is the capacity for managing calls occurring at
the same time. Those are just trade-off with transmission capacity allocated to each call.
Therefore, the innovations in the wireless interface have been focused on higher
transmission speeds and efficient use of radio bandwidth in order to achieve a larger
capacity. Moreover, aspects of terminal performances such as battery life and usability are
counted as capability.

3.4.3. Coverage
Connectivity to network is very important for customers, because, if they are out of service
area or in a black spot, they really experience inconvenience and may switch to a different
mobile network operator. Since preparing for perfect coverage in the planning phase of a
new platform is a major task, because of its network cost, mobile network operators need to
build their scenarios of service area expansion carefully with regard to market requirements.
Additionally, indoor coverage is becoming more important for customers in a statistical
wireless environment. Cell phone are used as wireless connection tools such as wireless
modem, mainly in an indoor environment.

3.4.4. Cost
Cost means how much customers need to spend for mobile service. It is composed of two
factors, namely the initial cost of the handsets and the call charge. These factors are
basically dependent on the productivity of supplier suppliers and mobile operators’ network designs. Operators apply a strategic pricing structure for successful migration. A commission fee paid to their distributors is one of the means of strategic price-reduction of handsets. Distributors can use this commission fee as the source of price reduction of terminal. In addition, pricing strategies need to be commensurate with coverage. That means small coverage in the beginning of the platform migration causes a bad publicity and reduces the brand-power of the new services. Therefore to heighten the initial costs in strategic pricing have a role in the barriers to prevent customers from transferring to the next platform in the first step.

3.4.5. Complementary Assets
Generally the profits from innovation may accrue to the owners of certain complementary assets around core platform. This means that the innovating company needs to establish a prior position in these complementary assets for further growth (Teece, 1986). Mobile platform has also several critical complementary assets in order to capture value of the service. In this framework, this concept is referred as anything relating to content and its delivery to a terminal, because these are influential factors for mobile services. After launching a mobile Internet access service, the available content adds value to the platform technologies, while the terminal is the essential user interface for delivering the content to customers. In particular, the availability of terminals on the market is quite important. For instance, in the case of the migration to GPRS, the delayed release of terminals to the marketplace resulted in a negative impact on the sustained growth of the European mobile market (Hoffman, 2003).
3.5. Case Analysis of Revolution-type Migration

This section and the next section analyze some case histories, which illustrate Revolution-type and Evolution-type migration, in order to clarify their features. For Revolution-type migration, Vodafone GSM and NTT DoCoMo PDC are shown. These two companies constructed their different digital systems relatively early compared with the rest of the world and spent several years bringing them to the maturity. Their management of these two cases gives us some implications of how mobile network operators may exercise care in driving Revolution-type migration.

The other cases relate to Evolution-type migration. Mobile operators, which owned cdmaOne platform, began to migrate their platforms to CDMA2000 1x. This is the reason why the quality of CDMA2000 1x has become stable in the last few years, and why fierce competition has emerged even in high-speed data services. SK Telecom, the first implementer of CDMA2000 1x in the world, is shown as first case study. The second Evolution-type case is that of KDDI, the second largest Japanese operators, which is presenting a challenge to DoCoMo’s 3G services by using CDMA2000 1x.

3.5.1. Overviews

As shown above, several Revolution-type migrations have already occurred in the mobile industry. Migration from 1G (Analog) to 2G (Digital) is a remarkable case of Revolution-type, because this is the first migration, which mobile network operators were faced with. Also, there was no compatibility between these two technologies. As a result, this migration may exaggerate not only the features of Revolution-type migration but also the problems that mobile network operators currently suffer from in 3G migrations.
In the early 1980s, foreseeing the future growth of mobile service, many operators started to investigate specifications for a new platform. Certain market requirements such as higher capacity, security and global mobility had indicated the choice of digital technology as wireless interface. Key technologies are compressed voice coding, to reduce the data volume and TDMA technologies for the efficient use of bandwidth, while an additional requirement was roaming for mobility beyond the boundary of an operator. In ITU, three *de-juré* specifications were adopted as digital cellular technologies as shown in Table 3-3. Once these specifications were stable, mobile network operators were faced with the first platform migration, from the analog mobile platform to the digital mobile platform.

This section shows these first migration cases in the world. The first one is the platform migration of Vodafone, from TACS to GSM, and the second is that of NTT DoCoMo, moving from NTT-Analog System to PDC.

**Table 3-3 Three Specifications for the 2G Wireless Interface**

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Speech Coding</th>
<th>Channel per kHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe GSM</td>
<td>22.8kb/s PRE-LTP-LPC</td>
<td>0.04</td>
</tr>
<tr>
<td>PDC (Japan)</td>
<td>11.2kb/s VSELP</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td>5.6kb/s PSI-CELP</td>
<td>0.24</td>
</tr>
<tr>
<td>North America IS-54</td>
<td>13kb/s VSELP</td>
<td>0.1</td>
</tr>
</tbody>
</table>

3.5.2. Case of Vodafone

Vodafone PLC, currently the largest mobile operator in the world, obtained a license for cellular telephone networks from UK Government in 1983. Before that, one other license had been awarded to Cellnet, a company owned by British Telecom and Securicor Communications Limited, currently known as mmO₂ PLC. In 1985, representatives of state-owned telecom operators in France, Germany and Italy agreed to establish and
promote a series of interlinked, compatible, digital cellular telephone networks, which could constitute a pan-European system and be used by subscribers throughout Europe. Vodafone and Cellnet became parties to this agreement in 1986. Vodafone’s next generation platform was designed to form part of the UK element of this pan-European system and follows the GSM specification (Stuart and Bhalla 2002).

In December 1991, Vodafone introduced its digital network in Central London. However in first three years it struggled to grab customers’ interest because of smaller coverage and lower stability than the analog platform. As can be seen by reference to its customer growth shown in Figure 3-7, we can see that around 1997 was the turning point for Vodafone’s digital service. The more detail analyses in terms of 4C framework are shown below.

*Capability of connectivity:* After facing the challenge to improve quality of its digital cellular service, its call completion success rate reached around 92%, which was about the same level as its analog service, which had a 91% call completion success rate in 1997.

*Coverage Expansion:* As shown in Figure 3-7, in 1994, the coverage of the digital service was around 70% of the population. Vodafone accelerated its building of base stations, and by the end of March 1997, there were 2,813 digital base stations in service in the UK, giving a declared coverage of over 95% of the population.

*Cost:* Vodafone introduced new digital tariffs such as “BusinessWorld” for corporate users and “PersonalWorld” for the low-use consumer in 1996, which offered per second billing, “bundled” free minutes and competitive call rates. These pricing structures were a significant factor underlying the level of net growth in customers connected to the digital services. In 1998, Vodafone introduced pre-paid services in digital cellular services.
Complementary assets: Unlike the more recent mobile Internet service, second-generation content of second-generation services were restricted to voice and low speed data services such as Short Message Service (SMS). In 1994, Nokia released its 2100 series supporting the SMS function. This new, smaller phone with SMS appealed to customers. Another notable point was that in 1997, Mr. Chris Gent, the new CEO of Vodafone, aggressively united the six cellular providers it had acquired (Vodac, Talkland, Vodacom, Voadcall, Astec, and People’s Phone) under the Vodafone brand.

![Figure 3-7 Customer Growth and Coverage Expansion in Vodafone GSM](image)

Source: Vodafone Annual Report and Form 20-F

3.5.3. Case of NTT DoCoMo

In Japan, to cater for further growth in the mobile market, studies on the technical requirements for digital cellular technologies began at the request of Ministry of Posts and Telecommunications. The studies crystallized in the form of a recommendation to adopt TDMA in 1990. In parallel, Research and Development Center for Radio System (RCR)
studied the radio interface specifications in detail, leading to the establishment of a digital
car phone system standard called Personal Digital Cellular telecommunication system
(PDC) (Tachikawa, 2002)

NTT DoCoMo Inc. was spun off from Nippon Telegraph and Telecom Inc. (NTT) in 1992.
It took over a large R&D sector focusing on mobile services from NTT for progressing
mobile technologies. The R&D arm of DoCoMo contributed many specifications for PDC.
Then, after the specifications were frozen, DoCoMo developed its network equipment, base
stations, and handsets in conjunction with several Japanese vendors. In 1993, DoCoMo
launched its digital cellular services in the center of Tokyo area and expanded its digital
cellular platform year by year. As shown by its customer growth in Figure 3-8, the turning
point was around 1996. The more detail analyses in terms of 4C framework are shown
below.

**Capability:** Consistent responses to challenges by its R&D department and Communication
Technology System department improved the quality of service year by year. A remarkable
improvement around 1996 was the release of the “HYPER” series of terminals, with longer
battery life and smaller body size. As the R&D arm of DoCoMo developed and improved
handsets almost every year, this “HYPER” achieved a weight of only 125g, half that of an
analog terminal, and a successive talking time 250 minutes, twice that of an analog one.

**Coverage Expansion:** As shown in Figure 3-8, during the first few years its service
coverage was under 90%. However, once it exceeded 95% in 1996, the number of
customers grew rapidly.

**Cost:** DoCoMo improved its tariff structure with constantly reduction of telephone charge
from 1995 to 1996. For instance, they abandoned contract fee in 1996.

**Complementary assets:** Through its close relationship with terminal vendors in the development process, DoCoMo improved its digital handsets and distributed a new series every year. Unlike the European market, DoCoMo purchased the handsets and sold them through their franchised DoCoMo-shops timely. Combined with its strong brand image in its analog service, this distribution structure can be thought of as one of its critical complementary assets.

![Figure 3-8 Customer Growth and Coverage Expansion in DoCoMo PDC](image)

### Figure 3-8 Customer Growth and Coverage Expansion in DoCoMo PDC

3.5.4. **Lesson from Revolution-type cases**

From the examination of the migration challenges of Vodafone and DoCoMo, we can see some common feature of migration as shown in Table 3-4. Vodafone took 6 years to double the progress of its digital services, while DoCoMo took 3 years.
Table 3-4 Analysis of cases of Vodafone and NTT DoCoMo

<table>
<thead>
<tr>
<th>Company</th>
<th>Turning point</th>
<th>Capability</th>
<th>Coverage In Turning point</th>
<th>Cost</th>
<th>Complementary Assets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vodafone</td>
<td>1997</td>
<td>Call Access Rate92%(91%)</td>
<td>95%</td>
<td>Bundle in 1996</td>
<td>SMS</td>
</tr>
<tr>
<td>(1991)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NTT DoCoMo</td>
<td>1996</td>
<td>Down sized Longer Battery</td>
<td>95%</td>
<td>New tariff in 1996</td>
<td>Smaller MS Distribution</td>
</tr>
<tr>
<td>(1993)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Firstly, it can be seen that mobile network operators will take several years for market expansion using Revolution-type platform migration. I assume that mobile network operators took some periods for feedback to improve their quality of capability and coverage. Secondly, customers did not move to 2G platforms until the coverage was nationwide and the capability was adequate, even though the first segment of the market targeted was business or corporate use. Therefore mobile network operators should enhance the quality of coverage and capability with a higher priority than for other factors. Then they can encourage customers to move by means of price reductions. This means that there are two steps for successful platform migration. The first step focused on coverage completeness and quality improvement. The next step is promotion in terms of price reductions and renewal of the brand. Just considering those points, we would like to extract some requirements for successful Revolution-type migration.

**Faster Implementation:** From a financial viewpoint, it is not a good strategy for telecom operators to support different kinds of platform simultaneously for a long time, because they have to spend their resources on maintaining and operating them. In particular, the next generation mobile platform can take over the services of immediately previous
platform. Therefore, it is strongly recommended that mobile network operators should invest in building a new platform, improve the quality of services, lower the cost barriers and manage the distribution of complementary assets as soon as they can.

**Technology Leadership:** One of the remarkable differences between the two cases is technology leadership in development process. DoCoMo led technical investigations in developing PDC and holds some of the essential intellectual property right (EIPR). Its technical capabilities allowed DoCoMo to investigate faults in its coming platform’s performance. Moreover, it enabled DoCoMo to modify some specifications for enhancement by itself, even though the operator had no internal manufacturing process.

**Integration of Value Chain:** Another reason why DoCoMo was able to achieve successful migration in such a shorter period than Vodafone is that it had both leadership of terminal development and its own distribution channels. Unlike mobile network operators in other countries, Japanese mobile network operators have their own distribution channels and sell handsets as their own products. This logistics enables Japanese mobile operators to keep their bargaining power to the handsets suppliers. As mentioned in Section 3.5.3, DoCoMo was able to distribute its new handsets, supporting the latest network services, on time, even though they held the risk of responsibilities for inventories.
3.6. Cases Analysis of Evolution-type Migration
3.6.1. Overviews
In this section, CDMA2000 migration is discussed mainly, because its migration path is the Evolution-type scheme proposed strategically by Qualcomm. And it exhibits close backward compatibility with cdmaOne also designed by Qualcomm. As mentioned in Section 2.3.6, mobile network operators choosing this cdmaOne migration path can enjoy its easier migration. Both SK Telecom and KDDI are in this situation.

3.6.2. Case of SK Telecom
SK Telecom, the leading mobile operator in the Korean market, was established in March 1984 under the name of Korea Mobile Telecommunications Co., Ltd (KMT), under the laws of the Republic of Korea. It changed its name to SK Telecom in March 1997, and became a member of SK Group (Song, 2002).

SK Telecom experienced Revolution-type migration from analog to cdmaOne as its digital service in 1996. This was the first implementation of cdmaOne in the world. Actually SK Telecom faced a severe capacity shortage in catering for customer growth, since it could not be given additional spectrum. This capacity problem was a strong influence on SK Telecom in facing the challenge of fast migration. SK Telecom has a well-organized R&D arm, which showed organized process management for its implementation, and successfully completed this Revolution-type migration in only three years.

After maturity was reached for digital services in the Korean market, competition with KT Freetel and LG Telecom became fiercer. In order to sustain its advantage, SK Telecom decided to migrate its platform from cdmaOne to CDMA2000 1x, which was also the world’s first launch in October 2000. In 2002, SK Telecom merged Shinsegi Telecom
completely. Shinsegi Telecom had provided a cell phone service in terms of the 800MHz band, the same frequency band as SK Telecom. Then this merger allowed SK Telecom to gain both additional spectrum in the 800MHz band and the 3.5 million subscribers of Shinsegi. The more detail analyses in terms of 4C framework are shown below.

**Capability:** CDMA2000 1x can provide 144kbps data service to customers, and content can be downloaded more smoothly than is possible with cdmaOne handsets. Additionally, since SK Telecom merged with Shinsegi Telecom in 2002, it was able to take over the spectrum of Shinsegi Telecom at 800MHz as additional spectrum for CDMA2000 1x.

**Coverage:** CDMA2000 1x was launched with backward compatibility and its evolution scheme of migration allowed its coverage to reach more than 90% for only one year as shown in Figure 3-9.

**Cost:** Most Subscribers who switched over to CDMA2000 1x handsets do not care too much about the technology. SK Telecom kept the price of CDMA2000 1x handsets almost the same as that of cdmaOne.

**Complementary Assets:** SK Telecom has a close relationship with a number of content providers like NTT DoCoMo i-mode. This content line-up was transferred seamlessly to CDMA2000 1x. In addition, SK Telecom released a CDMA2000 1x handset with a color-display. Considering the fact that users using new handsets with color-display and polyphonic sounds generate higher ARPU compared to users with normal phones, these newly equipped handsets have encouraged customer transfer. SK Telecom has a very strong branding power and successfully provided differentiated services to various market

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4 Gartner Operational Management Research, Jan. 2003
segments. In particular, “011”, the first three digits of its subscriber number range, is one of its strong brand images.

Figure 3-9 Customer Growth and Coverage Expansion in SK Telecom

3.6.3. Case of KDDI

In the Japanese mobile market, KDDI, the second largest mobile operator, had already implemented cdmaOne to their network in 1998 and faced the challenge of Evolution-type migration from cdmaOne to CDMA2000 1x in 2002.

KDDI Corporation was established in June 1984 as Daini-Den Den Planning Company, changing its name to DDI Corporation in April 1985. In October 2000, DDI Corporation merged with KDD Corporation and IDO Corporation to form the new DDI Corporation. (In April 2001, the company changed its name officially to KDDI Corporation.) In this merger, KDDI set two brands as their cell phone services. One is “Tu-ka”, which focuses on PDC service in the 1.5GHz band, and the other is “au” for cdmaOne service in the 800MHz band.
Actually, IDO and DDI had already completed their cdmaOne platform nationwide by 2000, because powerful pressures from its competitors such as NTT DoCoMo and J-phone, the third mobile operators and currently a subsidiary of Vodafone, forced them to accelerate expansion of its service coverage. The more detail analyses in terms of 4C framework are shown below.

**Capability**: Compared to DoCoMo’s PDC handsets, even the cdmaOne handsets of au had a shorter average battery life for standby time than those of DoCoMo. However fortunately the technology maturity of CDMA2000 1x ensured that the same capability could be retained as cdmaOne. This meant they did not have any disadvantage in the market place over battery life. On the other hand, CDMA2000 1x can provide 144kbps data service to customers and content can be downloaded more smoothly than with cdmaOne handsets.

**Coverage**: CDMA2000 1x was launched with backward compatibility and an evolution scheme of migration allowed its coverage to reach more than 90% in only one year as shown in Figure 3-10. Therefore the users hardly perceived that CDMA2000 1x coverage was limited.

**Cost**: KDDI set the street price of CDMA2000 1x handsets as almost the same as that of cdmaOne, and did not give a special service name to it at the beginning. That is, KDDI categorized CDMA2000 1x handsets as one of “cdmaOne Series.” Meanwhile au stopped introducing new models for cdmaOne terminal after it launched CDMA2000 1x in April 2002. Then its customers naturally concentrated on CDMA2000 1x models when they upgraded their handsets at regular periods. Therefore au did not have to set additional budget for customer transfer. Another point is about reduction of call charge. Regardless of
this CDMA2000 service, KDDI introduced “Gakuwari”, Japan’s first discount mobile service plan for students in November 2000. This new pricing attracted the Japanese younger generation to the au mobile services.

**Complementary Assets:** KDDI has provides its own mobile Internet access service, branded “EZ web”. This service has similar the business model with a number of content providers like DoCoMo i-mode. In platform migration to CDMA2000 1x, KDDI was able to transfer its content line-up seamlessly to the new platform like SK Telecom.

The other issue in the KDDI’s platform migration strategies is about its spectrum allocation. au first introduced first CDMA2000 1x with a focus initially on a system operating in the 800MHz band. This enabled au to use the existing cdmaOne infrastructure and therefore maximize financial efficiency.

![Figure 3-10 Customer Growth and Coverage Expansion in au CDMA2000 1x](image)

Source: KDDI Annual Report and press release, DDI Annual Report
Furthermore, au have planned to launch 2GHz CDMA2000 1x and 800MHz CDMA2000 1x EV-DO between fiscal 2002 and fiscal 2003. That is, it will use its 2GHz bandwidth allocation for 3G to provide future increase in capacity of 800MHz CDMA2000 1x, and simultaneously implement CDMA2000 1x EV-DO, the next phase of CDMA2000 series, using their 800MHz network resource as shown in Figure 3-11.

![Figure 3-11 KDDI Spectrum Usage](image)

3.6.4. Lesson from Evolution-type Case

It is very clear that Evolution-type migration is more advantageous for mobile network operators than Revolution-type. The noteworthy features of Evolution-type migration are summarized below.

**Backward Compatibility:** This function is quite strong. Mobile network operators can time the release of their new handsets for customers’ upgrades. This continuity prevents customer churn. SK Telecom states that its churn rate is around 1%, while NTT DoCoMo has 3.6% of DoCoMo in March 2002 and KDDI au has 1.8% at the same time.

The other issue is that, in the KDDI case, cdmaOne and CDMA2000 1x had already been installed in Korea and the United States. Therefore, KDDI did not have to pay...
attention to improving the quality of software and hardware, tuning-up the network equipment, and network design. We should also recognize that these two companies had previously invested a significant amount of capital to migrate from analog or PDC to cdmaOne. Finally, we have to recognize the fact that Qualcomm had developed both the cdmaOne and CDMA2000 series. This meant that SK Telecom and KDDI did not have to propose anything in the investigation phase. Not taking a strong position in driving development investigation and standardization, it should be noted that these two companies focused on the operation of their platform implementation.

**Much Faster Expansion of Coverage**: Evolution-type migration can use the legacy network elements of the previous platform. As a result, it enables a mobile network operator not only to replace its platform much faster but also to expand its coverage with lower network cost than Revolution-type.

**Transfer of Complementary Assets**: These two cases clearly illustrate that killer applications are not dominant factors in platform migration, because customers of SK Telecom and KDDI were not conscious of the implementation of the new platform technologies. Both these two companies delivered new handsets supporting CDMA2000 1x as the normal product and eventually ceased providing those for cdmaOne. It is not denied that new attractive applications will accelerate customer transfer, but the most important point is to transfer the existing complementary assets, for example ensuring that a set of content should be transferred completely. A reduced line-up of services or content makes customers disappointed and prevents them from transferring.
3.7. Recommendations for Successful Platform Migration
3.7.1. Evaluation Criteria for Entry in Platform Migration

Two kinds of platform migration process have been introduced. It is much easier for mobile operators to drive the Evolution-type migration than the Revolution-type.

As mobile technologies become more complicated, it will be more difficult to harmonize a unique standardized specification from now on. In particular, since the large market scale has given attractiveness to operators and vendors, several standardization groups will propose many wireless specifications based on their own investigation in the future. Therefore, it will also be much harder for mobile network operators not only to choose the appropriate technologies but also to migrate at financially reasonable intervals.

Considering such uncertainties, mobile network operators should prepare some strategies for successful future platform migration. Based on these lessons, the first recommendation is that mobile network operators should arrange their migration path to be of the Evolution-type. In Evolution-type migration, they can retain their market power and upgrade their platform performance smoothly without incurring churn. In this section, three criteria, namely technology leadership, value chain leadership and investment capability are proposed for evaluation of the operators capability to drive platform migration successfully as shown in Figure 3-12.

Next, in situations where mobile network operators have to choose Revolution-type migration, they should build their migration scenario quite carefully. They should consider the four factors of coverage, capability, cost and complementary assets, in order to avoid the bitter trail, which can accompany Revolution-type migration to the next platform.
3.7.2. Technology Leadership

Platform migration is a kind of technology innovation. For successful implementation and launch of the platform on time, mobile network operators have to show their technology leadership. From the case analyses, there are two necessary competencies for mobile operators. One is the capability to assess technology investment, such as an R&D arm, and the second is process management for outsourcing and testing the new platform.

In respect of R&D arms, there are some problems for mobile network operators. As mobile technologies have become globalized, the development stage and manufacturing processes have become more complicated. Some of vendors, Nokia, Ericsson, Motorola, Alcatel, Siemens and recently Qualcomm own R&D resources all over the world, and they have led technology trends in the telecom industry. Historically Public Telecommunication and Telegraph groups also have their own R&D sectors and have led technical investigations in the telecom industry (Lehenkari and Miettinen, 2002). Government policies in the 1990s,
however, had a great impact on the industrial structure, and reduced the competitive power of mobile network operators in technology innovation\(^5\). It can be said that an R&D facility is essential for mobile network operators if they are to take initiatives in future mobile technology trends and finally active leadership in the migration process. Another important point is process management. Historically, mobile operators have outsourced the manufacturing process to telecom vendors. This means that the progress of manufacture and quality improvement is hidden from operators. As mobile technologies become more complicated, even vendors may not be able to guarantee to release a set of equipment to operators. For instance, this matter caused a delay in the schedule of GPRS launch in 2000 and same situation can be seen in DoCoMo’s 3G launch. Therefore, mobile operators should adopt a strategy of working with multiple vendors and build internal capabilities for the process management of their platform implementation.

3.7.3. Leadership in Value Chain Dynamics
Successful migration can be defined as the transfer to new technology in the way the mobile network operators planned. This does not only apply to network equipment; in addition, a set of content and terminal handsets should be prepared and released to the marketplace in a form which appeals to customers and grabs their attention. This means mobile network operators should encourage these kinds of suppliers to provide their products and should build close relationships with them. The horizontal and vertical integration in the value chain are quite important in encouraging these suppliers. This aspect of integration has a direct impact on relationships with partners, and so influences

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\(^5\) Referring to Section 5.2.4
the development of complementary assets.

3.7.4. Investment Capability
For faster migration to next technologies, mobile network operators should invest their capital in installing the required number of base stations, in core network equipment and software. Therefore a higher investment capability will directly influence the expansion of coverage, one of the critical factors to be solved in the first step. In addition, higher investment capability will enable mobile network operators to adopt strategic pricing policies such as offering a commission fee to reduce the initial cost, in order to accelerate customer transfer to the new platform. Investment capability is dependent on revenue from the existing services. It is natural that they can raise money from the outside. However it is a little bit risky, because there is no guarantee that the new platform will enable them to recoup without new profitable service.

As mentioned in Chapter 3, since migration process is a reinforcing feedback loop, mobile network operators should always investigate new services and business models as a source of further revenue. The concept of service innovation in mobile operators is based on this principle. Additionally, recent spectrum auctions have forced mobile network operators to spend huge amount of money to acquire new bandwidth and licenses. Because of this, it is the more important for mobile operators to sustain their investment capability for further growth.
3.8. Tactical Operation from Empirical Analysis

3.8.1. Recommended Process for Revolution-type Migration

With reference to the above recommendation, the appropriate approach to Revolution-type migration is proposed as shown in Figure 3-13.

This process can be divided into two steps. The first step is just focused on quality improvement and the expansion of coverage as mentioned in Section 3.5.4. In this step, mobile network operators concentrate on improvement in platform performance. They should also transfer complete sets of complementary assets on the existing platform.

![Figure 3-13 Recommended Approach to Revolution-type Migration](image)

After listening to their customers’ reaction, mobile network operators move to next step. In this step, they can change the call charges and initial cost for fitting customer preference. This phase will lead to a turning point in customer transfer. Mobile network operators should then start to investigate and invest in the service innovation process.

This means that complementary assets are not dominant factors in the first step of platform migration; customer requirements are more fundamental. That is, customers want to have the same coverage level as the existing services and improved quality at the first. Without
adequate connectivity, new complementary assets will get a bad reputation as a result of the lower quality of the platform. Even though attractive services and terminals may be provided in the first step, poor network quality will deaden customers’ enthusiasm immediately. The most important thing in the first step is to provide at lease the same performance as that of the existing platform. Considering services and content based on these points, transfer of the existing line-up is a factor to be done in this first step. After this, mobile network operators should not only advance but also innovate their complementary assets. This concept is discussed in Chapter 5.

3.8.2. 4C Operation Model for Successful Platform Migration

These four factors add attractiveness to a new platform. It can be assumed that these factors have influences on platform migration as shown in Figure 3-14.

The increased attractiveness of the new platform encourages customers to transfer from the existing platform to the new one. Therefore platform migration will be accelerated if each of these factors offers a higher value than that in the exiting platform. In this model, one of the most important things is revenue from the existing services.

R&D cost, spectrum auctions cost, initial network coverage cost and a commission fee to the franchises are out of the revenue generated from the existing service.

This means migration forms a reinforcing feedback loop as mentioned in Section 2.4.3. Without cash from the existing service, migration to the next platform migration will not be feasible. After new services launched, each of four factors will have an effect on service attractiveness.
Figure 3-14 4C Operation Model for Successful Platform Migration

Finally, when the value of these four factors in the next platform is greater than in the existing one, platform migration will be accelerated. It is difficult to place these factors at a higher level during initial phase. Investment in coverage expansion is, for instance, quite expensive, because recent customer priority of the coverage moving from outdoor to indoor, namely in-building, underground, and so on, enhances the coverage designs from two-dimension (2D) to three-dimension (3D). Mobile operators should spend their capital year by year to complete these kinds of complicated coverage. Therefore, during the first few years, the coverage attractiveness of a new platform is smaller than that of existing one. This discourages customers from transferring to the next platform.
3.9. Implication of 3G migration in Japanese Market

The 3G migrations in the Japanese market can be explained by means of the platform migration approach. Three incumbent operators, namely NTT DoCoMo, KDDI au and J-phone, have already launched their own 3G services.

The platforms in DoCoMo and J-phone are based on IMT-2000 CDMA DS-CDMA (W-CDMA), while the platform in KDDI au is CDMA2000 1x MC, the upgrade version of cdmaOne. Therefore, DoCoMo and J-phone have to face with Revolution-type Migration from PDC platform. In particular, since DoCoMo challenged to implement the world’s first IMT-2000 in May 2001, DoCoMo have to expend its resources to improve the quality and expand the service coverage. Compared to the growth in KDDI CDMA2000, DoCoMo’s migration scenario was estimated as a reckless challenge in some presses, because of no killer application and no customer preference.

But DoCoMo’s migration is just at the midway point of the first step of Revolution-type migration. Its technology leadership from its R&D arms, investment capability from i-mode breakthrough and value chain leadership through integration of complementary assets satisfied the requirements of Revolution-type migration adequately as shown in Figure 3-15. They now need to accelerate completion of service coverage to the same level as its PDC platform and to improve QoS. Actually, DoCoMo invested supportively in the development activities of its partner terminal vendor on Jan. 2003 in order to accelerate to reinforce the line-up of its 3G terminals. Its powerful technology leadership and this value chain leadership will give DoCoMo successful results at the end of this bitter trail. The next

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DoCoMo’s challenge will be how new profitable services will be produced in its service innovation process after the completion of its 3G platform.

Figure 3-15 Three Evaluation Criteria in NTT DoCoMo’s 3G Migration
3.10. Summary
This chapter clarified “Platform Migration Dynamics” by means of the empirical analyses. The key points in this dynamics are the following:

- The triggers of the platform migration process are the capacity shortage by traffic growth and the new functions for the next services.

- Revolution-type migration and Evolution-type migration are the traditional process for platform migration. The backward compatibility with the existing platform determines the appropriate scheme.

- Capability, Coverage, Cost and Complementary Assets are the critical factors for the platform migration. Successful platform migration arises from the effective operation of those tactics.

- Three evaluation criteria, namely technology leadership, value chain leadership and investment capability, are proposed as the evaluation criteria for entry to the platform migration.
4. Service Innovation Dynamics

4.1. Overviews
The main key issue in this chapter is clarification of the mechanism of the service innovation process. The discussion covers what the triggers of service innovation are, how innovative services for the mobile industry have been created in the past, and what the next approach to service innovation for future market changes should be.

During the last decade, the mobile industry has seen two remarkable services, namely the Short Message Service (SMS) on the GSM platform and the i-mode service on the DoCoMo PDC-P platform. This chapter introduces these two services as examples of innovative services in the past. Empirical analysis shows that these were introduced as a result of the mental breakthrough approach. Additionally since the process for the i-mode service has allowed identification of some remarkable features, those can be enhanced in future service innovation process.

4.2. Triggers in Service Innovation Dynamics
4.2.1. Reversal of ARPU Decline
Service innovation has been undertaken when mobile network operators were faced with a declining ARPU. As mentioned in Chapter 2, ARPU is one of the most useful measures for the evaluation of the customers’ usages and declines as time passes. An analysis of the decline in ARPU reveals two reasons. One is that customers lose interest in existing services, and the second is price reduction. In particular, pressure from the market for price reduction is a dominant factor (See Appendix 1).

This research shows that price reduction for the purpose of increasing traffic does not always lead to improved ARPU as mobile operators expect. Generally price reduction
tempts low-end users, whose traffic is too low to contribute significantly to traffic growth to join the services, while it also encourages core users to use mobile services more frequently. However there is a possibility that the additional usage of core users might be insufficient to raise the total traffic. So it cannot be denied that ARPU might decrease even after price reduction. Therefore it is suggested that mobile operators should innovate new services and add value to their services in order to capture newly additional new ARPU.

4.2.2. Platform Migration Cost
There are two kinds of cost associated with platform migration. One is spectrum acquisition cost and the other is equipment upgrade cost. Firstly the spectrum acquisition cost depends on government policies and the form of auction in each country. For instance, the Japanese government did not ask the operators to pay a 3G license fee.

In contrast to Japan, European countries held auctions for spectrum in which the auctions raised a total of over $100 billion (or over 1.5% of GDP) as shown in Table 4-1 (Klemperer, 2002, Hart and Chapman 2002). The award of the licenses in Europe could well be seen as the turning point in the fortunes of the mobile network operators.

In the US market, there are three pockets of spectrum, which have been considered by mobile operators as the best place to gain additional spectrum. These pockets of spectrum include NextWave spectrum, the Department of Defense and UHF spectrum. The FCC and US mobile operators have discussed these possibilities.
Table 4-1 3G Spectrum Auction Cost

<table>
<thead>
<tr>
<th></th>
<th>Result of the auctions</th>
<th>3G Operators</th>
</tr>
</thead>
<tbody>
<tr>
<td>France</td>
<td>Only the two largest incumbents bid for four “beauty contest” licenses priced at $4.74 billion each</td>
<td>France Telecom, SFR (Bouygues entered later)</td>
</tr>
<tr>
<td>Germany</td>
<td>Auction netted the most money from 3G auctions, $45.85 billion</td>
<td>Mobilcom Multimedia, E-plus, Group 3G, T-mobile, Viag interkom (currently O₂), Mannesmann D2 (currently Vodafone D2)</td>
</tr>
<tr>
<td>UK</td>
<td>Raised $34 billion from its auctions held in April 2000</td>
<td>Orange, Vodafone, O₂, One-2-One</td>
</tr>
<tr>
<td>Japan</td>
<td>3G spectrum available at no cost</td>
<td>NTT DoCoMo, KDDI (au), J-phone</td>
</tr>
</tbody>
</table>

Next, network cost, namely equipment upgrade cost, is the dominant factor in platform migration. Generally speaking, network cost depends on the compatibility with the existing platform, the population, size of the country and so on. For instance, platform migration from GSM to UMTS requires investing in infrastructure and subsidizing new 3G compatible handsets. These costs are just for upgrades, but these additional costs are expected to reach $80 billion in all networks worldwide. After the 3G auctions, Deutsche Telekom, owner of T-mobile, and British Telecom, formerly owner of mmO₂, created a partnership to share the cost of constructing and maintaining their 3G network infrastructure in June 2001\(^7\). Furthermore, one of mobile operators abandoned its 3G license\(^8\).

As mentioned in Chapter 2, it can be said that mobile network operators should recoup this investment through the revenue growth. Revenue recouped in this way will form the source of investment for the next platform migration. With respect to declining ARPU, it can be

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\(^7\) Gartner Research 2002

\(^8\) Broadband Mobile in Norway returned its 3G license, Gartner Research 2002
seen that platform migration by itself cannot lead to an increase in revenue. Therefore innovative services will be quite essential in allowing mobile network operators in order to grasp the opportunities for further growth, in reducing network costs simultaneously.

4.3. Service Innovation Dynamics
4.3.1. Dynamics for Future Investment Capability
Compared to platform migration dynamics, service innovation dynamics will be quite important for mobile operators from now on, because it leads directly to revenue growth. Since the future mobile technologies will be made more complicated, the total cost of implementations will become more expensive. Therefore, mobile operators should innovate to produce new profitable services directly connected to investment capability in order to drive the next platform migration dynamics in the future. In addition, we should be considered that sophisticated future mobile technologies might lead to an “over-performance” situation that offers advanced services that go far beyond customer requirements. Mobile operators should avoid the situation where technology-oriented migration leads to the provision of services that are not wanted, and should instead drive the future migration process in accordance with customer preferences. In this respect, service innovation dynamics will be more important than platform migration for mobile operators.

4.3.2. Service Innovation Dynamics
The declining in ARPU and future migration costs are triggers of service innovation dynamics, as indicated in the model shown in Figure 4-1. Risk management considerations of these two critical factors should urge mobile operators to explore new sources of future
profitable services. Then they will reach innovative service breakthrough after several stages of trials and feedback.

Once mobile network operators achieve breakthrough of a new service, their traffic revenues improve dramatically. However, to meet service innovation is quite difficult, because future customer preferences are so unpredictable. In particular, the diversification of current customer preferences makes it even more difficult to create profitable future services. Therefore, mobile network operators have to experience many steps of “trial and feedback” in order to grasp the opportunities.

This uncertainty in customer preference is another reason why mobile operators have hesitated to invest in service innovation up to now. Considering services introduced the past, mental breakthrough is the most successful approach for mobile operators. This approach means bringing a concept for new products and services from outside the industry before
there has been a demand for it. Historically, the mobile industry has experienced several breakthroughs of this kind, as shown in Table 4-2.

For instance, the i-mode service is just a harmonization of mobile telecommunication and the Internet. The i-mode business model has other remarkable features such as the fee collection business, but this harmonization may be called a mental breakthrough. Another reason why these services were successful is that the mobile services involved collaboration, with handsets directly affecting the portal interface to the customers. Moreover, the dominant design of handsets might be a trigger for this service breakthrough. To summarize, these innovations resulted from a combination between mental breakthrough of service and dominant design of handsets.

<table>
<thead>
<tr>
<th>Service Innovation</th>
<th>Break Point</th>
<th>Source of Innovation</th>
<th>Handsets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital Voice</td>
<td>Around 1996</td>
<td>Wired Digital Voice</td>
<td>Down sized</td>
</tr>
<tr>
<td>Short Message Service (SMS)</td>
<td>Around 1997</td>
<td>E-mail</td>
<td>GSM Terminals</td>
</tr>
<tr>
<td>Mobile Internet Access</td>
<td>1999</td>
<td>Internet</td>
<td>Browser Handsets</td>
</tr>
<tr>
<td>Message with pictures</td>
<td>2001</td>
<td>Internet</td>
<td>Camera Equipped</td>
</tr>
</tbody>
</table>
4.4. Analytical Framework for the Service Innovation Process

This section provides an analytical framework for the service innovation process in terms of breakthrough management as shown in Figure 4-2.

It can be assumed that four factors lead to breakthroughs of service innovation in the mobile industry, these being: prediction of a future crisis or problem, corporate management, technical background and innovation. Prediction of a future crisis stirs the operators to new action. In respect of service innovation, the predicted crises result from ARPU decline and, secondarily, future migration costs.

Corporate management and organizational decisions are the critical factors that lead to the implementation of innovative services. With reference to migration dynamics, service breakthrough emerges after the completion of platform migration. This can be considered as the technical background for service breakthrough. The innovation process means the major steps leading to service breakthrough. Each operator has own process of service creation, but innovative services can be created by specific approaches. The difficulty of finding this process makes it hard to arrive at innovative services.

Figure 4-2 Analytical Framework for the Service Innovation Process
4.5. Case Analysis of SMS Breakthrough

This section and the next section examine two successful cases of service innovation through empirical analysis. These two services became widespread as a result of breakthrough management. In particular, the development process of i-mode was completely different from that of the previous services. Compared to those previous data services, the service innovation process of i-mode will be examined and the key points clarified.

4.5.1. ARPU Decline in the European Market

European mobile services have a long history and constitute a powerful market in the world. However fierce competition has forced European mobile operators to reduce their prices and provide cheaper services like free phone. This excessive competition has had a severe impact on their financial health and level of ARPU, even though the mobile market in Europe has grown rapidly. For instance, European mobile operators introduced prepaid cell phones in the early 1990s. From the customers’ point of view, the advantage of prepay is that it allows them to buy a phone straightway, without a credit check or a contract to sign. This convenience attracts even teenagers to own a cell phone. In contrast to the United States, where the penetration of prepay is around 10%, the prepay system accounts for two-thirds of all new mobile phone subscribers in Europe. From the operators’ points of view, the prepay system was originally a great way to grow the number of subscribers, but it has become something of a threat to their original customer base. In particular, the new market segment, which was attracted by the prepay system is not so heavy in traffic. Therefore as a result, ARPU did not grow as had been predicted, although both traffic and the market grew dramatically. It can be seen that this behavior by the European operators
had a severe impact on their ARPU level as shown in Figure 4-3.

![Figure 4-3 ARPU Comparison Q3 2002](image)

**Figure 4-3 ARPU Comparison Q3 2002**

4.5.2. Background to SMS

All 2G technologies have some functions for a messaging service. This service allows subscribers to receive and sometime send short text messages. It is quite similar to paging, but the bi-directional concept is the significant feature and the reason why it has contributed to traffic increase. Short Message Service (SMS) is one of these functions for the GSM system and it has spread through the worldwide market. It began as part of the original GSM specification, but the concept has since spread to all the other digital system.

The spread of SMS basically depended on the situation in the European market as outlined above. That is, especially for pre-paid customers, SMS has often been a cheaper way to communicate, especially across networks. Then data ARPU in European mobile operators became relatively higher than that in United States market as shown in Figure 4-4.

SMS’s greatest limitation is hinted at in its name: messages have to be short. GSM imposes
a limit of only 160 bytes, or characters. The limitation to such a short length arises because making use of vacant space in signaling channels called control channels sends the messages.

As the result, this feature made this service more reasonably price and easier to use than other messaging services. SMS is known as a store-and forward service. Messages are stored in Short message centers for a few minutes, before the center transmits them to the recipient. Therefore, if operators owning systems different from GSM wish to implement this concept, they need to deploy such a center in their networks, with some enhancement of the transmission protocol.

Its ease of use has encouraged customers to use it and this has contributed to traffic growth, but the first implementation of SMS was strategically limited and allowed users to communicate only with customers of the same operator. In 2000, the GSM Association (GSMA) advocated SMS interoperability over the boundary of GSM operators. Since then

Figure 4-4 Voice and Data ARPU Comparison Q3 2002

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usage of SMS has progressed dramatically as shown in Figure 4-5. SMS contributes about 90 percent of data ARPU. That is, SMS is currently the dominant service in the European mobile data market. In respect of revenue, 5% of the total service revenue was from SMS. One research study has indicated that 25% of service revenue would be from SMS and Multimedia Messaging Service (MMS), an enhanced form of SMS, by 2005 (Yunus, 2002).

4.5.3. Breakthrough Management

From the SMS case in Europe, we can see that there are two fundamental triggers for SMS breakthrough as shown in Figure 4-6. The first trigger is a declining in ARPU caused by fierce price reductions and introduction of the prepaid system. Risk management pushed the aggressive introduction of the SMS function and the deployment of GSM phones supporting SMS in the market. Secondly, the efforts of operators and the GSM Association to implement inter-operability across network boundaries caused the breakthrough.

Those fundamental factors have been supported of several remarkable features of SMS, in particular the facts that GSM technologies were already implemented in European Market.
and that the SMS pricing structure was cheaper than voice telephony for pre-paid users. Moreover, the mental breakthrough approach should be noticed. Basically SMS is like e-mail or the regular postal service. That is, sending and receiving a text-based message was not a new concept. In this respect, SMS is a mental breakthrough service drawn from the Internet and postal market. However the most remarkable point is that SMS is deployed on every GSM phone. The powerful portal of the cell phone was endowed with new value by SMS.

Figure 4-6 SMS Breakthrough Management

4.6. Case Analysis of i-mode Breakthrough
4.6.1. ARPU Decline before i-mode

After the PDC platform was implemented nationwide by 1997, the Japanese mobile market grew rapidly. Customers’ requirements changed from higher clarity of sound quality to lower initial cost and lower call charge. With fierce competition among mobile network operators, voice ARPU declined year by year as shown in Figure 4-7. In 1998, the i-mode service was launched and this has kept the total ARPU level approximately same as that of 1998, since data ARPU has grown, while voice ARPU has continued to decrease.
4.6.2. Trial and Lessons before i-mode

In the middle of the 1990s, some customers would have liked to use cell phones as access tools to the Internet while out and about. In particular, some customers familiar with wireless products proposed the provision of data access even for analog cell phones. Dialing up to connect to the Internet was too difficult, since they had to modify the dial-up software themselves. These requests from these customers encouraged mobile network operators and vendors to enhance their services and product to include mobile data services as a new source of revenue. Although several types of data services had been proposed before the i-mode service, as shown in Table 4-3, these trial services did not contribute to halting the ARPU decline. One of the reasons why these services were not able to achieve breakthrough is that they focused on terminal enhancement, without an organized business model.
4.6.3. Breakthrough Management

After a number of trials to explore the mobile data market, DoCoMo arrived at the concept of Mobile Internet Access and control of the design of handsets as the i-mode phone.

The breakthrough management model of DoCoMo is shown in Figure 4-8.

Firstly mental breakthrough was applied to mobile services by bringing in the Internet business model. In addition, the attractiveness of handsets, equipped with an “all in one” concept with a large, color display, clamshell body and browsing function, matched customer preferences in the Japanese mobile market (Natsuno, 2003).

![Figure 4-8 i-mode Breakthrough Management](image)

Table 4-3 DoCoMo’s Trial of Data Services before i-mode

<table>
<thead>
<tr>
<th>Service/Product</th>
<th>Year</th>
<th>Concept</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 yen mail</td>
<td>1997</td>
<td>E-mail</td>
<td>Cell phone + PC/PDA</td>
</tr>
<tr>
<td>Short mail service</td>
<td>1997</td>
<td>Messaging (Limited to 50 characters)</td>
<td>Cell phone (Only to cell phone)</td>
</tr>
<tr>
<td>Value mail</td>
<td>1998</td>
<td>E-mail (Business use)</td>
<td>Cell phone + PC/PDA</td>
</tr>
<tr>
<td>mopera</td>
<td>1998</td>
<td>Internet Browsing</td>
<td>Cell phone + PC/PDA</td>
</tr>
</tbody>
</table>

Source: NTT DoCoMo
In respect of technical background, PDC-P, the packet transmission platform, had already been complete nationwide and so provided the push and pull environment. With i-mode, cellular phone users can get easy access to more than 60,000 Internet sites, as well as specialized services such as e-mail, online shopping and banking, ticket reservations, and entertainment services, as shown in Figure 4-9.

![Figure 4-9 i-mode Service Configuration](source: NTT DoCoMo)

Users can access sites from anywhere in Japan, and at unusually low call charge rates. This is because the service charges are based on the volume of data transmitted, and not the amount of time spent connected. DoCoMo's i-mode network structure not only provides access to i-mode and i-mode-compatible content through the Internet, but also provides access through a dedicated leased-line circuit for added security.

4.7. Lessons from the Case Studies
4.7.1. Mental Breakthrough from Internet Services

The messaging services and mobile Internet access services created new value for mobile services. These services are not original, but the transfer of the Internet concept to the mobile platform, with some modifications, was quite effective because mobile handsets
provide a user-friendly interface. As a result, users have gradually changed their usages from voice telephony services to data transmission. The business model of the primary i-mode services was focused on B2C. Despite the lower speed of the radio interface, the i-mode services are focused on “light” content such as text-based messaging, e-mail, music, transactions and entertainment, and this enabled DoCoMo to capture the new mobile business market. By using this packet technology, subscribers can access sites from anywhere, usually at low rates because they are charged in accordance with the volume of data transmitted, but not the amount of time spend connected.

4.7.2. Profitability Capture
The SMS and the i-mode service have some ingenious features, which enhance its attractiveness. In this study, two distinctive characteristics, which are discussed below, indicate the future approaches of mobile operators to service innovation. One is the integration of complementary assets such as content providers and terminals, and the other is partnership with firms familiar with their particular industries.

**Partnership with terminal vendors:** The maturity of handsets had a great influence on the mobile industry. Generally, the product, which acquires the leadership in the market, is called “dominant design” (Utterback, 1994). Since it is difficult to reach the design, mobile operators need to survey the trends in customer preference carefully and provide the new terminals on time. In this respect, mixture of the marketing and the close relationship with terminal vendors are the critical points. Now the terminal vendors have a powerful bargaining power in the market. Therefore the partnership with them will be one of the critical factors for mobile operators.
**Partnership with content providers:** An important factor influencing the rapid success of i-mode is the strong partnerships with the content providers (CPs). Other than the attractiveness and business opportunities created by DoCoMo’s dominant market-share, the rich line-up of content provided by CPs has encouraged many customers to access them. The strategy for this partnership is the “i-mode license”. Although CPs can provide content over the i-mode platform without a license (called “voluntary sites”), CPs which have a license with DoCoMo are known as “official sites” and are guaranteed to have many privileges, for instance, the collection of payment for content through DoCoMo’s billing system and the allocation of official pages. This kind of partnership can be applied to Multimedia Messaging Service (MMS), enhanced SMS.

4.7.3. Implications and recommendations
In the two cases, the remarkable traffic growth shows that mental breakthrough was the key approach providing these new services for the mobile industry. These were based on the Internet business model, but this conception suggests that the various perspectives of other industries could provide mobile operators with new ideas for innovative services. In this respect, partnership with companies well-informed in the other industries is essential in reaching the breakthrough required to capturing the necessary information from these development partners (Shiba and Walden, 1993).

The other key issue is then how to create new services for sustainable growth. The analysis of these two cases is just second-guessing. Considering the uncertainty in the customer preference, it will be more difficult to foresee the future profitable services. However, mobile operators can compensate their lack of experience with close partnership. In
addition, technology leadership will enable them to acquire the favorite terminals and equipment on time. Therefore both partnership and technology leadership are the critical resources that mobile operators need to hold.

In the relationship between DoCoMo and content provider, we can see the organized corporate assistance in terms of the “toolkit” concept. Some research studies on service innovation have indicated that companies may give content providers real freedom to innovate their own content, so allowing them to develop their own custom product (von Hippel, 2001). DoCoMo encouraged content providers to propose various kinds of content services by providing toolkits, namely, compact HTML and Java. In particular, since HTML is the dominant language in the Internet content business, choosing a language compatible to HTML gave content providers great opportunities to entry to the mobile Internet business. In addition, these toolkits encouraged voluntary content providers to enter this business field, since it made it easy for them to do so. This illustrates how value of innovative services may be added from the market itself.

4.8. Service Innovation Model

The service innovation process has not yet really become established in the mobile business. Of course, to grasp the opportunities of the service sources is too difficult. However mobile network operators need to recognize the importance of the service innovation in migration process and create its dynamics in order to achieve competitive advantages. Referring to the lessons from SMS and i-mode, the transplantation of an idea from outside was introduced. In this respect, the Internet is only one possible source of new ideas. For future service innovation, mobile network operators should consider more different types of industry to
gather idea for applying mobile technologies or services. After identifying some critical ideas, mobile network operators should build well-defined partnerships and encourage their partners to create new sources for services, while the mobile operators themselves also continue the challenge of identifying further ideas.

**Figure 4-10 Service Innovation Model for Content Services**

4.9. Implication of 3G migration in the European Market

European mobile operators are faced with the 3G migrations like Japan. Their problems in this migration can be clarified by means of the service innovation dynamics.

They are experiencing trouble with regard to their severe financial situation resulting from
the extremely costly spectrum auction. However according to the migration model, they failed to evaluate two points, namely the level of investment capability and the migration cycle from GPRS platform to the UMTS platform. In particular, time-contiguous platform migrations are too expensive for mobile operators. Their original scenario for UMTS is based on successful GPRS migration with MMS breakthrough. Improved investment capability from MMS and transfer of the MMS business model were key factors in entry to the UMTS migration cycle. Unfortunately European mobile operators were faced with a delayed release of GPRS handsets in the market, which disrupted their original migration scenarios. Compared to successful migration processes, this sort of platform migration should be avoided, because European operators will have to double investment in their platform. They should delay the implementation of 3G platforms until they captured profitable services, which will improve their financial condition, or wait for their MMS breakthrough as shown in Figure 4-11.
4.10. Summary

In this chapter, service innovation dynamics was discussed. The points are the following:

- Since service innovation contributes directly to the future traffic growth, mobile operators should pursue the source of new profitable services.

- The two triggers, namely “Decline in ARPU” and “Platform Migration Cost”, cause the service innovation process in the mobile industry.

- Mental breakthrough approach has been one of the popular schemes in mobile service innovation.

- One of the key factors is partnership with the companies that familiar with the new industries. Considering the uncertainty in customer preferences, to reach the profitable services will be more difficult. Therefore, the mixture of partnership and technology leadership will be also critical factors in successful service innovation.

- In the i-mode case, DoCoMo provided not only Win-Win business model, namely billing collection business, but also sets of toolkits composed of common software and applications, which encourage many content providers to support the new business.
5. Future Directions in Mobile Telecommunication Industry

5.1. Overviews
The research study focuses on the analysis about the migration process in the current mobile industry up to Chapter 4. Considering the future direction in the mobile market, we have to foresee the trends in future mobile services and clarify the strategies for future successful migration, according to the roadmap to the future services and the migration scheme in the past. This chapter, firstly, forecasts the future mobile services and the platform configurations, taking account of the roadmap analysis. Secondly, future platform migration scheme, namely “Collaboration-type migration”, is proposed for the convergence network situation. Finally, since the technological performance of mobile operators is quite critical to drive the migration process, the current performances of mobile network operators, compared to those of mobile vendors, are measured in the rest of this chapter.

5.2. Roadmap to the Future Mobile Services
5.2.1. Overviews
Over the previous decade mobile and wireless technologies have been improved dramatically. During this era, customer priorities were not complicated and the focus was on technology enhancement. However such rapid market growth has promoted commoditization of mobile services, and customer preference will be more diversified from now on. Then it will become harder to forecast the future service trends, but mobile operators need to prepare an integrated network environment to handle this diversification. This section forecasts the future mobile services and the platform configurations by means of the following factors: future customer preference, technology dynamics, regulatory dynamics, industry structure and corporate strategies dynamics.
5.2.2. Customer Preference and Service Dynamics

There are two directions in the future mobile services. One is “All in mobile”, and the other is “Mobile in all” as shown in Figure 5-1. “All in mobile”, the main trend up to now, focuses on the enhancement of the mobile handsets. The target segment in the market is the traffic from both the customer uses and the business uses. “Mobile in all” will be new trends based on the ubiquitous environment and mean the harmonization between mobile and any kinds of the products and services.

Firstly, “All in mobile” is so quite fundamental concept that customer preferences encouraged mobile terminals to equip kinds of functions, namely voice telephony, Internet access, messaging, commerce and so on. It is quite difficult to foresee the future customer preferences in the commodity market, but the supposed services are more diversified.

Considering the future traffic growth, mobile operators need to explore the new business field, while they continue progressing the “all in mobile” evolution for the end users. One of the powerful directions is “Mobile in all”. This means the small devices equipped with the mobile communication are applied to any kinds of product. Future ubiquitous services, namely telematics, M to M communications will be based on this “mobile in all” concept.

The noteworthy point is that these business fields may have various kinds of traffic patterns,
in which call occurrences are not relatively frequent. However this new trends will contribute to the traffic increase cumulatively. These trends will force the mobile operators to make their business field more diversified. Therefore, the operators need to survey them carefully and adjust their organization more flexibly.

5.2.3. Technology Dynamics beyond the Third Generation

The noteworthy points in the future mobile technologies are “convergence network” in the mobile platforms and “evolved mobile devices” in the mobile terminals.

Firstly, considering the future platform technologies, some common capabilities, namely higher transmission speed, higher mobility and ubiquity, are required for the technology beyond the third generation (B3G\(^9\)) (Yamao et al, 2000). ITU-R, a study sector in ITU focusing on the radio interface, has already described a future vision of B3G technologies as shown in Figure 5-2.

![Figure 5-2 ITU-R Vision of Beyond 3G](image)

\(^9\) The fourth generation technologies (4G) are not clarified in the ITU still now, because of its uncertainty in the market requirement. Basically some study groups have started to clarify the requirement for the system after IMT-2000. They call this technologies “Beyond IMT-2000”\(^{10}\). In this research, I would like to define the technologies beyond the third generation (B3G) as the term for more general concept of this kind of technologies.
The degree of mobility as used in this figure is described as follows: low mobility covers pedestrian speeds, and high mobility covers high-speed movement on highways or in fast trains (60 km/h to ~250 km/h, or more). B3G technologies will form an integrated system composed of existing systems such as IMT-2000, and also enhanced functions, nomadic wireless access systems and any other wireless systems as shown in Table 5-1.

**Table 5-1 Possible Wireless Interface Specifications**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Peak Data Rate</th>
<th>Radio Bandwidth</th>
<th>Complementary service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long-range and high mobility Wireless (Mobile technologies)</td>
<td>2G(GSM)</td>
<td>14.4 kbps</td>
<td>800MHz</td>
</tr>
<tr>
<td>3G(IMT-2000)</td>
<td>384kbps – 2Mbps</td>
<td>2GHz</td>
<td>Multimedia</td>
</tr>
<tr>
<td>B3G (F.F.S)</td>
<td>Around 100Mbps</td>
<td>-</td>
<td>Rich content in Multimedia</td>
</tr>
<tr>
<td>Short-range Wireless (Fixed Wireless)</td>
<td>IEEE802.11a</td>
<td>6Mbps-54Mbps</td>
<td>5.4GHz</td>
</tr>
<tr>
<td>IEEE802.11b</td>
<td>2Mbps-11Mbps</td>
<td>2.4GHz</td>
<td></td>
</tr>
<tr>
<td>HiperLAN/2</td>
<td>54Mbps</td>
<td>5.15-5.3GHz</td>
<td></td>
</tr>
<tr>
<td>Bluetooth</td>
<td>2Mbps-12Mbps</td>
<td>5.4GHz</td>
<td>Inter PCs and Equipments</td>
</tr>
</tbody>
</table>

*Source: The Essential Guide to Telecommunications*

These technologies should provide seamless inter-working between these systems. The basic requirements for performance of future mobile technologies are 100Mbps data transmission in higher mobility environments and around 1Gbps data transmission in lower mobility environments. Then some companies have also started to investigate the future cellular specifications for B3G technologies, and some of them have provided better performance than that of 3G in the laboratories\(^{10}\).

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\(^{10}\) NTT DoCoMo Laboratory has succeeded with around 100 Mbps downlink in its indoor test bed by means of OFCDM (Orthogonal Frequency Code Division Multiplexing). NTT DoCoMo Press Release 9th Oct. 2002
A more detail diagram of the B3G platform is shown in Figure 5-3. This figure shows that multiple wireless interfaces are linked to a single core network. The core network technologies will be required to provide flexible inter-working and quality management with seamless communication services.

![Network Configuration of B3G](image_url)

**Figure 5-3 Network Configuration of B3G**

Recent technology trends indicate that IP technologies will be deployed in the mobile core network for the efficient use of network resource and cost reduction. However the implementation of seamless services will force mobile operators to concentrate on complicated quality control procedures. Quality of Services (QoS) across the boundaries of diversified network systems will be also needed.

Another technology trend is “evolved mobile devices”. Considering the innovations in the other industries, namely biotechnologies and nanotechnologies, will have a great impact on the future mobile terminals as shown inFigure 5-4. In particular, nanotechnologies will make the mobile devices much smaller by provision of the advanced integrated chip and
DNA chip. These smaller devices will enable mobile operators to provide diversified products and services in the “mobile in all” situation.

Figure 5-4 Evolution of the Mobile Terminals by Bioelectronics

5.2.4. Regulatory Dynamics and Industry Structure

The viewpoint of regulatory dynamics also allows us to see the movement to a converged network. From the record of government policies concerning the telecommunications industry, we noted that historical trends pointed towards an environment encouraging deregulation and resulting in the current modularity and disintegration of the industry. For instance in the case of US government policies, noteworthy policy change in 1984 and the telecommunications act of 1996 resulted in the following:

- Vertical disintegration of telecommunications operation and manufacturing (i.e. US Government vs. West Electrics and Government vs. AT&T)
- Horizontal disintegration of telecommunications operation, in order to encourage new entrants and competition (1984 long distance operators, 1996 local operators)
- Reducing the barriers between different telecom industries such as local, long distance, CATV and wireless.

In contrast to the success in the 1984 deregulation in promoting the growth of the industry, the 1996 Act did not urge the new entrants to expand their business, but resulted in them being acquired by the big operators (Economides, 1999). These deregulatory policies will
continue to encourage not only telecom operators but also mobile operators to penetrate to their own and other telecom industries through further mergers and acquisitions.

This horizontal integration in the mobile industry is quite effective for mobile operators, because they can reduce network cost by procurement of large amount of network equipment and increase their traffic revenue by the global roaming service (Kedia, 2001, Trillas, 2002). Therefore, some mobile operators have accelerated to integrate their market horizontally in these five years as shown in Figure 5-5.

![Diagram of horizontal integration in the mobile industry](image)

**Figure 5-5 Horizontal Integration in the Mobile Industry**

From this viewpoint, it can be assumed that the world’s big operators, called Mega-Carriers, such as some European operators (Vodafone, Orange and T-mobile), some US operators (Verizon Wireless, Cingular, Sprint and AT&T Wireless), and DoCoMo will lead the future worldwide mobile services. In addition, these operators, even though they have been
segmented in each industry, still maintain the close relationships with their subsidiaries. By combining their network resources to establish a ubiquitous network, each of the telecom companies can share the various kinds of complementary assets.

Another restructure in this industry is related to the public network telecommunications. The public network operators historically have a great influence on the mobile industry even now. That is, they are holding the share of some leading mobile operators as shown in Figure 5-6.

![Figure 5-6 Relationship with Public Network Operators](image)

**Figure 5-6 Relationship with Public Network Operators**

These relationships limit the mobile operators’ behavior, however they can use technical resources of their parent companies. In case of mmO2, former BT Cellnet, was spun off from BT group completely on November 2002, however it keep the rights to use Intellectual Property Rights (IPRs) owned by BT. In addition, they can introduce
convergence network structure in terms of the network resources\textsuperscript{11}. AT&T Wireless was separated from AT&T Corp. by an Initial Public Offering (IPO) in July 2000. However, a wide range of cooperative agreements remains in effect.

These integrations will produce new services and market structures with technology innovations (Fine, 1998). The technology innovations, namely IP v6, mobile IP and future B3G, will give powerful compatibility to mobile network infrastructures with fixed networks operators and Internet providers. These technical advantages with the horizontal integrations will accelerate leading mobile operators to produce the large convergence networks and services. For instance, NTT DoCoMo has, with AOL, established its Internet service operator, DoCoMo AOL\textsuperscript{12} in order to realize future fixed-mobile convergent services (Kalakota and Robinson, 2001).

5.2.5. Corporate Strategies Dynamics in Mobile Value Chain
The paradigm changes, in the telecommunications industry, force telecom operators to improve their corporate strategies in the value chain (Kawashima, 2002). In the mobile value chain, two dynamics are existed in the mobile value chain. One is dynamics by mobile operators and the other is by equipment suppliers, known as vendors in this study. As a result of the recent globalization of mobile technologies has enabled some vendors to develop stronger power in this value chain as the market has grown (Munsinger, 2002). This means that they have been able to cross the boundaries and develop powerful bargaining powers to mobile operators. Unlike the situation of vendors, mobile network

\textsuperscript{11} Source: mmO\textsuperscript{2} Annual Report
\textsuperscript{12} Source: NTT DoCoMo press release 24\textsuperscript{th} Jan. 2001
operators had been limited to their home nations and so had lost opportunities until
deregulation emerged. In the respect, the case of Nokia is shown in Figure 5-7. Its current
bargaining power based on supplying kinds of terminals cannot be ignored (Steinbock,
2001).

Another dynamics is from mobile operators. NTT DoCoMo has shown its leadership in the
Japanese mobile value chain. DoCoMo’s powerful bargaining power in the Japanese mobile
industry is based on the partnerships with both content providers by the Win-Win business
model and vendors through the technical alliances. In addition, its powerful R&D arm also
enables itself to propose lots of technical contributions to standards body like Nokia.
Considering its logistics, DoCoMo also has a number of franchised retail shops, called
DoCoMo-shop, throughout the countries. This value chain leadership becomes more
popular in other leading mobile operators, namely Vodafone, Orange, and so on.
The advantages based on the vertical integrations will accelerate mobile operators and
vendors to have kinds of partnership and alliances in the future.
5.2.6. Summary

Key issues in this section are to clarify the future platform and services. The points indicated above are the following:

- Future mobile services can be categorized into the two directions: “All in mobile” and “Mobile in all”. The “mobile in all” will contribute to the traffic increase cumulatively.

- Next generation technologies such as B3G will be composed of a unique core network and kinds of wireless technologies. This means that network configuration of the next platform will be based on the “Convergence Network” concept.

- Not only technology dynamics but also other dynamics, namely regulatory, corporate strategies and industry structures go forward to the integration of various kinds of technologies.

- The corporate strategies of mobile operators should be based on the partnerships with the other players in the value chain.
5.3. Platform Migration for Beyond the Third Generation (B3G)

5.3.1. Overviews
Two types of platform migration have been examined in Chapter 3. These are for providing higher transmission speed and higher capacity to all customers in their existing service area. However, when we look at the market segments, not all customers require such a higher transmission environment. Therefore mobile operators need to investigate new type of platform migration in order to match the future customer preferences. With reference to the roadmap to the technologies beyond 3G (B3G), this section proposes Collaboration-type migration for future migration paths.

5.3.2. Assumed Migration Scenario to B3G
As mentioned in Section 5.2.3, some standardization bodies and companies have already started to investigate B3G technologies. It is natural that wireless interfaces will need to provide a higher transmission speed for downloading richer content and services. However future customer requirements are unclear still, because even 3G technologies have not expanded to cover the market. Therefore mobile operators need to design the next platform with the careful survey of the future customer preferences. As mentioned in Section 5.2.3, since some substitutes for higher transmission speed interface have already proposed, the concept of the convergence network with several interface technologies is quite feasible for avoiding to invest in out-performed technology and redundant platform migration.

On the other hand, traffic has some geographical features. That is, high-speed data services are often required in relatively urban areas because of the business use. Considering that these mobile data services will be diversified, ranging from lower speed data to higher speed data, new wireless technologies, namely OFDCM, may be applied to the limited area
where high speed traffic will be estimated. Or, alternatively, it may take a longer time to
complete its coverage. Then backward compatibility providing seamless services will
support these situations. Moreover, indoor deployment of wireless equipment will be more
popular, because the wireless communications environment will be required from outside to
inside of buildings.

5.3.3. Migration Cycle for B3G
As mentioned in Section 3.6.4, mobile network operators should pursue Evolution-type
migration for financial efficiency. Actually this type of migration has a profitable feature
for handling in uncertainty of traffic increase, owing to its backward compatibility.
However, considering the geographical characteristics of traffic and future customer
preferences, we can deploy new platform technologies at specific points and retain these
collaborated conditions for a longer time. In this situation, the existing platform will have a
longer life and platform migration will take longer, as shown in Figure 5-8.

![Figure 5-8 Migration Cycle in 3G and B3G](image-url)
5.3.4. Collaboration-type Migration

The newly suggested platform migration process is the Collaboration-type scheme, which can be categorized as strategic Evolution-type migration. That means long-range collaborated conditions between the existing platform and the next platform. The comparison between complete migration and this Collaboration-type migration is shown in Figure 5-9.

![Figure 5-9 Comparisons of Complete Migration and Collaboration-type Migration](image)

Both Evolution-type and Revolution-type can be referred as the complete platform migration, because new technologies should be implemented and replace the existing technologies during short period. However, to avoid such large investments in network infrastructure, mobile operators will be able to choose to keep this Collaboration-type situation of two platforms. As mentioned, generally mobile network operators replace their platform to new platform in order to provide higher transmission speed service and maintain their infrastructure efficiently. However the operation of the wireless interfaces with backward compatibility and the maintenance of core network enable mobile operators to improve their financial condition more efficiently. Moreover mobile operators can
upgrade to the next platform according to the customer requirements.

Mobile operators need to pay respect to three technical points: backward compatibility, convergence of networks and quality control in order to realize the Collaboration-type migration. First, backward compatibility is an essential function for gradual migration. Next, mobile operators should investigate sharing core network resources for efficient management. This means that the core network will support several wireless interfaces simultaneously as a convergence network. Therefore mobile network operators should investigate the core network structure more carefully, taking initiatives in the converged situation. Finally, QoS management systems in the network guarantee a certain bandwidth and seamless services according to a service level agreement with customers. The current trend is to maintain a certain bandwidth by collaboration between the traffic management system, policy server and QoS management system. Therefore, quality control needs to be designed more detail for seamless services.

5.3.5. Recommended Process for Collaboration-type Migration
Because its features are related to Evolution-type migration, some of the factors in Collaboration-type migration needed not to be changed. The point in which it is most different from the Evolution-type is coverage. In Collaboration-type migration, mobile network operators do not have to accelerate replacement as shown in Figure 5-10. They can deploy new equipment at specific areas where a specific segment of customers would like

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13 “Convergence Network” concepts are particularly discussed for the combination of public telecommunication services and the Internet. However, in the stretched convergence concept, mobile core network can support not only cellular technologies but also wired and wireless LAN technologies.
to use the new platform technologies.

As mobile network operators confirm the effect of the new technologies, they can allocate these technologies in accordance with the expansion of customer requirements. Moreover, the backward compatibility allows customers to use the new mobile terminals in the area deploying the existing platform. As a result, operators can provide various kinds of pricing strategies from the initial provision of the new technologies.

![Collaboration-type Migration Process](image)

**Figure 5-10 Collaboration-type Migration Process**

5.3.6. Summary

This section proposed "Collaboration-type migration", enhanced Evolution-type migration. Considering the future technological trends, convergence network and integrated wireless interfaces will be the core technologies. In particular, the cycle of each wireless interface will be longer than that of the previous generations. Therefore, mobile operators can consider new scheme by means of advantages from convergence network. This scheme has some technical problems to be solved, namely **backward compatibility**, **seamless communications**, and **QoS control**. But its efficient deployment of network equipment will be quite effective for mobile operators to reduce the budget of huge network cost.
5.4. Measuring the Technical Performance of Mobile Operators

5.4.1. Overviews
This chapter clarifies the current technological performance of mobile network operators, because technological capability is quite important in driving both platform migration and service innovation. Considering the mobile technology innovation, some technical factors, namely R&D Expenditure, a number of contributions to the international standardization bodies and essential IPR in stable specifications.

5.4.2. Required Technical Competencies for Mobile Network Operators
In all migration processes, one of the most important factors is technical capability. Some implications from analyses up to now indicate that mobile network operators should think about four capabilities, namely technology investigation, process management, quality control and service creation as shown in Figure 5-11.

![Figure 5-11 Capabilities for Technology Leadership](image)

In particular, technical investigation capability and process management are quite important because these two capabilities are mainly responsible for driving the migration process.
Service creation can be supported by various kinds of partners, while quality control can be counted as a form of process management. First of all, the R&D Expenditure of mobile operators is clarified in order to show the current state of R&D arm of them. The actual performance is shown, compared to that of mobile vendors.

5.4.3. Measuring R&D Performance for Platform Innovation

As mentioned in Chapter 3, Evolution-type is better than Revolution-type migration for mobile network operators. For implementing the Evolution-type, mobile network operators need to have enough capabilities in areas such as technology investigation to drive the platform innovation. This means that a higher research and development performance than that of manufacturers will be needed. This section clarifies the process of platform innovation and measures the current R&D performance of mobile network operators. Generally, the requirement for R&D performance depends on the features of industry (Shim, 1999). As shown in Chapter 2, mobile platform technologies, particularly the wireless interface have been standardized in international organizations. This means that mobile technology has been closely related to spectrum allocation, which is also controlled internationally. With reference to this position of the mobile industry, three measurements are proposed as evaluation criteria: R&D Expenditure, the number of “contributions” to standardization bodies and Essential IPR (EIPR). That is to say, these measurements allow evaluation of the presence and effectiveness of an R&D arm, the capability of technical investigation, and the power of technology leadership in platform innovation as shown in Figure 5-12.
5.4.4. R&D Expenditure

Generally R&D strength is quite important for many companies in order to lead technology trends. Mobile operators and vendors propose that the result of their investigations become standardized specifications, by means of contributions to standards bodies. A recent survey of R&D expenditure of the telecom industry shows that many telecom operators have reduced their investment in R&D as shown in Figure 5-13. These expenditure figures were obtained from R&D Ratio & Budgets, Compustat Database and R&D Expenditure Book (1995 to 2000). In particular, operator’s intensity of investment in R&D has been around 3%, compared to around 11% of vendor’s R&D intensity.

Additionally, as mentioned in Section 5.2.4, almost all mobile network operators do not own their R&D arms because some of them were spun off from public network operators and others were new entrants from another industry. Some mobile network operators have retained their relationship with their parent companies to share some of intellectual property...
concerning mobile technologies. However the current level of R&D shows that mobile network operators have not respected the need for technology innovation.

![Figure 5-13 R&D Expenditure in the Mobile Industry](source)

**Figure 5-13 R&D Expenditure in the Mobile Industry**

5.4.5. Standardization Process

Historically technology innovation in the telecom industry has been closely related to standardization. As telecommunication systems cross national borders and are developed into global networks, which are neither controlled nor even coordinated by any single authority, compatibility is the crucial requirement that has to be fulfilled by the various components (Schmidt and Werle, 1998). Standards can overcome many of the disadvantages related to a wide variation in products, services or methods. Without standardization, conflicts between different technological systems may emerge, and the economics of the market will be lost (Bekkers, Verspagen and Smits, 2002). In particular,
wireless interfaces are key technologies for global mobility, and these are associated with the allocation of spectrum. The relationships between standardization organizations and companies are shown in Figure 5-14.

5.4.6. Contributions to the Standardization Bodies

In the standardization process, there are two main parts; the first is clarification of the requirements for a new specification and the second is the investigation of detailed specifications. Companies wishing to take part have to propose their requirements and investigation results functions in terms of “contributions” to the process. Through various stages of discussion and harmonization, these components will be formulated into tentative specifications and, in the end, approved as standard specifications. The number of contributions can be one of the measures of not only companies’ interest in the technology but also their technical influence on the specifications. Many contributions have been proposed to the Third Generation Partnership Project (3GPP), in which operators and vendors with a strong relationship investigate tentative specifications with ITU as shown in Figure 5-15. 3GPP is composed of a Project Coordination Group (PCG) and several
Technical Specifications Groups (TSGs). Each TSG is allocated to functional components of IMT-2000.

![Diagram of Technical Specifications Groups (TSGs)](image)

**Figure 5-15 the Third Generation Partnership Project (3GPP)**

In this analysis, I used document lists from 1999 to 2002 of the Technical Specification Group for Radio Access Network (TSG-RAN), in which the wireless interface and its control protocol have been discussed. These data are shown on the official 3GPP web site. Some kinds of contributed document, such as liaison with other study groups, editing reports and agendas of meetings are excluded from this analysis. Contributions proposed jointly by several companies are counted by dividing them by the number of contributing companies. The result of this analysis is shown in Figure 5-16. The total number of contributions in these four years was 25,567 articles.

![Pie chart showing contributions](image)

**Figure 5-16 Contributions to TSG-RAN from 1999 to 2002**
The contributions from operators are around 8% of the total. This means that vendors have the dominant influences in investigations in this study group. Additional analysis involving a breakdown of the different operators’ contributions shows that the main contributors were NTT DoCoMo, Vodafone, SK Telecom and Telia. These operators have their own R&D arms and try to take initiatives in TSG-RAN. These tendencies can also be seen in other study groups in 3GPP.

5.4.7. Essential IPR
Technology leaders in standardization bodies wish, at the same time, to establish their intellectual property rights (IPR) based on their internal investigation in order to protect their proposals to the standardization bodies. After specifications are frozen, IPR holders register some of their IPRs, which are essential in the implementation of the standards, to standardization bodies as “Essential IPR (EIPR)”. Despite such self-declaration, EIPR has a powerful influence in the implementation, because the ownership of essential IPR may strengthen a firm's position in a supply chain and alliance network (Megantz, 1996). Essential IPR can be defined as protected knowledge that is indispensable for a product that has to comply with that standard. Therefore, the number of items of EIPR in standardization is another measure of companies' technological capability. In this research, the number of EIPR declared in European Telecommunications Standards Institute (ETSI) for UMTS were investigated.

This analysis is based on the registered EIPR shown on the official web site of ETSI and focused on the EIPR for UMTS up to March 2003. I have omitted IPR accepted by different countries under the same title, because this web site counts these IPR as different ones. Therefore inclusive IPRs are counted as one IPR in this analysis. Figure 5-17 shows a
comparison of EIPR between operators and vendors using the same analysis also for GSM. This means that, compared with GSM standardization, the technology leadership of mobile operators clearly reduced in UMTS standardizations.

![Figure 5-17 Essential IPR for UMTS](image)

5.4.8. Correlation between Contributions and EIPR

Additional analysis involved correlation between contributions and EIPR. It can be seen that some of powerful vendors such as Motorola, Ericsson, Nokia and Qualcomm were able to relate their contributions effectively to EIPR, as shown in Figure 5-18.

![Figure 5-18 Correlation between Number of Contributions and Essential IPR](image)
This means that these vendors propose their investigations strategically and have a clear
influence on specifications. Another conclusion from this analysis is that contributions from
operators are focused only on requirements and are not based on solid technical
background.

5.4.9. Summary
Over the last decade, vendors have improved their technology background as the market
has grown globally. **Technology leadership** in mobile platform innovations has already
moved from network operators to vendors. These series of analysis can clarify the reduced
leadership of mobile network operators in the standardization process. The reduced
leadership can have severe influences on the migration process as mentioned in Chapter 3.
It will be more difficult for mobile network operators without technological leadership to
drive platform migration process. That is they will hardly be able to acquire information
about when specifications will be launched, what kinds of technologies will be released,
how quality of service will be improved. In particular, they are only involved in
outsourcing vendors to supply complete network element. These tendencies could be seen
in the delayed schedule of GPRS in European countries in 1999.
6. Future Migration Strategies for Competitive Advantage

6.1. Overviews
Considering the implications in the study, the following two requirements can be suggested for future migration dynamics. Firstly mobile operators should pursue profitable services for revenue growth and investment capability towards next platform migration. Second they should also avoid redundant investment in platform innovation and migration. Currently huge migration costs have prevented many operators from installing new technologies dynamically. Mobile operators need to invest in their platforms at regular interval, but they should also exploit new services in a way that encourages customers to use the new platform. Therefore, mobile operators should drive migration dynamics with an orientation to service innovation, and adopt efficient platform migration such as the Collaboration-type scheme.

This chapter proposes two key strategies for successful migration, which offer competitive advantages to mobile network operators. First, they should concentrate on “Successive Service Innovations”, in which mobile operators diversify their investment in several service fields and create profitable services successively on a platform. Second, mobile network operators should survey new technology trends for backward compatibility and evaluate their leadership and capability in the industry. Third, they should also organize the environment to create innovative service in conjunction with their external partners, because future mobile services will penetrate to every business and service field. In particular, they should prepare various kinds of applications to encourage these partners to create and enhance new services by themselves.
6.2. Driving Migration Process by Successive Service Innovation

This research has clarified that investment capability is one of the critical criteria for entry to the platform migration and is just the revenue from existing services. If they are not able to earn enough capital from existing services, they should hold back on the platform migration process and look for alternative strategies. Therefore, mobile operators need to drive migration process, concentrating on service innovation dynamics.

As mentioned in Section 5.2.2, there will be two service dynamics, namely “all in mobile” and “mobile in all” in the mobile market. In particular, “mobile in all” will be the not explored but potential market in the future. Cumulative traffic from kinds of “mobile in all” services will be the new source of traffic revenue. The most important point is that not all services require high-speed transmission. The combined effect of a number of small traffic will also be as important as large data transmission services as shown in Figure 6-1.

![Figure 6-1 Multiple Waves of Service Innovation on a Platform](image)

It will therefore become more important for mobile operators, not only to pursue sophisticated transmission technologies but also to explore new service sources. Therefore
it can be proposed that mobile operators should drive the migration process model by concentrating on the service innovation process as shown in Figure 6-2.

![Diagram](image)

**Figure 6-2 Successive Service Innovation**

Considering advantages of improved investment capability, it will enable mobile operators to enhance their technology leadership. It is natural that the reduction of network cost will be effective to drive migration process as well as the profitable services for the next migration. Choosing the appropriate migration scheme and also enhancing the technology leadership will enable mobile operators to entry the migration process more smoothly. This issue is discussed in next section.
6.3. Strategies for Future Platform Migration

6.3.1. How to Choose among the Platform Migration Schemes

This study has already clarified three types of platform migration as Evolution-type, Revolution-type and Collaboration-type. Considering a particular operators’ position, one additional approach is not to select platform migration at all, but to skip to the following platform. In this study, this scheme is called “Skipping”.

As mentioned in Chapter 4, service innovation will be the more important activity for mobile operators in obtaining higher revenue. So operators should not stick rigidly to the need for platform migration but also consider service innovation. Therefore skipping the next platform cycle and waiting for the next opportunities of the platform migration might be a better decision. The most important issue is how to choose the appropriate scheme, taking the current market situation into account. On this question, Figure 6-3 shows the logical tree for the decision as to which type of platform migration should be adopted.

![Figure 6-3 Logical Tree for Scheme Decision](image-url)
Three issues should be considered after platform innovation.

The first point is backward compatibility. This means whether or not the next platform technologies have aspects of compatibility with the existing platform. If there is some compatibility, mobile operators can choose Evolution-type migration and build their migration scenario more easily. In this case, the next point is whether or not the market requires the proposed performance capability of next platform. That is, mobile network operators should avoid over-performance of the platform and deploy new technologies efficiently. If the existing platform provides adequate performance to support profitable services and next platform technologies do not offer any new services, mobile operators should not accelerate the expansion of new technologies. In this case, Collaboration-type migration should be adopted. Naturally, if the new technologies promise to have a great impact on the whole market and improve the ARPU decline dramatically, mobile operators should not hesitate to deploy these technologies.

Next, in the case that these next platform technologies have no compatibility with their existing platform, mobile operators should investigate their technology leadership, value chain leadership and investment capability quite carefully, because this discontinuous situation is quite difficult to drive. Technology leadership involves two points: the ability to create new technical specifications and the ability to manage the migration process from a technical perspective. Value chain leadership means whether or not operators can integrate their complementary assets, such as content providers and terminals, in an effective manner. An associated point is whether or not the market scale is enough large to gives telecom vendors economic advantages. Investment capability relates to whether or not mobile
operators have enough capital to go ahead with platform migration or not. In particular, technology leadership is relatively important, because mobile operators owning R&D facilities and profitable services on existing platforms can take on Revolution-type migration by considering the 4C framework. Even though they do not have Research facilities, some of those that try to organize a strong process management team for checking the manufacturing process of vendors and controlling supply schedule will achieve successful migration. Mobile operators that cannot carry out these activities should not decide to deploy new technologies, but should hold back and focus on service innovation for future migration.

In addition, there is another solution for avoiding Revolution-type migration without backward compatibility. That is the introduction of multiple-mode handsets, which support several wireless interfaces simultaneously. Current technology enhancement has realized this concept, but a number of customized specifications for the core network and terminals are required. If the market scale of the mobile operator who wants to have these sophisticated handsets is not large, its lower attractiveness will prevent handset vendors from providing them. Therefore, this case will be limited to the mobile operators that have relatively large-scale operations and powerful technology leadership.

6.3.2. Advanced Process Management

Process management is quite important, when mobile network operators outsource their technology investigation and standardization.

One of the most critical issues in the platform migration process is whether or not mobile network operators can acquire their network equipment and complementary assets,
particularly terminals, on time. As a result of the recent movement of platform leadership from mobile operators to vendors, operators should not stick to reinforce their research capabilities but focus on reinforcing process management as shown in Figure 6-4.

![Figure 6-4 Process Management for the Migration Process](image)

Process management gives mobile operators a number of advantages in the whole migration process in the absence of R&D capability, because it allows operators to use vendors’ technical performance and reinforce their bargaining powers in the end. In addition, they can transfer their technical resources to the innovation of new services and support their customers and partners. Figure 6-5 shows an example of process management for future platform innovation. A portfolio of multiple vendors reduces the risk of a delayed schedule and control of their performance in terms of competition. A trial platform is necessary to allow total debugging and an efficient testing process for mobile operators. They have to let not only vendors but also their service partners such as content providers share this environment for efficient development.
However, this issue depends on the current level of R&D performance. Some mobile network operators have still sustained their R&D performance and submitted proposals based on their investigation to standardization bodies. For future competitive advantage, those activities will be quite effective. Therefore these operators owning their own R&D should maintain their activities to enhance the specification in the future.

Finally, other mobile network operators, which do not own their R&D arms or cannot use technical resources from their group companies, should not feel they have to resist this paradigm shift in platform leadership. The most important leadership in the migration process is process management. Despite outsourcing to vendors, mobile network operators should have responsibilities for the implementation of new platform technologies in their network as in the original migration scenario. Therefore, the first suggestion is that mobile

Figure 6-5 Development for Process Management
network operators should reinforce their Development function, not for fundamental research but for process management. In addition, they should have a portfolio of different vendors for the purpose of risk reduction.

6.3.3. More Creativity for the R&D Facility Owner
This proposal is for only mobile operators that own powerful R&D facilities. Mobile network operators have designed the next technologies and proposed them to standardization body many times in the past. It is certain that keeping technology leadership in standardization is quite important. It is proposed that the key feature of an R&D facility for mobile operators is focusing not on productivity but creativity. Even without a manufacturing facility, they can protect their technology leadership in terms of IPR. Therefore, the proposed focuses for the R&D facilities of mobile operators are basic investigation, system design and trial manufacture, in order to create effective IPRs.

However in order to avoid the technological dependence and over-performance, mobile network operators need to pursue not only technology enhancement but also profitable services in the future. In particular, since the first step of platform migration is technology driven, mobile network operators should pursue their own R&D functions for migration.

6.4. Strategies for Service Innovation Dynamics
6.4.1. Overview for Future Service Innovation Approach
In the face of future uncertainty, mobile operators should expand this philosophy in order to survive in a diversified market. In Chapter 4, the mental breakthrough approach creates such service breakthroughs, but mobile operators should not be satisfied with these
successes and should pursue new sources of future profitable services.

Fortunately mobile handsets have become a powerful portal for customers with tremendous potential to replace other commodity items. For instance, the ability to transmit pictures taken by users themselves had led to new types of cell phone equipped with downsized digital cameras, which are invading the existing digital camera market. In this way, mobile operators are able to accelerate entry into various kinds of markets such as telematics, content delivery, health care, m-commerce and so on (Sadeh, 2002). A service portfolio composed of these diverse industries reduces the future risk of failure in the service innovation and next platform migration. In this respect, this research proposes that mobile operators should pursue partnerships with organizations, entrepreneurs and users in the targeted industries.

6.4.2. Service Platform Concept

From an empirical analysis of service innovation dynamics, this research proposes enhanced adaptation layers in order to match the diversified markets of the future. Little experience with innovative services up to now may force mobile operators to lose not only their technological leadership but also future opportunities to become powerful service providers.

For instance, Nokia has already started “Forum Nokia”. This is the supporting function for develops and entrepreneurs for reinforcing the complementary applications and use of content in Nokia phones. Multimedia Message Service (MMS) will require various kinds of content like i-mode, to enhance its attractiveness, because MMS might be provided in terms not of Internet content but of internal content provided by operators. Nokia’s strategy for
MMS is that terminal vendors will create a new content line-up through their initiatives in collaboration with content providers.

In this respect, mobile operators will lose their own opportunities and will only be able to reinforce partnerships with specific vendors for the use of their content and mobile terminals. Therefore mobile operators need to evolve their technical, organizational and business structure quickly to ensure their future competitive advantages. The concept of a service platform will allow them to investigate and improve future profitable services flexibly. Mobile operators can expand the concept of an adaptation layer as the “Service Platform” as shown in Figure 6-6.

Figure 6-6 Service Platform for Mobile Network Operators

The existing platform can be defined as the “Core Platform” for connectivity. The adaptation layer has a role in facilitating protocol convergence, but in this concept of a service platform, it is opened broadly not only to partner providers but also to the market. That is, this platform will also provide toolkits such as software applications adapted to each industry. Also, a multiple service platform can be prepared for a portfolio of innovative services corresponding to entities of target industries.
6.4.3. Service Innovation Model by Partnership Dynamics

The implication from the i-mode analysis demonstrates for mobile operators the importance of partnerships with content providers. Partnerships give mobile operators a host of market information, covering the histories, the market segment and customer preferences. Therefore mobile operators should investigate organized partnership structures. This research proposes a partnership dynamics model featuring corporate initiative, partner initiative and market initiative as shown in Figure 6-7.

**Corporate Initiative:** Mobile operators should take the lead in proposing a series of services including prototypes, in order to establish future leadership and knowledge of the market. They should develop new toolkits and application matched to the market features in order to encourage future partners to provide new services.

**Partner Initiative:** The second dynamics is partner initiative. Breakthrough of the i-mode service was triggered by a full line-up of i-mode content provided by official content providers in the first step. The mobile operators might encourage companies and organizations to enter the service line-up, with aspects of tangible and intangible support being provided by mobile operators. Basically these supports will include technical information about platform, toolkits and applications, and know-how for innovating services. Additionally partnership can be divided into several grades according to the level of support provided. In Figure 6-7, two kinds of partnership are shown. One is a group of the secondary partners given fundamental support, and the other is a group of partners given premium support including rewards for their contribution to traffic growth. These partnerships can be designed according to corporate strategies.
**Market Initiative:** Referring to the Internet market, even users can provide their own content to the market by means of simple programming tools. This behavior can be called as the “Market Initiative” approach. Sometimes entrepreneurs have appeared from among these users and founded new companies offering innovative services. This may be a quite significant point for mobile operators in order to survive the future uncertainty. Therefore, mobile operators should prepare some tools and modules of network resources and scan the behaviors of entrepreneurs in order to lead them into the future partnerships.

**Figure 6-7 Partnership Dynamics Model for Service Innovation**
6.4.4. Organizational Perspective

The organizational structure will also need to be changed according to the target industry. Mobile operators, first, build new project team internally in order to understand the features and segmentation of the newly targeted markets. These new units should develop the toolkits and applications to support future partners, while they progress market research. This means that this project team has two functions: marketing and development. If they are faced with any problems that will have an impact on the core platform technologies, they will require new functions from their R&D arms or outsourced manufacturing companies. Then they should develop a prototype for trial purposes and to provide feedback in order to finalize the innovative service.

Each department has responsibilities for its own service platform and enhances it based on requirements from providers. The mobile operator can encourage its organizations to compete internally in providing profitable services in the future.

6.4.5. Business Perspective

From the business perspective, the service platform will provide a series of toolkits and environmental support, which can be called “Premium Support”, to officially partner providers. However the most important issue for service breakthrough is how mobile operators encourage voluntary providers who are invisible in the gestation phase of the service industry, to enter the market and provide new concepts by themselves. Therefore, service divisions should provide a minimum set of toolkits that allow voluntary providers to check their new service by themselves, while also giving partner providers the full treatment. In the end, there is possibility that mobile operators may prepare several levels of this premium support based on the contract fees.
7. Conclusion

Historically the mobile industry was driven by technology innovation, and platform migration has been observed to be a progression of technology generations, such as 1G, 2G and 3G. However, the saturation of subscribers and the maturity of voice telephony services have forced mobile operators to ask themselves what the mainstream of the mobile operators is. This market change indicates that the mainstream of this industry is simply the traffic business. Therefore, mobile operators need to pursue not only technology innovation but also service innovation to ensure traffic increase directly connected to revenue growth.

In this respect, this thesis establishes that the migration process is a reinforcing feedback loop composed of two powerful dynamics, namely Platform Migration Dynamics and Service Innovation Dynamics. Since successful migration will allow mobile operators to grasp further revenue and a leading position of the market, the migration scenario is an important element in corporate strategies in order to sustain their competitive advantages. Empirical analyses explain the mechanism of the migration model in more detail. In brief, shortage of network capacity causes platform migration dynamics and then successful platform migration leads to market growth and market pressure for price reduction. This phenomenon results in ARPU decline, and mobile operators are forced to innovate to establish new profitable services for traffic growth. In the end, the result of service breakthrough gives mobile operators further revenue, while it encourages the next platform migration in order to acquire further network capacity.

Platform migration dynamics is an implementation process in new platform technologies.
and can be categorized into Revolution-type and Evolution-type. Basically if next platform technologies have backward compatibility with the existing platform, mobile network operators can select the Evolution-type scheme for smooth upgrade of the network capacity and function. However recent uncertainty of technology and their loss of technology leadership in this industry might sometimes give mobile operators discontinuous situations and lead them to choose Revolution-type. In this case, mobile operators should evaluate their current level of investment capability, technology leadership and value chain leadership carefully and choose whether to opt for Revolution-type migration with 4C operation or Skipping of platform migration. Referring to the technology roadmap about for Beyond the Third Generation Technology (B3G), mobile operators may have another alternative, Collaboration-type migration, which is an enhanced Evolution-type, adapted for a technically diversified future situation. Collaboration-type migration allows mobile operators to reduce the risk of huge network investment, although they will need to carefully investigate a seamless service environment and sophisticated quality control.

Service innovation dynamics is a process for innovating new profitable services for further revenue growth and enhancing investment capability for the next platform migration. As mentioned above, ARPU decline is the key trigger that forces mobile operators to create innovative services. Case analysis of Short Message Service (SMS) and i-mode service clarifies that mental breakthrough management is a common approach in the mobile industry. However, considering the uncertainty in the future customer preferences, mobile operators need to pursue not only “All in mobile” for consumer uses and business uses, but also “Mobile in all” for the new traffic sources. In addition, the mixture of corporate
initiative, partner initiative and market initiative should be adopted in order to explore the new market effectively.

The current two big problems in the mobile industry can be explained in terms of this platform migration process. In its struggle with 3G platform migration, NTT DoCoMo is just midway through the first step of Revolution-type migration. DoCoMo needs to accelerate to completion of service coverage to provide the same level as their PDC platform and to improve network quality. Its powerful technology leadership and value chain leadership will give DoCoMo a successful result at the end of this bitter trail. The second problem is the severe financial situation of European mobile operators owing to the extremely costly spectrum auctions. From the viewpoint of the migration model, those operators failed to evaluate two key points, namely the level of their investment capabilities and the migration cycle between the GPRS platform and the UMTS platform. In particular, time-contiguous platform migrations are too expensive for mobile operators. They should skip or delay the implementation of 3G platforms until they have gained profitable services, which improve their financial condition or wait to see their Multimedia Message Service (MMS) breakthrough.

This thesis then proposes the following Migration Strategies for future competitive advantages of mobile network operators. First, mobile network operators should drive the migration cycle powerfully by concentrating on Successive Service Innovation Dynamics for their revenue growth and the next platform migration. The second point is with regard to Platform Migration Strategies in which mobile operators should carefully choose from
three possible migration schemes according to their level of technology leadership, value chain leadership and investment capability. Next, they should reinforce their process management capability for successful platform migration. Finally, mobile operators should enhance the adaptation layer as the Service Platform. Successive service innovation requires a portfolio of three types of Partnership Dynamics, that is corporate initiative, partner initiative and market initiative. In this respect, mobile operators can provide various levels of toolkit applications.

Generally, the creation of the profitable services is quite difficult work. Since the customer preferences become more diversified in the future market, mobile operators need to harmonize the technology leadership and the partnerships in order to grasp the opportunities for the future profitable services. This means that exploring new business fields positively, building differentiated business models based on technology resources and protecting the property rights are the required tactics. Then the migration led by technology innovation and, particularly, sustainable service innovations should be placed as a core strategy for mobile operators.
Appendix 1

Analysis of Decline in ARPU (Average Revenue Per User)

1. Introduction

Key issue in this simulation is to clarify the behavior in ARPU under the market saturation circumstance. As mentioned in Chapter 2, ARPU is decreasing in the fierce competition because of the price reduction. This simulation illustrates this trend from the brief quantitative analysis.

2. Source of Decline in ARPU

Considering the definition of Average Revenue Per User (ARPU), the following three subjects have a close influence on ARPU decline.

- Call charge reduction by fierce competition in the market
- Customers decrease
- Minute Of Use (MOU) decrease

The call charge reduction is the popular reason for ARPU Decline; it heightens the service attractiveness, which makes both the number of customers and the MOU grow up. Of course, some external factors, namely new substitutes and decline in customer preferences, which have a negative impact on the service attractiveness and, finally, ARPU. But in this simulation, I don’t take these external factors into account for the simplification.
3. Simulation Model

Figure A-2 illustrates the mechanism of both the customer transfer to the new service and ARPU decline. The bottom part of this model explains the simple market transition model like S-curve (Sterman, 2000). In this model, the service attractiveness has an influence on entry rate and MOU. The source of the call charge reduction comes from the revenue. The mobile operators adjust the investment in the reduction, according to the market competition. Market competition, in this simulation, means the ratio of the investment in the price reduction to the total revenue. Although the actual value of ARPU arises from total revenue and the total number of the customers, in this model, it is dependent on the MOU, Price per minute and Monthly fee. Then, MOU is defined as the value, which increases as the price reduces, because the customers call more frequently in the situation.

4. Environment

The number of the customers who transfer to the next services is saturated around one year later. Initial MOU is 200 minutes/month and is made longer at the reciprocal ratio of the call charge reduction. The mobile operator reduces the call charge in each month. The initial call charge is 0.2$/minute.
5. Implication

The ARPU decline can be seen in Figure A-3. Even though MOU grows gradually, ARPU decreases. This means that price reduction caused by the market pressure in the fierce competition is a dominant factor of the ARPU decline. Actually this trend has a severe impact on the revenue trend, while the MOU grows after the market saturation as shown in Figure A-4 to Figure A-6. Actually the frequent price reductions do not happen. Therefore, ARPU decrease more slowly.
Figure A-3 ARPU Decline (Investment Ratio = 1% to 3%)

Figure A-4 Price Reduction in Call Charge (Investment Ratio = 1% to 3%)
Figure A-5 MOU Growth (Investment Ratio = 1% to 3%)

Figure A-6 Revenue Growth (Investment Ratio = 1% to 3%)
The parameters in the simulation

(01) Adoption Fraction=0.05
Units: 1

(02) Adoption from Word of Mouth=Adoption Fraction*Contacts with Adopters
Units: customers/month

(03) ARPU="Minute Of Use (MOU)"*Price per Minute + Monthly Fee
Units: dollar/customers/month

(04) Attractiveness Service=(2*Initial price per minute-Price per Minute)/Initial price per minute

(05) Competition in the market=0.01
Units: **undefined**

(06) Contact Frequency=10
Units: 1/month

(07) Contacts with Adopters=Probability of Contact with Adopters*Social Contacts
Units: customers/month

(08) Customers= INTEG (Entry Rate, Initial Customers)
Units: customers

(09) Entry Rate=Adoption from Word of Mouth*Attractiveness Service
Units: customers/month

(10) FINAL TIME  = 48
Units: month

(11) Initial Customers=10000
Units: customers

(12) Initial MOU=200
Units: minute/month/customers

(13) Initial price per minute=0.2
Units: dollar/minute

(14) INITIAL TIME  = 0
Units: month

(15) Investment Ratio=Competition in the market

(16) "Minute Of Use (MOU)"= Initial MOU*Attractiveness Service
Units: minute/month/customers

(17) Monthly Fee=20
Units: dollar
(18) Potential Customers = INTEG (-Entry Rate, Total Markets Size-Customers)
Units: customers

(19) Price per Minute = INTEG (-Source of price reduction, Initial price per minute)
Units: dollar/minute

(20) Probability of Contact with Adopters = Customers/Total Markets Size
Units: customers/customers

(21) Revenue = Customers*ARPU
Units: dollar/month

(22) SAVEPER = TIME STEP
Units: month [0,48]

(23) Social Contacts = Contact Frequency*Potential Customers
Units: customers/month

(24) Source of price reduction = Revenue*Investment Ratio/Customers/"Minute Of Use (MOU)"
Units: dollar/month

(25) TIME STEP = 0.0625
Units: month [0,48]

(26) Total Markets Size = 1e+008
Units: customers
### Appendix 2

**The Generations in Mobile Technologies and Specifications**

<table>
<thead>
<tr>
<th>System(^{14})</th>
<th>Region</th>
<th>Radio Band</th>
<th>Multiple Access</th>
<th>Data Speed (max)</th>
<th>Voice Coding</th>
<th>Compatibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>NMT</td>
<td>Northern Europe</td>
<td>800MHz</td>
<td>FDMA</td>
<td>-</td>
<td>Analog</td>
<td>-</td>
</tr>
<tr>
<td>TACS</td>
<td>Europe</td>
<td>800MHz</td>
<td>FDMA</td>
<td>-</td>
<td>Analog</td>
<td>-</td>
</tr>
<tr>
<td>AMPS</td>
<td>North America</td>
<td>800MHz</td>
<td>FDMA</td>
<td>-</td>
<td>Analog</td>
<td>-</td>
</tr>
<tr>
<td>NTT Analog</td>
<td>Japan</td>
<td>800MHz</td>
<td>FDMA</td>
<td>-</td>
<td>Analog</td>
<td>-</td>
</tr>
<tr>
<td>GSM</td>
<td>Europe et al</td>
<td>800MHz(^{15})</td>
<td>TDMA</td>
<td>14.4kbps</td>
<td>13kbps</td>
<td>GPRS</td>
</tr>
<tr>
<td>D-AMPS (IS-54)</td>
<td>North America</td>
<td>800MHz</td>
<td>TDMA</td>
<td>9.6kbps</td>
<td>8kbps</td>
<td>AMPS (dual)</td>
</tr>
<tr>
<td>PDC</td>
<td>Japan</td>
<td>800MHz</td>
<td>TDMA</td>
<td>14.4kbps</td>
<td>11.2kbps/5.6kbps</td>
<td>PDC-P</td>
</tr>
<tr>
<td>PCS (cdmaOne) (IS-95A)</td>
<td>North America et al.</td>
<td>800MHz</td>
<td>CDMA</td>
<td>14.4kbps</td>
<td>13kbps</td>
<td>IS-95B, CDMA2000 1x</td>
</tr>
<tr>
<td>PCS (cdmaOne) (IS-95B)</td>
<td>North America et al.</td>
<td>1.9GHz</td>
<td>CDMA</td>
<td>64kbps</td>
<td>-</td>
<td>IS-95A, CDMA2000 1x</td>
</tr>
<tr>
<td>PCS (CDMA2000 1x)</td>
<td>North America et al.</td>
<td>800MHz</td>
<td>CDMA</td>
<td>144kbps</td>
<td>-</td>
<td>IS-95A, IS-95B</td>
</tr>
</tbody>
</table>

*Source: Essential Guide to Wireless Communications Applications*

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\(^{14}\) Each name before abbreviated is shown in “Terminologies” in the end of this thesis.

\(^{15}\) GSM has other frequency allocations, namely GSM 450 (450MHz), GSM 900 (900MHz), DCN 1800 (1.7GHz) and PCS 1900 (1.9GHz).
## Terminologies

<table>
<thead>
<tr>
<th>Abbr.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1G</td>
<td>the First Generation Mobile Technologies</td>
</tr>
<tr>
<td>2G</td>
<td>the Second Generation Mobile Technologies</td>
</tr>
<tr>
<td>3G</td>
<td>the Third Generation Mobile Technologies</td>
</tr>
<tr>
<td>3GPP</td>
<td>The Third Generation Partnership Project</td>
</tr>
<tr>
<td>AMPS</td>
<td>Advanced Mobile Phone Service</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
</tr>
<tr>
<td>ARPU</td>
<td>Average Revenue Per User</td>
</tr>
<tr>
<td>B-ISUP</td>
<td>Broadband ISUP</td>
</tr>
<tr>
<td>B3G</td>
<td>Technologies Beyond the Third Generation Mobile</td>
</tr>
<tr>
<td>BS</td>
<td>Base Station</td>
</tr>
<tr>
<td>BTS</td>
<td>Radio Base Station</td>
</tr>
<tr>
<td>CA</td>
<td>Complementary Assets</td>
</tr>
<tr>
<td>CDMA</td>
<td>Code Division Multiple Access</td>
</tr>
<tr>
<td>CDPD</td>
<td>Cellular Digital Packet Data</td>
</tr>
<tr>
<td>CN</td>
<td>Core Network</td>
</tr>
<tr>
<td>CODEC</td>
<td>COmpressor DECompressor</td>
</tr>
<tr>
<td>CP</td>
<td>Content Provider</td>
</tr>
<tr>
<td>D-AMPS</td>
<td>Digital Advanced Mobile Phone Service</td>
</tr>
<tr>
<td>DS-CDMA</td>
<td>Direct Spread CDMA</td>
</tr>
<tr>
<td>EDGE</td>
<td>Enhanced Data GSM Environment</td>
</tr>
<tr>
<td>EIPR</td>
<td>Essential Intellectual Property Right</td>
</tr>
<tr>
<td>ETSI</td>
<td>European Telecommunication Standards Institute</td>
</tr>
<tr>
<td>EV-DO</td>
<td>Evolution Data Only</td>
</tr>
<tr>
<td>EV-DV</td>
<td>Evolution Data Voice</td>
</tr>
<tr>
<td>FCC</td>
<td>Federal Communication Commission</td>
</tr>
<tr>
<td>FDMA</td>
<td>Frequency Division Multiple Access</td>
</tr>
<tr>
<td>FOMA</td>
<td>Freedom Of Mobile multimedia Access</td>
</tr>
<tr>
<td>GPRS</td>
<td>General Packet Radio Service</td>
</tr>
<tr>
<td>GSM</td>
<td>Global Service for Mobile Communications</td>
</tr>
<tr>
<td>GSMA</td>
<td>the GSM Association</td>
</tr>
<tr>
<td>GW</td>
<td>Gateway Server</td>
</tr>
<tr>
<td>IMT-2000</td>
<td>International Mobile Telecommunications 2000</td>
</tr>
<tr>
<td>IP</td>
<td>Internet Protocol</td>
</tr>
</tbody>
</table>
IPO  Initial Public Offering
IPR  Intellectual Property Right
IS-41  Interim Standard-41
IS-54  Interim Standard-54
ISUP  ISDN User Part
ITU  the International Telecommunication Union
MC-CDMA  Multicarrier CDMA
MMS  Multimedia Message Service
MOU  Minutes Of Use
MP3  MPEG Audio Layer-3
MPEG  Moving Picture Experts Group
MS  Mobile Subscriber station
MSC  Mobile Switching Center
MSS  Message Storage System
NMT  Nordic Mobile Telecommunication system
PCM  Pulse Code Modulation
PCS  Personal Communication Services
PDC  Personal Digital Cellular
PDC-P  Personal Digital Cellular Packet
PLMN  Public Land Mobile Network
PSTN  Public Switched Telephone Network
QoS  Quality of Service
RAN  Radio Access Network
RCR  the Research and Development Center for Radio System
RNC  Radio Network Controller
SMS  Short Message Service
TACS  Total Access Communication System
TDD  Time Division Duplex
TDMA  Time Division Multiple Access
UMTS  Universal Mobile Telecommunications System
VC  Value Chain
VSELP  Vector Sum Excited Linear Prediction
W-CDMA  Wideband CDMA
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