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LATECOMER FIRMS AND PURSUIT OF A DUAL FRONTIER:

THE CASE OF KOREAN HANDSET MANUFACTURERS

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LATECOMER FIRMS AND PURSUIT OF A DUAL FRONTIER

ABSTRACT

The subject of this thesis is a group of emergent leading firms in developing countries pursuing a ‘dual frontier’, achieving technology supremacy and establishing market autonomy, and entering a newly emerging market in the context of the latter half of the 20th century. Whilst the previous literature on catching-up and transition generally centres on the area of technological development of latecomer firms, this thesis extends the scope of analysis to a broader issue of technological development and marketing strategies of latecomer firms in transition. The thesis builds upon two different streams of literature: first the catching-up process in latecomer firms for the theoretical and empirical rationales, and second the boundaries of a firm and inter-firm coordination in technological frontier firms for the theoretical guidance to a systematic analysis.

Using industry case studies of the Korean mobile handset manufacturers Samsung and LG Electronics, the thesis first shows that there could be windows of opportunity available for international technology transfer to emergent leading firms in the emerging stage of a new industry from competition to achieve a dominant compatibility standard among technology leaders. However, the research stresses that the characteristic of these technologies is cutting-edge but technologically incomplete and commercially unproven, which highlights the importance of previous experience and capacity for successful commercialisation.

Moreover, the thesis shows that Korean firms pursuing a dual frontier overcame their uneven development between technological and marketing capabilities through intensive inter-firm collaborations with intermediary users, that is Mobile Network Operators (MNOs). In the thesis, it is stressed that Korean firms competed against technology leaders like Nokia in export markets by complementing weak marketing capabilities based on continuous collaborations with MNOs, evolving from von Hippelian to Teecean inter-firm relationships.

Lastly, the thesis introduces to the literature on industry organisation a new form of an outsourcing organisation, termed a 'contract developer' (CD), which has been identified as a group of firms that is unilaterally specialised in, and that carries out development outsourcing projects for, mobile handset Own Brand Manufacturers (OBMs). The thesis reveals that CDs emerged from the industry shake-out and the co-specialised structure between mobile handset OBMs and MNOs in the industry and served as one of main mechanisms that supported the successful globalisation of the Korean firms.

Therefore, the thesis argues that the key strategy that Korean emergent leading firms adopted to compete at the world frontier can be described as a 'quasi' extension of firm boundaries in terms of development resources (the CDs) and in terms of downstream capabilities (the MNOs).

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Recurring Abbreviations

AMPS: Advanced Mobile Phone Service

ARPU: Average Revenue Per User

ASIC: Application-Specific Integrated Circuit

CAS: Conditional Access System

CD: Contract Developer

CDMA: Code Division Multiple Access

DMB: Digital Multimedia Broadcasting

DRAM: Dynamic Random Access Memory

DVB-H: Digital Video Broadcasting–Handheld

EDGE: Enhanced Data rates for GSM Evolution

EMS: Electronics Manufacturing Services

ETRI: Electronics and Telecommunications Research Institute

FDMA: Frequency Division Multiple Access

GPRS: General Packet Radio Service

GPS: Global Positioning System

GSM: Global System for Mobile communications

iDEN: integrated Digital Enhanced Network

IPR: Intellectual Property Right

LCD: Liquid Crystal Display

M&A: Mergers & Acquisitions

MBS: Mobile Broadcast Solutions

MNO: Mobile Network Operator

OBM: Own Brand Manufacturer

ODM: Original Design Manufacturer

OEM: Original Equipment Manufacturer

PDC: Personal Digital Cellular

PCS: Personal Communications Service

SIM: Subscriber Identification Module

TDMA: Time Division Multiple Access

WAP: Wireless Application Protocol

WCDMA: Wideband Code Division Multiple Access

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1. INTRODUCTION

1.1 Research issues and research questions

The subject of this thesis is the firms in developing countries that are approaching the technology frontier and entering a newly emerging market, especially in the context of the latter half of the 20th century. For the past several decades, the issue of 'catching-up', especially as it has occurred in East Asia, has been of interest to academic researchers (Amsden 2001; Ernst 2002; Hobday et al. 2004; Kim 1997a; Lee & Lim 2001).

From a historical perspective, the phenomenon of catching-up is not uncommon: since the Industrial Revolution in the United Kingdom (UK), some important instances include the United States of America (US) and several European countries like Germany with respect to the UK in the second half of the 19th century, and Japan with respect to the US in the post-World War II era (Abramovitz 1986; Gerschenkron 1962; Rosenberg 1970). Unlike the early industrialisations, however, the catching-up in the second half of the 20th century has occurred under new technical and market environments. Firstly, technologies have become highly science-based (Rosenberg 1970) and ever more complex and systemic with the emergence of information and communication technologies (Steinmueller 2001). Product markets have grown most rapidly for technologies with a high science content – this does not discount the continuing importance of more traditional industries, but points to the more rapid growth opportunities associated with science-based industries. Secondly, a series of successful General Agreements on Tariffs and Trade (GATT) rounds has resulted in a sustained period of trade liberalisation which has been governed by the World Trade Organisation

(WTO) and accompanied by considerable reductions in the barriers to international investment, creating the conditions for a more globalised financial and product market (Radosevic 1999).

Under the circumstances, one of the distinctive characteristics in the catching-up experienced in East Asian countries has been their export-led growth in the electronics industry, which mainly occurred through foreign direct investments and Original Equipment Manufacturer/Original Design Manufacturer (OEM/ODM) arrangements with multi-national corporations (Amsden & Chu 2003; Hobday 1995b; Kim 1997a). Although the roles of multi-national corporations and local firms differ across East Asian countries (Hobday 1995b), such arrangements have been core mechanisms for access to advanced foreign technologies and international markets in the region. In addition, firms in East Asian countries generally began to accumulate their capabilities by taking mature products as models or targets for development of the capabilities necessary to produce them (Kim 1997a).

As some firms in these countries approached the international technology frontier, they began to capture the attention of researchers; for example, there are studies of Taiwanese electronics firms (Chu 2009; Kuo 2009) and large Korean firms (Hobday et al. 2004; Lee & Lim 2001; Lee et al. 2005), and the rarer case of a Latin American firm (Dutrénit 2000). The rationale for these studies is that firms from developing countries face a different set of technical and managerial challenges at the point where they are close to the frontier. One such challenge is the so-called ‘strategic dilemma’ (which at the level of the country is sometimes described as the ‘middle income trap’) (Hobday et al. 2004). This dilemma poses the alternatives of whether the firm should continue to intensify its competition by employing the capabilities it developed during the catching-up process – perhaps building in-house R&D and its own brands – or diversify into new and emerging industries (nanotechnology, biotechnology, or as other industries not yet fully visualised).

In retrospect, though not covered in the literature[1], latecomer firms facing this strategic dilemma have developed several pathways. Some have specialised in their current business by increasing scale and pursuing a cost advantage strategy[2]. Others have begun to compete with their own brands on the basis of in-house R&D, which implies that they have to be a 'dual frontier', namely attaining technology supremacy and establishing market autonomy. 'Technology supremacy' in this instance means the technological competitiveness of a firm to achieve parity with, or surpass, its forerunner rivals, and 'market autonomy' is defined as the ability of a firm to introduce products of its own design and manufacture while retaining control of upstream and downstream parts of the production and marketing chain. The concern of previous studies in regard to a dual frontier, which is the focus of this thesis, is that these new types of leading firms in developing countries would confront serious managerial challenges, and have to organise their own R&D to substitute for previous technology licensing and reverse engineering which would increasingly be subject to litigation over trade disputes (Chu 2009; Hobday et al. 2004). For example, in the mobile phone industry which is examined in this thesis, BenQ lost its ODM contract with Motorola as soon as it launched its Own Brand Manufacturer (OBM) handset business (Kuo 2009). Earlier

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[1] One exception is Lee and Lim (2001) who categorised different catching-up trajectories based on the nature of particular markets in which the cycle time between models or versions of the technology is an important variable.

[2] Such examples include Foxconn in contract manufacturing services and TSMC in foundry business.

studies also point out that these firms struggle to overcome uneven development not only within technologies that they have (Dutrénit 2000; Hobday et al. 2004) but also between technology and marketing stages within an organisation (Hobday 1995b). It is difficult for firms from developing countries not only to develop a cutting-edge product, but also to adjust their organisational routines and customise their products to specific demands across different markets, the process of which is a prerequisite to compete at the top level but not an easy task with high-technology product markets like mobile phones that the thesis studied.

After raising some interesting questions, however, the existing literature does not proceed further and therefore, does not provide explanations of how these firms have managed to overcome the aforementioned challenges in order to compete at the technological frontier. If these firms are pursuing a dual frontier, as explained above, do they simply have to invest in their in-house R&D and own brand and distribution channels, taking high risks and bearing high costs? In addition, how do firms pursuing a dual frontier manage to cope with technical and managerial issues such as uneven development within technologies and between technology and marketing stages within an organisation, which are the main concerns of earlier studies? Furthermore, considering that these firms have largely caught up with frontier firms, might there be available windows of opportunity for these firms if they enter newly emerging markets rather than those that are mature? If so, how do windows of opportunity arise at this nascent stage and how do these firms in developing countries manage to cope with such highly uncertain technological and market environments? Even technology forerunners often fail to overcome these uncertainties in an emerging market (Christensen 1997). This is what the literature on the contemporary catching-up process is missing and it is this area which is the focus of this thesis.

Another limitation of earlier research is that it is focused solely on internal issues within firm organisations during their adjustment process, neglecting the role of external counterparts such as upstream suppliers and downstream users for interactive learning (Jensen et al. 2007; Lundvall 1988; Malerba 1992; von Tunzelmann & Wang 2007). Firms pursuing a dual frontier may need to compensate for the deficiencies from external complementary asset holders (Teece 1986). Even technology leaders heavily depend on active interactions with their external partners (Foxall & Johnston 1987; Lundvall 1988; von Hippel 1998; von Tunzelmann & Wang 2007) to sustain their competitiveness and accordingly, firms' competitive advantages sometimes come from beyond their boundaries (Asanuma 1989; Dyer & Singh 1998; Jap 2001; Teece 1986). This shift of attention towards inter-firm relationships requires consideration of an additional literature stream, one dealing with the boundaries of the firm and inter-firm coordination, and which is the hybrid mode of coordination between market transactions and firm organisations. This stream of literature explains how firms set their boundaries and where firms' competitive advantages come from in relation to other parties (Brusoni et al. 2001). By including external partners within the scope of the analysis, a new theoretical perspective is provided on understanding the pursuit of a dual frontier by latecomer firms.

Some countries have been successful so far in catching up with levels of income and other measures of performance of countries that had industrialised earlier (Fagerberg & Srholec 2005), and Korea is one of those countries. In the Korean context, as in the earlier experience of Japan, the catching-up process is strongly related to the evolution of business organisations, particularly to local large firms so-called ‘chaebols’ (Amsden 1989). Since the focus of attention in this thesis is an industry in which advanced technological capabilities are of central importance, the thesis employs the terminology of ‘forerunner firms’ for firms that first developed and commercialised particular advanced technologies, and ‘emergent leading firms’[3] for firms in developing countries pursuing a dual frontier. The principal focus in this thesis is the nature of technological and marketing strategy adopted by these emergent leading firms in their efforts to achieve parity with or surpass their forerunner rivals. This contest is most clearly apparent in the industry chosen for this thesis – the mobile handset industry.

The mobile handset industry encompasses some unique features with regard to the competition (catching-up) of Korean mobile handset manufacturers against their technology forerunners such as Nokia and Motorola. Firstly, the Korean mobile handset manufacturers entered the market at a very early (embryonic) stage of the second generation of mobile phone networks[4]. Although the Korean makers commenced the development of Code Division Multiple Access (CDMA) technologies slightly later than Motorola and Lucent, they were the first movers with Qualcomm in the CDMA handset market when Korea commercialised a CDMA network for the first time in the world in 1996 (Song 1999). Secondly, the mobile handset industry has been characterised by a very short product life cycle (Lee & Lim 2001) featuring frequent technical changes, a condition which poses significant technical and managerial

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[3] In this sense, firms in the catching-up process become emergent leading firms as they get to pursue a dual frontier.

[4] The technical bases of the first generation (analogue) and the second generation (digital) in the mobile communications were fundamentally different. Also, Korean emergent leading firms focused on CDMA technologies because the opportunity for licensing Global System for Mobile communications (GSM) or US-Time Division Multiple Access (TDMA) technologies were unavailable. See detailed explanations in Chapters 4 and 5.

challenges for industry participants and yet also provides the motivation for understanding how emergent leading firms overcome these uncertainties. Lastly, mobile handsets have become more and more multi-component and multi-technology products on the basis of functional convergences pushed forward by Mobile Network Operators (MNOs) (Whang 2009). This phenomenon in handsets pushes handset manufacturers towards system integration and also leads to the division of innovative labour in handset production going beyond the boundaries of a firm organisation (Prencipe et al. 2004). It gives emergent leading firms strong motives to collaborate with external partners, which in turn brings more managerial challenges to such emergent leading firms.

Motivated by the broad issues of strategies available to catching-up economies and emergent leading firms, and the specific conditions of the mobile handset industry, this thesis addresses the following set of questions.

(1) When emergent leading firms in latecomer economies pursue a 'dual frontier' of technology supremacy and market autonomy, how do they reconcile uneven development within technologies and between technology and marketing stages within an organisation?

(2) How does the fact that emergent leading firms enter the newly emerging market rather than mature markets affect their pursuit of a dual frontier? In addition, what is the role of inter-firm collaboration in their pursuit of a dual frontier under these market conditions?

1.2 Thesis structure

The rest of the thesis is constructed as follows.

Chapter 2 explores the literature that offers a theoretical background to help us understand the issue of the transition process of one candidate for latecomer firms approaching the world frontier. The thesis combines two distant streams of literature: latecomer firms and technological frontier firms. More specifically, it draws upon the literature on catching-up in latecomer firms and, as noted above, the literature on boundaries of a firm and inter-firm coordination for technological frontier firms. In doing so, it identifies a theoretical gap in the existing literature related to what will be called the 'dual frontier' (meaning the meeting of managerial and technological challenges simultaneously), and establishes a theoretical guideline for the thesis, which also aims to illuminate a wider range of issues than the 'dual frontier' problem. Based on the literature review on the catching-up of latecomer firms and their 'transition process', the chapter presents the rationale for differentiating the transition process of latecomer firms from their catching-up process and identifies an array of transition paths of latecomer firms, including the 'dual frontier' possibility. It then turns to the literature on technological frontier firms with respect to the issues of firm boundaries and inter-firm coordination in order to carry out a systematic analysis of the dynamic definition of the boundaries of latecomer firms during their transition process in which the 'dual frontier' problem is addressed. It attempts to draw the implications of theories on firm boundaries and inter-firm coordination towards latecomer firms' transition based on the resource-based view of a firm.

Chapter 3 introduces research methodologies adopted in the thesis. It explains the implementation of this study as in a single industry with a focused case study as a unit of analysis, and the choice of the transition success (at least in terms of market share) of the Korean mobile handset industry with two particular Korean latecomer firms, Samsung Electronics and LG Electronics[5]. It further identifies interesting features from the case of the mobile handset industry and the Korean handset manufacturers' catching-up effort, and outlines the details of two rounds of fieldwork with respect to data gathering through secondary documents and in-depth interviews.

The aim of Chapter 4 is to present readers with some basic knowledge of the mobile handset industry so they can understand its fundamental characteristics. The chapter begins with the history of mobile telecommunication technologies and the evolution of corresponding mobile handsets and mobile network services. It then identifies core actors in a given industry structure, which are baseband chip suppliers, handset manufacturers and MNOs. While the chapter tracks the unbundling and specialisation of handset manufacturers in collaboration with upstream baseband chip suppliers, it also illuminates the bundling of mobile handsets and services led by handset manufacturers and network operators under the given technology and market evolution.

Having provided some basic information on the evolution of the industry, the thesis proceeds to three empirical chapters (5 to 7) that provide the practical foundation for answering the research questions. These three chapters are roughly chronological but not entirely as there are causal relations intertwined between Chapters 6 and 7.

Chapter 5 investigates the window of opportunity for Korean handset manufacturers in regard to the international technology transfer of new technologies. It starts from the time when the Korean government and Qualcomm, the pioneer of CDMA technologies,

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[5] Hereafter, the thesis uses shortened versions of the names of the two companies (Samsung and LG).

agreed to jointly develop CDMA telecommunication technologies. It identifies the rationale for the decisions by both the Korean government and Qualcomm to pursue the project and traces how the Korean side successfully implemented the project, resulting in the world's first commercialisation of a CDMA network with the support of Qualcomm. The chapter concludes that windows of opportunity are available for emergent leading firms at an early stage of a new industry.

Chapter 6 focuses on the collaboration of Korean handset manufacturers with their downstream distributors, the MNOs (especially in foreign markets), which is undertaken to compensate for the handset manufacturers' lack of marketing assets. It begins by showing how Korean handset manufacturers became dominant in the domestic CDMA handset market based on their first-mover advantage in CDMA handsets. It then examines the way in which Korean handset manufacturers forayed into advanced foreign markets like the US CDMA handset market. It describes how they were confronted by the barriers of complementary assets in the market that differed from the control they were able to exert in their domestic market. These disadvantages in foreign markets included low brand awareness and lack of distribution channels. The chapter directs attention to the role of collaboration between Korean handset manufacturers and foreign MNOs in solving these problems. A typical example of co-specialisation between them is illustrated by the case of the world's first Digital Video Broadcasting-Handheld (DVB-H) mobile TV service by 3 Italia. The chapter concludes by arguing that this was a key mechanism behind the Korean handset manufacturers' transition process as it required the delivery of more sophisticated network services through customised handsets.

Chapter 7 deals with the issue of how the Korean handset manufacturers have expanded their global market shares while coping with the burden of co-specialisation with their downstream partners. It shows that Korean handset manufacturers utilised a new business organisation of ‘contract developer’ (See Chapter 7 for its definition) in connection with a global platform strategy. By using one of LG’ global platform models (the Shine Phone series) as an example, the chapter identifies the mechanism of how Korean companies implemented their platform strategies and utilised their contract developers over time in order to meet the demands of highly customised handsets from various MNOs globally.

Chapter 8 recapitulates the main findings from the three empirical chapters and draws out the implications of these findings for theories on the issue of the transition process of latecomer firms. In addition, it suggests implications of the thesis for management practioners of developing countries. It concludes with some of limitations of the thesis originating from a case study approach and therefore makes some suggestions for further research.

2. THEORETICAL BACKGROUND

2.1 Introduction

The main objective of this chapter is to articulate the transition process of emergent leading firms and to derive theoretical guidelines from a literature review for the analyses in the following empirical chapters. In order to do so, the thesis builds upon two different streams of literature: first the catching-up process in latecomer firms and second the boundaries of a firm and inter-firm coordination in technological frontier firms. From the first strand of literature, the chapter identifies theoretical and empirical gaps that the previous literature has not covered as a rationale for the thesis. Using the second strand of literature as a theoretical guide, a systematic analyses of the transition process of emergent leading firms is then carried out. This combination permits in a complementary manner the analysis of the transition process of latecomer high-technology firms.

This chapter is composed as follows. Section 2.2 identifies the motivation for studying the transition process of emergent leading firms. Starting with a definition of the latecomer firm, the section identifies the nature and distinctiveness of the contemporary catching-up process in comparison with those of earlier industrialisations[6]. Based on the literature review of the contemporary catching-up process and particularly its final stage, the section identifies the theoretical limitations and gaps, and uses this analysis to describe the rationale behind the research for the thesis. Section 2.3 then examines the

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6 The term 'late industrialisation' is used in many studies for a macro level approach to catching-up (Amsden 2003; Gerschenkron 1962), whereas 'late late industrialisation' is used for catching up by East Asian countries to differentiate this phenomenon from earlier catching-up processes (Shin 1996).

literature on boundaries of a firm and inter-firm coordination with regard to technological frontier firms as a way of building up the theoretical guidelines for subsequent empirical chapters. The review on boundaries of a firm compares transaction cost theories and capabilities view and highlights the differences and their complementarities in relation to emergent leading firms. In particular, drawing on multi-dimensional, dynamic and relational perspectives on firm boundaries, the issue of inter-firm coordination is employed to discuss the processes by which emergent leading firms compete against their frontier competitors in relation to their external suppliers and users. The chapter concludes with a summary of the features and implications of the transition process of emergent leading firms by linking these two (distant) streams of literature.

2.2 Catching up, latecomer firms and their transition to world frontiers

This section reviews the literature on latecomer firms and their catching-up process. The thesis first differentiates latecomer firms from firms representing different stages of entry in the context of the previously industrialised economies; these latter firms are typified as forerunners, followers and late entrants.

2.2.1 Forerunners, followers, late entrants and latecomers

First of all, what differentiates forerunners, followers and late entrants? By definition, there is a difference of time element between them. Forerunners are the first to arrive in a market and have to pioneer their own way without reference to other experience that can be observed. They face the problem of non-existent markets to varying degrees. In return, they are able to secure 'supernormal profits' if their attempts are successful (Shin 1996). In some cases, their 'forerunner' technology must compete against incumbent technologies – e.g. the motor car with the horse and carriage – and sometimes overcome uncertainty over the scale of the market for the new technology. In other cases, the forerunner firm is unable to match the performance of fast seconds (followers) that imitate or adapt the initial technology in commercially fruitful ways – e.g. the CT scanner or personal computers prior to the IBM PC (Teece 1986).

In contrast, followers and late entrants have a point of reference in being able to observe some of what forerunners have gone through in terms of technology and market developments. They can learn from the experience of forerunners, both of success and failure. However, they also have to compete against forerunners as well as with other followers and late entrants. Therefore, the existence of forerunners is both advantageous and disadvantageous to them (Lieberman & Montgomery 1988). In this vein, the difference between forerunners, followers and late entrants comes down to the 'order of entry' into the market, and both forerunners and followers and even late entrants can be considered as leaders. Hereafter, the thesis uses the term 'leaders' collectively for forerunners, followers and late entrants in advanced countries.

Latecomer firms look similar to late entrants in that they enter target markets at a later stage of industry life cycle in terms of their order of entry. However, latecomers have innate 'negative externalities' from their developing economy context (Radosevic 1999). Hobday (1995b, p.34) distinguished the term 'latecomer firms' from technology leaders in acknowledging two distinctive disadvantages: they are cut off 'from the main international sources of technology and R&D' and 'from international markets and demanding users'. Drawing on the resource-based view of a firm (Penrose 1959), Mathews (2002) similarly acknowledged a latecomer firm's poor endowment of resources and technology and market access. In this regard, the catching-up process of a latecomer firm can be understood as the process by which it incorporates mechanisms to compensate for those negative externalities.

2.2.2 Unique aspects of the contemporary catching-up process

The history of modern economic development provides us with a series of catching-up examples. These include the US and some European countries like Germany taking over from the UK in the second half of the 19th century, Japan taking over from the West after the Second World War, with the most recent example being East Asian countries taking over from the West and Japan from the second half of the 20th century onwards.

Early successful instances of catching-up share important similarities. Developing countries have benefited from the exploitation of 'borrowed technologies' from advanced countries despite newly imposed Intellectual Property Rights (IPRs) and other forerunner advantages (Gerschenkron 1962; Rosenberg 1970). At the same time, efforts of 'internal technology capability building' for borrowed technologies (Bell & Pavitt 1993) have been vigorously made in these instances. Rosenberg (1982, p.271–272) stated:

> The most distinctive single factor determining the success of technology transfer is the early emergence of an indigenous technological capacity. In the absence of such a capacity, foreign technologies have not usually flourished…the transfer of technology must not be conceived of as a once-and-for-all affair. It is not something that happens at a single point in time. It is, rather, an ongoing activity. Any perspective that ignores this fact is likely to distort the essential issues in technology transfer.

Odagiri and Goto (1996) showed that the Japanese textile and steel industries failed to utilise the imported British technologies and succeeded only through subsequent adaptation efforts by local engineers during early Japanese industrialisation. Bell and Pavitt (1993) also emphasised that there is no room for the simple innovation–diffusion models. They concluded that latecomers are required to build capabilities not only to modify, adapt and even improve foreign technologies according to local needs but also to make the right decision in the first place among a variety of candidate foreign technologies. Firms without such knowledge and technological capacity will lag behind.

The catching-up process in the second half of the 20th century, as had occurred mainly in East Asia, bears some distinctiveness in technical and market environments compared to earlier instances. Firstly, technologies have become more and more science-based (Rosenberg 1982) and systemic and complex with the emergence of information and communication technologies (Radosevic 1999; Steinmueller 2001). Some have argued that the science-based nature of borrowed technologies has increased the size of backwardness that latecomers had to cope with (Amsden 1989; Shin 1996). Rosenberg (1982) also contended that latecomer firms in East Asian countries would struggle to imitate and adapt foreign advanced technologies without proper absorptive capacity (Cohen & Levinthal 1990) in the 20th century due to the nature of contemporary technologies.

Market environments in the second half of the 20th century can be characterised by trade liberalisation among countries and globalisation of production by multi-national corporations (Radosevic 1999). The former neutralised an array of previous policy measures that ‘a developmental state’ (Amsden 1989; Evans 1995) adopted to promote its infant industries, and the capacity of a state to control its finance, trade, banking system and production has significantly decreased (Chang 2002). On the other hand, the latter resulted in the hike of foreign direct investment flow from multi-national corporations towards developing countries, and multi-national corporations gradually took the centre stage in the contemporary catching-up process (Ernst 2002). The less prominent role of a state and more conspicuous role of multi-national corporations in the contemporary catching-up process fundamentally changed the mechanisms and channels of international technology transfer.

However, the new technical and market environments have also created new channels for, and mechanisms of, a catching-up process. While efforts to catch up in heavy industries continued across developing countries, many firms in East Asia began their catching-up with competitive advantages based on cheap labour focusing on consumer goods in the latter half of the 20th century (Amsden 1989; Amsden & Chu 2003; Hobday 1995b); in particular, a unique and important feature arose in the electronics industry that offered relatively high value added to assembly on the basis of cheap labour without demanding heavy investment in capital equipment like other heavy industries. The export-led growth in East Asian countries was also an important feature in that it could generate economies of scale sufficient to attain sustainable growth in terms of quantity and introduce the sophisticated demands of advanced markets to keep pressure in terms of quality in spite of small and underdeveloped domestic markets (Amsden 1989).

For example, South Korea has succeeded in catching up from having been considerably behind in the second half of the 20th century. The process was initiated by the advantages of cheap labour in industries like the textile industry (although heavy industries did become important by the 1970s). In addition, Korea's breakthrough in electronics involved moving from being an assembler to being a system designer and component producer, a move which made it possible to become a world-leading frontier.

In summary, this section has explained that, despite sharing some similarities, the catching-up process in East Asia in the latter half of the 20th century occurred in the different contexts of technical and market environments and bears some unique features compared to earlier catching-up. This illustrates the necessity of research into the contemporary catching-up process on its own and, so far, the knowledge accumulated on this issue is considerable. More recently, observations from across different countries and industries have shown that a group of latecomer firms in newly industrialising economies, albeit few in number, have successfully cleared the final hurdle in the catching-up process and have begun to compete with forerunner firms. Despite some early studies, the existing literature does not reveal enough about how this 'final stage' in the catching-up process was achieved. It is this final triumph in the catching-up process that the thesis tries to examine. The next two subsections examine how this contemporary catching-up process and the final stage at the level of the firm occurred.

2.2.3 The contemporary catching-up process

This section describes the stylised model of the contemporary catching-up process and the mechanisms of technology transfer carried out by firms in East Asian countries.

Technology capability building by latecomer firms in East Asia

Rather than provide a general review of the literature on technology capability building within the contemporary catching-up process, this section introduces two influential studies by Kim (1997a) and Hobday (1995b) on latecomer firms in East Asia and uses them as the basis for a discussion on transition processes by emergent leading firms.

Based on Utterback and Abernathy's innovation model (1975) and Lee et al.'s model (1988), Kim (1997a) describes the catching-up process of Korean latecomer firms as occurring in three different stages: introduction, internalisation, and generation. In the first introduction stage, the dominant innovation activity is the acquisition of matured foreign technologies from developed countries, especially process technologies by assembling. In the second internalisation stage, the assimilation of adopted technologies occurs along with the development of the product design capabilities. In the last generation stage, latecomer firms finally acquire new product-development capabilities. Starting from process and moving to product innovation, this is exactly the reverse direction of the typical leadership innovation process.

Hobday (1995b), on the other hand, explains the catching-up process from the global production network perspective as a stepwise advancement from OEM through ODM, to OBM. Latecomer electronic firms in Korea and Taiwan started their catching-up phase as OEM assemblers of simple products based on cheap labour costs. Based on the accumulated capabilities by 'learning the art of assembly', they advanced to the second phase of ODM with some design capabilities to meet customers' requirements. Finally, they moved to OBM with their own brands, as well as in-house R&D.

Kim (1997a) and Hobday (1995b) captured much of the dynamics of the late 1980s and early 1990s in East Asia and both models are very useful in terms of their clarity and simplicity. However, subsequent developments in the field have shown that the last stage of both models seems to be problematical because the models suggest, at best, a deterministic single pattern; one of main rationales for this thesis is to examine the problems arising out of these two models. The models assume that latecomer firms in the final stage compete on the basis of technological supremacy and marketing autonomy; but recent developments of East Asian firms manifest several different paths, as will be discussed further in Section 2.2.4. What is emphasised here is that the status of OBM in latecomer firms is neither a necessary condition nor a sufficient condition for achieving a technological frontier level and should not be directly related to attainment of the technological frontiers. OBM is rather the consequence of reaching the frontier in marketing capabilities[7] where the producer is able to bring its product to the customer without the intervention of a firm with stronger brand recognition (and with which it has to share revenues).

Mechanisms of technology transfer from technology leaders to latecomer firms in East Asia

International technology transfer is mutually beneficial between latecomer firms and technology leaders. Through international technology transfer to latecomer firms, a technology leader in a developed country is able '(1) to prolong the life cycle of products that are becoming obsolete in the home market, (2) to find new, growing markets, and (3) to ensure its own survival by relocating production segments to developing countries where labour costs are lower' (Kim 1997a, p.223). Drawing on Fransman (1985), Kim (1991) provided a systematic categorisation of technology transfer mechanisms between technology leaders and latecomer firms with respect to

[7] In the marketing literature, marketing capabilities consist of market-sensing capabilities, (customer and competitor) relational capabilities, and brand management capabilities (Day 1994; Morgan et al. 2009; Smirnova et al. 2011)

market mediation and the role of foreign suppliers as shown in Table 2.1.

The mode in Cell 2 is transfer of technologies embodied in goods as a commodity such as capital goods (standard machinery) and components. It is clearly mediated by the market but the role of foreign suppliers is limited because the transfer of knowledge occurs as a form of commodity trade where there are competitive sources of supply. Therefore, foreign suppliers have limited control over the process. Cell 3 includes various forms of informal imitation mechanisms such as reverse engineering, observation, trade and technical journals. It is not mediated by the market and nor is it involved with foreign suppliers. Kim (1991) stresses that absorptive capacity (Cohen & Levinthal 1990) of the recipients really matters in determining how much they can materialise the potential of technology transfer in both Cells 2 and 3.

Table 2.1 Modes of foreign technology transfer

Market mediation	**The role of foreign suppliers**	
	Active	**Passive**
Market mediated	Formal mechanisms (Foreign direct investment, foreign licensing, turnkey plants, consultancies) **Cell 1**	Commodity trade (Standard machinery transfer) **Cell 2**
Non-market mediated	Informal mechanisms (Technical assistance of foreign buyers and vendors through OEM, ODM contracts) **Cell 4**	Informal mechanisms (Reverse engineering, observation, trade and technical journals, etc.) **Cell 3**

Source: Originally introduced by Fransman (1985) and modified by Kim (1991, p.224).

The mode in Cell 1 denotes formal forms of international technology transfer such as foreign direct investment, foreign licensing, technical consultancy and made-to-order machinery. In this mode, the process is mediated by the market, and foreign suppliers play an active role in negotiating terms and conditions of technology transfer[8]. Lastly, technology transfer in Cell 4 comes from OEM/ODM arrangements between latecomer firms and foreign buyers. In this mode, foreign buyers deliberately provide latecomer firms with technical know-how and assistance to meet product specifications. Therefore, the mode in Cell 4 occurs with the relatively active role of foreign buyers without a formal market transaction.

In summary, international technology transfer between latecomer firms and technology leaders occurs via a variety of formal and informal mechanisms. Concerns may arise over 'boomerang' effects of international technology transfer, the contention being that technology leaders should stop transferring technologies to latecomer firms. In what follows, the thesis considers whether this argument is plausible.

Can technology leaders stop technology transfer to latecomer firms?

With respect to the possibility of hindering technology transfer to a latecomer firm, Rosenberg (1982, p.270) contended:

> The transfer of industrial technology to less developed countries is inevitable. Indeed, as we have seen, the process has already been going on for about a century and a half, and there is no compelling reason to believe that it will stop. Not only is industrialisation elsewhere inevitable, but so is some alteration in the relative positions of the industrial countries…Thus, a historical perspective suggests that the central questions are not whether industrial technologies will be transferred, but rather when it will happen, where it will happen, which technologies will be transferred, how they will be modified in the process, and how rapidly this process will occur.

[8] Countries like China which have a big domestic market may coerce foreign firms into technology licensing in return for access to the market, the mechanism of so-called 'trading market for technology' (Mu & Lee 2005).

Moreover, there have been numerous historical examples of such attempts to prevent technology transfer from developed countries to developing countries. In the early days of industrialisation, for instance, Britain prohibited the export of its industrial technologies such as the emigration of British artisans until 1825 and the export of new machinery until 1842. Yet around two thousand British artisans had emigrated to the Continent by 1825, and the adoption of the modern British spinning factory (first established in 1771) across the Continent had taken place by the end of the century (Clark 1987).

In the context of the contemporary catching-up process, Kim (1991) has provided explanations in a more systematic way based on Table 2.1. Firstly, he contends that Cells 2 and 3 leave no measures for technology leaders to stop technology transfer by definition of their passive role. As a pure market transaction of commodity trade, stopping the mode in Cell 2 may hurt the growth of capital goods/components producers in developed countries, particularly when producers in these countries face rivalry from other advanced country producers. The transfer mode in Cell 3, which includes mechanisms such as reverse engineering and information gathering, solely depends on latecomer firms' absorptive capacity (Cohen & Levinthal 1990).

In Cells 1 and 4 where the role of technology leaders is active, the situation needs more complex explanation. In case of the transfer mode in Cell 1, Kim (1991) argues that the restriction on foreign licensing will shorten the life cycle of technology leaders' technologies or products and that on foreign direct investments will harm technology leaders due to competition with other multi-national corporations. Moreover, latecomer firms may actively turn to other multi-national corporations for alternative sources or sometimes take the risks of moving to other technology transfer modes such as Cell 3. In case of Cell 4, Kim contends that technology leaders themselves do not want to break OEM or ODM arrangements with latecomer firms as the former need to keep their international price competitiveness through the mode.

Therefore, it seems reasonable to assume that the collaboration between technology leaders and latecomer firms will continue as a form of technology transfer. Subsection 2.2.4 below discusses this issue in more detail in consideration of windows of opportunity in the context of an emerging market.

2.2.4 Transition of emergent leading firms and windows of opportunity in an emerging stage

Based on some early research on the transition of emergent leading firms, this section seeks the rationale for the research on the final stage of catching-up – a 'transition process' by emergent leading firms – and discusses windows of opportunity for emergent leading firms in the context of an emerging market.

Rationale for the transition process of emergent leading firms and their hardships

First of all, the term transition process needs to be unified. Several different terms have been used in the literature with respect to the challenges of emergent leading firms in the second half of the 20th century. While the Science Policy Research Unit (SPRU) of the University of Sussex in the UK originated studies (Dutrénit, 2000; Hobday et al., 2004) utilising the term 'transition phase or process'[9], most of the Korean studies (e.g.

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[9] When a term needs to imply the meaning of a mechanism, 'transition process' is preferentially used. Otherwise, 'transition phase' and 'transition process' are used interchangeably.

Choung et al. (2000) and Song et al. (2006)) preferred ‘post catch-up stage’. The term ‘post catch-up stage’ has been widely used in the Korean literature because in the Korean language the term has the distinctive meaning of the discontinuity between the catching-up stage and the frontier stage. Here, the thesis uses the term ‘transition’ as it is written in English and in what follows, the meaning of the term is specified.

Emergent leading firms in East Asia have exemplified more varied forms of business than is suggested in the literature[10]. Rather than advancing to OBM in order to capture more value added as Hobday (1995b) has suggested, several Taiwanese firms actually stayed as ODMs. The data on Taiwan IT exports between 1993 and 2002 in fact show that the percentage of OEM and ODM in most export products had increased (Chu 2009). Moreover, some Taiwanese electronics manufacturing firms even transformed themselves into firms specialising in manufacturing, so-called ‘contract manufacturers’ or ‘electronics manufacturing services’: examples are firms like Foxconn and Pegatron, the annual company sales of which amounted to $[11]139 billion and $31 billion respectively as of 2014[12]. They are different from conventional OEMs in that they acquire contracts from multiple customers for multiple products based on their competitive advantages of economies of scale in manufacturing services, which was possible due to their access to the low-wage labour force of the Chinese mainland. Other Taiwanese firms such as the Taiwan Semiconductor Manufacturing Company (TSMC) and the United Microelectronics Corporation (UMC) specialised in a

[10] Lee and Lim (2001) showed several technological trajectories from the cases of Korean emergent leading firms, categorising them into three groups: path-following, path-skipping and path-creative catching up.
[11] All reference to ‘$’ in the thesis is to US dollars.
[12] *Manufacturing Market Insider*, ‘Inside the contract manufacturing industry’, http://mfgmkt.com/wp-content/uploads/2015/04/March-2015-revised.pdf, accessed 13/09/2015.

semiconductor foundry business to serve multiple fabless semiconductor companies in advanced countries[13]. The former is not only the world's largest semiconductor foundry company but was also the world's third largest semiconductor company in terms of its revenue in 2012[14]. Yet several conglomerate firms, especially from Korea, competed with their own brands on the basis of new products and in-house R&D as described in the literature. ASUS from Taiwan has also successfully negotiated the transformation from ODM to OBM, increasing its brand presence in the overseas market (Kuo 2009). The problem here is that the competitive advantages that each group of emergent leading firms are based on are different in each case. Therefore, it is important to analyse each group of them separately.

The thesis focuses on the last group of emergent leading firms; they compete head on with technology leaders in advanced countries. They have to transform their competitive advantages from original cost advantages to incremental process and production capacities, and finally to in-house R&D with their own brands, namely a 'dual frontier' of technology supremacy and market autonomy. A dual frontier involves the most dramatic changes in terms of the competitive advantages that emergent leading firms rest on. This group of emergent leading firms should not only develop a cutting-edge product but also adjust their organisational routines and customise their products to specific demands across different markets, the process of which is a prerequisite to compete at the top level but not an easy task with high-technology product markets like mobile phones that the thesis studied. In this regard, the thesis applies the term

[13] Anam in Korea also became its own kind of firm, being a packaging-only service for semiconductor chip-makers (Hobday 1995a).

[14] http://www.icinsights.com/news/bulletins/PurePlay-Foundries-And-Fabless-Suppliers-Are-Star-Performers-In-Top-25-2012-Semiconductor-Supplier-Ranking/ (accessed 15/09/2013).

'transition' to a group of emergent leading firms who advance to compete in the same segments of markets with their technological leaders, hence pursuing a dual frontier.

The question then becomes 'why did previous studies differentiate the transition of emergent leading firms from latecomer firms engaged in catching-up?' And 'what is the rationale for studying it as a separate topic?'

The first rationale arising from previous studies comes from the assumption that transition or transformation is accompanied by change in the structure of capabilities or competitive advantage within these emergent leading firms. Drawing on the literature on both strategic management and marketing based on resource-based view of the firm (Barney 1991; Day 1994; Eisenhardt & Martin 2000; Richardson 1972; Teece et al. 1997; Smirnova et al. 2011), capabilities here are defined as a firm's ability through its organisational processes and routines to co-ordinate, integrate, and leverage its internal and external resources of technical and marketing knowledge, experience and skills to address market requirements. In particular, emergent leading firms are required to reconfigure their internal and external resources in their transition not only to produce a high-technology product but also to market the product to a variety of markets at the world frontier level as 'dynamic capabilities' suggested (Eisenhardt & Martin 2000; Teece et al. 1997). The following studies raise issues in that regard.

In the earliest in-depth research (using the case of a Mexican glass company, Vitro-Glass Containers), Dutrénit (2000) conceived the transition process as a step of building new core/strategic capabilities from an earlier simple knowledge base. On the other hand, Kuo (2009) and Chu (2009) rely on Hobday's transition model (1995b) of contract manufacturer or ODM to OBM derived from the case of Taiwanese electronics firms. From the resource-based view of a firm, Kuo (2009) argued that some of a firm's innovation capabilities, which used to be useful for contract manufacturer or ODM business, become obsolete in the OBM stage of business development. Therefore, new innovation capabilities needed to be developed to meet new market demands. In this regard, Kuo's concept of a latecomer firm's transition process describes how a latecomer firm manages this reconfiguration of innovation capabilities within itself. Hobday et al. (2004) argue that if latecomer firms decide to enter the OBM stage, global leading firms would show a growing reluctance towards technology transfer to those latecomer firms. Losing earlier access to advanced technologies and sophisticated market demands, emergent leading firms face a strategic dilemma over whether they should take the high risk of in-house R&D investment and build their own brand or stay in either OEM or ODM business as before. In this regard, emergent leading firms have to be different from what they used to be (Chu 2009) and confront different levels of technological and managerial challenges, requiring realignment and adjustment of internal capabilities within their organisations as Teece el al. (1997) stressed.

A number of researchers also observed other common problems that emergent leading firms faced. Firstly, Dutrénit (2000) and Hobday et al. (2004) identified the problem of the unevenness of the knowledge bases within these firms. According to Dutrénit (2000), Vitro-Glass Containers pursued two distinct technology strategies in parallel. It tried to build the capabilities that were required for it to reach technological frontiers in certain areas, and at the same time pursued a fast-follower strategy in others[15]. The failure to

[15] In the case of Korean mobile handset manufacturers, a portfolio strategy approach was applied within the same business unit for a short period. When the first commercialised CDMA network began to

coordinate an uneven depth of technological capacity across different organisational units within the firm was attributed to the failure of the firm's transition process. Similarly, Hobday et al. (2004) contended that Korean latecomer firms, which are mostly conglomerates selling a wide range of products at the same time, adopted a 'portfolio strategy' across different products. These firms held leading positions in some product areas, were followers in other areas, and remained latecomers in yet other areas within the same entity (or OBM/ODM/OEM in the same firm).

The second rationale used in early studies suggests emergent leading firms are required to internalise activities with regard to both generations of new technologies and marketing capacity[16], requiring significant additional investment in human and financial resources. Chu (2009, p.1057) describes this burden as:

> ...branding requires the firm to produce its own inventory rather than for order. To market the products in the developed countries... requires a large amount of long term investment; i.e. building new warehouses, setting up sales offices in the export market, learning about the export market, committing funds for promotion, arranging new lines of long term credit to finance these activities, and so on.

Kuo (2009) showed that Taiwanese firms making transitions initially confronted the loss of contracts from their OEM/ODM clients due to the business overlap originating from their OBM business. Unlike Korean conglomerate firms, most Taiwanese firms were specialised and therefore they could not abandon their OEM/ODM business until their

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provide services in 1996, LG designed and produced its own model of a mobile handset (OBM) while it also assembled mobile handsets designed by Qualcomm (OEM). By assembling Qualcomm's handsets, LG had the chance to look closely at the design of handsets that were at technological frontiers.

[16] In the marketing literature based on resource-based view of the firm, it comprises customer and competitor relations, brand management, and innovation capabilities (Day 1994; Morgan et al. 2009; Smirnova et al. 2011).

OBM business had become well established because these types of business were a major source of cash flow for their transition to OBM business. Kuo (2009) showed that some Taiwanese emergent leading firms had to return to ODM business but some were relieved from the conflict with foreign buyers by splitting their business units into independent entities.

Last but not least, Hobday (1995b) implied that emergent leading firms pursuing a 'dual frontier', by definition, also open up the possibility of uneven development between marketing and technology stages within their organisations. In explaining the 'stages of marketing and technology assimilation', Hobday (1995b, p.42) contended,

> There may not always be systematic, causal links between the stages of technology and market development. It is theoretically possible for a firm to acquire advanced technological skills but still remain at the early stages of marketing – or vice versa. However, it is likely that latecomer firms will tend to improve both their technology and marketing capabilities simultaneously

Reading customer needs, especially customers distant from a domestic market, may expose emergent leading firms to high risk even though they are fully equipped with cutting-edge technologies. Building up their brand values and distribution channels (marketing capabilities) is as time and money consuming as acquiring cutting-edge technologies (Chu 2009), and implies the possibility of uneven development even between technology and marketing stages within emergent leading firms (e.g. technologies are at frontier level but weak brand values[17] lie behind frontier level).

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[17] Brand awareness was defined as 'a rudimentary level of brand knowledge involving, at the least, recognition of the brand name. Awareness represents the lowest end of a continuum of brand knowledge that ranges from simple recognition of the brand name to a highly developed cognitive structure based on detailed information ... the distinction between awareness and recognition is a subtle one, the former denoting a state of knowledge possessed by the consumer and the latter a cognitive process resulting from awareness' (Hoyer & Brown 1990, p.141). The literature supports positive effect of strong brand

Such uneven development may serve as another important obstacle for the transition process. Hobday (1995b) did not provide an explanation of its consequences on the transition of emergent leading firms, which will be analysed in detail in Chapter 6.

The issues identified above suggest that having nearly closed the gap with their forerunners, emergent leading firms may still need to establish a collaborative relationship with foreign forerunners (at least during an early stage) for access to technologies and market. Some early studies support this argument, at least in the case of technologies. Although not directly tackling the issue of catching-up, the case of Korean handset manufacturers studied by Whang (2009) illuminated how emergent leading firms successfully engaged with their external partners in the course of handset convergence. Lee et al. (2005) also showed in the digital TV industry the successful cases of the Korean emergent leading firms Samsung and LG; these firms succeeded, not by pure endogenous capabilities but by collaboration with, or acquisition of, foreign partners for new nascent technologies. In this regard, the final stage in earlier catching-up models may confine the scope of analysis within boundaries of latecomer firms and lead to the misunderstanding of the catching-up process; therefore, this thesis seeks to expand the scope of the analysis beyond the boundaries of emergent leading firms and towards their external partners.

Windows of opportunity and the transition of emergent leading firms in an emerging stage

This section expands the discussion of Section 2.2.3 and examines windows of opportunity in an emerging stage of industries from the perspective of emergent leading

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awareness on consumer’s choice (Hoyer & Brown 1990; Macdonald & Sharp 2000).

firms. According to Perez and Soete (1988), there are windows of opportunity available for latecomer firms under the emergence of a new technology paradigm. In this emerging stage of technologies and markets, advantages such as low entry cost and no lock-in effect to old technologies work in favour of latecomer firms rather than incumbent forerunners. This argument is now extended to the transition of emergent leading firms.

Stigler (1951) and Rosenberg (1976) argue that firms in the early stage of a new industry are initially vertically integrated because demands in the stage are not profitable enough for specialised suppliers to emerge, but in later stages the market expands sufficiently to allow for the differentiation of the production process and the emergence of various specialised suppliers. In the context of developing economies, Kim (2000, p.4) also argued that ‘when engineering infrastructure is weak and capable component manufacturing firms are rare, as was the case in Korea, vertical (backward) integration would be a more plausible option for the assemblers’. However, the assumption of vertical integration brings several challenges to emergent leading firms. It seems unlikely that emergent leading firms in developing economies by definition have mastered all necessary technology areas to be vertically integrated. As Dutrénit (2000) and Hobday et al. (2004) suggested, the uneven development of technological areas within these firms is common. In this regard, the pure form of vertical integration does not seem to be a viable option for most of emergent leading firms, and collaborative arrangements with external forerunner partners seem inevitable.

Obvious questions to emerge from the discussion above are: will there be forerunner firms who pursue the partnerships with emergent leading firms? And, if so, what would be their motives for the partnerships?

Firstly, the argument of Soete (1985) and Steinmueller (2001) provides one logic to these forerunners. They argued that competition among forerunner firms could produce opportunities for technology transfer. Established technologies that continue to be improved attract a wide range of competitive firms in developed economies. Some of them are likely to be successful in technological development but not in product markets. It is these companies that try to preserve some part of the investment made and sell their knowledge assets in knowledge markets. This logic can be applied to an emerging market as well. An emerging market based on new technologies will attract a wide range of competitive firms in the developed economies. But not all of these firms retain sufficient capital to the point when product markets are created. Some companies may have a financial problem from losing shares in their previous businesses or others may be small venture companies generally struggling to finance for the long term. It is these forerunner firms that are interested in partnerships with emergent leading firms. For example, LG acquired shares of financially struggling Zenith in the pursuit of access to digital TV technologies (Lee et al. 2005), and Samsung was also able to obtain new Dynamic Random Access Memory (DRAM) design technologies from smaller venture-capital funded companies in the US who required the infusion of R&D investments for their survival (Kim 1997b).

Another possibility in this category is that there is competition to achieve a dominant compatibility standard among forerunner firms. In this case, forerunner firms are likely to have incentives to attract as many allied companies as possible in order to set their technologies as a dominant standard. In addition, some countries may command technology transfer by setting a national standard in return for ensuring the market, so-called 'trading market for technology' (Mu & Lee 2005).

Secondly, another forerunner group who may wish to collaborate with emergent leading firms can arise from its different knowledge base; the group may comprise firms that had been specialised suppliers in their industry and that may prefer to remain as specialised suppliers in a newly emerging market. For example, Hyundai Motors Corporation was able to develop a new compact car engine (the α-Engine) in collaboration with its English engine design maker, Ricardo, when Mitsubishi Motors refused to transfer its engine design technologies to Hyundai Motors Company (Lee 2005). POSCO, a group comprising the top five steel producers in the world, also developed the FINEX (fine iron ore reduction) process based on its shop-floor knowledge, initially through the technology transfer of VAI's (an Austrian engineering company in the steel industry) embryonic COREX (coal ore reduction) process (Song & Song 2010). Other groups may comprise specialised supplier firms as well but from adjacent industries and they would participate in a new industry in the case of technology or product convergence.

Firms that have a specialised knowledge base sometimes require a downstream knowledge base to complete their embryonic technologies to a commercial level. Therefore, these firms have incentives to collaborate but in order to realise them, emergent leading firms wishing to set up partnerships will have to have complementary assets to attract these forerunner firms. One example is the case of General Instrument (GI), a cable TV equipment maker in the US. Without previous experience in the production of TV, it collaborated with Samsung, which was an analogue TV producer, in order to develop a prototype of a digital TV (Lee et al. 2005).

If windows of opportunity exist for an emergent leading firm as suggested above, the issue for them comes down to the nature of technologies licensed to the recipient. Technologies licensed to emergent leading firms in the above examples were in a primitive form in both technical and commercial terms, and hence products from those technologies were also yet unproven in their markets. Therefore, the question shifts from the issue of whether or not there will be an opportunity of technology licensing for emergent leading firms, to one of how an emergent leading firm can successfully manage to master, upgrade, and finally commercialise unripe technologies licensed from leaders to a commercial level; this second issue is examined in more detail in Chapter 5.

The discussion so far implies that the analysis of the transition of emergent leading firms focusing on their internal aspects does not seem to capture the whole landscape of these transitions properly. Challenges for the transition of emergent leading firms and availability of windows of opportunity suggest that the scope of the analysis should extend the boundaries of emergent leading firms. It is these aspects that link the literature on the transition of emergent leading firms with the literature on boundaries of a firm and inter-firm coordination.

2.3 Boundaries of a firm and inter-firm coordination

This section draws on the theoretical implications from the literature on boundaries of a firm and inter-firm coordination to examine how emergent leading firms can reconcile their innate deficiencies such as the uneven progress of technologies during the pursuit of a dual frontier.

The boundaries of a firm are determined by those activities that are subject to direct control compared to those that require negotiation with other parties or that are entirely outside the significant influence of the firm. The literature on boundaries of a firm is mainly concerned with why firms establish their boundaries with markets in a certain way and what factors influence decisions in the design of these boundaries. This is a very important strategic issue for the competitiveness of a firm, and in case of emergent leading firms, these kinds of decisions are likely to be affected heavily by their capabilities, sometimes leading to narrower firm boundaries.

In this vein, this section reviews theories on boundaries of the firm among technology leaders and highlights the implications of these theories in the pursuit of a dual frontier by emergent leading firms. The contractual view of the firm based on transaction cost, and the capabilities view of the firm based on firm-specific capabilities, are two main strands of literature. Both views are reviewed in this section in terms of dichotomic make or buy decisions, and – acting upon recommendations from recent reviews in the literature on the boundaries of a firm – the section then discusses the hybrid mode of a firm organisation based on various inter-firm arrangements. The implications of boundaries of the firm and inter-firm arrangements are also discussed in the context of emergent leading firms and the industry which is the subject of analysis in this thesis, i.e. the mobile handset industry.

2.3.1 Transaction cost theory: contract level

Transaction cost theory, mainly led by industrial organisation economists, aims to provide a theory of firm boundaries. Transaction cost theory conceives of a firm as a 'nexus of contracts' economising transaction costs. It assumes that there are coordination costs for negotiating, contracting and enforcing when we use the price mechanism of markets (Coase 1937). It argues that firm boundaries are determined in order to minimise these transaction costs which in turn arise from asset specificity, uncertainty, and the corresponding opportunisms and bounded rationalities of contract partners (Williamson 1985). For example, firms tend to vertically integrate when suppliers need to invest assets with high asset specificity which can be used only for a particular producer (Afuah 2001).

Industrial organisation economists have extended the theory with regard to the issue of 'hold-up' from relation-specific assets between suppliers and producers (Klein et al. 1978) and have contended that vertical integration occurs to resolve 'hold-up'. Joskow (1985; 1987) empirically verified Williamson (1985) by studying the relation-specific investments and contract duration in US coal markets. Monteverde and Teece (1982) also showed that producers sometimes purchase and provide manufacturing equipment (relation-specific assets) to their suppliers to avoid the possibility of 'hold-up'. This partial integration enables producers to acquire 'residual right of control' (Grossman & Hart 1986) over manufacturing equipment owned by suppliers and therefore remove the fear of 'hold-up' between suppliers and producers.

Transaction cost theory mainly pursues the question of what institutional arrangements will minimise the transaction costs of achieving an objective. Because of its attempt to derive general principles with regard to institutional arrangements, it does not take account of the heterogeneity of a firm's capabilities to implement market transactions

(Jacobides & Winter 2005). In this regard, Williamson (1999, p.1103) mentioned that the earlier question put forward by himself, ‘What is the best generic mode (market, hybrid, firm) to organize X?’ should be replaced by the question ‘How should firm A which has pre-existing strengths and weaknesses (core competences and disabilities) organize X?’ in the case of important and less frequent transactions of the firm. The lack of consideration of the role of firm heterogeneity in determining the boundaries of a firm in transaction cost theory seems to entail a larger problem in the case of emergent leading firms. Due to the negative externalities of emergent leading firms in resources and capabilities, transaction cost theory does not cater for the type of a question that this thesis asks.

2.3.2 Capabilities view: firm level

The resource-based view was articulated in terms of a consideration of the limits to firm growth by Penrose (1959) and has come to focus on the internal resources of a firm; it conceives of a firm as a bundle of resources, which include those that are tangible (physical assets), intangible (technology, reputation and culture) and human (skills and knowledge embodied in employees) (Grant 1998). Later authors have noted that firm-specific capabilities emerge when these resources are organised, coordinated and utilised within a firm’s own organisational routines (Nelson & Winter 1982), and capabilities that are a source of sustainable competitive advantage have been termed core capabilities (Leonard-Barton 1992). These capabilities are valuable, rare, imperfectly imitable and non-substitutable (Barney 1991) and therefore sticky (i.e. relatively immobile) and firm-specific. They have to be systematically nurtured through learning within the boundaries of the firm. Core capability theory provides a guide as to what activities the company should maintain in-house and what it should outsource to the market.

Some researchers have further attempted to evaluate the effects of changing conditions, a dynamic perspective that investigates questions like whether or not firms with a vertically integrated structure perform better when they face an emerging stage of technologies or technological changes that are competence-destroying. Afuah (2001) argued that firms need to be vertically integrated into new technology during technological discontinuities while being able to move towards market transactions for technologies that are mature or nearing obsolescence. On the other hand, Langlois and Robertson (1989) reject a single general theory because of the experiences of the early US automobile industry, contending that many factors such as type of innovation, level of market demand and degree of specialised suppliers all affect the performance of vertical integration in a combined manner. Still, the dynamic perspective implies that if an emergent leading firm enters an emerging market (the situation analysed in this thesis), it needs to master a wide array of technology areas to cope with frequent technical changes, which is common in an emerging stage.

In summary, while transaction cost theory looks at recurrent dyadic transactions from the perspective of selecting the best institutional arrangement for coordinating acquisition, the capabilities view adopts a firm-level approach which can be thought of as the assessment of the make or buy decision. The two theories overlap when transactions are recurrent and numerous, with the resource-based view providing further guidance about the risks of dissipating a firm’s core competences, even if these are frequently exercised. However, when transactions are episodic and large, it makes more sense to take account of the firm’s capabilities for particular transactions rather than creating a general rule. Many of the issues this thesis will consider actually involve large and relatively infrequent transactions, such as the decision to license or construct technologies. For this reason, this thesis will primarily employ the capabilities view; in this view, a firm's capabilities are heterogeneous and dynamic over time and accordingly boundaries of firms will be designed and adjusted. Therefore, the heterogeneity of a firm's capabilities will result in heterogeneity of its boundaries. In this regard, the capabilities view also seems more suitable to reflect on the features of an emergent leading firm.

2.3.3 Inter-firm coordination: beyond firm level

Subsequent research on theories on the boundaries of the firm has been extended to inter-firm relationships, adding upstream suppliers and downstream users in the analysis. The systemic nature of technologies leads to the increasing importance of managing a close inter-firm relationship with a system-integrator firm as a focal point linked to upstream and downstream chains, extending our interests beyond the boundaries of the firm. This section reviews the nature and sources of competitive advantages of inter-firm coordination and how they are sustained, especially in the context of the case studied here, i.e. the mobile handset industry.

Multi-dimensionality of boundaries of a firm in the systemic nature of technologies

Although the concept of modularity (Sanchez & Mahoney 1996) provides a strategic guide to what a firm should do at a later stage in its product life cycle, several authors have shown that this is not necessarily the best strategy (Brusoni 2001; Prencipe 2000; Takeishi 2002).

From an empirical study on the division of labour between the automaker Toyota and its first-tier suppliers in Japan, Takeishi (2002) argued that knowledge partitioning is different from task partitioning. Unlike regular projects which have clear-cut boundaries, innovative projects require automakers to have both architectural knowledge and component-specific knowledge. In order to maintain both levels of knowledge, Toyota co-developed innovative components with suppliers while leaving the production of those components to suppliers. In a similar study on the aircraft engine industry, Prencipe (2000) also found that aircraft engine makers as system integrators retained their capabilities not only at a system level but also in some components, innovations of which affect design of a system even though the engine makers do not produce those components. By differentiating two boundaries of a firm, namely knowledge boundaries and production boundaries, he concluded that the former, 'what firms know', are wider than the latter, 'what firms do' (Brusoni et al. 2001)[18].

These studies showed that production of a product and production of technological knowledge supporting a product do not always occur in the same place and, as a matter of fact, boundaries of production and knowledge are not the same. Therefore, it may be appropriate to take a multi-dimensional perspective when we interpret boundaries of a firm as there is a clear distinction between the division of labour in knowledge and the division of labour in production between suppliers and producers. In the setting of a multi-technology and multi-component product, producers as system integrators should retain component-specific knowledge as well as system-integrating capabilities over core components which may entail the change of system architectures despite high

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[18] These types of boundary arrangements were realised only through close cooperative relationships between system integrators and component suppliers; this is the main reason that the multi-dimensional perspective of firm boundaries is presented in Section 2.3.3 on inter-firm coordination.

modularity and an increasing trend towards outsourcing.

Of particular note here is that even though automobile and jet engines are relatively mature products, both are still products in which technological change is competitively important. Utterback and Abernathy (1975) examined the automobile industry before a number of important changes in the electronic content, fuel economy and environmental regulations changed the competitive dynamics of this industry. Therefore, where technological changes are prevalent, multi-dimensionality of boundaries should be carefully considered. Aggregate measures of firm boundaries may lead to a wrong snapshot of such boundaries. The fact that both parties may look similar in terms of their production boundaries, namely 'what they produce', does not mean that the boundaries of a latecomer firm and a technology leader are identical. They may be significantly different in terms of their knowledge boundaries, 'what they know', as Brusoni et al. (2001) stressed. For example, as will be further discussed in Chapter 4, Nokia outsourced the production of its baseband chips to Texas Instruments while it kept developing its protocol stack[19] for the Global System for Mobile communications (GSM), Enhanced Data rates for GSM Evolution (EDGE), and Wideband Code Division Multiple Access (WCDMA) baseband chips until 2005. In the meantime, Korean handset manufacturers sourced both their baseband chips and protocol stack from external baseband chip suppliers. In this instance, production boundaries of both sides may look the same but knowledge boundaries of them are unequivocally different and, therefore, the strategies adopted by both parties are fundamentally different.

[19] 'Protocol stack' in the mobile telecommunication technologies is the term for the family of telecommunication protocols between a baseband in a mobile handset and a base station to secure reliable communications. These protocols are called a 'stack' as they are generally modularised as layers to make design and evaluation easier (definition provided by a protocol stack engineer).

Relational view and joint competitive advantages beyond firm boundaries

Advantages from close inter-firm relationships have been well documented in the literature for the past two decades. Long-term collaboration enhances relation-specific knowledge and skills, which can be acquired only through repetitive transactions with specific partners. These relation-specific capabilities allow partners in alliances to develop a product with better performance based on customised components and facilities. Therefore, a close inter-firm relationship can bring to participants greater gains than a conventional arms-length procurement relationship or a firm hierarchy (Dyer 1996; Dyer & Singh 1998; Jap 2001).

Relational view and competitive advantages beyond firm boundaries

While other studies on inter-firm alliances have been largely phenomenological and empirical, Aoki (1988) formalised the theory of cooperation from the success of the Japanese car manufacturing industry based on its unique subcontracting system.

Aoki interpreted that in Japan a close inter-firm relationship in the form of subcontracting was regarded as a form of quasi (or partial) integration. He recognised that the organisational form of quasi integration has advantages over vertical integration. Quasi integration with a close inter-firm relationship allows prime manufacturers to utilise their subcontractors' resources without the governance costs of vertical integration. It can draw relation-specific investments in skills and products that are fully customised for prime manufacturers while keeping informational efficiency between manufacturers and suppliers, and endowing suppliers with the autonomy to explore new R&D opportunities. He termed surplus of rent originating from relation-specific investments as ‘relational quasi rent’. Aoki (1988, p.128) explained the mechanism in the way relational quasi rent is created through the bilateral collaborations between manufacturers and their suppliers:

> …that there arise group-specific economic returns attributable to the relational cooperation between the prime manufacturer and its subcontractors… One may call such returns relational quasi rent in the sense that it is generated by the unique informational efficiency of relational contracting in the subcontracting grouping…

In the same vein, Asanuma (1989) also addressed different relation-specific skills that suppliers accumulate according to types of components in his study of the Japanese automotive industry. In the industry where customised components are common, he classified automobile parts into three categories depending on the division of design activities between suppliers and car manufacturers: drawing-supplied parts, drawing-approved parts and marketed goods-type parts. In his classification, drawing-supplied parts suppliers only provide to car manufacturers capabilities for manufacturing while drawing-approved parts suppliers provide capabilities in design and development as well as manufacturing. Finally, marketed goods-type parts are transacted as a pure market relationship without any interactions between suppliers and car manufacturers. By categorising them, Asanuma argued that suppliers require and accumulate different relation-specific skills (or capabilities) according to their relationship with car manufacturers. These skills or capabilities can be developed through repetitive transactions with their buyers and added to their original capabilities. Therefore, they can be acquired only through longstanding relationships with buyers. He clearly addressed the fact that these skills are the source of surplus value added (relational quasi rent (Aoki 1988)) in comparison with pure market transactions.

Dyer and Singh (1998) approached the issue of inter-firm coordination with respect to sources of competitive advantages. They advocate the relational view in that firms' competitive advantages sometimes come from a combination of network firms' resources, which are beyond firm boundaries. They listed sources of inter-organisational competitive advantage as (a) relation-specific assets, (b) knowledge-sharing routines, (c) complementary resources/capabilities and (d) effective governance, and further outlined how relational rents can be preserved over the long term. They contended that the close relationship between two parties can be sustained in that inter-organisational assets are interconnected and their resources are indivisible. In addition, they argued that partners who have complementary assets and capabilities are scarce in practice and thus their relationship can be sustained.

Co-specialisation and directions of relation-specific investments

The concept of co-specialisation was originally proposed by Teece (1986) to explain who actually appropriates value from innovation. He embodied dyadic dependence between assets and innovation through the concept of specialisation. He used the labels 'specialised' when either assets or innovation showed unilateral dependence on each other and 'co-specialised' when they showed bilateral dependence. Co-specialisation may look similar to Chesbrough's 'open innovation' in that the latter argues that firms should take full advantage of both internal and external resources (Chesbrough 2007). However, open innovation does not speak to the issue of why and how partners collaborate, market transaction of intellectual property, nor encompasses the mutual dependency of their resources based on long-term inter-firm collaboration, which is the essence of Teecean type inter-firm collaborations.

Drawing on the concept of Teece (1986), 'co-specialisation' can be applied to the phenomenon of two parties investing relation-specific assets in each other. If only one side invests relation-specific assets, this can be labelled as 'unilateral specialisation'. As well as differentiation between co-specialisation and unilateral specialisation, there is a necessity to differentiate two opposite types of unilateral specialisation. As with vertical integration, where we call upstream-side integration 'backward integration' and downstream-side integration 'forward integration', this thesis will employ the term 'forward specialisation' if only the upstream firm invests in relation-specific assets for the downstream firm and 'backward specialisation' if the downstream firm invests in relation-specific assets for the upstream firm. This extension of co-specialisation will be used to elucidate inter-firm coordination of Korean handset manufacturers with upstream and downstream partners in the empirical chapters of 6 and 7.

Multi-dimensionality of capabilities with respect to co-specialisation

Some studies have identified that the capabilities of firms (regarding asset specificity) are multi-dimensional. From research on the automotive industry, Asanuma (1989) differentiated between two layers of suppliers' capabilities, a basic layer and a surface layer; the former refers to general technological capabilities, while the latter refers to capabilities accumulated from learning through relation-specific investments and repeated interactions with a specific manufacturer. In the automotive industry, the relationship between a car manufacturer and customised component suppliers is a monopsony. In other words, a single car manufacturer generally hires multiple suppliers of customised components and these suppliers are not allowed to do business with other car manufacturers (this monopsony may lead to forward specialisation). Because of these limitations, suppliers will be unable to transfer surface-layer capabilities to basic-layer capabilities that might be useful in their search for new customers (customers who are likely to be rivals to a supplier's principal customer).

In a similar manner to Asanuma (1989), Yasumoto and Fujimoto (2006) proposed the notion of 'interface capabilities' in order to explain why Japanese handset manufacturers who incorporated the most cutting-edge technologies into their handsets and who dominated domestic markets failed to be successful in overseas markets. They expanded the previous dichotomy of either a closed inter-firm relationship with one specific partner or complete market transactions. By considering open inter-firm relationships with multiple partners on the downstream side, they argued that not only can a firm still assimilate partner-specific knowledge and skills while customising components or products for its partners, but also it can apply these relation-specific capabilities to other partners by absorbing these relation-specific skills and adapting them as general capabilities. They defined this kind of a firm's ability as 'interface capabilities' and argued that firms can quickly provide customisations to new customers by resting on interface capabilities.

If we combine the views of Asanuma (1989) and Yasumoto and Fujimoto (2006), firm capabilities can be categorised into three layers: general capabilities, relation-specific capabilities and interface capabilities. The last layer includes capabilities that enable firms to facilitate exchanges between the first two layers. Thus, interface capabilities may play an important role in the case where both sides of co-specialisation deal with multiple suppliers or customers. If markets are highly segmented by country borders, technology standards or language barriers, there may be more than one co-specialisation partner on the downstream side. Unlike co-specialisation in the case of monopsony, however, these downstream customers will not be affected as long as they receive guarantees that co-specialised products will be kept from their direct competitors, in other words, monopsony is maintained in their market segment.

Despite its utility, operationalising the concept of interface capabilities seems highly problematic. Firstly, the capabilities are difficult to measure from the definition. Secondly, the reason why firms have difficulties in exchange between two layers may be due to other reasons such as organisational barriers, information stickiness and tacitness. Even though firms are equipped with proficient interface capabilities, it may take some time and effort for a firm to transform its relation-specific capabilities to general capabilities and establish relation-specific skills to new customers in practice. For example, in 2006 when LG started to produce handsets for Nippon Telegraph and Telecom-Docomo (NTT-Docomo), the biggest MNO in Japan, it had to deliver low-end handset models even if LG was competing as the fourth biggest handset manufacturer in the global market at the time. Not only was the Japanese handset market the most sophisticated in the world, but also NTT-Docomo utilised various software modules which are highly specific to itself. These include the Access web browser, Felica e-money service etc. LG did not have the capabilities to incorporate the newest version of a mobile web browser into handsets in the beginning and it took more than two years for LG to finally deliver high-end handset models for NTT-Docomo.

Is a close inter-firm relationship through co-specialisation always advantageous?

Some researchers have questioned the relation-specific advantages of close relationships between manufacturers and suppliers, asserting that the close inter-firm relationship sometimes exposes firms to a specific partner only, restricting opportunities for learning by interactions with external partners.

Since an inter-firm relationship is embedded in social contexts (Eisenhardt & Schonhoven 1996; Gulati 1995), it may entail country-specificity in relationships. If firms establish their network alliances within their countries, the capabilities accumulated from their networks may not be compatible with requirements from overseas customers (Gulati, 1995; Yasumoto & Fujimoto, 2006). Therefore, a close relationship with local users might hinder manufacturers in their efforts to cope with the unique requirements of users in other markets. The failure to achieve globalisation by Japanese mobile handset manufacturers supports this argument. Moreover, a close relationship entails huge relation-specific costs to a firm, and there always seems to be the possibility of 'hold-up' caused by opportunistic behaviour of partners who have market power (Klein et al. 1978). Lastly, close relationships may lead to a firm's capabilities becoming locked into those of its partners, because a firm making relation-specific investments is bound to develop capabilities that are customised to its partners (Christensen 1997). If a firm's partners fail to discern the right technology trajectory or market demands, then any investment by that firm in huge relation-specific assets is also exposed to risks. Therefore, who you meet really matters for the result of the inter-firm relationship. If this relationship is deep-rooted, such as in the form of a long-term contract, the cost is very likely to prove fatal.

Asset specificity in the context of the handset manufacturing industry

Mobile handsets have shown relatively short product life cycles of between six and twelve months (Whang 2009); in addition, the markets are highly segmented by the standards of network technologies and country-specific services across borders. These industry-specific attributes may significantly affect the end-result of close inter-firm relationships between handset manufacturers and MNOs.

In conventional industries like the automobile industry, manufacturers and suppliers establish idiosyncratic inter-firm relationships based on long-term contracts, as explained in the previous section. In contrast, a short product life cycle in the mobile handset industry makes it undesirable for either party to establish long-term contracts between handset manufacturers and MNOs. Thus, it is not possible to prevent opportunistic behaviour on the part of either side by way of a long-term contract.

However, short product life cycles are not likely to be invariably linked to the absence of long-term partnerships. It is clear that there have not been conventional inter-firm arrangements based on long-term contracts in the mobile phone industry. On the other hand, the absence of long-term arrangements may have heightened the competition between handset producers with considerable benefits to the MNOs, and those handset makers that have been successful have had long-term partnerships with the MNOs (though not by a formal contract) as will be empirically analysed in more detail in Chapter 6.

2.3.4 Implications of the literature on boundaries of a firm on emergent leading firms

Concluding the discussion on boundaries of a firm, it would appear that in an emerging stage of a new industry, firms should conduct many activities internally in order to deal with frequent technological changes. This extensive (knowledge) boundary may be drawn back towards a tighter boundary later in the product life cycle when the technology has matured (if it does). In this case, the frontier firm increasingly specialises in core capabilities which often migrate from production to design and marketing with the design element including some of the critical components – this is a narrower scope of the firm boundary than when the firm is first introducing the product and either producing or co-developing all of the components. In some industries where technologies are of a systemic nature, firms are required to maintain a wider knowledge scope than their product scope.

However, unlike the forerunner firm which is capable of following this pattern, emergent leading firms may have to settle for a more limited position due to the problems of uneven technical development. They are unlikely to have the capacity to fully vertically integrate and therefore may have to collaborate with other firms, relying on some core activities during their transition process. This will limit the ability of emergent leading firms to launch their own products or brands, leading to the high possibility and importance of inter-firm coordination during the transition process.

2.4 Summary

This chapter has combined the literature on the contemporary catching-up and transition process of latecomer firms and the literature on boundaries of a firm and inter-firm coordination in technological frontier firms. The review of the first strand of literature has reconfirmed the research rationale of the transition process of emergent leading firms and has highlighted the idiosyncratic challenges faced by emergent leading firms; the second strand has been reviewed in order to systemically analyse the transition process of emergent leading firms.

In the first section of the chapter, the term 'latecomers' has been differentiated from leaders such as 'forerunners' and 'followers'. The uniqueness of the contemporary catching-up process compared to earlier similar processes has also been discussed in terms of technical and market environments. The chapter has shown that unique characteristics in the second half of the 20th century created new mechanisms and channels for international technology transfer and technology capability building for firms in East Asia; these characteristics are typified by export-led growth on the basis of competitive advantages from cheap labour, even in the newly emerged electronics industry.

Based on two schematic catching-up models of the contemporary catching-up process, the thesis has extracted the transition of emergent leading firms to the world frontier and identified several different groups of emergent leading firms based on their competitive advantages. Among these groups, the thesis focuses on a group of emergent leading firms pursuing a 'dual frontier' of technology supremacy and market autonomy because they compete head on with technology leaders on the basis of in-house R&D capabilities with their own brands. From the several early studies, the thesis has also documented the unique challenges of these emergent leading firms and discussed the windows of opportunity that are available to them, linking their challenges to the literature on boundaries of the firm. Compared to the economic significance of these issues and their potential relevance for other latecomer countries and firms, there has not yet been sufficient systematic analysis of these phenomena.

In the second section of the chapter, the literature on boundaries of the firm and inter-firm coordination has been drawn upon to provide theoretical and empirical guidelines for the analyses in the following empirical chapters. After reviewing transaction cost theories and capabilities view, the thesis has acknowledged that the capabilities view is more suitable for explaining the dynamic boundaries of an emergent leading firm, particularly because of such a firm's documented deficiencies in resources and its large and episodic transactions. The review of the issue of boundaries of a firm has identified dynamic aspects of firm boundaries and provided an important hint of the challenges an emergent leading firm will face when it enters an emerging market rather than a mature one.

The literature on inter-firm coordination has enabled the scope of analysis on the transition of emergent leading firms to be widened beyond the boundaries of a firm. The multi-dimensionality of firm boundaries has enlightened us over the difference between 'what firms know' and 'what firms do' when boundaries of an emergent leading firm are analysed. The chapter has reviewed how close inter-firm relationships with longstanding relational contracts produce relation-specific investments, relation-specific skills and therefore, relational quasi rents. Focusing on sources of competitive advantages and appropriations of innovation, the concepts of relational view, joint competitive advantages, and co-specialisation have also been reviewed with regard to how competitive advantages arise from inter-firm relations and how they can be sustained. Furthermore, negative aspects of inter-firm coordination have been discussed in addition to how they can be reconciled, especially in the context of the industry which is the subject of this thesis, i.e. the mobile handset industry.

3. RESEARCH METHODOLOGIES

3.1 Introduction

The previous chapter reviewed the relevant literature on the catching-up process, especially the transition of latecomer firms to technology frontiers in the context of the second half of the 20th century. Based on the review, the chapter identified the need for a deeper consideration of the processes involved in latecomer firms' transition to technology and marketing frontiers. In search of relevant tools for examining these processes, the preceding chapter highlighted the role of theories of 'boundaries of a firm' and 'inter-firm coordination'.

The main objective of this chapter is to address the research design adopted for the thesis. The research design is based on a study of a single industry and employs focused case studies of two latecomer firms in Korea. Within the overall objective of the thesis of improving the understanding of latecomer firms' transition to world technological frontiers, the research design allows (a) some generalisations for the case of an important contemporary industry and (b) while the 'situated particularities' of the specific case studies in the thesis are important in explaining the outcomes that the thesis observes, the types of issues that are identified can provide a guide to examining the issue of attaining a frontier position more generally. In other words, the principal aim of the thesis is to provide a contribution to the interpretation of the transition processes in industries where latecomer firms seek to attain a frontier position.

In this regard, the thesis presented the following set of questions in Chapter 1:

(1) When emergent leading firms in latecomer economies pursue a 'dual frontier' of technology supremacy and market autonomy, how do they reconcile uneven development within technologies and between technology and marketing stages within an organisation?

(2) How does the fact that emergent leading firms enter the newly emerging market rather than mature markets affect their pursuit of a dual frontier? In addition, what is the role of inter-firm collaboration in their pursuit of a dual frontier under these market conditions?

In order to answer the questions, this chapter designs the research framework in more detail, presenting the rationale for the choice of industry and selection of the case studies, and describing why specific methodologies were adopted and how they were implemented. Section 3.2 sets up the rationale for the choice of the Korean mobile handset industry and two Korean handset manufacturers, Samsung and LG, as case studies for the purpose of the thesis; it also explains how these choices are expected to contribute to existing knowledge. Section 3.3 explains the methodologies, reviewing how data from secondary sources and interviews have been acquired and then used to undertake qualitative analysis and to come to conclusions.

3.2 Why Korean latecomer firms in the mobile handset industry?

As noted previously, relatively few latecomer industrialising countries have made the transition to a world-leading position in any of their industries. Those examples that exist include East Asian countries such as Korea and Taiwan. The industries at a world-leading position are also relatively limited – they include shipbuilding, DRAM, liquid crystal display (LCD), plasma display panel (PDP) and mobile handsets[20] in Korea, and electronics manufacturing services (EMS)[21], semiconductor foundry and computer manufacturing in Taiwan. As discussed in detail in Chapter 2, they can be categorised into three different groups on the basis of their competitiveness; of these groups, the thesis deliberately focuses on the group of latecomer firms that competes head on with international technology leaders on the basis of in-house R&D capabilities with their own brands. In this case, 'achieving leadership by a latecomer firm' means that the firm reaches a dual frontier – technology supremacy and (in part)[22] market autonomy, that is, attaining stages 4 to 5[23] in both technology and marketing stages as defined by Hobday (1995b).

Among the limited candidates who have reached a 'dual frontier' – technology supremacy and (in part) market autonomy, the thesis investigates the case of two Korean mobile handset manufacturers, Samsung and LG, which have recently acquired high global market shares. Table 3.1 shows the rising rankings of these two firms in the world mobile handset market between 1998 and 2009. They were second and third behind Nokia in the market in terms of their market shares by 2009 but had not been among the top five before 2001.

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[20] A mobile handset here means the electronic device compatible with cellular mobile communication networks. Therefore, the scope of the thesis excludes other mobile communication gadgets such as pagers, walkie-talkie radios and similar systems which involve a limited number of 'base stations' and comprise 'closed' radio communications systems.

[21] Also referred to as a contract manufacturer.

[22] The very existence of mobile network operators was highly influential in the marketing strategy of the Korean emergent leading firms during their transition, hence the addition of '(in part)' to the term 'market autonomy'. See Chapter 6 for details.

[23] Although Hobday (1995b) conceived of moving from selling products indirectly to retailers and distributors to selling directly to customers as an advancement (from stage 4 to stage 5, respectively), the findings of this thesis do not concur. The analysis in Chapter 6 shows that the Korean handset manufacturers started in Stage 4 to compensate for their lack of brand awareness in the first place but stayed in that stage rather than transiting to Stage 5 even after acquiring high brand awareness.

Table 3.1 Rankings of major handset manufacturers in the world handset market[24][25]

Ranking	1998	1999	2000	2001	2002	2003
1	Nokia	Nokia	Nokia	Nokia	Nokia	Nokia
2	Motorola	Motorola	Motorola	Motorola	Motorola	Motorola
3	Ericsson	Ericsson	Ericsson	Siemens	**Samsung**	**Samsung**
4	Panasonic	Siemens	Siemens	**Samsung**	Siemens	Siemens
5	Alcatel	Panasonic	Panasonic	Ericsson	SonyEricsson	SonyEricsson
6	NEC	**Samsung**	**Samsung**	Panasonic	**LG**	**LG**
7	**Samsung**	Alcatel	Alcatel	NEC	Alcatel	Others
Ranking	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
1	Nokia	Nokia	Nokia	Nokia	Nokia	Nokia
2	Motorola	Motorola	Motorola	Motorola	**Samsung**	**Samsung**
3	**Samsung**	**Samsung**	**Samsung**	**Samsung**	Motorola	**LG**
4	Siemens	**LG**	SonyEricsson	SonyEricsson	SonyEricsson	SonyEricsson
5	**LG**	SonyEricsson	**LG**	**LG**	**LG**	Motorola
6	SonyEricsson	-	-	-	-	-

NEC, Nippon Electric Company.
Source: Strategic Analytics.

The mobile handset industry itself has been highly interesting for both academic researchers and management practitioners in several respects. First of all, due to its relatively short technology and product life cycle, the industry has already gone through several generations (1G to 3G) of new telecommunication technologies during the last two decades. The dynamic industry setting in the mobile handset industry allows us to examine the several changes in technologies and product architectures and their

[24] It should be noted here that the two Korean handset manufacturers that this thesis investigates had held the second and third positions in terms of market shares in the world mobile handset market by 2009. Therefore, the table does not go beyond 2009.
[25] As this table is based on the number of mobile phone units sold, Blackberry, one of the most prosperous smart phone makers, did not attain a world top 10 mobile phone position due to its presence only in a smart phone segment with the maximum sales of 34.5 million units at 2009 (Strategy Analytics).

relationships to changes in the industry structure within a short period (see Chapter 4)[26].

Secondly, the industry is one of a limited number of cases where latecomer firms, specifically Korean handset manufacturers, had begun their transition process in the context of an emerging stage of the industry. Many other instances, whether they were successful or not, occurred in more mature markets. Unlike conventional circumstances, Korean handset manufacturers had entered the competition during the embryonic stage of the industry, even before commercialisation of the digital cellular communication technologies in the early 1990s.

During the transition process, starting from an embryonic stage of an emerging industry, brings additional managerial challenges to executives in emergent leading firms that are not present in the case of a transition in more mature markets. They are related to uncertainty of both technological and market issues: identifying and exploring the ‘right’ technology trajectory, and market development.

In mature markets, there are often firms at technological frontiers who are willing to offer their technologies slightly or somewhat behind the cutting-edge to latecomer firms. To be successful, these transferred technologies must be applicable with some modifications in another context. At the same time, latecomer firms do not need to take the risk of strategically selecting a specific technological trajectory if they make transitions in a mature industry, since in most cases, de facto standards are already

[26] It is also noted here that as shown in Table 3.1, the two Korean handset manufacturers that this thesis investigates had held top five positions in the world mobile handset market before the emergence of smart phones, which were introduced to the market at a relatively late stage in 3G and now are dominant in mobile handset markets. Therefore, the scope of this thesis focuses on the emergence of digital mobile handsets up to the era of multi-functional phones and does not include the issue of smart phones.

established in the industry. In this case, an entrant's task amounts to following an established technological trajectory set by incumbents in the past.

The emerging markets, on the other hand, will provide a more complex landscape for technology transfer and subsequent developments. It may be risky for incumbents to transfer technologies to possible competitors in this stage as rival firms may be more successful in developing the technology and, in doing so, also escape efforts to limit their autonomy by 'inventing around' IPRs-defended positions. However, the discussion in Chapter 2 supports the notion that there will be opportunities for technological transfer from within the fierce competition among technology leaders. At this stage, because of the uncertainty facing all firms at the frontier, the value of technology licensing agreements is unlikely to be high. High access fees are not possible because of the uncertainty and high royalties are not likely because buyers may expect other sources of technology to become available later in the life cycle.

From the buyer's perspective, there is not only the prospect that uncertainty will be resolved over time, but also the possibility of independent development. A latecomer entering an industry may be sufficiently confident to undertake a 'go- it-alone' strategy. For instance, Samsung refused the offer of technology transfer from a foreign firm when it began the development of 1M DRAM (Kim 1997b)[27]. Whether or not latecomer entrants have capabilities to act alone will vary depending on circumstances.

Thus, the nascent nature of technologies characterising the embryonic stage of a new

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[27] It is noted here that the semiconductor capital equipment industry was not vertically integrated and that Japanese companies were actively competing with US companies to build a rival semiconductor capital equipment industry – a window of opportunity that was fortunate for Korean producers.

industry development is at the centre of uncertainty. During the embryonic stage of an emerging market, even frontier firms have to keep their eyes open to all the possible technological trajectories due to high rate of technical changes. Therefore, latecomer firms penetrating an embryonic market also have to gamble on which trajectory to pursue; some trajectories may prove obsolete or infertile and become pernicious to them in the end. Under the circumstances, latecomer firms have to deal with enormous ambiguities coming from the uncertainty of the direction of technological trajectories, product architectures and the corresponding industry architecture.

In addition to challenges from technical uncertainties, challenges from market uncertainties are also very large at the emerging stage of markets. An emerging market is highly uncertain in every aspect, e.g. market participants or size of demand, and changes of market participants are commonly observed. New entrants with different capabilities may join in the market while some incumbents may retreat due to pessimistic expectations or weak performance. The size of a market may explode one year but considerably shrink the next. While latecomer firms may find their role easier in a stable industry structure in a mature industry, inevitable changes during the early stage of an industry's life will present them with many strategic and managerial issues.

In summary, the assumption of a technology licensor with a well-established technological development path always being available for latecomer firms cannot be taken for granted in the emerging stage of a new industry (as it can in a mature stage). Technologies and products in an early stage are simply unproven and untested. In addition, as shown in Table 3.2, Korean handset makers have been competing in the high-end segment with their global competitors in terms of the average selling price

(ASP), a situation which is unusual in the catching-up of latecomer firms. Therefore (and as this thesis establishes) in cases such as the emerging digital mobile handset industry, a group of latecomer firms not only entering an emerging handset industry but also competing in high-end segments offers an interesting perspective on contemporary catching-up processes.

Table 3.2 ASP of all handsets by global major vendor (unit: current US dollars)

Year	2000	2001	2002	2003	2004	2005	2006
Samsung	218	185	202	194	179	180	173
LG	179	185	177	159	164	169	169
Motorola	220	156	151	134	155	147	141
Nokia	157	148	144	151	138	144	137
SonyErisson	125	115	172	195	191	179	172

Source: Park and Kim (2007, p.144).

Lastly, a (digital) mobile handset is a product that incorporates a range of technical knowledge and diverse functionalities together within its product architecture (Whang 2009). It is a typical example of a multi-technology and multi-component electronic device. In particular, it has become a product with high complexity due to the evolution of digital telecommunication technologies and functional convergence spearheaded through collaboration with MNOs. Therefore, although a mobile handset is a typical mass-produced electronic device, the rapid change in its components and subsystems makes the role of manufacturers closer to a system integrator rather than a simple assembler[28]. This characteristic of the industry makes it very difficult to nurture all of

[28] The role of a handset manufacturer seems very much analogous to that of gun makers in the UK during

the requisite technologies and capabilities within a single firm. To do this, a handset manufacturer must coordinate the upstream and downstream actors such as component suppliers and MNOs in the mobile handset industry. Therefore, the industry demands highly sophisticated system-integrating capabilities on the part of handset manufacturers (Prencipe 2000), and these demands are among the key issues discussed in this thesis.

3.3 A qualitative study on a single industry with two firm-level case studies

The primary research method for the thesis is a qualitative case study of an industry with more focused case studies of two mobile handset manufacturers in Korea, excluding the utility of a survey-type quantitative analysis. According to Yin (2009), a case study approach is desirable for the type of research questions that this thesis seeks to answer, that is, 'how'. The main objective of the case studies as a methodology in this thesis is not 'statistical generalisation' but 'analytical generalisation' (Yin 2003). This type of research in general adopts theoretical sampling not statistical sampling (Strauss & Corbin 1998) and cases are purposefully selected for theoretical reasons in order to 'replicate previous cases or extend emergent theory or they may be chosen to fill theoretical categories and provide examples of polar types.' (Eisenhardt 1989, p.537). The thesis investigates a specific type of latecomer firms in transition, achieving a dual frontier, and in practice, the number of candidates of this kind is limited. Although guided by theoretical sampling (Glaser & Strauss 1967), however, the research process here does not pursues a theoretical finding based on diverse cases within each category to replicate the finding as Eisenhardt (1989) suggested because we know the strategies

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the 19th century (Rosenberg 1972). Unlike the so-called 'American System of Manufacturing' which allowed US gun makers to produce guns with complex mechanisms on an interchangeable basis with standardised components such as locks and stocks, the production of guns in the UK at the time was typified by the 'fitting' or 'adjustments' process among parts. The role of a handset manufacturer involves 'fitting' or 'adjustments' in both hardware and software aspects, a process that occurs for a particular model rather than for each individual device (as was the case with British guns).

and behaviours of the control group (e.g. foreign companies like Nokia or Motorola).

As Glaser and Strauss (1967) suggested, the process of theoretical sampling provided with a local concept a foothold where initial interviews were able to embark for the research. Then, new issues were uncovered from the initial round of interviews. With growing theoretical sensitivity, these polar types of strategies and behaviours that Korean handset makers adopted against foreign ones, were identified and further investigated at the subsequent round of interviews as they are of interest with 'transparently observable' (Eisenhardt 1989, p.537).

Two types of data were mainly gathered for the thesis: secondary documents and in-depth interviews. This permits one to strengthen grounded theory by triangulation of evidence (Eisenhardt 1989, p.533). In order to collect data, two rounds of fieldwork were carried out in Korea between January 2010 and March 2011, each round taking roughly three months. Two rounds of in-depth interviews with various experts related to the Korean mobile handset industry were conducted, the first and the second round comprising 16 and 20 interviews respectively - additional seven interviews were carried out in the final stage of writing between 2012 and 2014 in order to complement the main findings. Secondary document-gathering also took place during both rounds of fieldwork and was focused on the evolution of mobile handset technologies, mobile handset manufacturers and their market performances (mainly utilised for Chapter 4). Secondary documents included specialised technical journals, trade publications, analysts' reports, company annual reports and other similar publications, and online newspapers. The collection of these types of data mainly aimed to establish the overall picture of the evolution of a mobile handset industry from both technical and market perspectives. What follows explains the nature, objective and progress of interviews in each round of the fieldwork.

3.3.1 The first round of fieldwork: open-ended interviews

The first round of fieldwork was mainly aimed at identifying key issues behind the transition of Samsung and LG. Therefore, the list of interviewees in the initial fieldwork included a diverse range of people directly and indirectly involved in the Korean mobile handset industry. It included:

(1) managers and engineers who had worked or were still working for mobile handset divisions in companies (e.g. Samsung, LG, Pantech, Motorola, and Maxon Telecom)[29], in strategic planning teams, software development teams, hardware development teams, protocol teams through to patent management teams;

(2) managers and engineers who had worked or were still working in downstream and upstream industries such as component suppliers (e.g. other divisions in Samsung and LG, EMW Antenna and Youngpoong Electronics) and MNOs (e.g. SK Telecom, Korean Telecom);

(3) industry experts in research institutes (e.g. Science and Technology Policy Institute (STEPI)) and other related organisations (e.g. Telecommunications Technology Association (TTA)).

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[29] The author admits that interviews on the mobile handset manufacturers were highly skewed to LG. This is because Samsung was highly sensitive to the issue of information leak through interviews, while LG was relatively indifferent to the issue. From the interviews with industry experts, the author confirmed that the strategies of LG that were to be discussed in the empirical chapters of the thesis would be regarded as identical to those of Samsung, the main themes of which included the technology sourcing of CDMA, the collaboration with MNOs, and the utilisation of contract developer organisations.

The interviews were carried out in a semi-structured form, with open and closed questions, due to its flexibility (Gillham 2000). While interviewees were asked for facts, therefore, opinions and insights about the evolution of Korean handset manufacturers, the discussion also followed other topics as the author (interviewer) developed an understanding of the issues that were raised by the respondents. The whole conversation was recorded except for a few cases when the recording was refused by the interviewee on the grounds of confidentiality. The interviews normally lasted one to two hours. Interviewees were sometimes contacted again on points requiring clarification or confirmation during the later analyses and writing.

3.3.2 The second round of fieldwork: focused interviews

In order to examine in depth the key issues that had been identified from the results of the first round of fieldwork, for the second round of fieldwork, the scope of interview topics was narrowed down, and specific persons were targeted. For example, the industry expert in STEPI in the first round of interviews was revisited for the Joint Development Project between the Electronics and Telecommunications Research Institute (ETRI) and Qualcomm (Chapter 5) whereas a team leader of an LG North American marketing team at the time was visited to discuss the relationship between LG and the US MNOs between 1999 and 2004 (Chapter 6). In addition, the project leader of LG at the time was visited for the 3 Italia Digital Video Broadcasting-Handheld (DVB-H) phone project in 2005 (Chapter 6) while engineers who participated in the ‘Shine Phone’ series were interviewed about the division of labour between handset manufacturers and their ‘contract developers’ (Chapter 7) and similar matters. Therefore, the questions asked and issues raised during the second round of interviews were more direct and specific than in the first round of fieldwork even though the interviews during the second round adhered to most of the interview principles applied to the first round.

The information gathered from the two rounds of interviews with industry experts was cross-checked for credibility against, and used to complement, data originating from secondary sources on the Korean mobile handset industry.

The thesis continues in Chapter 4 with an overview of the mobile handset industry. It then presents, in Chapters 5 to 7, the empirical evidence which is used to answer the research questions; these three chapters use the methodology and theoretical perspectives developed in Chapter 2 to present the detailed analysis on the efforts of the two Korean mobile handset producers to attain a world frontier position.

4. OVERVIEW OF THE DIGITAL MOBILE HANDSET INDUSTRY

4.1 Introduction

By way of laying foundations for the main empirical studies, this chapter aims to present key features of the (digital) mobile handset industry. It examines the evolution of technologies and industry structure over time. Based on the evolution of mobile communication technologies and the corresponding capacity improvements in wireless data communications, the chapter shows how mobile network services provided by the industry have gradually expanded from simple voice-centric to various data-centric services such as text messaging, music downloading, mobile Internet browsing and video calling. Furthermore, the chapter explores the dynamics of industry structures over time through the identification of key actors across the value chain of handset manufacturers. In particular, it investigates the dynamic division of labour among these key actors, focusing on dynamic competition with respect to baseband chip capabilities on the upstream side of handset manufacturers and with respect to intermediary roles of MNOs on the downstream side. In doing so, the chapter aims to provide readers with the fundamental knowledge for understanding the evolution of the mobile handset industry and the subsequent empirical chapters.

The remainder of the chapter comprises three sections. Section 4.2 sets forth the history of the emergence of modern mobile communication systems and describes the co-evolution of mobile communication technologies, functions of mobile handsets and mobile network services. Section 4.3 identifies two key actors – baseband chip suppliers and MNOs – based on the importance of their roles in the value chain of handset manufacturers. It shows how these key actors have affected innovation and the competitive advantage of handsets by looking at the dynamics of their inter-firm relationships in the industry over time. Firstly, the section stresses the role of the handset manufacturer as a system integrator and presents a general handset development process. Secondly, it addresses the importance of the baseband chip as a core component in the mobile handset industry and explains how unbundling of baseband chip makers from vertically integrated handset manufacturers occurred and affected competitions among handset manufacturers. Lastly, it presents how MNOs as key downstream players shaped two distinct distribution structures of the industry and affected the innovation of handsets by mobile handset manufacturers according to their mobile services.

The final section of the chapter recapitulates the dynamic characteristics of the mobile handset industry explained in the previous sections, and highlights the implications of the technical and managerial challenges for the Korean handset manufacturers.

4.2 Evolution of the mobile handset industry

This section offers a brief history of modern mobile communication systems and the evolution of (modern) mobile communication technologies. Here, a modern mobile communication system is characterised by the 'cellular' concept and its 'handheld' portability, the latter of which turned out to be the feature that established the trajectory for mass acceptance.

4.2.1 Advent of a modern mobile handset industry

The concept of 'cellular network' was originally proposed by Bell Labs in 1947 (Agar

2004). Cellular network communication systems have two advantages over a conventional radio communication system. First, the 'cell' involves a limited geographic area so that, over a larger area, frequencies that are used in other cells may be reused for carrying calls, allowing the larger area to support many more calls than a system having a single base station. The other advantage is that the 'cell' enables mobile stations (handsets) to save a considerable amount of energy while communicating with the more numerous cellular base stations, because cells covering small geographic areas require lower power transceivers.

However, cellular radio systems were not used in early mobile communication systems. These early systems involved manual switching between the frequencies of adjoining cells using different frequencies[30]. In 1956, Ericsson commercialised the first (outgoing calls) automated mobile system – called Mobile System A (MTA)[31] in Sweden – and several other improved automated services followed. Even so, the mobile phone services were limited within the coverage of one base station throughout the phone call. The concepts of 'frequency reuse' and 'handoff' were provided in the late 1960s[32] and were realisable in practice in the late 1970s as, by then, semiconductor and high frequency directional antennae technologies were sophisticated enough to support the concepts.

In 1973, Martin Cooper with his colleagues[33] in Motorola developed the first

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[30] Signals from two cells away were (ordinarily) sufficiently attenuated such that the same frequency could be re-used in an alternating pattern over the larger.

[31] http://www.businessinsider.com/complete-visual-history-of-cell-phones-2011-5?op=1, accessed 22/12/2014.

[32] http://fonenews.weebly.com/who-is-fone.html, accessed 30/09/2015.

[33] According to the US patent registered as US03906166 in 1975, inventors include Martin Cooper,

prototype[34] of modern concept of mobile (portable by hand) handset, DynaTAC[35] 8000X (Gow & Smith 2006). Cooper made the first call to his rival, Joel Engel, the head of research at Bell Labs, the only competitor to Motorola at the time. By 1977, American Telephone and Telegraph (AT&T) and Bell Labs had constructed a prototype cellular system. A year later, public trials of the new system began in Chicago with over 2,000 trial customers. In 1979, in a separate venture, the first commercial cellular telephone system was made operational by NTT in Tokyo. Subsequently, after several attempts to establish regulatory structure for commercialised cellular systems, the Federal Communications Commission finally authorised a commercial modern cellular network service in the US in 1982. A year later, Ameritech introduced the first American commercial analogue cellular network service in Chicago (Agar 2004).

4.2.2 Evolution of mobile communication technologies

Since the commercialisation of the first modern cellular network, mobile communication technologies have dramatically evolved over a relatively short period of time. Based on technical standards and the speed of mobile communications, such technologies can be generally divided into four different generations: 1G to 4G. As Korean handset manufacturers acquired top global positions in terms of market share before the commercialisation of 4G, the thesis excludes 4G from the scope of the description in this subsection. Here, the brief story of the transition of technologies and the corresponding functions of, and services provided by, handsets over generations is

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Richard W. Dronsuth, Albert J. Mikulski, Charles N. Lynk Jr., James J. Mikulski, John F. Mitchell, Roy A. Richardson, John H. Sangster (http://inventors.about.com/library/weekly/aa070899.htm, accessed 21/12/2014).

[34] The commercial type of Motorola's DynaTAC was available to the public in 1983 (http://www.businessinsider.com/complete-visual-history-of-cell-phones-2011-5?op=1#ixzz3MbzGFrft, accessed 21/12/2014).

[35] DYNamic Adaptive Total Area Coverage.

discussed.

(1) 1st Generation (1G)

1G mobile communication technologies are mainly based on analogue voice modulation technologies, using Frequency Division Multiple Access (FDMA) for transmitting information (see Box A). Three different modes based on FDMA were mainly used across the world: Advanced Mobile Phone Services (AMPS) in North America and Asia, Total Access Communications System (TACS) and Nordic Mobile Telecommunication-900 (NMT-900) in Europe. The purpose of communication was solely voice-centric, and therefore the function in handsets was limited to voice calls. The main factors for competition amongst handsets producers in the market were the quality and connectivity of voice calls.

From the late 1980s, however, 1G based on FDMA was unable to cope with the upsurge of customers' demands on mobile communications due to its limited method of utilising frequency resources. It therefore triggered the adoption of digital communication technologies, i.e. 2G.

(2) 2nd Generation (2G)

The most radical shift to have occurred in the history of mobile communication technologies was from 1G to 2G, in terms of both technical and market competitions. With regard to a technical perspective, voice modulation technologies switched from analogue to digital technologies, and this transition enabled the significant expansion of mobile communications. In addition to the advantage of enhanced capacity, digital communication technologies allowed more stable and secure communications by their unique error correction and encrypting mechanisms in comparison with analogue communication technologies.

There are two standard modes of digital communication: Time Division Multiple Access (TDMA) and Code Division Multiple Access (CDMA) – brief explanations of these mobile communication technologies are given in Box A. Three main technologies based on TDMA have been used around the world. They are Digital–Analogue Mobile Phone System (D-AMPS) for North America, Global System for Mobile communications (GSM) for Europe, and Personal Digital Cellular (PDC) for Japan. The whole European continent adopted GSM as the only 2G standard in 1992 to allow for easier and cheaper roaming services in the region. The following year, Japan established its own standard of digital communication technologies with PDC. The other mode of digital communication, CDMA, was first commercialised by the Korean MNOs in January1996. Throughout its existence, the 2G market was composed of roughly 70% GSM, 20% CDMA and 10% other technologies[36].

The main functions of a 2G mobile handset included new text messaging services as well as voice calls provided by 1G. The form factors[37] of 2G mobile handsets also became diverse as handset manufacturers introduced clamshell and flip types in addition to the bar type in the market.

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[36] Market data from Strategic Analytics.
[37] Form factor in the mobile handset industry means the physical appearance and operation of a handset.

Box A Principles of mobile communication technologies

*** FDMA**

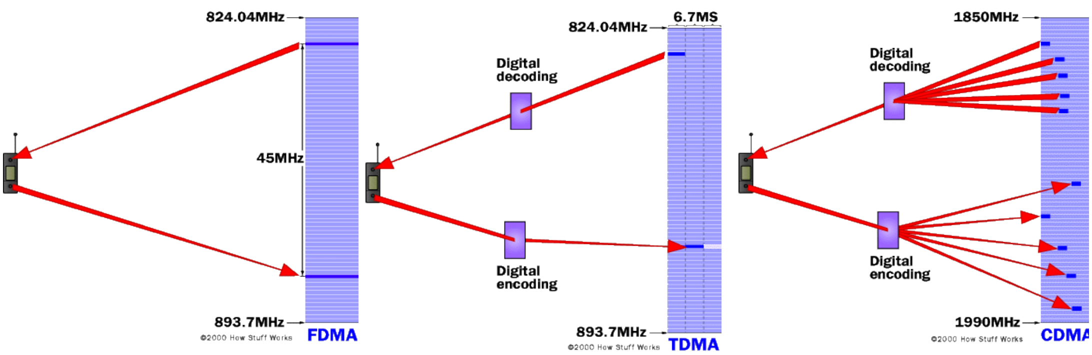
FDMA is mainly used for analogue transmission technologies that divide the allotted spectrum into uniform 30kHz bandwidths so that base stations and mobile phones send their signal through these channels. (Below TDMA and CDMA are compared with the normal analogue system.)

*** TDMA**

TDMA is a digital transmission technology that splits channels that are uniformly divided into 30 kHz-wide bandwidths as with FDMA, but that are 6.7 milliseconds long in the spectrum into three uniform time slots. Therefore, in principle, TDMA has three times the capacity of an analogue system.

*** CDMA**

CDMA is a digital transmission technology that spreads out each digitalised sound segment over the entire spectrum. Multiple calls are spread over the spectrum (1.25MHz channel) with unique sequence codes, which can be used to recover the signals. CDMA has theoretically 15 to 30 times the capacity of an analogue system.



Source: HowStuffWorks, http://electronics.howstuffworks.com/cell-phone7.htm, accessed 22/07/2010.

Comparison of analogue FDMA, and digital TDMA and CDMA

(3) 2.5 Generation (2.5G)

Although 2.5G is normally considered as a transition phase from 2G to 3G, it is worth noting as a separate generation here because MNOs provided services that were distinct from services available in 2G or 3G technologies. 2.5G technologies include General Packet Radio Service (GPRS) and Enhanced Data rates for GSM Evolution (EDGE) originating from GSM, and CDMA2000 1x originating from CDMA. In 2.5G, the superiority of digital over analogue technologies was consolidated, product design of mobile handsets underwent a drastic change, and a diverse group of new network services were introduced. An interview with a manager in a Korean MNO revealed that the quality of voice calls was not a factor differentiating handsets in 2.5G, mainly for two reasons. He argued:

> The first was that the capabilities of handset manufacturers had matured enough for voice quality capabilities to have become generic. Second, the surge of demand for 2G mobile handsets meant that MNOs were forced to set up enormous numbers of base stations, resulting in smaller average cell zone coverage and therefore yielding better quality of voice calls.

In addition to the achievement of generic high-quality voice calls, strong demand and quick market saturation among advanced countries further heightened market competitions for both handset manufacturers and MNOs. Against fast market saturation, handset manufacturers sought ways to stimulate the replacement demand of handset customers. In contrast, MNOs pursued ways to boost Average Revenue Per User (ARPU). Competition for customers under these conditions drove a functional convergence and an incorporation of data services in a mobile handset due to the compatible incentives facing both handset manufacturers and MNOs (e.g. handsets with a colour camera are more expensive and produce more data charge) (Whang 2009).

These became the 'other features' that differentiated competition, and these functional evolutions in mobile handsets could be realised through the enhanced data transmitting capacities of new 2.5G network technologies. Through various interviews, handset engineers insisted that the competition among handset manufacturers be mainly based on two factors:

> (1) how fast handset manufactures could integrate and stabilise new functions in a mobile handset system such as colour screen, camera, mobile TV and mp3 (hardware and software integration capabilities); and (2) how manufacturers could accommodate these multimedia functions into more attractive designs (e.g. slimmer design and diverse form factors).

In case of the competition among MNOs, new mobile data services became paramount, typified by uploading/downloading of pictures, songs, video clips, and Internet browsing. However, 2.5G mobile network technologies could not deliver the speed and the price that wired communications technologies provided, nor, in fact, that all of the new data services began to require. Two distinct approaches were adopted in order to overcome this issue: Wireless Application Protocol (WAP) delivering web pages with less data and mainly led by big handset manufacturers[38], and operator-specific services such as NTT-Docomo's i-mode led by each MNO (Haas 2006).

(4) 3rd Generation[39] (3G)

3G technologies encompass WCDMA originating from GSM, CDMA 2000 1x

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[38] Ericsson, Motorola, and Nokia were the main founders of the WAP Forum in 2002, which later became the Open Mobile Alliances (OMA).

[39] As already noted in Chapter 3, Samsung and LG had already achieved global top five positions with their successful launch of multi-functional handsets onto the world mobile handset market before the emergence of smart phones, which started to be introduced to the market at a relatively late stage in 3G. Therefore, the scope of this thesis does not include smart phone-related issues such as platforms of iOS of Apple and Android of Google.

Evolution-Data Only (EV-DO) Rev.A originating from CDMA, and the Chinese standard of Time Division-Synchronous Code Division Multiple Access (TD-SCDMA).

These mobile technologies surpassed some of the restricted data capacity of 2.5G network services, allowing fully fledged Internet-based services. The classes of new services introduced through the adoption of 3G technologies were not that different from those provided by 2.5G. Based on considerably faster wireless data connections, however, 3G technologies provided full-browsing Internet services by 3G handsets (rather than WAP-enabled Internet), and real multimedia messaging services, particularly represented by video calls. In 3G handsets, the functional convergence was further reinforced.

To summarise, the evolution of mobile communication technologies from 1G to 3G has gradually expanded the functions and services which were delivered through mobile handsets in each generation, correspondingly incurring changes in product architecture of a mobile handset and rules of competition in the industry. While the competitive advantages of earlier (1G) incumbents were based on voice quality and connectivity, they were diminished due to the progress of digital mobile technologies in the 2G era. The subsequent heavy investment in the mobile network infrastructure by MNOs made these capabilities even more obsolete. Even so, the main service in both 1G and 2G stayed as voice-centric. In some ways, to differentiate their products from those of their competitors, handset manufacturers from 2.5G onwards began to integrate multimedia functions into the handset system such as colour screen, camera, mp3, and movie clips. In the meantime, in order to create additional revenue, MNOs also introduced various new mobile network data services from the commencement of 2.5G based on advanced mobile wireless technologies. This further pushed the direction of a mobile handset towards multi-functionality. This interdependency between handsets and services led to close inter-firm relationships between handset manufacturers and MNOs. Table 4.1 summarises the evolution of mobile communication technologies, embedded services, and phone types of each generation described above.

Table 4.1 Evolution of mobile communication technologies, mobile handsets and their functions

Generation	1G	2G	2.5G	3G
Technology	AMPS, TACS, NMT	GSM, US-TDMA CDMA, PDC	GPRS, EDGE CDMA2000 1x EV-DO	WCDMA, TD-SCDMA CDMA2000 1x EV-DO Rev. A
Embedded services	Voice Call	Voice call Text message	Voice call Multimedia message Camera and mp3 WAP-enabled or operator-specific Internet service	Voice/video call Multimedia message Camera and mp3 Full-browsing Internet
Handset form factor	Candybar	Candybar /Clamshell	Candybar /Clamshell /Slide	Candybar /Clamshell /Slide
Phone type	Basic phone	Basic phone	Feature phone	Feature phone Smart phone

Source: Author's elaboration.

The next section investigates further how the evolution of mobile communication technologies and corresponding mobile data services has shaped the dynamic structure of the mobile handset industry, including key actors and their relationships over time.

4.3 Dynamic structure of a mobile handset industry: key actors and their inter-firm relationships over time

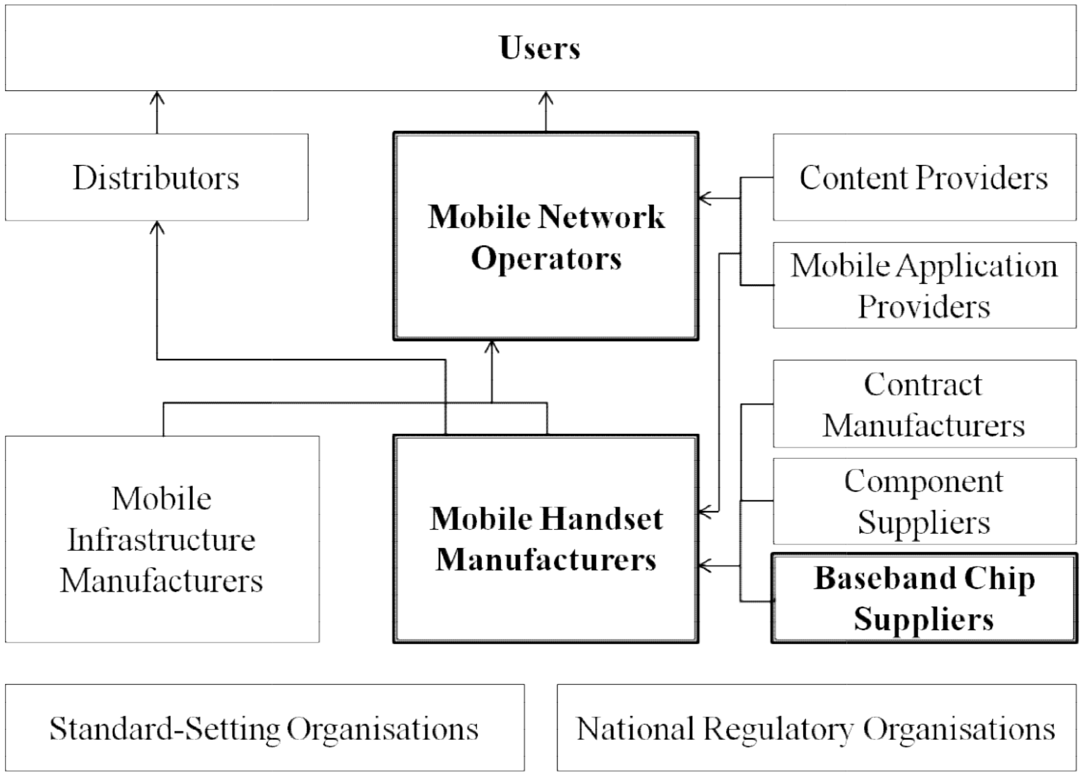
This section presents a discussion on the dynamic structure of the mobile handset industry. Considering the handset manufacturer to be at the centre of a model, it identifies two key actors on the supplier and user sides of the manufacturer and discusses how the inter-firm relationships have changed in the course of the evolution of the mobile handset industry.

4.3.1 Key actors with regard to competitions in the industry

To identify key actors that are associated with handset manufacturers, the mobile phone value system provided by Porter & Paija (2011) has been modified in the thesis (Figure 4.1) based on the review of secondary documents and interviews with experts in the mobile handset industry. The figure shows handset manufacturers at lower centre, and two key actors (in bold boxes): baseband chip suppliers and MNOs.

On the upstream side of handset manufacturers, baseband chip suppliers have been set apart from other component suppliers because a baseband chip is one of the most important hardware components in terms of the criticality of components (it is identical to a CPU in a PC). Criticality of the chip here means that significant innovation in a baseband chip at the component level can entail a corresponding change of product architecture at the system level (Prencipe 2000). In particular, the capabilities of a baseband chip can have a significant impact on the performance and competitiveness of mobile handsets in several respects, which will be discussed in detail in the next subsection.

On the downstream side, MNOs have been set apart from general distributors as they also play significant roles, such as being source of innovation and financial intermediaries. In addition to selling handsets to customers, they contribute to innovations in a mobile handset by promoting multimedia functionalities to support their mobile services.



Source: modified by the author based on Porter & Paija (2011, p.23).
Figure 4.1 Structure of the mobile handset industry

Further detailed discussion on the three key actors – handset manufacturers, baseband chip suppliers and MNOs – are presented in the following three subsections.

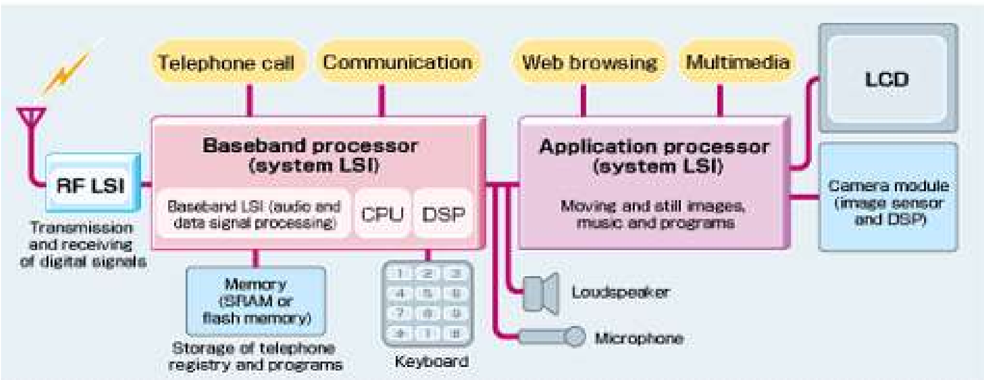
4.3.2 Handset manufacturers

Three different types of firms can be considered as handset manufacturers in the value chain of the mobile handset industry, depending on their vertical scope: OBM, ODM and design house (Kim 2005) (see Figure 7.1 as well). OBMs produce their handsets in in-house factories and market them with their own brands (sometimes co-branding with MNOs) to downstream distributors including MNOs. ODMs develop, assemble and deliver their handsets to OBMs or MNOs so that these buyers can market them with their brands. Design houses are specialised in handset design and development; they are basically an ODM without production facilities. However, these three forms are not mutually exclusive. For example, OBMs sometimes act as an ODM (especially to MNOs) and outsource development of handsets to ODMs or design houses.

In what follows, the role of handset manufacturers is identified through an examination of the nature of capabilities and activities required for handset development. In addition, the general procedure of new handset development is provided.

Handset manufacturer as a system integrator

A mobile handset is a multi-technology, multi-component, electronic device. As shown in Figure 4.2, a general multi-functional mobile handset comprises several hardware modules of baseband processor, application processor, memory, radio frequency module, display module, camera module and other peripheral components. These hardware modules are incorporated through a mobile operating system with software modules such as middleware platform, graphic user interface and various application programs.



RF, Radio Frequency; LSI, Large Scale Integrated Circuit; CPU, Central Processing Unit; DSP, Digital Signal Processor; SRAM, Static Random Access Memory.

Source: Nikon homepage[40].

Figure 4.2 Block diagram of a mobile phone system

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[40] Types of ICs and applications, http://www.nikon.com/products/precision/society/story0201/index.htm, as reproduced in Whang (2009, p.135), accessed 22/07/2010.

In terms of product architecture, therefore, a mobile handset is also a system composed of several subsystems supported by multiple components and software modules. The main role of handset manufacturers is to understand and maintain knowledge resources on a mobile handset as part of a mobile communication system as well as a system that integrates these subsystems into a single system from a hardware/software perspective (Prencipe et al. 2004). On the other hand, handset manufacturers generally outsource most of these hardware components and software modules to specialised suppliers (with some exceptions around core semiconductor chips and mobile operating systems of a mobile handset). The trend towards modularity of handset subsystems and specialisation of handset manufacturers in the mobile handset industry is clear (Anderson & Jönsson 2006).

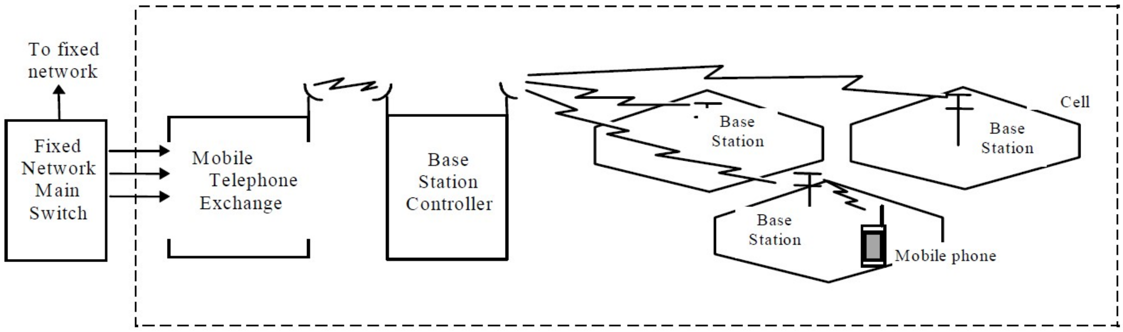
This contrast in characteristics of mobile handsets between system integration and modularity needs some consideration. The fact that the level of modularity in a mobile handset system is extremely high does not directly imply that the role of handset manufacturers is confined to being a comparatively simple assembler. It is important to consider the level of system integration required to design and develop a mobile handset. Sako and Murray (2000, p.4) have described system integration capabilities, and differentiating them from simple assembling capabilities:

> Although the basic architecture of an automobile is fairly stable, it is said that there are many aspects of the linkages within the electro-mechanical architecture that are not yet fully understood. For example, to achieve a particular noise/vibration/harshness level at different maximum speeds, engineers need a deeper understanding of the subtle linkage between the body, chassis, engine, and drive-train. This means that *without the integration capability of vehicle manufacturers*, the body, chassis, engine, and drive-train produced by separate suppliers each with their own specialised systems

> knowledge *may not, upon assembly, lead to a workable automobile*…[this author's emphasis].

In addition, Whitney (2004) has also stressed that the nature of the car door design process is that of a complex system. The assembling of components for a car door appears comparatively simple. Taking the design process into account, car manufacturers have to consider 'attributes' of a door system that affect customers such as safety, closing effort, wind noise and water leakage. These attributes sometimes affect each other in conflicting ways, which makes the design process more complex.

As mentioned above, a mobile handset is one of the subsystems of a mobile telecommunication system. According to ETRI (1994) and Porter and Paija (2011), a mobile telecommunication system consists of mobile stations (or mobile handsets), base stations (base transceiver stations plus base station controllers) and mobile telephone exchanges, as shown in Figure 4.3. A mobile handset is therefore part of a mobile telecommunication system and in order to communicate in a wireless manner, it should be compatible with a base station through predetermined protocols within a system. Therefore, a mobile handset manufacturer should understand the complete mobile telecommunication system, and in particular the interface between a mobile station and a base station. The implication is that a handset manufacturer cannot leave aside other parts of the system as if they were in a black box.



Source: Porter & Paija (2011, p.23).

Figure 4.3 Schematic view of a mobile cellular network

In the beginning of 2G, the role of handset manufacturers was similar to that of motor companies, and most components were procured from component suppliers. Handset manufacturers mainly focused on the design of a main circuit board for a mobile handset system, arraying hardware components in order to minimise the interferences among hardware components and therefore guarantee connectivity and quality of voice calls. The industry also began to be pushed towards standardisation and modularisation of components, subsystems and their interfaces (Anderson & Jönsson 2006).

From 2.5G onwards, on the other hand, the incorporation of multimedia functions of colour screen, camera, and music to video into a handset system and intensive software integration activities have emerged as other competitive advantages for handset manufacturers, especially since the emergence of multi-functional handsets (Whang 2009). A former handset developer in Maxon Telecom witnessed this issue in the early stage of convergence:

> Maxon was one of the successful early Korean handset companies that specialised in wireless technologies, having acquired these capabilities from a Danish company. However, it struggled to cope with the complexities of

> integrating a colour screen with a camera module into a handset system. Adding the camera module resulted in many problems such as poor display of colour under low light intensity and the control of standby power. The camera module provider did not have knowledge of the handset system while Maxon Telecom had capabilities that were limited to wireless technology.

The ratio of hardware to software engineers in handset makers also significantly changed from 1:1 before multi-functional handsets to approximately 1:5[41] after multi-functional handsets[42]. Due to the evolution of mobile technologies and their data services, complexities residing in integration of hardware components and software modules have significantly increased.

In this vein, the requirements of incorporating all the features – or, as in Whitney (2004), ‘attributes’ – in a mobile handset did not disappear in the course of the evolution of a mobile handset system despite high modularity in a mobile handset. This meant a continuing role for mobile handset manufacturers in collaborating with their specialised suppliers and their MNO partners to sustain their competitive advantages[43].

Development process of new handsets and the division of labour[44]

Bearing in mind the specialisation of handset manufacturers over time, the general

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[41] Interview with a protocol stack engineer.

[42] In the case of a Chinese design house company producing low-end multi-functional handsets, the ratio was approximately 1:3.8 (Imai & Shih 2007). Also, Yasumoto & Fujimoto (2006) reported that the proportion of software engineering accounted for more than 70% of human resources in a project for the Japanese market where handsets featured the most advanced functions.

[43] Kim (2008) studied the change in handset architecture originating from the adoption of a camera application processor. On the other hand, Whang (2009) investigated the change in handset architecture originating from the change in baseband chip processors.

[44] The original information for this section was provided by an employee of one of the Korean mobile handset manufacturers who asked for anonymity; this information was added to by several interviewees afterwards.

procedure[45] of new handset development and the role of manufacturers in each development stage are explained below. A complete development process generally takes between six and twelve months.

(1) Stage 1 – product planning

A product planning team in a handset manufacturing firm takes charge of the first stage, together with product-development teams (both hardware and software teams) and marketing teams. First of all, each team discusses, debates, and finally agrees on a concept and the target market of a new handset. Subsequently, they contemplate the detailed specifications of a new handset, which includes retail price, form factor (e.g. candybar/clamshell/slide type etc.), external design as well as size (e.g. length and width, thickness, screen size, etc.), screen type (monochrome or colour, LCD or OLED[46]) and additional functions that will be embedded (e.g. GPS/mp3/camera/DMB[47]).

On the basis of the concept and required features proposed by the new product-development team, hardware and especially mechanism teams in a manufacturing firm verify the producibility of a newly designed handset. They check whether components required for delivering the concept are actually available on the market or can be developed by component suppliers, and that they can physically fit into the proposed design. Finally, a mock-up is produced to verify producibility and feasibility and this is used for acquiring orders from MNOs (only one or two mock-ups, which are identical to a real product apart from exterior finishing, are produced as their manufacturing cost is

[45] The development process provided here is from one of the Korean mobile handset manufacturers. Based on confirmation by several interviewees, the author acknowledges that each handset manufacturer may have slightly but not significantly different development processes.

[46] Organic Light Emitting Diode.

[47] Digital Multimedia Broadcasting.

between $5,000 and $10,000). There is a final round of discussion amongst the product planning team, the product design team, the development team and the marketing team to cross-check the requirements.

MNOs may be involved in a new product-development process from stage 1, particularly in regard to up-to-date handsets. In such cases, the entire development schedule will be planned and customised right up to the release date of a product by MNOs. In other words, handset manufacturers fully coordinate with the product portfolios and roadmaps of an MNO. In addition, most of the basic specifications, for example, retail price, form factor and secondary functions, are heavily influenced by the opinions of MNOs (see Chapter 6).

(2) Stage 2 – working-sample production

At this stage, working samples operating only primary functions are produced under the responsibility of development teams. Manufacturers assess material and component costs based on produced working samples, and select appropriate components on the basis of performance and cost. Mechanisms are made from an interim mould because there may be modifications in design. Generally, 30 to 100 handset samples are produced. Working-sample productions can be iterated between two and four times depending on the extent to which they employ new technologies.

(3) Stage 3 – engineer sample production

This is the last stage led by development teams in a manufacturing firm. Both hardware and software development teams need to complete the development of all handset functions and simultaneously carry out bug corrections. Thereafter, the design of the handset and hardware components cannot be modified for any reason other than solving any production and compliance problems arising from this engineer sample stage. The stage is normally gone through once or twice, but sometimes three times if the sample is not satisfactory. In each round, 100 to 200 samples are manufactured, and these are used for certification by MNOs or other certification organisations. Finally, a manufacturer determines which component suppliers will deliver each component and places orders accordingly with the required specifications. Such orders are placed four to eight weeks ahead of mass production stage, and take account of time needed for deliveries.

(4) Stage 4 – pilot sample production

From stage 4 onwards, the responsibility shifts from development teams to production management teams. Any minor modifications at this stage and afterwards are reported and registered as an engineering change order (ECO). Based on the design and engineer samples, production management teams consider all possible problems that may occur at the time of transitioning from the pilot phase to mass production. During the pilot phase approximately 100 to 200 samples are produced.

From stages 3 through to 4, MNOs and handset manufacturers perform a sample test, also known as an ‘event’, roughly three times to verify the completion of a new handset development (e.g. to check that further problems have not been re-introduced). MNOs and handset manufacturers concurrently carry out field tests by connecting newly developing handsets through either a test network or a real network. Each MNO has its own checklists and requirements[48] for a handset manufacturer to meet regarding a new mobile handset. While the first event mainly concentrates on checking on primary

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[48] Each event has mandatory and optional requirements designated by network operators.

functions in a mobile handset, second and third events focus on rather peripheral functions in line with development processes at a handset manufacturer. For each event, MNOs and quality assurance (test) teams from the manufacturing firm test the newly developing handset according to checklists and report to a handset manufacturer any errors for corrections. The handset manufacturer then corrects all the errors reported by test teams from both sides.

Software integration activities by software development teams are carried out simultaneously from stages 2 to 4. These activities are the most time-consuming and also the most important in the current mobile handset development process. Software integration consists of three main integration activities: functional porting, graphic user interface development and protocol stabilisation. First, software teams in a manufacturing firm connect and integrate all subsystem modules into a baseband chip as a system, based on software architecture provided by baseband chip makers. Second, software teams also build graphic user interfaces with which customers directly interact to utilise the phone’s features. Third, the teams undertake protocol stabilisation, which allows a handset to communicate and utilise other services through base stations run by MNOs.

(5) Stage 5 – mass production and quality control

The final stage consists of actual mass production, with assembly and quality control for manufactured products. Mass production eventually begins after receiving the guarantee of quality assurance teams.

During several interviews with respect to the development process of a new mobile handset, interviewees stressed the involvement of MNOs in stages 1, 3 and 4 for operator-specific models. To meet the requirements, the development process for these mobile handsets cannot be executed by a handset manufacturer alone.

4.3.3 Baseband chip suppliers

Baseband chips are application-specific integrated circuits (ASICs) that process calls and data in and out through wireless transmissions – this is the primary function of a mobile handset. 'ASICs are integrated circuits that are designed and built for a specific application, and for a specific customer' (von Hippel 1998, p.633). The performance of these ASIC systems requires specific elements to be implemented in electronic circuitry which also includes microprocessor-type circuitry that can be programmed and hence needs software which, in turn, can be modified and improved within the rules established by the design of the ASIC. Therefore, a baseband chip generally comes to handset manufacturers as a package, including hardware baseband chips in tandem with protocol stack software and reference design from which handset manufacturers develop their handsets.

The subsequent sections discuss the importance of baseband chip capabilities with respect to competitiveness of handset manufacturers and the trend towards the dis-integration of baseband chip divisions from handset manufacturers.

Criticality of baseband chip capabilities

In order to guarantee interoperability with mobile networks, a baseband chip must be designed according to predetermined standards and protocols by international standard-setting organisations. Designing a baseband chip requires knowledge of mobile communications and semiconductor technologies. Knowledge and experience from both technological streams are required to acquire the design capabilities.

Apart from technical difficulties, the main question that arises is ‘why are design capabilities of baseband chips so important in the mobile handset industry?’, and the following points offer some answers.

(1) Royalty: burden or leverage?

The mobile handset industry is based on communication standards that are set in advance of product introduction. This requires R&D activities on a new generation of mobile communication technologies to precede the process of setting standards and communication protocols. R&D activities driven by market players produce many newly developed technologies and corresponding patents. These patents play an important role as ‘essential IPRs’ on the process of setting standards by standard-setting organisations with a group of interested participants. When the standards are put in place by nations for commercialisation, manufacturers in the mobile handset industry can claim their rights according to their contributions on setting standards to other manufacturers under the terms of the Fair, Reasonable and Non-Discrimination (FRAND) standard (Geradin & Rato 2007). Companies with essential IPRs are given an option to cross-license with each other or license them to companies without essential IPRs.

During the 2G era, for instance, Korean handset manufacturers had to pay 5% and 7.5% of the handset prices within their domestic and export markets, respectively, on each CDMA handset to Qualcomm as a running royalty (Song 1999). These payments resulted from the manufacturers' active participation in two big telecommunication standards bodies: the 3rd Generation Partnership Project (3GPP)[49] and the 3rd Generation Partnership Project 2 (3GPP2)[50]. Korean handset makers had heavily invested in R&D, had accumulated patents on new mobile communication technologies and exerted influence to make these patents part of the essential IPRs accepted by telecommunication standards bodies[51].

(2) Dependency on the chip makers' technology roadmap

The production capacity of manufacturers can be limited by the production capacity of baseband chip makers, especially in the embryonic stage of the industry. This challenge was witnessed in the early phase of the CDMA handset market when Qualcomm was the only CDMA baseband chip supplier in the world. When Korea commercialised the CDMA network for the first time in the world in 1996, Korean handset manufacturers could not match the very rapid growth in demand due to an insufficient supply of baseband chips from Qualcomm (the firm could not keep up with the increasing demand in both the US and Korea).

More importantly, a new-generation handset cannot be introduced into the market without a new-generation baseband chip; this means that handset manufacturers without chip design capabilities cannot become first movers in a new-generation handset market on their own and hence are hampered in their ability to react quickly to market demands.

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[49] 3GPP is a telecommunication standards body which produces technical specifications and technical reports for a 3G mobile system based on evolved GSM core networks and the radio access technologies that they support (http://www.3gpp.org/About-3GPP, accessed 17/09/2015).

[50] 3GPP2 is also a telecommunication standards body which produces technical specifications and technical reports for a 3G mobile system, but based on CDMA (http://www.3gpp2.org/Public_html/Misc/AboutHome.cfm, accessed 17/09/2015).

[51] Interview with a product planning manager in LG.

Therefore, a protocol stack engineer argued:

> Without the support of baseband chip makers, it is impossible for handset makers to become a first mover strategy, failing to pursue their own technology/product roadmap independently of the baseband chip makers' product roadmap.

In addition, such dependence on baseband chip makers' capabilities may bring high risk of lock-in problem as well.

(3) Cost competitiveness

Manufacturers with design capabilities are able to reduce production costs by not incurring royalty payments on its in-house baseband chips and software architectures. When chip makers provide handset manufacturers with baseband chips, they sell not only hardware chips but also embedded software architecture, which specifies the integration of other components and functions with baseband chips, as explained earlier. Therefore, the first handicap of handset manufacturers without design capabilities for a baseband chip is the cost burden incurred from market transactions with specialised suppliers. In addition, these manufacturers must secure multiple sources of baseband chips in order to avoid heavy dependency on a specific baseband maker; if they do not, they will be locked into a specific chip maker, which will limit their product portfolios and make them entirely dependent on a chip maker's competitiveness[52].

The second handicap mainly comes from the fact that these software architectures are unique to each chip maker. Therefore, manufacturers also have to build unique (relation-

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[52] Interview with a protocol stack engineer at Pantech and a product planning manager at LG.

specific) capabilities for the different baseband chips and software architectures that they utilise. Given that software integrating capabilities based on software architectures are the main role of handset manufacturers, adopting two distinctively different baseband chips means that manufacturers not only have the burden of two licence fees but also have to retain and develop two distinct capabilities. However, these manufacturers have no choice but to keep two groups of human resources for R&D in multi-functional handsets.

Unbundling of baseband chip production and specialisations of handset manufacturers

Since the commercialisation of digital mobile communication technologies, large firms such as Motorola, Nokia and Ericsson have dominated the mobile handset industry. All these firms vertically integrated themselves into baseband chipset and network equipment. They utilised their own proprietary baseband chip packages developed from their semiconductor divisions. These baseband chips can be categorised as typical ASICs as they serve one specific customer, which is its internal handset manufacturing division. However, specialised baseband chip makers such as Texas Instruments and Analog Devices Inc. had emerged in the market between 1996 and 1998 (Funk 2002; Yasumoto & Shiu 2009). These specialised suppliers began to offer baseband chips as a form of Application Specific Standard Processor (ASSP), serving multiple (specialised) handset manufacturers (von Hippel 1998).

The unbundling (Anderson & Jönsson 2006) of the mobile handset industry started in the late 1990s (see Table 4.2) when Qualcomm split their mobile handset and baseband chipset divisions. Qualcomm was the only CDMA baseband supplier until 1998 and therefore the only vertical integrator in CDMA at the time. Selling off its handset division to Kyocera in 1999, it became a specialised baseband chipset provider. Qualcomm insisted that this change of strategy was to allow it to focus on the baseband chipset market, but it was in fact the poor financial performance of the handset division that made investors pressurise Qualcomm's top management to dis-integrate (see Section 6.3.1). In addition, Siemens, which was focused on low-end GSM handsets, also dis-integrated its structure by creating Infineon (hardware chipset and its software solutions) in 1999 after the acquisition of Comneon (software architecture platform solutions).

Ericsson also divided its organisational structure by creating Ericsson Mobile Platforms, and its handset division became a joint venture with Sony, creating Sony Ericsson Mobile Communications (Sony Ericsson) in 2001. In 2008, it was announced that Ericsson Mobile Platforms had merged with ST-NXP Wireless[53], a mobile phone system solution provider, and in 2009, ST-Ericsson was created as a 50/50 joint venture between Ericsson and STMicroelectronics[54]. Freescale was also created from the divestiture of Motorola in 2004[55]. Dis-integration in these handset manufacturers, summarised in Table 4.2, is due to bad performance of their handset divisions. Apart from this trend, only Nokia stayed as a vertically integrated handset manufacturer, retaining baseband chip design capabilities in-house.

[53] ST-NXP Wireless was originally a joint venture of wireless business of STMicroelectronics and NXP Semiconductors in 2008. NXP was also formerly a semiconductor division of Philips Electronics, created in 2006.

[54] Ericsson Mobile Platforms, ST-NXP Wireless homepages.

[55] *Cellular Monthly*, 'M&A in mobile handset manufacturers', 08/2005.

Table 4.2 Dis-integration of semiconductor divisions and handset divisions in the mobile handset industry

Companies	Semiconductor divisions (Baseband chip + software platform)	Handset divisions
Qualcomm	Stayed as Qualcomm	Sold to Kyocera (1999)
Siemens	Infineon (1999) -> Bought by Intel (2010)	Sold to BenQ (2005)
Philips	NXP (2006) -> ST-NXP Wireless (2008) -> ST-Ericsson (2009)	
Ericsson	Ericsson Mobile Platforms (2001) -> ST-NXP Wireless (2008) -> ST-Ericsson (2009)	Joint venture with Sony as Sony Ericsson (2001)
Motorola	Freescale (2004)	Motorola Personal Communications Sector

Source: Author's elaboration.

The logic behind the dis-integration of baseband chip divisions from handset manufacturers has several elements. While the trend towards modularisation in the mobile handset industry accelerated specialisation of industry participants, first of all, the emergence of specialised baseband chip suppliers such as Texas Instruments and Analog Devices Inc. in late 1990s allowed many handset manufacturers without baseband chip capabilities to enter the market. These new entrants would have no reason to source baseband chips from vertical integrators due to concerns over knowledge spillover and information leakage. Given this reluctance, the performance of baseband chip divisions in incumbent vertically integrated firms would be entirely reliant on that of their handset divisions regardless of competitiveness of the former. If the latter suffered in sales, the former had a reason to become an independent entity as was the case of Qualcomm (see Chapter 6).

In vertically integrated industries more generally, component divisions of vertical integrators would have an incentive to dis-integrate, or new entrants would join if the market were to reach ‘critical minimal size’, as discussed by Rosenberg (1976). Becoming a specialised supplier, a component division would be able to serve multiple customers more efficiently on the basis of economies of scale, which would be beneficial for original vertical integrators.

At the time of their market entry, Korean handset manufacturers specialised in handset design and manufacturing, relying on baseband chips from Qualcomm. Given that Qualcomm was also a CDMA handset manufacturer at the time, the competition between Korean makers and Qualcomm seems to have had two opposing aspects. On the one hand, Qualcomm as a vertical integrator was competing with Korean handset manufacturers in the CDMA handset market. While Qualcomm retained cost advantages from in-house production of baseband chips, Korean competitors might be more susceptible to Qualcomm’s hold-up and technical changes in the early stage of CDMA technologies (Afuah 2001). On the other hand, Qualcomm was also a beneficiary from sales of CDMA chips to, and royalties for sales of CDMA handsets by, Korean handset producers. This issue will be discussed in more detail in Chapter 6.

Overall, the emergence of specialised baseband chip suppliers, the unbundling of baseband chip divisions from incumbent manufacturers and the modularisation of handset architecture presented above seemed to relieve handset manufacturers without capabilities in baseband chips from being vulnerable to vertically integrated incumbents. Due to the persistent importance of baseband chips in handset development, however, specialised manufacturers would still have to collaborate with the right partners (as they generally source from plural suppliers) in order to keep their competitiveness.

4.3.4 Mobile Network Operators (MNOs)

Positioned between handset producers and end-users, MNOs play a unique role in the mobile handset industry. Here, the changing role of MNOs and their impact on the distribution structure over time are discussed.

From a network operator to a service provider as an intermediary user

Until the 2G era, MNOs' activities were mainly focused on the operation and management of mobile telecommunication networks. The early saturation of the mobile communications market, however, pushed MNOs towards deployment of new services for customers in order to seek an opportunity to increase ARPUs (Whang 2009). Since 2.5G, MNOs have tried to adopt various new data services like NTT-Docomo's i-mode and have strongly encouraged handset manufacturers to develop handsets for them with multi-functionalities. Since these handsets were generally expensive owing to their technological novelty, MNOs provided subsidies which reduced the price of novel handsets to an acceptable level, stimulating the growth of handset demand and data usage. As a result, MNOs did not have to rely solely on voice calls for their revenue and have created many data services that are accessed using multi-functional handsets (and paid for by data charges that are part of a service package or are separately charged to their customers).

Therefore, MNOs have not remained as mere distributors who purchase handsets from producers (handset manufacturers) and distribute them through their own channels to end-users (final customers). In this sense, they have acted as 'intermediary users'[56] in that they have provided product definitions and specifications to handset producers, purchased these handsets, bundled them with their mobile services, and marketed them through their own channels to end-users (sometimes with subsidies).

There arises the necessity of distinction between the concept of intermediary users and that of 'lead users' proposed by von Hippel. Lead users are a small fraction of end-users of a certain product who 'face needs that will be general in a marketplace but face them months or years before the bulk of that marketplace encounters them, and are positioned to benefit significantly by obtaining a solution to those needs' (Urban & von Hippel 1988, p.549). Intermediary users in fact play a role of lead users by conveying end-users' needs to producers. However, the former do not belong to end-users like lead users, lying between producers and end-users. In addition, the former benefits by selling products to end-users instead of obtaining products.

During this intermediation process, they have played several important roles for both producers and end-users. Firstly, MNOs are innovation facilitators, acting as sources of innovation on behalf of end-users. Positioned closer to end-users than handset manufacturers[57], MNOs are quicker to recognise end-users' needs, experience and new ideas and feed these back to handset producers. However, this does not mean that MNOs will act for the benefit of end-users all the time. Sometimes MNOs guide the direction of handset innovation towards their own benefits at the expense of end-users'

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[56] The concept of an 'intermediary user' used in this thesis has not been articulated yet in the literature. Boon et al. (2011) utilised the term 'intermediary user organisations' but these were representative groups of heterogeneous potential users. For an overview of general 'intermediary innovation organisations' as facilitators of interactions among actors, see Howells (2006).

[57] If producers originate from foreign countries, the gap between producer and end-user will be wider.

utilities. In mid 2000s, for example, Korean local MNOs did not introduce handsets with a WiFi module prior to the introduction of the iPhone in order to secure their profits from 3G data transmission[58][59].

Secondly, MNOs have played the role of 'guarantor of quality' (Jacobides et al. 2006) for end-users in the market. In comparison with simple distributors, they are equipped with the experience and knowledge of mobile network services that enable them to verify the quality of handsets from producers through interoperability tests based on an operator's requirements specification. Of course, the level of knowledge varies depending on the MNO. A software engineer at LG at an interview described:

> The knowledge gap between 1st and 2nd tier MNOs is 'enormous'. Checklists of 1st tier MNOs like Verizon in the US exceed by almost a factor ten to those of 2nd tier MNOs like Movistar in Latin America. Sometimes, they act as a market barrier to those trying to penetrate 1st tier MNOs.

However, new entrants will benefit from 1st tier MNOs' strict quality screening process if they clear this hurdle because they will then be able to access the marketing, distribution and financial resources of MNOs (Chapter 6 discusses this issue in detail).

Lastly, MNOs are also important financial intermediaries for handset makers. On the one hand, MNOs provide handset makers with direct revenue on purchases of handsets that are, in fact, leased from an MNO. Although this arrangement allows the MNO to earn financial profits from its subscribers, it provides handset makers with immediate cash flow from handset sales. On the other hand, MNOs also promote their new mobile

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[58] Korean customers called this kind of domestic handset without a WiFi module a 'castrated phone'.
[59] *Ddaily*, 'Spec down of LG's new Chocolate: Domestic version without WiFi module', 22/09/2009, http://www.ddaily.co.kr/news/article.html?no=54368, accessed 27/01/2015.

services bundled with new handsets (especially from 2.5G) by giving substantial subsidies, generally together with handset producers, to customers who commit to long-term contracts (usually more than 18 months).

Globalisation of MNOs and bundling of their mobile Internet services

Against fast market saturation, the two main strategies adopted by MNOs were: (1) creating a new business model with mobile Internet services; and (2) globalisation through Mergers & Acquisitions (M&A) across borders. The former was related to efforts for higher ARPU and the latter was an endeavour to achieve cost reductions through economies of scale, mainly by global sourcing of handsets and the launching of new mobile services.

Table 4.3 shows the globalisation of major MNOs by 2005. Examples of globalisation by European MNOs through M&As across borders include Vodafone, France Telecom (Orange), Deutsche Telekom (T-Mobile) and Telefonica[60]. Among these, Vodafone is the biggest globalised MNO in terms of subscribers; it also exceeds 90% in terms of share of foreign subscribers, and operates in 32 different countries, as shown in Table 4.3. These globalised MNOs launched their wireless data services on a global scale. The global launch of such examples are 'Vodafone Live!' by Vodafone in 19 countries and 'i-mode' by NTT-Docomo in 13 countries as of August 2004.

[60] These four MNOs accounted for 78% of the EU market in 2009 in terms of subscriptions (EC, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: A Digital Agenda for Europe*, 2000).

Table 4.3 Global presence of MNOs and their respective numbers of subscribers (as of 31/12/2005)

Network operator	Origin of company	Number of subscribers (thousands)	Global presence (no. of countries)	Per cent of foreign subscribers
Vodafone	UK	179,316	32	90.9%
America Movil	Mexico	92,635	14	61.2%
Deutsche Telekom	Germany	85,428	14	65.6%
France Telecom	France	71,946	27	68.6%
Telefonica	Spain	71,273	25	74.2%
Mobile TeleSystems	Russia	59,014	6	25.1%
Sprint Nextel	US	44,780	7	1.5%
Telenor	Norway	42,599	15	93.6%
Verizon Comms	US	37,203	5	24.1%
NTT-Docomo	Japan	33,975	7	13.9%
Singapore Telecom	Singapore	30,698	7	94.7%

Source: Curwen & Whalley (2006)

Economies of scale were realised mainly through co-sourcing handsets and mobile telecommunication equipment and sharing mobile service platforms. In particular, European MNOs – who for lack of scale had not been able to order customised handsets (Haas et al. 2006) – could guarantee enough volume for handset manufacturers. Therefore, globalisation of MNOs through M&As gave these operators greater bargaining power over handset manufacturers than previously[61]; however, it also presented an opportunity for handset manufacturers who were willing to engage in customisations. Contracts with these global MNOs for a new mobile service allowed handset manufacturers to easily attain economies of scale mainly due to the global scale

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61 *Businessweek*, 'Can Nokia get the wow back?', http://www.businessweek.com/printer/articles/184300-can-nokia-get-the-wow-back?type=old_article, accessed 15/01/2015.

and sharing of data platforms instead of serving multiple MNOs across borders at a lesser scale and with various data platforms. Therefore, the influence of MNOs in the market has increased through the process of globalisation.

Distribution channels: open market vs closed (operator) market

The mobile handset market can be divided into two different types of market according to who is a final distributor to handset customers: open market and closed market (or operator market).

An open market is where handset manufacturers sell their own handsets directly to customers through their own distribution channels or professional distributors (non-network operators) such as Carphone Warehouse. In this market, handsets are compatible with any networks utilising the same standards. These handsets are sometimes called ‘unlocked phones’. They include manufacturers’ own standard platforms without supporting operator-specific services. Therefore, this type of handset is generally low-end and cheap with standardised functions.

A closed market (or operator market) is where MNOs are the main distributors; here, new mobile handsets are generally introduced in association with new services provided by network operators. Handsets sold through closed market channels generally include platforms to accommodate specialised services created by MNOs. They tend to be high-end products with brand-new functions and are therefore expensive. These handsets are marketed with subsidies from network operators or sometimes together with handset manufacturers, provided that customers accept long-term contracts, as explained above. In a closed market, collaboration between handset manufacturers and MNOs is crucial.

As noted in Section 4.3.2, MNOs are closely engaged in the development process of a new handset from initial (product specifications) through to final stages. The main functionalities of a new handset are heavily influenced by MNOs who also strictly control the development schedule by their own release schedule for these new products.

The proportion of an operator market vs an open market varies significantly across the world. As shown in Table 4.4, the European market has had a higher ratio of pre-paid subscription ratios compared to countries like Japan, Korea and the US. A high proportion of pre-paid subscribers generally means the dominance of open market. The proportion of an operator market around the world is approximately 50% in Western Europe, 98% in Latin America, 96% in the US, and close to 100% in South Korea and Japan (2007 data); in contrast, it is only 5% in emerging markets excluding Latin American countries (Jo & Mun 2007). In the next subsection, the main reasons behind the discrepancies between the EU, Japan, Korea and the US are examined.

Table 4.4 Mobile pre-paid subscription ratios among major OECD countries (in %)

	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
France	35	47	49	44	39	37	35	33	32
Germany	24	55	56	53	51	42	51	47	55
Italy	84	88	90	90	91	91	92	90	89
Japan	3	2	-	3	3	3	3	2	2
Korea	-	-	-	2	2	1	2	1	2
Spain	62	66	65	66	58	52	49	56	54
UK	50	77	70	69	67	67	66	65	64
US	5	6	9	8	7	8	11	15	17
OECD	26	37	41	41	41	40	42	43	44

Source: OECD Communications Outlook (2009, p.135).

The origin of discrepancies in the distribution channels across countries

When the GSM standard was commercialised in Europe as a single 2G standard, the standard setting and the development of the GSM were promoted mainly by companies like Nokia and Ericsson. They manufactured both network equipment for network operators and handsets for end-users in the course of the GSM commercialisation. Therefore, the European telecommunication market was driven by manufacturers rather than MNOs (Tee & Gawer 2009). As a result, the business scope for these manufacturers covered entire European countries, while most of the European MNOs stayed as local players. At the time, handset functions were oriented towards voice calls and simple text messaging services. It made it hard for MNOs to differentiate themselves, unlike handset manufacturers. The situation was intensified as manufacturers like Nokia and Ericsson grew into global market players based on the success in the European GSM market. In particular, Subscriber Identity Module (SIM) cards used in GSM handsets allowed customers an easy shift between MNOs[62]. Therefore, under a single 2G standard of GSM in the whole European continent, handset manufacturers enjoyed strong bargaining power over local MNOs. During the interview, a former marketing manager at an European MNO mentioned:

> During Nokia’s heyday, no MNOs could engrave their brand in Nokia's handset. Not a single character was allowed. Contracts with Nokia, without exceptions, were made solely under the Nokia’s terms.

The advantage of global handset manufacturers continued till the emergence of global MNOs such as Vodafone and T-Mobile through continuous M&As across borders and the ensuing launch of global wireless data services (Haas 2006).

[62] Interview with a manager in a Korean MNO.

In contrast, the markets in Japan, the US and Korea are typically operator-dominated, where the operators control more than 90% of handset distribution (Jo & Mun 2007). However, the reasons for operator domination of the market differ across these countries.

Japan has been one of the most operator-dominant countries in the world (Tee & Gawer 2009). This mainly comes from the fact that in the emergence of the 2G era, NTT-Docomo took the leading role in the development of PDC (the first national 2G standard) with the collaboration of handset manufacturers (Haas et al. 2006). Therefore, technical specifications in the mobile communication systems were ruled by NTT-Docomo. In order to source handsets, MNOs designate specifications of new handsets and share the development costs with handset manufacturers in Japan. If handset manufacturers deliver developed handsets, MNOs purchase at wholesale cost new handsets from manufacturers and market them with their service. Printed in a single Roman alphabet character in a model number, the brand of handset manufacturers has been shadowed by those of MNOs. This arrangement was very similar to a form of ODM contract. In addition to subsidies from MNOs, three dominant MNOs had strong bargaining power against more than ten local handset manufacturers (Haas et al. 2006; Tee & Gawer 2009).

In Korea, on the other hand, the nature of CDMA technologies and the government's policies mattered. Given that CDMA handsets do not use a SIM card and are locked to one specific MNO (due to subsidies provided by the MNOs), customers cannot switch from one MNO to another, like GSM, by just purchasing and inserting a new SIM card (Husso 2011). The Korean government acknowledged CDMA as a single national 2G standard in 1993 as a way to support the successful commercialisation of the joint CDMA development project between Qualcomm and ETRI (see details in Chapter 5). When the CDMA network system was commercialised in 1996, the Korean government also issued the licence for sales to MNOs so that they could establish operator shops and sell handsets directly to customers to promote the domestic digital mobile industry. Two MNOs sourced handsets at bulk from more than five local and two foreign handset manufacturers, thus enjoying stronger bargaining power over manufacturers. In tandem with subsidies[63] from November 1996, Korean MNOs never lost their bargaining power against handset manufacturers.

In the US, there were the intertwined effects of the diversity of national 2G standards and the tradition of subsidies over the strong bargaining power of nationwide MNOs. Switching MNOs was also cumbersome for US customers for two reasons. First, four different national 2G standards – CDMA, GSM, TDMA and integrated Digital Enhanced Network (iDEN) – in the US made it difficult for customers to change their network providers because of incompatibility. Even though GSM was one of 2G standards, most GSM handsets were also locked to a specific MNO in the US. Second, US customers were accustomed to buying handsets at lower prices with subsidies based on long-term contracts or purchase of bulk minutes with MNOs. These handsets were also locked to a specific MNO. Nokia's chairman Jorma Ollila explained the nature of

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[63] In Korea, the history of subsidies for the purchase of mobile handsets began with advent of the second MNO, Shinsegi Telecom. It joined in the market in April 1996 but showed less successful results than its main rival (Korean Mobile Telecommunications Corporation), gaining only 77,000 subscribers over the first seven months. Facing retreat from the market, Shinsegi Telecom provided subsidies to new subscribers from November 1996, which turned out to be a huge success, securing around 130,000 subscribers over just one month. Korean Mobile Telecommunications Corporation, the dominant operator, had no choice but to join in the subsidy race. Marketing based on subsidies among MNOs became more fierce from October 1997 when new three Personal Communications Service (PCS) MNOs penetrated the market (*Cellular Monthly*, 'History of handset subsidies in Korea',11/2005).

US market as 'It's not like we have 300 million+ customers in the US. There are four to five customers who control access.' (Steinbock 2010, p.205). Concerning these operator-dominant markets, Ollila also commented '...MNOs will decide which phones are sold, when and at what price. Their brands are strongest than those of manufacturers... If you don't get along with operators, you are out of the market.' (Husso 2011, p.72).

The transition of mobile communication technologies from 2G to 3G and the corresponding network services from voice-centric to data-centric generally enlarged the role of MNOs in the mobile handset industry and therefore reduced the open market, especially around developed countries. Moreover, the globalisation of MNOs as explained in the previous subsection further strengthened the bargaining power of MNOs, in favour of operator markets in those countries.

4.4 Summary

The main objective of this chapter has been to provide some basic knowledge about how mobile telecommunication technologies and services have evolved and how three key actors (handset manufacturers, baseband chip suppliers and MNOs) within the industry have set their roles and scopes across the value chain over time. While the transition from analogue (1G) to digital (2G) was a gradual process in order to meet increased demands, that from 2G to 3G fundamentally has evolved from simple voice-centric to data-centric. The later transition had a significant impact on the product architecture of handsets and the role of MNOs in the industry, leading to the co-evolution of mobile handsets and data services through close inter-firm relationships.

On the upstream side, leading handset manufacturers like Nokia, Motorola and Ericsson were all vertically integrated with in-house baseband chips in the early stage of the industry. With the emergence of specialised baseband chip suppliers in late 1990s, however, the unbundling of baseband chip division from these leading manufacturers began to proceed along with modularisation of handset architecture, as presented in 4.3.2. At the same time, the main role of a mobile handset manufacturer has been specialised to hardware design and software integration activities as a system integrator. This change of the division of labour on the upstream side can be summarised as vertical dis-integration and specialisation.

On the downstream side, two distinctive distribution channels exist: open and closed markets. The former is where handset manufacturers sell their handsets through their own distribution channels as well as specialised distributors. In the latter, MNOs play an important role in the industry as intermediary users. They influence handset designs, purchase handsets, bundle their mobile services and distribute these handsets to customers exclusively through their own branches. Globalisation of these MNOs has further helped to reinforce their bargaining power against handset manufacturers. As a result, interactive collaboration between handset manufacturers and MNOs has become more prevalent.

Given the evolution within the industry of technology, market and actors, as elucidated in this chapter, the thesis now moves to three empirical chapters in order to investigate how Korean handset manufacturers achieved the transition from being latecomers to reaching the world frontier of their industry.

5. JOINT CDMA DEVELOPMENT BETWEEN QUALCOMM AND ETRI[64]

5.1 Introduction

This chapter addresses how Korean handset manufacturers accumulated (or acquired) technological capabilities to compete head on against global leaders in the industry. The conventional conjecture regarding the situation facing emergent leading firms is that, to the extent that they seek technological leadership (i.e. being at 'the top tier of the game'), they will be considered as potential competitors by previous technology licensors who may discontinue licences (Chu 2009; Hobday et al. 2004; Kuo 2009). The outcome of this logic is that the emergent leading firms are forced to rely solely on in-house development. Others, however, have argued that the more common situation will be the existence of continuing opportunities for technology licensing due to competition among global frontier firms, new market entries by venture companies and firms from adjacent industries (Kim 1997a; Soete 1985; Song & Song 2010; Steinmueller 2001). In this chapter, we consider this issue with the case of the Korean government's 'Digital Mobile Telecommunication Development Project' [65] implemented by ETRI as the 'Joint Development Project' in tandem with Qualcomm (the pioneer[66] of CDMA technologies).

[64] This chapter is mainly based on ETRI final reports (1992–1996), Lee (2009) and Song (1999).

[65] This project has been shown as a successful example of a developing state's active intervention in its early technology development and industrial and market creation. The author acknowledges the importance of the role of the Korean government for the success of the project. As this issue has been extensively studied so far (Ahn & Mah 2007; Kim 2001; Lee & Lim 2001; Song 1999), this chapter will focus on the issue of windows of opportunity.

[66] Qualcomm should not be called an inventor of CDMA technologies as the concept had been known since 1935.

The chapter is composed as follows. Section 5.1 describes in detail the challenges that the Korean government faced in the course of providing its AMPS network to the public, and the reasons for pursuing the development of a digital mobile communications system. Section 5.2 explains the factors behind the change of strategy from in-house to joint development (with technology licensing), the options that were available to the Korean government, and how the government's efforts to license US-TDMA were blocked. Section 5.3 looks at how Qualcomm agreed to a joint project with ETRI, and Section 5.4 traces the chronological progress of the Joint Development Project between Qualcomm on the one hand, and ETRI and four Korean designated manufacturers on the other. In Section 5.5, the results of the project are presented in terms of the division of labour between Qualcomm and its Korean counterparts during the project and the knowledge boundaries thereof after the project. Section 5.6 examines the likelihood of emergent leading firms that acquire technology licence of getting to 'the top of their game', and – as a conclusion for this chapter – the role of technology licensing is discussed in the transition of emergent leading firms into technology leaders, in comparison with the more conventional views that are expressed in the literature on the catching-up process.

5.2 Pursuit of the development of a digital mobile communications system by the Korean government

The history of commercial mobile telecommunication services in Korea commenced with the AMPS analogue cellular service for the Seoul Metropolitan area in 1984. Between then and 1992, the number of subscribers of the service dramatically increased at an average annual growth rate of 60% (see Table 5.1). In the early years, there was a surge in demand for the service leading up to the Seoul Olympics in 1988. From 1987 to1992, the number of new subscribers in the analogue mobile telecommunication service roughly doubled each year. Due to the rapid increase in demand, the quality of voice calls in the Metropolitan area became noticeably worse, and it was anticipated that the capacity of analogue mobile telecommunication services in Korea would not be able to serve the demands from 1996 onwards[67]; from the Korean government's perspective, this represented a looming crisis.

Table 5.1 Number and annual growth rate of new subscribers in the Korean mobile telecommunication service

Year	Subscribers*	Growth rate
1984	2,658	76.3%
1985	4,685	51.4%
1986	7,093	44.7%
1987	10,265	98.3%
1988	20,353	98%
1989	39,718	95%
1990	80,005	101%
1991	166,198	107%
1992	271,868	64%

*All subscriber numbers represent AMPS subscribers. There was no digital service until January 1996.

Source: modified by the author based on Song (1999, p.66 & p.79).

The other concern for the Korean government was a huge trade deficit in the industry. At the commencement of the analogue mobile service in 1984, Korean Mobile

[67] In order to cope with the increase of 960,000 new subscribers over the previous five years, Korean Mobile Telecommunications Corporation (which became SK Telecom in 1993) had to order telecommunication equipment worth $100 million from AT&T, in August 1995, only four months before the commencement of the digital mobile telecommunication service (*Businessweek*, 'Seoul Finally Dials Competition's Number', 01/10/1995).

Telecommunications Corporation adopted Motorola's network equipment with its mobile telephone exchanges. In addition, all mobile handsets were imported from Japan (Toshiba, NEC), US (Motorola, E.F. Johnson) and Canada (Novatel). Without adequate knowledge of mobile telecommunication technologies, Korean Mobile Telecommunications Corporation had to rely on foreign suppliers, even for minuscule network problems. It had no bargaining power[68] against foreign sellers to keep prices down or to transfer technology. Without domestic products in the mobile telecommunication market, high demand for the service directly meant a high trade deficit on network equipment and mobile handsets. Throughout the modern development of the Korean economy, the government has used trade deficits as an indicative planning tool for areas needing domestic development (Kim 2000).

To make matters worse, from January 1987, the US government began to call for the opening up of the Korean telecommunication market (Amsden 1989), which included the telecommunication service and telecommunication equipment markets, and removal and/or lowering of tariff barriers. There were numerous indirect attempts by the US to pressurise Korea into opening its market, including the designation of Korea as a priority foreign country for trade diplomacy. Eventually in 1991, the two counterparts agreed that the Korean telecommunication equipment market would be liberalised from 1993 (Lee 2009).

[68] All that Korean Mobile Telecommunications Corporation could do was to change the bidding system. In November 1988, two executives of the company travelled to Motorola to ask for greater capacity of exchange, more base stations and extra maintenance resources and technology transfer on equipment production. The CEO of Motorola, however, refused to accept the terms based on Motorola's relationship with the Blue House (Lee 2009). Korean Mobile Telecommunications Corporation changed the bidding system for a contract to a designated open bid for the subsequent purchase of analogue telecommunication equipment. The three foreign companies of Motorola, AT&T (later Lucent) and Ericsson were allowed the opportunity to bid, and AT&T took over the position of a monopolistic supplier. However, the price did not go down as much as expected (ibid.).

Three factors – the fast saturation of the analogue mobile network, a corresponding high trade deficit, and the added pressure on trade due to the opening of the market – drove the Korean government towards the launch of immediate and drastic policies on mobile telecommunication technologies. Firstly, the Korean government swiftly implemented policies on privatisation and competition into the previously monopolised industry in 1988. Secondly, the Ministry of Information and Telecommunication delegated to its nationally funded institute, ETRI, an ambitious nationally sponsored R&D project on digital mobile communication technologies, the 'Digital Telecommunication System Development Project' in January 1990[69]. The scope of the project was to develop a complete system of digital mobile telecommunications including a mobile handset, a base station and a mobile exchange, and to provide a full commercial service by 1997. The length of the project was to be seven years from 1990 to 1996 with 411 man-years and a budget of about $60 million.

5.3 Failed efforts on technology licensing

When the Korean government announced the Digital Telecommunication System Development Project in January 1990, the plan was for ETRI to develop an in-house system based on US-TDMA technologies. However, it did not take long for the researchers in ETRI to realise that it was impossible to implement the project without proper knowledge of digital mobile communication technologies (Lee 2009). ETRI

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[69] The decision of the Korean government to launch such an ambitious project mainly came from the success of the telephone digital exchanges R&D project. Its goal was to develop in-house and commercialise a Korean digital electronic telephone switching system, substituting imports with domestic goods. It was carried out successfully from 1977 to 1991 by ETRI with the support of four private companies (Samsung, LG, Daewoo, Dongyang). This import substitution effort proved to be successful with the domestic product share of the digital switching market and became the template for the digital mobile communication system development project (Song 1999).

surrendered its original in-house development strategy and decided to undertake a joint R&D project with a foreign manufacturer. There were three different kinds of digital mobile telecommunication technologies by the time ETRI changed its strategy. The first technology was GSM which was ready to be commercialised in Europe, and which had been mainly developed by European companies such as Nokia and Ericsson; the second was US-TDMA, which was very close to the commercialisation stage[70], mainly through the efforts of US companies like AT&T (later Lucent), Northern Telecom and Motorola; and the third was CDMA pioneered by Qualcomm, which at the time was merely a small US venture company, and had not yet demonstrated its serviceability on a commercial scale.

Initially, CDMA was not considered by ETRI engineers to be a candidate for licensing; they did not know of the existence of CDMA at the time, an indication of the limited knowledge of Korean engineers on the latest trends in digital mobile telecommunication technologies (Ibid.)[71]. In case of GSM technologies that were about to become commercialised in the European market, many stakeholders like Nokia, Ericsson, Siemens and Alcatel had contributed towards them. Therefore, GSM was not appropriate for ETRI's plan for technology licensing since the Korean side would have had to make multiple licensing contracts with these foreign companies. With no alternatives left, and given the inclination of the Korean trade market towards the US, ETRI and the Korean government agreed to pursue the US-TDMA technology as the country's 2G standard.

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70 US-TDMA had already been announced as a digital standard in the US in 1989.

71 The remaining details on the Joint Development Agreement with Qualcomm in section 5.3 and 5.4 are mainly retrieved from Lee (2009) unless specified otherwise.

At the time, there were three candidates that could have been the designated technology licensor of US-TDMA in the US: AT&T (which later became Lucent), Motorola and Northern Telecom. Both AT&T and Northern Telecom instantly declined the request from ETRI for technology licensing (Song 1999). ETRI had anticipated such responses as it did not have adequate technologies to leverage for a technology licence from these two companies. It may be significant that both AT&T and Northern Telecom produced digital switches, the technology which ETRI had developed from the national telecommunication digital exchange R&D project which resulted in a loss of market share by these companies. ETRI expected a better chance with Motorola as a possible licensor as it did not produce digital switches (Ibid.). ETRI assumed that some exchange of mobile technology for digital switching capabilities could be arranged. In November 1990, engineers from ETRI visited the Motorola headquarters to request a joint development project for US-TDMA. However, Motorola's conditions were unacceptable to ETRI, given that it had provided Korea with early AMPS network equipment and dominated the Korean market for the analogue mobile handsets to the extent of having had more than 50% of the market share. Motorola demanded that the Korean government should guarantee its company a certain portion of the Korean domestic market in return for technology licensing, to ensure that the successful completion of the project would benefit itself. Moreover, it also demanded that Korean manufacturers would have to get permission from Motorola whenever they exported developed products overseas. For the Koreans, these conditions were not compatible with the main purpose of technology licensing, i.e. substituting domestic production for imports and exporting Korean products (Lee 2009).

5.4 Qualcomm's offer of joint development

Having failed to reach agreement with Motorola, the ETRI engineers that had contacted Motorola came across the existence of CDMA technologies by accident through a former ETRI engineer, who at the time worked for a US venture company in New York (Ibid.). At the same time, the CEO of Pactel[72] Korea, Park Heon Seo, who knew that Pactel had invested in Qualcomm's CDMA technologies, visited ETRI and recommended that they consider the potential of CDMA technologies. Within days, William Lee, the vice president of Pactel, visited the Institute with Allen Salmasi, a vice president of Qualcomm, and gave a seminar on the trends of digital mobile telecommunication technologies in ETRI, and it was Allen Salmasi who first proposed a joint CDMA development project at a subsequent meeting with the president of ETRI (Ibid.).

Why did Qualcomm intend to allow technology licensing with a Korean counterpart? This requires some insight into the context of the US digital mobile communication market at the time. Qualcomm was a small venture company running OmniTRACS – a satellite-locating and messaging service for long-haul trucks – and serving digital radio communications projects for the Department of Defense in the US. In the early 1990s, it was trying to apply CDMA technologies, originally developed for military purposes, to the field of civilian mobile telecommunications. When Qualcomm visited ETRI, US-TDMA had already become the first US 2G standard in 1989, and was expected to be commercialised with the support of large groups of network operators and network

[72] Pactel (Pacific Telesis) was one of seven so-called 'baby Bells' originating from Bell System around San Francisco area.

equipment companies. On the other hand, Qualcomm was seeking capital investment for the verification of CDMA's commercial potential in order for CDMA to be approved as another 2G standard by the US Cellular Telecommunications Industry Association. Therefore, it had the incentive to pursue the technology transfer of CDMA technologies from manufacturers of network equipment and mobile handsets to as many network operators as possible (i.e. not only to ETRI) in order to push CDMA as a global digital mobile telecommunication technology.

In the absence of an alternative, ETRI finally decided to pursue a joint project with Qualcomm for the commercialisation of CDMA technologies and signed a memorandum of understanding (MOU) with Qualcomm in January 1991 (Song 1999). On 6 May 1991, after four months of in-depth negotiations to finalise the MOU, Qualcomm and ETRI signed the Joint Development Agreement which consisted of two forms: the first was the Joint Development Agreement between Qualcomm and ETRI, and the second was the Licence Agreement between Qualcomm and designated manufacturers. Designated manufacturers were private companies that would produce commercial network equipment and mobile handsets under Qualcomm's licence. Therefore, the project's final goal was the full-scale commercial service provision of a digital mobile telecommunication system.

The original plan of the project was to be executed in three steps. Firstly, ETRI would study CDMA technologies with the help of Qualcomm. Secondly, ETRI and Qualcomm were to jointly design and develop a CDMA system and its sub-modules. Lastly, Qualcomm and ETRI would hand over the results of their co-development to designated manufacturers who would in turn deliver commercial-level products to MNOs. Qualcomm was also supposed to provide technical support to these manufacturers during the commercialisation process. Table 5.2 presents the timetable, licensing fees paid to Qualcomm and the goal for each phase of the joint development.

Table 5.2 Original timetable, fee, and goal for each phase of the Joint Development Project

Phase	Period	Fee	Goal
Phase I	5 months	$1.9 M	Understanding CDMA technologies
Phase II	9 months	$10 M	High-level design of a CDMA system
Phase III	5 months	$5.05 M	Low-level design of a CDMA system
Phase IV-1	19 months	To be renegotiated	Pre-production support
Phase IV-2		To be renegotiated	Field tests and full-scale commercialis ation
Total	38 months	$16.95 M	

Source: modified by the author based on Song (1999) and corroborated by ETRI (1992–1996).

By the time Qualcomm and ETRI had signed the Joint Development Agreement in 1991, there was still intense dispute among industry experts and government officials over the likelihood of CDMA commercialisation (Song 1999). Therefore, ETRI proposed a stepwise project whereby they would move to a new phase only if the previous phase had been carried out successfully. Such an approach would enable ETRI to lessen the risk of the joint project and would also appease those who were pessimistic about the future of CDMA technologies (Lee 2009). The Joint Development Project comprised four phases. Given that ETRI did not possess basic knowledge on wireless technologies, Phase I was intended to provide its staff with the opportunity to understand the fundamentals of CDMA technologies by working with Qualcomm. Phase II was to be targeted at the high-level design of a CDMA system, including a mobile telephone exchange (later to become a mobile switching centre), base station controller, base transceiver station, and mobile station by installing a roving test system developed by Qualcomm in ETRI. Phase III was to comprise the low-level design of a CDMA system, and Phase IV was intended to provide pre-production support (including support of field tests and full-scale commercialisation).

5.5 The progress of the Joint Development Project[73]

Like most projects, the Joint Development Project did not proceed as planned. In this section, we present a detailed description of what has been learned and accomplished over the course of the joint project, mainly from a Korean perspective, and what was changed against the original plan and why.

Phase I lasted for five months from September 1991 to January 1992. The goal of the phase was for the Korean engineers to understand the fundamentals of CDMA technologies with the support of Qualcomm.

During the period, five researchers from ETRI were sent to Qualcomm in San Diego, US, and given the opportunity to study CDMA system technologies through secondary documents, seminars, and by participation in CDMA system tests carried out by Qualcomm. As planned, this phase enabled ETRI researchers to understand and absorb knowledge on the fundamentals of CDMA technologies. However, as a preliminary

[73] This section was mainly based on ETRI reports (1992–1996), which were submitted at the end of each year to the Korean government.

R&D step, this phase did not result in much tangible outcome for ETRI (1993).

While Phase I was nearing its end, the negotiations for Phase II had begun (in January 1992) and the main concern in the joint venture was the amount of royalty that designated manufacturers had to pay to Qualcomm for the licence of CDMA products. After intense negotiations, both sides agreed on a royalty in April 1992 and moved into Phase II (Lee 2009).

Phase II began in August 1992 and lasted for 15 months (originally nine months had been expected), until November 1993. The main objectives of this phase included the installation of Qualcomm's roving test system in Korea and its field tests, i.e. the high-level design of a CDMA system and selection of designated manufacturers.

Qualcomm handed over the roving test system to ETRI in December 1992, which was installed in Daejeon (where ETRI was situated) and in Seoul for field tests. The roving test system produced by Qualcomm was a prototype machine system with digital switches, base stations, base station controller, and a mobile handset within a rack enabling CDMA mobile communications with minimum size and functions, in order to showcase the potential for commercialisation of CDMA technologies. Although minimal, it demonstrated the essence and revealed the scope of Qualcomm's cutting-edge CDMA technologies. In addition, ETRI engineers could accelerate their assimilation of knowledge on CDMA technologies by reverse engineering and field tests with the roving test system. In March 1993, based on the design of Qualcomm's roving test system, ETRI produced its own prototype of a CDMA network system named 'Korea Cellular System-1'.

When the recruitment of designated manufacturers was announced, six companies submitted applications in September 1992: Samsung, LG, Daewoo, Dongyang, Hyundai and Maxon[74]. During the negotiations, however, Daewoo and Dongyang withdrew due to the scale of royalties and R&D investment (Song 1999). In January 1993, the Korean government announced that Samsung, LG, Hyundai and Maxon were to be the designated manufacturers of the project and assigned the first three companies to collectively take on the role of network equipment developer and all four companies to take on the role of mobile handset developer[75]. As project coordinator, ETRI assigned to these designated manufacturers research areas according to subsystems, and facilitated sharing of research results among them, as shown in Table 5.3; 30 personnel from each designated manufacturer were dispatched to ETRI for collaborative design work from April 1993.

Table 5.3 Division of labour amongst Korea's designated manufacturers

Subsystem	**Company participants**
Mobile station (mobile handset)	Samsung, LG, Hyundai, Maxon
Base transceiver subsystem	LG, Hyundai
Base station controller	Samsung, Hyundai
Mobile eXchange	Samsung, LG
Subscriber location registry	Samsung, Hyundai

Source: Song (1999, p.123).

74 The first four companies were all main participants in the former telecom digital exchange R&D project organised by ETRI. Maxon was a specialised wireless telephone company, but Hyundai, the second biggest conglomerate in Korea, had not been involved in the telecommunications industry before and regarded the project as a good opportunity to extend its activities into this new field.

75 From the beginning, the Korean government targeted only the domestic market for network equipment but both domestic and foreign markets for mobile handsets. Assuming that there would be very little opportunity in the export market for network equipment and considering the size of the Korean domestic market, the government judged that three manufacturers would be adequate (Song 1999).

In addition, a total of 20 researchers from ETRI and the four designated manufacturers were sent to Qualcomm to agree on the fundamental structure of a CDMA digital mobile communications system. According to the Joint Development Agreement, Qualcomm and ETRI were supposed to jointly design a CDMA network system based on Qualcomm's roving test system and develop other sub-modules (Lee 2009). However, they disagreed on the technologies for a CDMA mobile exchange (Song 1999). In the end, both sides agreed to follow their own designs while sharing information on some identical subsystems that could be utilised for both designs.

Korean designated manufacturers were also dissatisfied with ETRI's design of the Korean Cellular System-1 based on Qualcomm's roving test system (Song 1999). Based on their previous experience with commercialising digital switches, these companies recognised that the Korean Cellular System-1 was inappropriate for commercialisation in terms of manufacturability and economic feasibility (Lee 2009). From August 1993, ETRI began to develop its new CDMA system, called 'CDMA Mobile System-2', reflecting all the requirements of manufacturability at a commercial level provided by designated manufacturers.

Phase III lasted for 12 months from February 1994 to February 1995 and aimed to accomplish the low-level design of a CDMA network and a mobile handset prior to a pre-production stage.

During this phase, the first air call was successfully made on 30 April 1994 through CDMA Mobile System-2, and the modifications and improvements to the system were successfully completed in November 1994 (Song 1999). While ETRI was responsible for completing its development of CDMA Mobile System-2, Qualcomm successfully developed the CDMA interface subsystem[76] and selector bank subsystem[77] of the base transceiver station and base station controller and handed over documents on hardware and software design of these subsystems between April and August 1994.

The other important events were 'Programme Review Meetings' that were held every two months between ETRI and Qualcomm with regard to the progress of Qualcomm's development of ASICs for a mobile handset and a base station. If Qualcomm's ASICs were to change, the software and design of a mobile handset and base station would have to change accordingly. As the commercialisation of a CDMA mobile communication network came close to becoming a reality, the development of Qualcomm's ASICs was of prime importance. Around this time Qualcomm was the only developer of CDMA ASICs[78] and it continued to improve its ASICs for a mobile handset and base station. ETRI's reliance on Qualcomm for the design of a CDMA handset was such that the deputy minister of the Ministry of Information and Communications asked the project leader to visit Qualcomm's headquarters in San Diego every two weeks in February 1994, which subsequently became every four weeks from March onwards when Qualcomm itself began to send engineers to Korea (Lee 2009).

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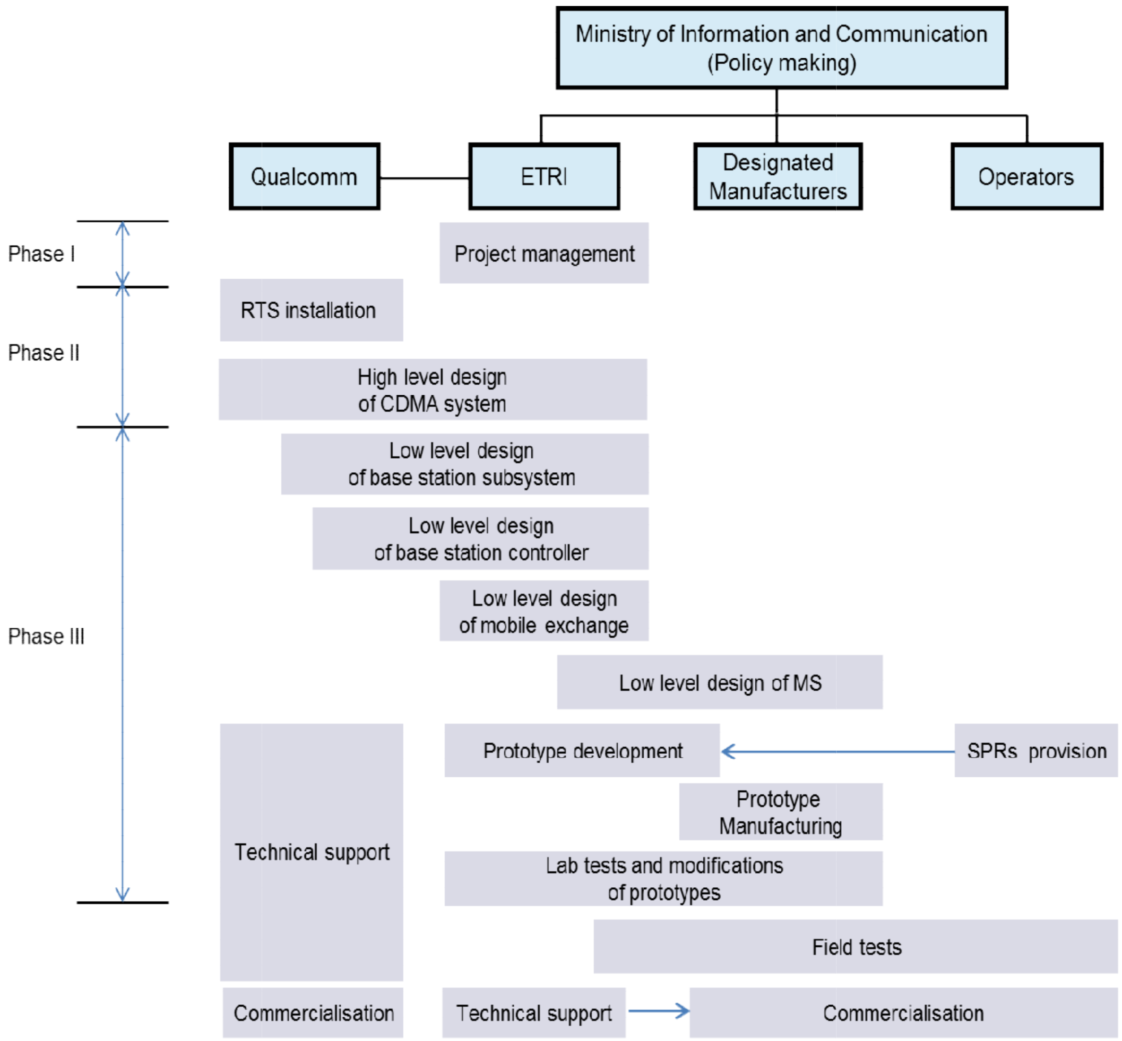
[76] The CDMA interface subsystem is a subsystem that routes traffic and control signals among base transceiver stations and subsystems in a base station controller.
[77] A selector bank subsystem is a subsystem in a CDMA base station controller that processes calls and transmits/receives voice data to/from a mobile switching centre.
[78] Samsung managed to develop ASICs for baseband chips in August 1996 (*Yonhapnews*, 'Samsung developing chips for mobile equipment', 23/08/1996).

Figure 5.1 shows the division of labour between Qualcomm and its Korean counterparts, the Ministry of Information and Communication, ETRI, the four designated manufacturers and Korean Mobile Telecommunications Corporation.



Source: modified by author based on Song (1999), ETRI (1995) and Whang (2009).

Figure 5.1 Division of labour between Qualcomm and its Korean counterparts

The role of Qualcomm and ETRI was significant in the project from start to finish, while that of the designated manufacturers became important in Phase III during preparations for the commercialisation stage. A significant aspect of phases II and III was the involvement in the project of the domestic network operator Korean Mobile Telecommunications Corporation. In September 1993, the Korean government forced the operator[79] to launch a 'project management group' within the company in order that technical experts could supervise and speed up progress of the project. The group first transformed the project structure from co-development by the four designated manufacturers with ETRI leading them, to competitive development among the designated manufacturers supported by ETRI. In addition, as the only national MNO at the time, Korean Mobile Telecommunications Corporation set the service provider requirements of more than 1,000 items for a commercial certification test in July 1994, and this helped the designated manufacturers to set clear R&D goals for a commercial product. Furthermore, Korean Mobile Telecommunications Corporation spurred on the competition among the designated manufacturers by declaring that it would procure network equipment only from the first designated manufacturer that passed the certification test.

Phase IV (optional) was originally composed of two sub-phases, including nine months of Phase IV-1 and ten months of Phase IV-2. Phase IV-1 was aimed at pre-production network development and manufacturing, and Phase IV-2 was targeted at carrying out field tests and full-scale commercialisation support of developed products. However, Phase IV was cancelled in its entirety when ETRI did not feel the necessity of Qualcomm's support after the successful development and subsequent modifications of CDMA Mobile System-2.

5.6 Outcomes of the Joint Development Project

In January 1996, the project had succeeded not only in terms of the resulting

[79] The operator was the wholly state-owned subsidiary of the monopoly phone company Korea Telecom, and the source of funding for the project.

commercial service but also as it had led to the creation of the world's first commercial service of a CDMA system.

Here, the importance of the policies implemented by the Korean government cannot be underestimated. The 'digital mobile communication system development project' of the government, including its joint project with Qualcomm was a very substantial national level R&D project that was unprecedented in the history of Korea's R&D. It lasted for eight years – from 1989 to 1996 – and the budget amounted to more than $125 million and represented 1,042 man-years of investment (ETRI 1996). Moreover, the total investment of both public and private sectors reached $275 million. Given that the telecom digital exchange R&D project was in only half its size in terms of budget (being only $75 million), the CDMA commercialisation project implemented by the Korean government was on an extremely large scale (Lee 2009).

In addition to the launch of this unprecedented project, the Korean government also ensured CDMA technologies were commercially viable by designating CDMA as a single standard both for cellular network services (800 MHz) and the PCS network (1.8 GHz), as shown in Table 5.4. In tandem with the early launch of CDMA network services, the project created an early market for CDMA products and protected CDMA technologies from competition against US-TDMA and GSM, both of which had been already on the market (Ahn & Mah 2007; Kim 2001).

Table 5.4 summarises the important events that occurred during the joint CDMA development project between 1989 and 1996.

Table 5.4 Chronological summary of main events during the Joint Development Project

Year.Month	R&D-related events	Policy-related events
89.1		■ Digital mobile communications system development project launched
91.5	■ JDA between ETRI and Qualcomm	
92.12	■ RTS installed in ETRI	
93.1	■ Designated Manufacturers appointed	
93.7		■ CDMA approved as a 2G standard by the US CTIA
93.11		■ CDMA designated as a single 2G cellular (800 MHz) national standard by MIC
93.12		■ GSM project launched by MOCIE
93.9	■ Project Management Group launched in KMT	
94.1	■ SPRs announced by KMT	
94.7	■ First CDMA handset (car-phone type, 40 sets) by Samsung	
94.6	■ CMS-2 design finished	■ KMT stocks sold to SK Telecom ■ Shinsegi Telecom acquired the cellular network licence
95.2	■ CMS-2 commercial-level tests completed	
95.10		■ CDMA designated as a single standard for PCS (1.8 GHz) 2G by MIC
96.1	■ Commercial CDMA service by SK Telecom	
96.4	■ Commercial CDMA service by Shinsegi Telecom	

JDA, Joint Development Agreement; RTS, Roving Test System; CTIA, Cellular Telecommunication Industry Association; MIC, Ministry of Information and Communication; MOCIE, Ministry of Commerce, Industry and Energy; KMT, Korean Mobile Telecommunications Corporation; SPRs, Service Provider Requirements; CMS, CDMA Mobile System.
Source: modified by author based on Song (1999, p.121).

At the beginning of the project, Qualcomm only possessed laboratory-scale knowledge on mobile handset baseband chips, mobile handsets, base stations and mobile switching centres, that demonstrated the potential of CDMA technologies. On the other hand, the capacity of Qualcomm's Korean counterparts was limited to the production of telephony switching centres (digital switches in wired telecommunication). By the time CDMA technologies were commercialised in Korea, both Qualcomm and the Korean manufacturers had significantly expanded the boundaries of their knowledge of CDMA systems, as shown in Table 5.5. Qualcomm successfully improved its capacity from laboratory-scale to a commercial level, producing baseband chips, mobile handsets and base stations[80]. Meanwhile, although its Korean counterparts had also successfully acquired the capacity to produce mobile switching centres, base stations and mobile handsets, they relied on Qualcomm for a baseband chip (which defined the core of Qualcomm's capabilities). Table 5.5 denotes the dynamics of knowledge boundaries of Qualcomm and its Korean counterparts in the course of the joint project.

Table 5.5 Change of knowledge boundaries in Qualcomm and its Korean counterparts

Phase	**Mobile station baseband**	**Mobile handset**	**Base station**	**Mobile switching centre**	**Telephone switching centre**
Qualcomm	O ↓ ■	O ↓ ■	O ↓ ■	O	
Korean counterparts		■ ←	■ ←	■ ←	■

O, laboratory-scale knowledge; ■, commercial-level knowledge; →, expansion of knowledge boundaries.

Source: Author's elaboration.

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[80] Qualcomm decided to produce mobile handsets and base stations because none of the leading handset producers showed any intention of developing them (Mock 2005).

The lack of knowledge on baseband chips in Korean manufacturers was witnessed through two episodes. In the first, CDMA handset development by Korean manufacturers was hampered by the late delivery of Qualcomm's second generation ASIC chip (MSM 2.0)[81]. Qualcomm was supposed to deliver MSM 2.0 in November 1994 but delivery was delayed by more than six months due to fatal errors in the initial circuit design. Until MSM 2.0 was finally received (in July 1995), the Korean designated manufacturers could do nothing but wait; this meant that they had only six months to develop the commercial version of the CDMA handsets instead of the original plan of one year[82].

In addition, several weeks prior to the launch of commercialised CDMA network services scheduled for 1 January 1996, Korean engineers kept experiencing call drops during interoperability tests between mobile handsets and the CDMA network. Through repeated experiments, they finally identified the reason for the call drops (which occurred mainly during hand-offs between analogue and digital networks). As the Korean engineers did not have knowledge of the software protocols between a baseband chip and a base station, the problem was left entirely to the Qualcomm engineers, who immediately flew to Korea to identify its cause. The call drops were due to the difference between the US and Korean AMPS networks. Despite the imminent Christmas holidays, several engineers from Qualcomm remained in Korea to adjust software protocols on the Korean AMPS (analogue) network, in order to meet the

[81] Unlike the pilot version of MSM 1.0, it was equipped with features of subscriber authentication, low-power consumption and sleep mode, which enabled smaller and lighter handsets.
[82] *Cellular Monthly*, 'Development of CDMA handsets this year looming', 05/1995.

commercialisation timeline.

The second episode occurred in the first half of 1996 when Korea commercialised the CDMA network. At this time, not only had LG produced its own handset model (LDP-200, OBM) but also it had assembled handsets from knocked-down kits of QCP-800 for Qualcomm (OEM). LG expected that the QCP-800 it had assembled itself and that imported from Qualcomm would display the same quality of voice calls and length of battery time. However, it turned out that the handset assembled by LG for Qualcomm showed much worse voice-call quality and much shorter battery (standby) time than Qualcomm's handset when tests for certification were run by Korean MNOs. Later on, the engineers in LG discovered that Qualcomm – for its own QCP-800 handset – had used the latest version of its baseband chip equipped with improved software protocol stack but had provided a slightly older version to LG[83]. This dependence of Korean counterparts on Qualcomm's ASICs capacity never disappeared (Whang 2009).

5.7 Discussion of the Korean technology access experience and the uneven expansion of knowledge boundaries

When ETRI pursued technology transfer from foreign technology leaders, most of the latter had no intention of transferring their US-TDMA technologies to Korea, with Motorola, Northern Telecom and AT&T turning down offers from Korea, as shown in Section 5.3. At the time, these companies were ready to commercialise their new technologies in the US digital mobile telecommunication market and achieve large

[83] *Cellular Monthly*, 'Development of CDMA handsets this year looming', 05/1996.

economic returns. They could be confident of dominating the Korean domestic market even in the digital era, following their successful monopolisation of the market during the analogue era.

Yet, as noted in Section 5.4, it did become possible for Korean firms to access digital mobile telecommunication technologies from a foreign source. This opportunity emerged from the small US venture company Qualcomm. At the time of the Joint Development Project between Qualcomm and ETRI, Qualcomm was at an early stage in developing and demonstrating the commercial potential of CDMA technologies. As a consequence, Qualcomm still required lengthy and costly R&D investment in the commercialisation of CDMA technologies to make them a viable alternative to the 2G standard. This laid the foundation for technology transfer between Qualcomm and its Korean counterparts.

Therefore, successful technology transfer for Korean handset manufacturers – as studied in the thesis – materialised for several reasons. Qualcomm was not a strong incumbent in the industry but a new entrant (although originating from the US) building upon its initial competences in a related but distinct industry, satellite telecommunications. Therefore, it endeavoured to set its CDMA technologies as a 2G standard across markets against other incumbents' 2G standards such as US-TDMA and GSM. Qualcomm was a vigorous licensor of its CDMA technologies (Mock 2005) because it had an interest in receiving licensing revenues for the technology, and it pursued the expansion of a CDMA market. In this regard, the lack of competition for new entrants from an adjacent industry increased the potential for entry and offered Korea an opportunity to facilitate Qualcomm's entry to provide a new mobile technology.

However, the existence of an opportunity for technology transfer itself should not be interpreted as a guarantee of success. First of all, success or failure of this kind of technology transfer is heavily influenced by the level of technological capabilities and subsequent R&D efforts of a technology licensee (Cohen & Levinthal 1990; Lee et al. 2005; Odagiri & Goto 1996). In particular, CDMA technologies licensed to Korean counterparts were in a nascent stage and not fully developed to a commercial level, as emphasised above. They had to be proven and tested in the subsequent commercial stage on a number of aspects: technical performance, economic production and marketing. This involved not only conventional learning, assimilation and localisation of transferred technologies (Bell & Pavitt 1993; Rosenberg 1970), but also a complex process of trial and error during field tests for commercialisation set by from a technology licensee. The Korean manufacturers could utilise their technical and market know-how from their experiences of a similar process during a previous telephony digital exchange project (Song 1999)[84].

How, then, can the collaborative relationship between Qualcomm and ETRI (and the Korean manufacturers) be described during the project? Was it mutual or unilateral?

During Phase II, Korean designated manufacturers were critical of developing a commercial product from Qualcomm’s roving test system and with ETRI, decided to design their own CDMA system (which later materialised as CDMA Mobile System-2). With the successful development of CDMA Mobile System-2, the cancellation of Phase IV (Qualcomm’s support in pre-commercialisation and commercialisation) points to the

[84] From the interview memos, which the author had access to with the interviewee’s permission.

extent of knowledge that Qualcomm's Korean counterparts had acquired on CDMA systems by the time. On the other hand, Qualcomm did not produce CDMA mobile switching centres from its original roving test system. Based on these facts, Song (1999) and Lee (2009) insisted that ETRI was able to acquire the opportunity for the joint project with Qualcomm in return for ETRI's capabilities on digital switches, arguing that the relationship was mutual.

However, Qualcomm did not intend to develop a commercial mobile switching centre (Yang 1996). In fact, the main efforts of its R&D activities were focused on mobile handsets and base stations including ASICs because leading handset manufacturers such as Nokia, Ericsson and Motorola were reluctant to develop CDMA handsets (Mock 2005)[85]. In addition, Qualcomm would have allowed technology licensing to any company, regardless of digital switch capabilities. Motorola and Lucent had already licensed Qualcomm's CDMA technologies before the signing of the agreement with ETRI (Funk 2002; Mock 2005). Therefore, it seems that Qualcomm was mainly keen on deriving licensing fees from its Korean counterparts. In tandem with Qualcomm's contribution to the commercialisation process presented above, it is likely that the collaborative relationship between Qualcomm and the Korean manufacturers was unilateral.

In summary, the opportunity in this case for technology transfer of technologies even in a nascent stage did arise from competition to achieve a dominant compatibility standard among technology leaders. Qualcomm licensed its CDMA technologies to its Korean

[85] Lucent was developing CDMA network equipment and became the first CDMA network provider to the US CDMA MNOs in 1996 (Funk 2002).

counterparts in order to promote CDMA markets in the early 1990s. Through this joint project, the Korean licensees successfully commercialised a CDMA system by expanding their knowledge boundaries in most areas across a CDMA system. Even so, the licensees' reliance on Qualcomm's knowledge on ASICs-related areas continued during the project and after commercialisation.

5.8 Summary

This chapter has addressed whether or not emergent leading firms in the pursuit of a dual frontier are given adequate opportunities to obtain licences for cutting-edge technologies from technology frontier firms during an emerging stage and if so, under what circumstances. The existing literature related to conventional catching-up concerns 'cutting off' from previous arrangements of OEM/ODM (Hobday et al. 2004; Kuo 2009). However, the chapter has illustrated that this issue can be reconciled through windows of opportunity from the competition to achieve a dominant compatibility standard among technology leaders in advanced countries, Korean manufacturers themselves have encountered the opportunity to license cutting-edge digital mobile telecommunication technologies. The US small venture company Qualcomm offered technology licensing of CDMA to its Korean counterparts in order to promote the market for CDMA technologies.

As is typical of technology transfer arrangements (Odagiri & Goto 1996), technology licensing of CDMA from Qualcomm did not automatically bring commercial success to its Korean partners. Qualcomm's support to Korean engineers to enable them to grasp the fundamentals of CDMA technologies (Phase I and II) was crucial at an early stage of the joint project. On the other hand, there were also indigenous R&D efforts (Phase

III) by the Korean partners that moved nascent CDMA technologies on to a commercial level, albeit again with Qualcomm's support. As a result, Korean manufacturers successfully managed to expand their knowledge boundaries across a CDMA system from their knowledge on wired digital telecom switches and commercialised the world's first CDMA network in January 1996. Even so, they did not acquire knowledge of ASICs in mobile handsets and base stations – as Nokia and Motorola had done – and continued to rely on Qualcomm.

In conclusion, the outcome of this chapter supports the argument that there is an opportunity available for technology transfer to emergent leading firms in the emerging stage of a new industry. At the same time, previous experiences and capacity of emergent leading firms also matter in the successful commercialisation of cutting-edge but commercially unproven technologies. At the time of commercialisation of the CDMA system, however, Korean handset manufacturers underwent uneven development in their knowledge boundaries (Dutrénit 2004; Hobday et al. 2004), lacking knowledge of a baseband chip, which is a critical component in a mobile handset.

In the next chapter, the thesis examines further how Korean handset manufacturers have competed against foreign incumbents in the mobile handset market under conditions of uneven knowledge boundaries.

6. COMPETITION AGAINST FOREIGN MANUFACTURERS: FROM THE DOMESTIC TO THE EXPORT MARKET

6.1 Introduction

The preceding chapter has illustrated how Korean firms acquired the opportunity for technology transfer, managed to assimilate laboratory-demonstrated CDMA technologies and expanded to a commercial level in collaboration with Qualcomm. The previous chapter has also provided an important example of how emergent leading firms might seize the opportunity to acquire advanced technologies due to competitive forces in other countries, particularly in the emerging stage of an industry.

This chapter presents how Korean handset manufacturers competed against foreign incumbents on the basis of the success from the Joint Development Project with Qualcomm. Starting from the Korean domestic (CDMA) market, Korean handset manufacturers subsequently entered the US CDMA handset market and later expanded to other foreign markets. The first part of the chapter focuses on the competition of Korean manufacturers in the Korean and US markets. In both markets, MNOs play a central and dominant role, as presented in Chapter 4. Despite the similarities at a superficial level, the chapter explains chronologically why the Korean manufacturers adopted different branding strategies in the US, i.e. ODM and co-branding, from those chosen for the Korean market. The second part of the chapter shows how Korean handset manufacturers created new market opportunities in the era of multi-functional convergence and mobile services through their strategic alliances with MNOs, the main mechanism of which was full customisation of handsets for MNOs. The case of the first

DVB-H mobile TV service by 3 Italia in the Italian handset market is presented as an example of the approach taken by the Korean manufacturers.

The structure of the chapter is as follows. Section 6.2 examines how Korean firms were able to establish dominance from the beginning of the digital (2G) mobile telephone era. It elucidates that these firms' dominance in the Korean domestic CDMA handset market was based on their technological advantages as first movers in CDMA technologies in tandem with their strong brand presence in the domestic market. It further explains how they successfully avoided the persistent challenges presented by global foreign giants such as Qualcomm, Motorola and Nokia.

Section 6.3 investigates the marketing strategy used by a group of Korean handset manufacturers to tap into the CDMA handset market in the US (the first country chosen as an export target), as a way of overcoming its weak brand presence with its technologically world-leading handsets. The section focuses on the nature of ODM and co-branding business conducted through foreign distributor networks (principally the MNOs) as a means to overcome an initial weak brand presence in the US market.

Section 6.4 delves more deeply into the significance of bilateral collaborations between Korean handset manufacturers and foreign MNOs for new mobile services introduced along with new handsets, using the example of the world's first DVB-H mobile TV service launched by 3 Italia with the support of Samsung and LG. It examines how Korean handset manufacturers took the opportunity to sell new handsets while other global foreign manufacturers such as Nokia were reluctant to provide similarly capable handsets when 3 Italia sought a major launch of its DVB-H mobile TV service in Italy.

Using the experience of Korean handset manufacturers, Section 6.5 discusses the merits and demerits of the operator-dependent business model adopted by Korean handset manufacturers and presents how these strategies affected the Korean firms' production structure in comparison with other foreign companies. It concludes with a discussion of concerns in the pursuit of a dual frontier, i.e. unevenness between technology and marketing stages.

6.2 Early dominance of Korean handset makers as OBMs in the Korean handset market

This section presents how Korean handset manufacturers dominated the domestic market as OBMs and prevailed over global foreign manufacturers like Qualcomm, Nokia and Motorola, largely eliminating them from the market.

6.2.1 Korean handset makers starting as OBMs in the operator-dominant domestic market[86]

When SK Telecom and Shinsegi Telecom began their CDMA network service in January and April 1996, six companies introduced CDMA handsets onto the market in the first half of 1996: Samsung, LG, Hyundai and Maxon (the four designated manufacturers of the Joint Development Agreement); and Qualcomm and Sony[87] (joint-

[86] There were early examples of co-branding between handset makers and MNOs in the Korean handset market. In June 1997, LG InfoComm (LG IC – which later merged with LG Electronics) co-branded its handsets with both the brand and logo of LG IC and the network operators. For example, SP-1000 was branded as 'Freeway' (the brand), 'LG IC' (the company logo) and '017' (the recognition numbers of Shinsegi Telecom), and SD-2000 was branded as '011' of SK Telecom (*Yonhap news*, 02/06/1997). However, co-branding between handset manufacturers and MNOs in the Korean market did not become dominant until the policy of mobile number portability was implemented by the Korean government.

[87] Hanchang was the local distributor for Qualcomm. On the other hand, Kolon was an OEM for Sony and one of the main shareholders of Shinsegi Telecom.

venture members of Qualcomm's CDMA handset division). At the launch of the CDMA network service, two Korean MNOs sourced network equipment and handsets as a package deal from their first service provider requirements qualifiers (see Chapter 5). They were LG for SK Telecom and Samsung for Shinsegi Telecom[88]. Korean domestic handset manufacturers immediately became dominant against foreign manufacturers. In this regard, the advantages of Samsung and LG against other manufacturers at the early stage came from their close relationship with local MNOs originating from the Joint Development Project.

This early dominance continued. Korean handsets outperformed foreign handsets in technical terms, especially in terms of talk time and standby time, as shown in Table 6.1. Qualcomm's first phone (QCP-800) showed 30% shorter battery time against Korean handsets and Motorola's SC-720 had a problem with its voice-call quality. Korean handset makers also presented many user-convenient functions. For example, all Korean handsets on the market came with two batteries: standard and large. In addition, Samsung and LG provided nine and five different ringtones, respectively, in addition to other functions such as alarm and lamp/vibration modes. Foreign handsets came with a single battery and ringtone without other functions.

Moreover, Samsung and LG outclassed their foreign competitors in terms of introduction of new models. Samsung had introduced six models during the 16 months between April 1996 and August 1997, and LG had also introduced four models onto the market[89]. As presented in Figure 6.1, new models came with a new form factor or

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[88] *Cellular Monthly*, 'Structure of the CDMA handsets market',09/1996).
[89] *Yonhap news*, 'Handset introduction cycle getting shorter', 07/08/1997,

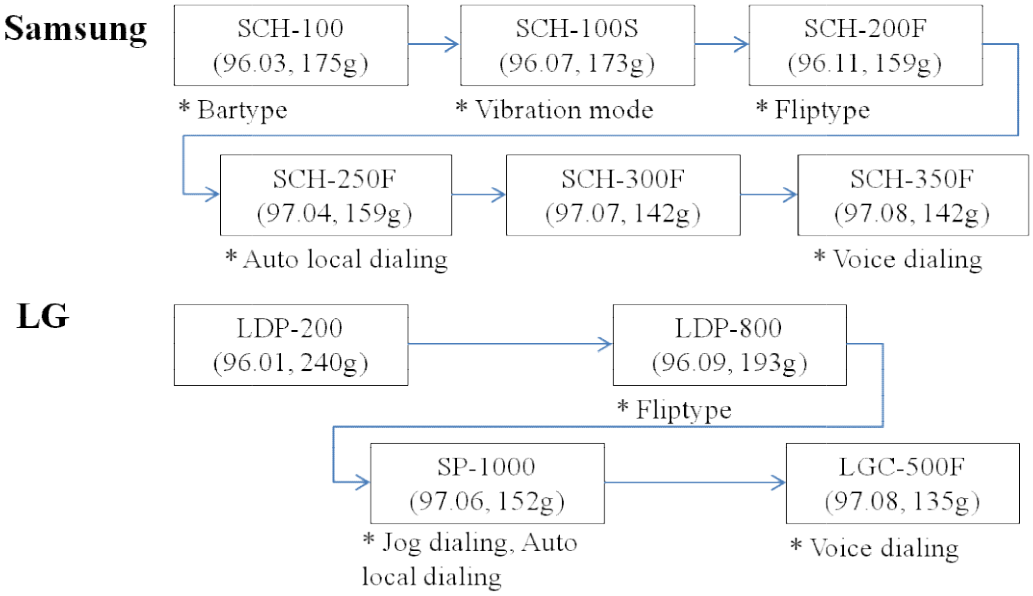
lightness, or sometimes additional user-friendly functions. Korean domestic customers were particularly sensitive to the weight of handsets[90]. In the meantime, Qualcomm and Motorola did not deliver their second model until early 1998[91]. For the first half of 1998, the situation became worse. Samsung, LG and Hyundai marketed 12, 8 and 5 models respectively on the shelves while Motorola, Kolon and Qualcomm had only one model. Foreign manufacturers did not keep up with their Korean competitors in the speed of introducing new models.

Table 6.1 Comparison of the performance of digital phones on the Korean market

Companies & models	Battery time			Ring tones	Weight (g)		Price ($)
	Stand by (h)	Talk (min) Fully charged	Talk (min) 30 min charged		Standard cell	Large cell	
Samsung SCH-200F	82	246	69	9	205	211	950–1,150
LG LDP-880	73	161	58	5	224	228	730–880
Hyundai HHP-9300	45	175	61	1	255	300	670–820
Maxon MAX-1000K	32	109	27	1	271	311	650–780
Qualcomm QCP-800	51	201	30	1	257		620–770
Motorola SC-720	18	145	42	1	219	290	810–920

* The Korea Consumer Agency found no difference among handsets in terms of call connectivity and quality other than Motorola SC-720's poor performance.
Source: Korea Consumer Agency (1997, p.77).

http://news.naver.com/main/tool/print.nhn?oid=001&aid=0004187193, accessed 14/01/2015.
[90] *Cellular Monthly*, 'Motorola, where is its turf gone?', 10/1997.
[91] Ibid., 'Supply status of mobile handsets in the first half of 1998', 08/1998.



Source: Author's elaboration.

Figure 6.1 CDMA handsets introduced onto the Korean domestic market by Samsung and LG between January 1996 and August 1997

In addition, Samsung, LG and Hyundai, the top three biggest conglomerates in Korea, established good after-sales service accessibility with their strong brand awareness. In contrast, neither Qualcomm nor the local distributor for Qualcomm, Hanchang, was well known to local customers and each lacked after-sales service channels compared to Korean local conglomerates. For instance, the number of after-sales service centres was 42 for Samsung vs 3 for Qualcomm in the Seoul Metropolitan area.

From the second half of 1996, Qualcomm enjoyed market expansion in the US CDMA market but struggled to meet the high demands from the US MNOs as a monopolistic CDMA handset supplier in the US market until Samsung entered the market (see the next section). Therefore, the importance of the Korean domestic market as the only CDMA market seems also to have diminished. To make matters worse for foreign brands, the retail price of handsets manufactured by foreign companies doubled in 1998 due to the Asian economic crisis. For example, the retail price of the Q phone from Qualcomm reached 60% higher than that of Samsung's new handset[92]. Since then, even though handsets made by foreign manufacturers were arriving in the market, they were unable to diminish the dominance of local handset manufacturers.

Table 6.2 shows the dominance of Korean handset makers, especially Samsung, in the domestic market in the course of the transition from analogue to digital network services.

Table 6.2 Market shares of vendors in the Korean handset market

Companies	**1992**	**1993**	**1994**	**1995**	**1996**	**1997 /06**	**1998**
	← **Analogue AMPS only** →				← **Digital CDMA** →		
Samsung	18%	15%	20%	30%	45% (42%+48%)*	55%	54%
LG***	8%	7%	4%	3.8%	15% (0%+24%)	22%	26%
Hyundai***	6%	3%	1%	0.3%	7% (4%+9%)	8%	12%
Motorola	50%	54%	50.7%	51.9%	21% (41%+0.5%)	6%	7%**
Qualcomm	-	-	-	-	7% (0%+14%)	5%	-
All Japanese****	9%	4%	2%	1%	-	-	-
Others	9%	17%	22%	13%	13%	9%	2%

*The first figure in parentheses indicates the analogue market share; the second figure indicates the digital market share.
**Motorola's ODM by Appeal Telecom (5% in 1998) was also included.
***LG and Hyundai were both assemblers of foreign mobile handsets in the analogue era.
****The import of Japanese handheld handsets was prohibited until January 1999.
Source: *Cellular Monthly*, January 1998 & January 1999.

It should be pointed out here that although the Korean CDMA handset market was

92 *Cellular Monthly*, 'Qualcomm-Motorola: dark future to return to the Korean handset market', 04/1998.

tightly controlled by local MNOs, large manufacturers like Samsung and LG maintained their handset business as OBMs, which was not the case in the US CDMA handset market, as presented in the next section. On the one hand, this was due to their strong brand presence in the domestic market. Local venture companies such as Appeal and Telson served the Korean MNOs as ODMs due to their weak brand presence. On the other hand, the Korean MNOs were not interested in promoting MNO-branded handsets to the public[93]. This was because subscribers bought handsets mostly through MNOs' sales channels and the first three digits of their phone numbers were an operator identification number so that everyone would know who was using which telecom company[94].

6.2.2 Failure of global incumbents in the Korean handset market

In the early days of CDMA commercialisation, Qualcomm entered the Korean CDMA handset market with its own CDMA handset in a similar manner to the Korean manufacturers. On the other hand, global handset incumbents like Nokia and Motorola appeared to have placed less effort in developing products for the CDMA market and to be observing whether CDMA could secure its market share in the 2G digital telecommunication market. This apparent indifference may also have been related to rapid growth of demand for GSM digital technologies in the global market. Although the CDMA market was burgeoning from the beginning, the market size was small compared with that of GSM. Motorola and Nokia introduced new CDMA handsets onto the market in 1997 and 1998, respectively, which proved to be too late to capture a major share of the CDMA market.

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[93] Interview with a manager in a Korean MNO.

[94] For example, a phone number of SK Telecom subscribers was 011-xxx-xxxx and that of ST subscribers was 017-xxx-xxxx. If subscribers changed their companies, they could not keep their phone numbers.

Motorola's failure due to the late response to the digital shift

In the mid 1990s, Motorola overlooked the rapid expansion of the digital handset market[95], believing that digital handsets would be too big and bulky to compete with analogue ones. Instead, Motorola introduced its new analogue StarTAC with slim design of 88 grams (but expensive at $1,500) in January 1996. However, Motorola's previous strength in the analogue market was eroded due to the local MNO SK Telecom's own interest. As SK Telecom allotted more bandwidth to its digital CDMA network rather to an analogue AMPS network, Motorola quickly lost its previously strong position by not introducing CDMA digital handsets. Moreover, Motorola exacerbated the relationship with local MNOs by introducing a distribution policy for StarTAC in both Korea and US called the 'Signature program', under which Motorola provided StarTAC only to MNOs and distributors purchasing more than 75% of their handsets from Motorola (and with stand-alone displays) in order to maintain high margins. This 'program' turned out to be a huge failure in both Korea and US.

In addition to Motorola's failure with analogue StarTAC, its failed attempts to introduce its first digital phone into the Korean market gave it a fatal blow. The company introduced its first digital cellular phone, MicroTAC SC-720, in July 1996. However, it had less than ten hours standby time due to technical problems and was finally withdrawn from the shelves within six months, leaving Motorola with a bad reputation for digital handsets. Having had less than 0.1% of the market share in 1997, it was 21 months later in March 1998 when Motorola provided its second digital CDMA handset,

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[95] In 1995, US MNOs including Ameritech, AT&T and Bell Atlantic requested Motorola to deliver digital handsets for them (*Businessweek*, 'How Motorola lost its way', 03/05/1998).

DMT-8000, to the Korean market. From 1998, Motorola also utilised several ODM models from local venture companies such as Telson Electronics (later Nokia Korea) and Appeal Telecom (later Motorola Korea). However, Motorola acquired only 2% of market share in 1998, and although it gained meaningful success in November 1998 from the digital CDMA version of StarTAC, it was never able to overcome the dominance of Samsung and LG.

Nokia's failed localisation through ODM strategy

Nokia entered the Korean handset market in 2001 in a joint alliance with the Korean ODM handset manufacturer Telson five years after CDMA commercialisation. At the time, Nokia was so successful in the 2G GSM market that it had caught up with Motorola and from 1997 onwards held the top position in the global handset market. The CDMA handset market never exceeded 21% of the global 2G handset market while the GSM handset market occupied an average of around 70%[96]. It can therefore be surmised that Nokia was less serious about the CDMA handset market than it was about the GSM market, and evidence for this supposition is that, instead of in-house development of CDMA handsets, Nokia established a partnership with the Korean CDMA handset venture Telson.

When Nokia launched its CDMA handset onto the Korean market using this ODM strategy, it had not paid sufficient attention to local customers' preferences for cutting-edge technologies (such as colour display), and it introduced handsets without the colour screens that were being popularised by Korean handset makers at the time. Moreover, all of the Nokia handsets that were introduced only supported the CDMAone,

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[96] Strategy Analytics.

and not the latest CDMA2000[97]. In addition, Nokia failed to introduce handsets for SK Telecom, which was the dominant MNO with CDMA cellular networks, having a market share of approximately 50% at that time[98]. The apparent reason for this failure to provide a handset for SK Telecom was that most of the CDMA cellular engineers of Telson that were experienced in developing handsets for SK Telecom, had left Telson due to internal conflict. This meant that Nokia could not promote its handsets to half of the market no matter how good its handsets were, and the first handset for SK Telecom did not arrive in the market until November 2001[99].

To make matters worse, Nokia made errors in an important localisation issue regarding polyphony ringtones in September 2001. While a polyphony ringtone service was heavily promoted by Korean network operators at the time, Nokia phone users realised that they could not play 16 polyphony ringtones after downloading them from networks. The problem resulted from the different chipsets used by Korean handset manufacturers and Nokia. While all Korean handset makers utilised Musical Instrument Digital Interface (MIDI) chips manufactured from Japanese midi-sound chipset maker, Yamaha, Nokia used the General Midi (GM) format, which was not supported by Korean domestic network operators. These problems with localisation encountered by Nokia – stemming from its ODM relationship with Telson – resulted in huge losses in terms of customer loyalty, and Nokia retreated from the Korean handset market[100]. Finally in 2003, Nokia decided to discontinue its Korean presence.

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[97] The CDMA2000 provided double the capacity and faster data packet speed of CDMAone.
[98] *Cellular Monthly*, ‘Interim evaluation on Nokia's penetration into the Korean handset market’, 11/2001.
[99] Ibid.
[100] *HanGyereh*, ‘Nokia retreats from the Korean market’, http://legacy.www.hani.co.kr/section-010100002/2003/01/010100002200301101511735.html, accessed 15/08/2015.

6.2.3 Local manufacturers' dominance driven by a close producer–user relationship and first mover's advantage

As presented above, Korean handset manufacturers were able to dominate the local Korean handset market as first movers since the market's creation. There were handsets available on the market also from foreign competitors such as Qualcomm and Motorola. However, handsets from local makers outclassed those from foreign brands in terms of both technical performance and the speed of introduction of new models, as shown in the previous section. Korean products benefited from the weak Korean currency[101] as well due to the Asian economic crisis in late 1997.

Lieberman and Montgomery (1988) originally contended that there are three main mechanisms for first movers to enjoy their advantages: technological leadership, pre-emption of assets and buyer switching costs. Although there are elements of each of these in the case of Korean mobile telecommunications, the pre-emption of scarce assets, in this case the relationship with local MNOs, seems to have played a particularly vital role. Firstly, the collaboration between two Korean MNOs and two Korean designated manufacturers during the Joint Development Project, i.e. SK Telecom with LG and Shinsegi Telecom with Samsung, enabled these local manufacturers to secure the first order of network equipment and mobile handsets. Secondly, pre-emption of the close relationship with MNOs during the Joint Development Project provided local handset manufacturers with many learning opportunities to improve the quality of handsets through operators' networks established by their own network equipment[102].

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[101] The annual average value of the Korean Won dropped by 32% in 1998 year on year and recovered only 17.6% in 1999 (Bank of Korea, *Annual report of foreign currency statistics* 2000, 2011).
[102] Interview with a former CDMA handset development leader at Samsung.

Korean MNOs dominated the distribution and sales of handsets through bulk purchase, and later fortified their influence through promotions with subsidised handsets based on long-term contracts (which also raised buyer switching costs). Under the circumstances, local Korean handset manufacturers supplied handsets according to local MNOs' demands while foreign manufacturers were slow to react to Korean MNOs' demands. This fortified the local collaboration between handset manufacturers and MNOs in Korea.

The strong collaborations between MNOs and local handset producers were further reinforced as Korean MNOs began to provide operator-specific mobile data services through the upgrade of CDMA networks to CDMA2000 1x (2.5G). This feature created a major barrier for foreign handset manufacturers that entered the Korean domestic handset market, as exemplified in the case of Nokia. Customising foreign handsets to meet the local requirements of the Korean MNOs not only entailed technical difficulties but also became too costly for foreign makers, considering the size of the Korean handset market[103].

The existence of the Korean CDMA domestic market played an important role also in terms of global competitiveness of Korean handset makers during the early stage of the global CDMA handset market. Firstly, the dominance of Korean manufacturers in the domestic market gave a scale advantage because the Korean CDMA market was bigger than that of the US until mid 1999 (Funk 2002). The scale was mainly due to the adoption of CDMA technologies as a single national 2G standard (both cellular and PCS) by the Korean government (see Chapter 5). Moreover, Korean CDMA networks

[103] Interview with a handset engineer at Motorola Korea.

functioned as a good test bed for exporting handsets[104] (Kushida 2008; Whang & Hobday 2011). The competition among local manufacturers and early launch of mobile data services by local MNOs stimulated miniaturisation and functional improvements (later convergence) of mobile handsets.

6.3 Entering the US CDMA handset market through ODM or co-branding

This section presents the Korean handset makers' entry into the US CDMA handset market subsequent to their domestic market developments discussed in the previous section. Since the US handset market was MNO-dominated in a similar manner to the Korean domestic market (see Chapter 4), Korean handset makers approached the US CDMA MNOs such as Sprint and Verizon. However, this section explains the contrasting strategy adopted by Korean makers in the US handset market and shows why they pursued different strategies.

6.3.1 Overview of the US CDMA handset market and Qualcomm's dis-integration

Unlike Korea and the European countries, the US opted for the policy of open competition in the 2G digital mobile market, and as a result adopted three different 2G standards, US-TDMA, GSM and CDMA, which were successively commercialised in 1992[105], 1995 and 1996, respectively. As the US Federal Communications Commission did not award new licences until 1995, most 2G telecommunication services in the country only began between 1996 and 1997 (Funk 2002). As seen in Table 6.3, the early stage of the US digital handset market was dominated by traditional handset giants such

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[104] In contrast, Samsung struggled with exporting GSM handsets in the late 1990s due to the absence of a domestic GSM network for testing (*Cellular Monthly*, 'Struggling to export GSM handsets', 02/2000).

[105] However, the digital handsets comprised only 0.1%, 1.5% and 7.5% of new subscribers in 1992, 1993 and 1994, respectively (Funk 2002).

as Nokia, Ericsson and Motorola due to their early adoption of US-TDMA and GSM. With the commencement of the US CDMA service in late 1996, however, the share of CDMA handsets among digital handsets rapidly grew from 3% in 1996, to 33% in 1997 and 38% in 1998 (Funk 2002).

Table 6.3 Shares of the US digital phone market between 1995 and 1998 (by company)

Company	1995	1996	1997	1998
Nokia	29%	33%	20%	34%
Ericsson	34%	56%	41%	21%
Motorola	36%	8%	6%	12%
Qualcomm (including Sony)	-	3%	24%	13%
Other	-	0%	9%	20%

Source: Funk (2002, p.170).

In the US CDMA market, Qualcomm was the only company with a completely vertically integrated structure spanning baseband chips to mobile handsets[106]. In the beginning, Qualcomm did not intend to produce CDMA handsets (Mock 2005). However, big mobile handset companies such as Motorola and Nokia were reluctant to develop CDMA handsets. As the commencement of the CDMA network service in the US approached, Qualcomm decided to provide its own CDMA handsets, and, in February 1994, it set up its new mobile phone manufacturing unit as a joint venture with Sony Corporation and let Paul Jacobs, the son of the co-founder of Qualcomm, Irwin Jacobs, run the business. The factory was set up based on a former medical-supply facility. However, neither Qualcomm nor Paul Jacobs had any experience in the

[106] In the GSM market, dominant players like Nokia, Ericsson and Motorola were all vertically integrated manufacturers with baseband chips as well. They competed against each other with handsets including their own baseband chips.

consumer electronics business where it is crucial to have knowledge of, and capacity for, mass production[107]. Analyst Albert Lin of American Technology Research Inc., commenting about Qualcomm's production plant, claimed that 'It was a very, very chaotic environment'[108].

Nevertheless, Qualcomm virtually dominated the early US CDMA handset market because it was the only handset provider until the first half of 1997. In addition, high licensing fees for CDMA technologies compared to other digital standards kept handset giants like Nokia, Motorola and Ericsson from entering the CDMA handset market for a while. Qualcomm's prominence in CDMA technologies to US CDMA MNOs also helped (Mock 2005). Once the shipment had started for Sprint and PrimeCo (later Verizon), Qualcomm could not keep up with market demand, and its founder Irwin Jacobs and his son Paul often disagreed over how many phones each carrier should get. Qualcomm's sales in the US market did rise with the rapidly growing market from 2.9% in 1996 to 24% in 1997 (Funk 2002). Even so, the sales of CDMA handsets were accompanied by a growing deficit in Qualcomm's financial performance[109].

To make matters worse for Qualcomm, its monopoly status in the US market was short-lived, leading to price competitions. New market entrants began to emerge from the second half of 1997 when the US CDMA market became more than negligible. Specialised baseband chip suppliers like Very-Large-Scale-Integration (VLSI)

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[107] Qualcomm also had a continuing loss in its network equipment business and later sold it to Ericsson in early 1999. (*EE Times*, 'Is chipset focus enough for the new Qualcomm?' http://www.eetimes.com/document.asp?doc_id=1124054, accessed 16/01/2015.)
[108] *Businessweek*, 'The once and future Qualcomm', 03/05/2004.
[109] Ibid.

Technology and Digital Signal Processing (DSP) Communications[110] joined the CDMA baseband chip market. For example, VLSI introduced sample baseband chips in June 1998 and finally launched volume shipments in early 1999. In addition, Nokia and Oki Electric with their own baseband chips also introduced their CDMA handsets in April and May in 1998. When these competitors lowered their CDMA phone prices by 14% below Qualcomm's price in late 1999, Qualcomm had no choice but to follow its competitors by lowering its prices (Funk 2002). Finally, Qualcomm sold its mobile phone business unit to Kyocera Corporation in 2000.

Qualcomm's experience may be explained by the fact that it was originally an R&D engineering company and had never acquired experience in manufacturing electronic goods. This lack of experience led to problems in scaling up production efficiently and achieving competitive production costs. Given the context of the US CDMA handset market at the time, the next section explores how Korean manufacturers penetrated the US CDMA handset market.

6.3.2 Samsung and LG's initial steps into the US CDMA handset market

Samsung and LG entered the US CDMA market in 1997 and 1998 respectively. They approached specialised distributors and US MNOs but received different reactions. When Samsung and LG approached electronics distributors such as Best Buy and Circuit City, these distributors refused to market handsets from Korean manufacturers due to lack of brand awareness[111] and credibility over the quality of handsets[112]. While

[110] VLSI Technology and DSP Communications were specialised baseband chip suppliers and were later acquired by Philips and Intel respectively in 1999.
[111] When a brand is weak, country of origin exacerbates the situation. See Ahmed et al. (2002).
[112] The Federation of Korean Industries, *The case study on the strategies of overcoming crisis in*

electronics distributors generally recognised Korean makers as OEM/ODM makers for electronic goods, they did not consider these makers as firms with the capability to produce cutting-edge handsets[113]. On the other hand, some US CDMA MNOs expressed their interests in expanding their handset sourcing from other manufacturers.

Co-branding[114] for Samsung and ODM to co-branding for LG

In June 1997, Samsung began its handset business in the US as it started to export CDMA PCS handsets (SCH-1011) to Sprint Spectrum L.P. of the US[115], the biggest CDMA MNO in the US at the time[116]. Sprint announced 100% digital service to cellular phone subscribers while other operators like AT&T and AirTouch were providing both analogue and digital network services. Originally, Sprint had mainly sourced its CDMA handsets from Qualcomm Personal Electronics[117], a joint-venture company of Sony Electronics and Qualcomm. However in 1997, plastic cases of the Q Phone (Q1900) from Qualcomm (and distributed by Sprint) turned out to be fragile and easily broken. Qualcomm and Sprint had to recall all their sold handsets and in August 1997, they withdrew from the market[118]. This incident led Sprint to diversify its handset sourcing.

While Sprint was looking for a new partnership other than with Qualcomm, Samsung

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companies, FKI Media (2010) (in Korean).

113 Interview with a marketing manager in LG.

114 In this thesis, the definition of co-branding is 'a form of cooperation between two or more brands with significant customer recognition, in which all the participants' brand names are retained' (Blackett & Boad 1999). One well-known example of co-branding is 'Intel Inside' of Intel with computer manufacturers.

115 This was a joint venture company of Sprint Corporation, Tele-Communications Inc., Cox Communications and Comcast Corporation, running services in the Washington DC/Baltimore area.

116 Federal Communications Commission, *The Commercial Mobile Radio Services Report 1999*.

117 This was founded in 1994 and was the only CDMA handset producer in the first half of 1997 in the US market.

118 *Cellular Monthly*, 'Fierce domestic competition in folder-type handsets', 11/1998.

proposed co-branding and co-marketing with Sprint[119]. The proposal was mutually beneficial for Sprint – who announced a brand-new service – and for Samsung, which was, at the time, a less well-known brand in the US market with no previous mobile phone products. The two companies agreed the deal and acquired a co-branding position with the 'Sprint–Samsung' label in their handsets. Even so, it was uneven co-branding as the Sprint logo was printed on the front cover in large letters while Samsung was printed on the back in much smaller letters[120].

LG followed a similar path to Samsung but in a different fashion as it entered the US handset market. In 1997, LG acquired the export contract of one CDMA model (LGC-300W) from Ameritech[121], the fourth biggest US CDMA network carrier at the time[122]. Unlike Sprint-Samsung, however, LG's LGC-300W was sold under the name of Ameritech. This type of ODM contract continued with LGC-320W and -330W in 1999 with other US CDMA MNOs such as GTE Wireless and Alltel. A marketing manager in LG recalls that US MNOs had been proposing co-branding to LG since 2000 after the recognition of the quality of its handsets. However, it was LG itself who decided to remain an ODM producer; according to her, co-branding of two sides meant co-marketing by two sides. Under co-branding, LG also needed to invest in marketing and share risks. She asserted that LG itself was not confident whether LG's brand would appeal to US customers at the time.

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[119] Neither Nokia nor Motorola was ready for Sprint (*Chicago Tribune*, 'Samsung getting Motorola's Number', 07/03/2004).

[120] The Federation of Korean Industries, *The case study on the strategies of overcoming crisis in companies*, FKI Media (2010) (in Korean).

[121] Ameritech was one of the seven regional Bell operating companies and later became part of AT&T.

[122] Federal Communications Commission, *The Commercial Mobile Radio Services Report*, 1999.

In January 2002, LG finally decided to pursue a co-branding contract in the US CDMA market[123]. Firstly, LG and Sprint agreed to co-brand LG's handsets, starting with LG's TP5250 dual folder phone. Similarly, LG and Verizon also concluded that they would co-brand all LG's handsets with both LG and Verizon brand logos in October 2002[124], starting with VX10. Therefore, it took about five years for LG to move from an ODM to become a co-branding handset provider.

Neighbouring support and provision of customised handsets for the US MNOs

Based on their brand awareness from success in the global handset market, Nokia and Motorola adhered to their own product roadmaps with own brands, resisting MNOs' request for customisations. An executive with a US network operator described the situation as: 'The attitude at Nokia was basically, "Here is a phone. Do you want it?"' (Husso 2011, p.60).

In contrast, Korean handset manufacturers dedicated resources in support of their partnerships with US MNOs. They not only dispatched their engineers during handset development projects but also strategically set up branches and stationed groups of engineers adjacent to the headquarters of MNOs so that they could cope with technical problems as quickly as possible. For example, the locations of these branches of LG Mobile phones included Overland Park (near Kansas City) for Sprint, Newark (New Jersey) for Verizon, Atlanta for Cingular and Seattle for AT&T. *Businessweek* wrote about the efforts taken by LG in support of its US network carrier partner:

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123 Interview with a marketing manager in LG.

124 *Etnews*, 'LG's Co-branding with Verizon: reinforcing North American market', 16/10/2002.

> LG flew 50 elite engineers, marketers, and product-development specialists to five sites across the U.S. to iron out glitches that inevitably pop up when synchronizing phones with new servers and networks. ‘We had noise and call cut-off problems at a Dallas test in March, and all of our hardware engineers in Korea worked day and night for four days to resolve the problem, ’ recalls Lim Joo Eung, the chief research engineer who led a 48-person-team for the VX6000. By applying that kind of manpower, LG was able to cut the time it normally takes to roll out a new service by 25%, to nine months[125].

In addition to neighbouring support, Samsung and LG began to provide customised handsets according to the needs of the US MNOs. In Korea with a small territory, each MNO ran a single band network with full national coverage. Two Korean cellular MNOs[126] were assigned to only 800MHz – like US cellular MNOs – while three Korean PCS MNOs were assigned to 1.8 GHz. Therefore, Korean manufacturers did not need to develop multi-mode (analogue and digital) or/and multi-band (multi-frequency) handsets for Korean MNOs. On the other hand, as shown in Table 6.4, the US mobile network services were far more complex in terms of the diversity of technology standards and the size of coverage. It also took much longer to establish new digital networks in the countryside than in Korea. Simply, no MNO or single wireless standard could provide nationwide coverage in the US at the time. Therefore, US MNOs made efforts to expand their network coverage by roaming agreements and M&As with other MNOs. The US MNOs sometimes had to support both bands of 800 MHz and 1.9 GHz and networks of analogue and digital, including analogue AMPS, CDMA, TDMA, GSM and even iDEN[127]. Accordingly, handsets compatible with different networks became crucial.

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[125] *Businessweek*, ‘Korea’s LG, Will it be the next Samsung?’, 12/05/2005, http://www.businessweek.com/magazine/content/05_04/b3917018.htm, accessed 24/03/2011.

[126] SK Telecom was the only MNO running an analogue cellular network in 800 MHz.

[127] iDEN was mainly developed by Motorola.

Table 6.4 Difference between Korean and US networks and standards

Country	**Korea**		**United States**	
	Cellular	PCS	Cellular	PCS
Frequency	800 MHz	1.8 GHz	800 MHz	1.9 GHz
Standards	AMPS CDMA	CDMA	AMPS CDMA TDMA iDEN	GSM CDMA TDMA

Source: Author's elaboration.

In 1999, for instance, Sprint PCS with 13 million subscribers in the market developed its new strategy of dual-mode service by adding an 800 MHz analogue service to its existing 100% digital service of 1.9 GHz CDMA PCS. As Sprint was keen to promote its dual-mode service, LG developed its TP5200 model supporting Sprint's digital and analogue networks. Sprint and LG introduced and marketed the model together from September 1999. Verizon Wireless, which at the time had 32 million subscribers, also ran both 800 MHz AMPS and 800 MHz CDMA cellular networks as well as 1.9 GHz CDMA PCS in April 2000. Therefore, it sought to maximise its network capacity and utility of customers by launching a Tri-mode service, which supported all three different network technologies. In tandem with the Tri-mode service, Verizon also introduced a new nationwide flat-rate plan[128] called the 'SingleRate' plan, which allowed customers to place calls without roaming (using other networks) or incurring long-distance charges in return for the advance purchase of bulk of minutes. In response, LG promptly offered a Tri-Mode handset (TM510), exclusively for Verizon Wireless[129].

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[128] A flat-rate plan in the US market originated from the 'digital-one-rate' introduced by AT&T in May 1998. The plan triggered the increase of minutes of use per month (Federal Communications Commission, *Fourth Annual Report and Analysis of Competitive Market Conditions With Respect to Commercial Mobile Services*, 2000).

[129] *Hankookilbo*, 'Opening 2.5G market in the US', 25/09/2001.

Since the commencement of mobile data services by the US MNOs, Korean manufacturers began to provide new handset models featuring carrier-specific services for them. Such successful instances between Verizon and LG include VX10, VX6000 and VX8000. In October 2002, LG provided VX10 to Verizon so that it could promote its own wireless data service 'Get It Now', allowing customers to download a variety of games and ring tones and giving them access to Internet and e-mail. In July 2003, LG developed Verizon's first built-in camera phone, VX6000. It incorporated with Verizon's 'Get Pix' service so that customers could take photos and save them to their phones, send them to an e-mail address, or upload them to an online photo album. In March 2005, LG delivered VX8000 to Verizon featuring Verizon's new video entertainment service, VCast, which offered video clips from the US news channels. All these handsets were exclusive to Verizon in terms of both handset design and Verizon-specific mobile data services.

Brian Finnerty, Sprint's senior director for new products, said, 'When we want to put in certain browsers for text messages, they're very fast to design a new handset for it. They're the only ones who say: "We can do that. No problem."'[130] In this way, Korean handset manufacturers provided timely delivery of and dedicated support for new handset models featuring carrier-specific services for the US MNOs. Korean handset makers and US CDMA MNOs (especially Samsung with Sprint, and LG with Verizon) shared not only product release roadmaps but also marketing plans with each other. Korean handset makers described this form of close relationship between handset

[130] *Businessweek*, 'Dialing for dominance in Korea', 27/05/2001, http://www.businessweek.com/stories/2001-05-27/dialing-for-dominance-in-korea, accessed 27/12/2014.

manufacturers and MNOs as that of a 'married couple'[131].

6.3.3 The role of co-branding for penetration by Korean handset manufacturers into foreign markets

As presented above, CDMA handsets produced by Samsung and LG were not appreciated in the US market as much as they were in the domestic market. Even if Samsung and LG produced technologically competitive handsets, they were still regarded as ODM electronics makers in the US. They also did not have their own distribution channels for their products. In this sense, the two Korean makers lagged behind at stage 4 in the marketing domain while they reached stage 5 in the technology domain, according to the typology of Hobday (1995). In order to overcome this unevenness, they initially adopted their original export strategy[132] (ODM) or an improved co-branding strategy with US MNOs. By relying on US MNOs' marketing resources, they slowly increased the exposure of their brands to US customers at lower cost and began to establish brand presence and customer loyalties as they proved their technological competitiveness to both network carriers and final customers[133]. The strategy adopted by Korean handset manufacturers has worked even better since MNOs began to launch their new mobile data services. The *Wall Street Journal* wrote,

> Unlike some of its big-name rivals, LG also has allowed its own brand to be overshadowed by that of the service providers distributing its phones... LG's strategy is to tailor its handsets tightly to a service provider's requirements and then piggyback on the service provider's own advertising... It's been Verizon's brand that has been carrying LG... An LG phone played a

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[131] *Edaily News*, 'Foray into the US handset market – Samsung Electronics: from handsets to network equipments', 10/12/2003.

[132] During interview, a marketing manager in LG said, 'That was how we had served foreign customers so far. It was nothing new for us.'

[133] Prestigious retailer is one of cues that can compensate for the negative effect of country of origin of a product (Thorelli et al. 1989).

prominent role in the launch of Verizon's picture-messaging service.[134]

In this sense, the relationship between MNOs and handset manufacturers was mutually beneficial. The MNOs' brand complemented the weak brand of Korean handset makers in the US handset market while the capabilities of Korean handset makers in delivering handsets featured with operator-specific services helped the US MNOs differentiate themselves from other MNOs by launching new features and wireless data services through customised Korean handsets. In this way, the 'strategic dilemma' (Hobday et al. 2004) for Korean manufacturers' transition from ODM to OBM could be overcome, although the unique structural characteristic of the mobile handset industry in terms of the very existence of MNOs as intermediary users should not be underestimated. By the first half of 2003, Samsung and LG were ranked first and second in the US CDMA market, occupying 49% of the market share between them[135].

The strengthened recognition of Korean brands in mobile handsets also had a synergetic effect on other consumer electronics businesses. For example, LG had tried to establish its 'Goldstar' brand in the US since 1978 but had not obtained much success. In order to overcome its weak brand, it decided to utilise a well-known local brand and acquired shares of Zenith, the US electronics brand, in 1995[136]. Nevertheless, this did not bring much success due to the cultural differences between LG and Zenith[137]. However, the success of co-branded mobile handsets turned the situation around, with these handsets

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[134] *Wall Street Journal*, 'LG Soars to Big League Among Handset Makers', 06/11/2003, p.B.4.
[135] Strategy Analytics.
[136] Samsung also acquired the US computer manufacturer AST for the same reason in 1996 but filed for bankruptcy in 1999.
[137] *Yonhapnews*, 'Considerations needed for FDI', 19/11/1999.

functioning as ‘walking billboards’[138] for Samsung and LG. From 2003, LG pursued a dual-brand strategy in the US electronics market based on the success in the mobile handset market, utilising its LG brand for the premium segment and its Zenith brand for the middle-range segment.

The next section investigates in greater detail how this collaborative relationship created learning and market opportunities for Korean manufacturers in the introduction of new services by MNOs.

6.4 Collaborating with an MNO in the introduction of a new mobile TV service[139]: a Teecean manufacturer–user relationship

This section shows how handset manufacturers took the opportunity to supply customised handsets to an MNO when they launched a new service. Using the example of 3 Italia’s DVB-H based mobile TV service (the world’s first DVB-H commercial service), this section discusses the role of co-specialisation in the competition between Korean handset manufacturers and their giant competitor Nokia.

6.4.1 3 Italia and its ambition to launch a mobile TV service in Italy

Italy was a country with one of the most highly developed markets in the mobile services industry in Europe. The revenues from the industry overtook those from the fixed-line industry in 2002 and the market penetration reached 122.2% in 2005 (Baglieri

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[138] *Edaily*, ‘The history of the US market penetration – LG Electronics’, 24/11/2003.
[139] The empirical data on the launch of the DVB-H in Italy generally derives from Baglieri et al. (2008) and two interviews with leaders in the development team and the marketing team in the LG’s DVB-H 3 Italia project. While the former mainly presented 3 Italia’s position, the latter mainly reflected LG’s perspective. In addition, both were complemented for corroborating the facts.

et al. 2008). It was also the second biggest European market after Germany accounting for 17% of mobile handsets sales in Europe. More importantly, Italy was dominating other European countries with the 3G WCDMA services with more than ten million subscribers. The Italian mobile communication market had been highly oligopolistic, being led by four major MNOs, namely, Telecom Italia Mobile (TIM), Vodafone, Wind and 3 Italia. Their market shares in 2005 are presented in Table 6.5.

Table 6.5 Market shares of Italian MNOs, based on number of subscribers (2005)

Network operator	TIM	Vodafone	Wind	3 Italia
Market share	40.0%	33.1%	19.1%	7.8%

Source: retrieved from OECD Communications Outlook 2007.

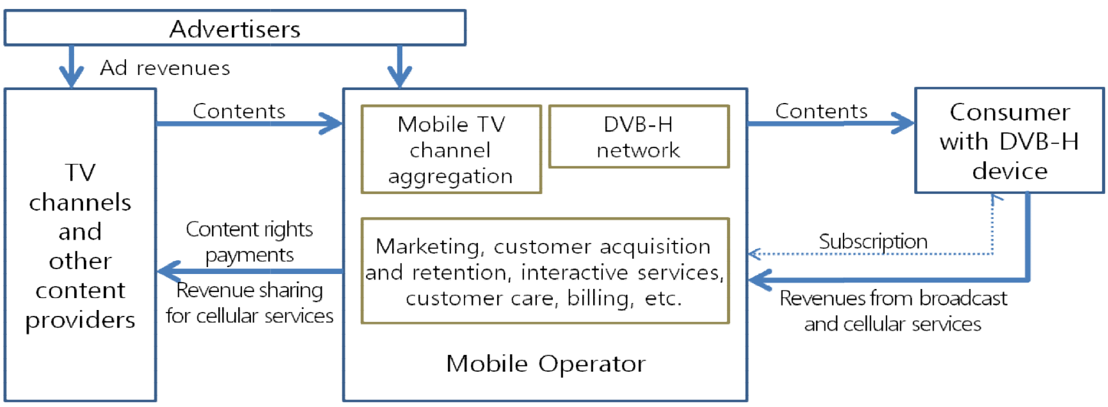
3 Italia, formerly known as the Andala 3G SpA, is one of six European 3G MNOs owned by Hutchison Wampoa based in Hong Kong. Founded by Tiscali and San Paolo in 1999, it acquired one of five 3G licences from the Italian government in 2000[140] and became the first Italian 3G MNO in March 2003. Although Italy had the highest 3G penetration rate in Europe and 3 Italia had the biggest market share in terms of 3G subscribers in Italy, 3 Italia was still far behind its competitors with a market share of 7.8%, as shown in Table 6.5. Therefore, 3 Italia was eager to introduce a new and difficult-to-imitate application/service which would enable it to dramatically increase the number of subscribers and its ARPU.

In July 2005, Vincenzo Novari, the CEO of 3 Italia at the time, made the decision to launch a mobile TV service in Italy based on DVB-H technologies. As it became the

[140] Hutchison Wampoa became the major shareholder and renamed itself H3G Italia in 2000.

first mobile TV service provider[141], 3 Italia specifically targeted the FIFA Football World Cup in Germany that was scheduled to be held from June to July 2006. At the time, it was considered an ambitious choice as 3 Italia was required to complete its DVB-H project within 10 months to meet the deadline, while by general consensus such projects normally require two years for completion (Baglieri et al. 2008)[142].

Moreover, the project became far more complex when 3 Italia pursued an ambitious network operator-led business model, in which the MNO would organise all facets of the project. First, it needed to acquire a DVB-H network licence and also build and operate its own mobile broadcast networks. Second, it had to negotiate with content providers, such as broadcasters (for attractive broadcast content) and with mobile handset manufacturers (for new mobile handsets featuring a mobile TV service). Lastly, it needed to construct a service portfolio and market it to end-users, sometimes bundling it with other mobile services. Figure 6.2 summarises these tasks and shows their interrelationships in a typical MNO-led business model for a mobile TV service.



Source: Pentinnen et al. (2009, p.21).

Figure 6.2 Mobile network operator-led business model in a mobile TV service

[141] The CEO's eventual ambition was far bigger than just taking a higher market share. He envisaged transforming 3 Italia, an MNO, into a multimedia broadcasting company based on the success of a mobile TV service (interview with a project leader of the LG DVB-H project).

[142] Also confirmed by a project leader of the LG DVB-H project during interview.

6.4.2 3 Italia's project management and the division of labour between participants

The project required 3 Italia to collaborate with many external partners, which included broadcast content providers, mobile components suppliers, software solution suppliers and handset manufacturers.

First, 3 Italia purchased Canale 7, the TV channel, and the licence to do the DVB-H broadcast. It then concluded a deal for content provision with the three main TV broadcasters, Rai, Mediaset and Sky. This allowed 3 Italia to acquire exclusive rights to broadcast popular sporting events like the MotoGP, the major league championship, the UEFA Champions League and Seria A football games (the most popular sports championships in Italy)[143].

In addition to broadcast content suppliers, many specialised hardware suppliers were needed to execute 3 Italia's DVB-H mobile TV project. These included NagraVision for SIM cards and Conditional Access Systems and Reti Radiotelevisive Digitali for mobile broadcast network equipment. Software solution suppliers also participated in the project. For instance, Expway developed the Electronic Service Guide and Accenture provided the billing system.

At the start of the project, 3 Italia contacted four handset manufacturers: Samsung, Motorola, Nokia and LG. At the time, each of them was in a different position in terms of readiness for DVB-H technologies and willingness to collaborate: Motorola was not

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[143] Roland Jakab, *Mobile TV market analysis*, http://www.ims.co.hu/mobile_tv_market_analysis.pdf, accessed 26/09/2011.

ready for DVB-H technologies and was automatically excluded from the list of candidates; LG expressed a willingness to invest even though it did not have a prototype; and both Samsung and Nokia were prepared with a prototype and showed their willingness to invest. However, Nokia asked for some control of the project. Table 6.6 denotes these manufacturers' attitudes towards 3 Italia's offer and the next subsections discuss in depth how Nokia failed to agree with 3 Italia while the two Korean makers participated in the project.

Table 6.6 Candidates of handset manufacturers for DVB-H by 3 Italia

	Samsung	**Motorola**	**Nokia**	**LG**
Technology	DMB, DVB-H and MediaFlo	DVB-H	DVB-H with integrated CAS phone-based	DMB
Time to market	Prototype available as of August 2005	Prototype not available in August 2005	Developing the security system for contents	Prototype not available
Willingness to invest	Willing to create a task force		Willing to invest, but some control on the choices	Willing to create a task force
Market position	Growing market share, strong competition with LG	Known to be slower than competitors in the adoption of new solutions	Market leader, promoter of the DVB-H standard	Previous partner of 3 Italia, strong competition with Samsung

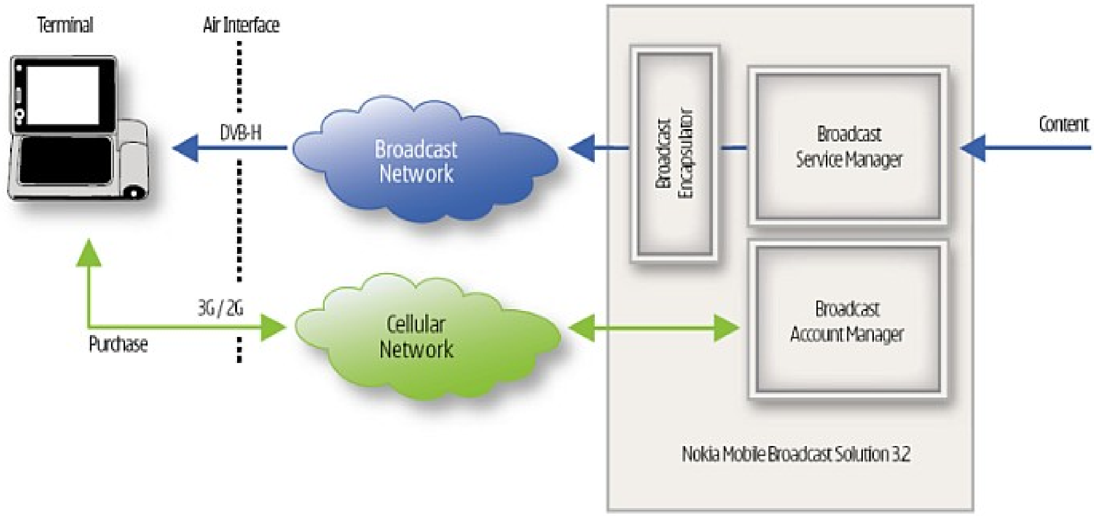
CAS, Conditional Access Systems.
Source: modified by the author based on Baglieri et al. (2008), p.8.

6.4.3 Decision on handset manufacturer participants and subsequent handset development

The following explains the different approaches of Nokia, Samsung and LG towards 3 Italia's offer and the reasons behind 3 Italia's decision over Samsung and LG. In addition, a short description of the handset development is provided.

Nokia's reluctance to join in the project

Nokia was the most important developer in pioneering DVB-H technologies. From November 2000, Nokia began to develop mobile TV technologies and announced its first DVB-H phone (N7700) in November 2003. Nokia developed not only a mobile handset featuring mobile TV based on DVB-H technologies but also mobile TV server solutions called 'Mobile Broadcast Solutions' (MBS), as presented in Figure 6.3. Its main functionality and the three major elements of the platform are given in Box B.



Source: http://www.medianama.com/2009/04/223-wipro-nokia-mobile-broadcast-solutions/, accessed 26/11/2011.
Figure 6.3 The concept of the Nokia Mobile Broadcast Solution

With MBS, Nokia explored a number of pilot-scale DVB-H services within European countries (e.g. Finland and the UK). MBS 2.1 was utilised in three pilot projects with the Nokia N7700 handset, MBS 2.2 was used in 15 pilots with the Nokia 7710 handset, and, by 2006, MBS 3.0 was used with N92 and N77[144]. Therefore, Nokia targeted both mobile broadcast operators and MNOs by marketing the DVB-H solution based on its

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[144] Juha Lipiainen, *DVB-H: Time to commercialize*, http://ce.sharif.ir/courses/85-86/2/ce342/resources/root/Lecture/2006-03-13_hongkong_lipiainen_juha.pdf, accessed in 26/11/2011.

own platform – MBS – and Nokia DVB-H handsets. It did not wish to be relegated to being a handset provider for either MNOs or mobile broadcast operators in the value chain of a DVB-H based mobile TV services. Instead, it had ambitions to become a solution provider in the value chain and take a central position in DVB-H services.

Box B Functionalities and elements of Nokia Mobile Broadcast Solutions*

☐ Main functionalities in the solution

(1) Streaming control: enables both network-wide and regional broadcasts from several content providers.

(2) Electronic service guide: generates and broadcasts the service metadata so that consumers can browse available services, view service descriptions and purchase new services.

(3) Service protection and purchase: controls stream encryption from end to end, generates decryption keys and delivers keys to consumers in a billing-integrated manner.

☐ Major elements in the solution

(1) The Broadcast Service Manager: controls the broadcast and end-to-end protection of streams and also generates the electronic service guide.

(2) The Broadcast Encapsulator: enables (as a gateway) the broadcast delivery of intellectual property content over DVB-H. These intellectual property encapsulators also perform the encryption of paid services.

(3) The Broadcast Account Manager: allows the user to buy rights for consumption of protected content, and produces charging data of the purchase transactions for billing purposes.

*Nokia homepage, http://www.nokia.com/NOKIA_COM_1/Microsites/3GSM/pdf/DVB-H_Press_Backgrounder.pdf, accessed 26/09/2011.

Nokia's strategy created a conflict of interests with MNOs and this seems likely to have contributed to 3 Italia's decision to source mobile TV handsets from the Korean manufacturers. The other issue was 3 Italia's Conditional Access Systems (CAS) called the 'Open Security Framework', which permitted flexibility in implementing conditional access method by content providers[145]. Both Nokia and 3 Italia clung to their own CAS standards during negotiations and Nokia refused to develop a CAS customised for 3 Italia. Due to these reasons, even though Nokia was well equipped for an integrated solution for a DVB-H service, 3 Italia refused to share its value added from the service, and pursued the apparently higher risk and higher return strategy of developing its own DVB-H service.

Successful launches of a DVB-H mobile TV service based on Nokia's MBS occurred in Vietnam and Finland[146]. In December 2006, Nokia helped the Vietnam Multimedia Corporation, the leading national broadcaster and operator, launch the first live DVB-H service in Asia Pacific. Then in May 2007, it also collaborated with Digita, the owner of the DVB-H licence in Finland for the launch of a DVB-H service based on its MBS platform. After announcing a DVB-H partnership with Malaysian MiTV in June 2007, however, Nokia remained silent until announcing, in May 2009, a plan to sell its MBS unit employing 40 engineers to Wipro, the Indian IT service provider. The history of Nokia's attempt to commercialise MBS provides significant support for the conclusion

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[145] In fact, each provider has come up with a slightly different Conditional Access System. The flexibility in the Conditional Access System brought significant development burdens for handset manufacturers. They had to integrate and customise each Conditional Access System for each MNOs. This significantly prolonged DVB-H handset development cycles, which became a significant barrier to the success of DVB-H (Itzik Klein, *Guidelines for a Conditional Access System that would serve the success of ATSC-M/H market*, http://www.siano-ms.com/CN/images/White_papers/Siano_wp_guidelines_for_ca.pdf, accessed in 26/09/2011).

[146] Contents of this paragraph is based on press releases in Nokia's homepage.

that MNOs in many countries seek to retain control over the revenue streams associated with content-related services. Ironically, this position has been significantly eroded in the 3G era which offers Internet-based access to a number of content services, bypassing MNO control.

Samsung and LG′s eagerness to join in the project

By the time 3 Italia approached the handset manufacturers, Samsung had been preparing for DVB-H technologies for almost a year in collaboration with several Korean software suppliers and with in-house resources from its R&D centre in India. As 3 Italia and Samsung had no previous contracts[147], Samsung regarded this project as a good opportunity to expand its customer base in the European WCDMA market. Equipped with a prototype, Samsung expressed its eagerness to join.

In contrast, LG was not prepared for DVB-H technologies at all[148] at the time, despite the successful commercialisation in 2005 of DMB, the Korean version of mobile TV service. LG made a counter-proposal in June, asking 3 Italia to utilise the successfully commercialised DMB technologies (rather than DVB-H technologies) for the service. However, this proposal was refused. In light of 3 Italia's planned future as a multimedia broadcasting company, it needed to continue with DVB-H technologies so that it would be able to expand into the Digital Video Broadcasting–Terrestrial (DVB-T) service. It sent an ultimatum to LG asking for a decision by July 2005[149]. Hutchison Wampoa (3

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[147] Instead, Samsung established good relationships with Vodafone and T-Mobile (interview with a marketing manager in LG).

[148] During interview, a project leader of the LG DVB-H project said, 'We engineers [had] actually never heard of DVB-H before. We had to look it up to find out what it was.'

[149] Interview with a project leader of the LG DVB-H project.

Italia's owner) and LG had maintained a very good relationship since the commencement of Hutchison's WCDMA service. The executives in LG were so concerned about losing Hutchison as their customer to Samsung that they ordered their engineers to accept 3 Italia's offer under any terms and conditions. In the end, both Korean handset makers, Samsung and LG, showed the commitment, flexibility and willingness to invest in the project and thus 3 Italia decided to do parallel sourcing from both Samsung and LG[150].

Sealing a contract and DVB-H handset development

3 Italia put together the same contract with Samsung and LG[151] with the following terms and conditions: (a) Samsung and LG had to deliver their DVB-H handsets by 20 May 2006 and (b) 3 Italia would purchase 300,000 units from each with a high-end price[152]. If either handset maker could not make the deadline the contract would automatically be considered void.

After accepting their contract, Samsung and LG each set up a dedicated research centre in Rome with 30 handset engineers[153] in collaboration with 3 Italia. 3 Italia purposefully made the two companies compete with each other by not allowing them to communicate with each other during the R&D phase. However, both companies were able to gauge their competitive position on the basis of attitudes of solution providers

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[150] The content of this paragraph is based on the interview with a project leader of the LG DVB-H project.
[151] During interview, a project leader of the LG DVB-H project said that with the wisdom of hindsight, he considered the term of the contract as a misjudgement by 3 Italia. According to him, 3 Italia did not expect that LG would be able to meet the deadline and therefore it carried on the project with LG purely as an insurance in case of Samsung's failure. He also believed that 3 Italia expected only 300,000 units (half of the contracted number) to be sold by the end of 2006.
[152] Interviews with a project leader of the LG DVB-H project and a marketing manager in LG.
[153] In the final stage of the project, the number of engineers went up to 100.

such as NagraVision[154]. This parallel sourcing clearly ushered in a development process that was accelerated by the competition between the two companies. In the end, both LG and Samsung developed their DVB-H featured handsets before the deadline (U900 and P910 respectively).

6.4.4 The commercial result of the project

After nine months of the development project, the DVB-H mobile TV service by 3 Italia was successfully launched in May 2006; 12 TV channels including Sky Sport, Sky Cinema, Rai 1, 2 and 3 were provided. Customers were given options to subscribe to daily, weekly, monthly or six monthly unlimited access for € (euros) 3, €12, €29, €59 respectively. Playboy and Penthouse channels were also available for an additional charge of €19 per month for each channel.

3 Italia acquired 100,000 subscribers after just 58 days from the start of the service, indicating that the penetration speed was faster than that of 3G by 3 Italia, (which by comparison had acquired 100,000 subscribers in 91 days). Further increases in subscriber numbers came with 300,000 in January 2007, 400,000 in April 2007[155] and 770,000 (the latter being around a 9% increase in total subscribers[156]) in October 2007. More importantly for 3 Italia, 80% of new DVB-H subscribers were previous customers of Vodafone and TIM and these mobile TV customers also showed 60% more ARPU on

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[154] If they were not cooperative with LG engineers over fixing a specific error, this would mean that Samsung had already solved the problem.

[155] *Cellular News*, 'Eastern European Operators Turning to Mobile TV for New Revenue', http://www.cellular-news.com/story/32350.php, accessed 20/10/2014.

[156] By the end of 2006, the numbers of subscribers to TIM, Vodafone and 3 Italia were 26, 20 and 6.8 million respectively.

average[157].

Despite the initial success, the general consensus on the 3 Italia's DVB-H service was that it had not been successful. Firstly, 3 Italia's original target (500,000 subscribers by the end of 2006) was not met[158] because two Italian market leaders TIM (with Samsung's P920 and later P930) and Vodafone (with Samsung's P940 and LG's KU950) subsequently followed 3 Italia to launch their own DVB-H services in September 2006 and December 2006 respectively[159]. Secondly, the majority of 3 Italia's subscribers seemed to prefer the daily basis option at €3 rather than weekly or monthly plans[160], and therefore the Italians' acceptance of mobile TV did not meet the expectations of 3 Italia. Lastly, customer groups generally wanting a mobile TV service could not afford the price of the DVB-H handset at $400[161], hindering the adoption of the service by the majority of users.

For handset manufacturer participants, this project also brought contrasting economic performances. Samsung and LG both delivered 100,000 units to 3 Italia as first shipments although 300,000 units per company were agreed in the contract[162].

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[157] Nagravision, *Maximizing mobile TV revenues*, November 2007, p.12. http://www.actuonda.com/pdf/Nagravision_maximizing_mobile_TV_revenues_Broadcast_Madrid_2007.pdf, accessed 26/09/2011.

[158] In case of TIM and Vodafone, Mediaset acquired network licences from Europa TV in December 2005 for €186.8 million, established a DVB-H network, then leased 25% of the network's capacity to TIM and another 25% to Vodafone (*Strategy Analytics Insight*, 'DVB-H in Italy: 3 and TIM Head-to-Head Analysis', 16/11/2006, http://www.strategyanalytics.com/reports/4w6Je8b0wB/htframe.htm, accessed 20/01/2015).

[159] *Faultline*, '3 Italia DVB-H sales slump after flying start', http://www.rethinkresearch.biz/articles/3-italia-dvb-h-sales-slump-after-flying-start/, accessed 22/01/2015.

[160] *Strategy Analytics Insight*, 'DVB-H in Italy: 3 and TIM Head-to-Head Analysis', 16/11/2006, http://www.strategyanalytics.com/reports/4w6Je8b0wB/htframe.htm, accessed 20/01/2015.

[161] During my interview, a marketing manager in LG said, 'Consider their social status. Customers affording $400 handset simply did not need to watch TV outdoors.'

[162] The next section discusses how contract works in practice between MNOs and handset manufacturers.

Regarding U900 and P910, a marketing manager for 3 Italia at LG at the time recalled that U900 by LG was preferred by 3 Italia shops – and LG received subsequent orders in the second half of 2006 – while P910 by Samsung struggled to compete against U900. By May 2007, the number of sales of U900 had reached 400,000[163] and LG's success led 3 Italia to introduce its second generation DVB-H phone (U960). In the meantime, Samsung had sold 170,000 units with P910, P920 and P930[164]. During my interview, a marketing manager for 3 Italia at LG explained:

> If MNOs are 1st tier like Verizon and Hutchison, the contract is simply nominal. They [MNOs] do not guarantee the quantity written in the contract. Of course, they take the first shipments and handset manufacturers also prepare only that amount, generally for one month. But if sales are under the expectation, MNOs themselves prepare special promotions but also push us to come up with promotion measures to help sales in their shops. We [have to] provide subsidies for handsets to discount handset price or incentives for salesmen to promote sales. Considering what I heard from 3 Italia at the time, Samsung must have done those promotions at the time.

6.4.5 Inter-firm collaboration, market opportunity and rule of competition in the mobile handset industry

The case of the DVB-H mobile TV service by 3 Italia demonstrates that market opportunities are available to producers if they are equipped with the technological capacity to deliver products that MNOs and their customers demand; the case also shows that producers need to have organisational flexibility (capabilities) to invest resources and share the costs of, and profits from, a co-specialisation process with MNOs (Eisenhardt & Martin 2000; Teece et al. 1997). Even so, not all qualified

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163 *Etnews*, 'LG taking mobile TV market in Europe', 10/05/2007, http://www.etnews.com/200705100147, accessed 22/01/2015.
164 Ibid.

producers were keen to participate in such partnerships, as exemplified by Nokia. Due to preceding investments in its mobile TV server platform (MBS), Nokia refused to support 3 Italia and pursued a leading role in a value chain in order to seize a larger share of profits. In its prospected business model, Nokia was not a customised handset supplier, but a solution provider with both a DVB-H handset and a service providing a platform for DVB-H service providers (these were mostly MNOs). This conflict of interests between MNOs and Nokia accordingly opened windows of opportunity for Samsung and LG who, in contrast to Nokia, were willing to invest their resources in 3 Italia.

When asked during an interview by *Businessweek*[165] why Sprint had an affinity for Korean phone makers, Sprint's president, Charles Levine, replied,

> We have focused on manufacturers that are willing to provide unique phones that customers say they want. Samsung, Kyocera, LG and Sanyo are some of our best suppliers. The European players [Nokia and Ericsson] are providing handsets along a similar line to as many carriers as possible. That's commoditizing the phones. And that's why you have not seen us work heavily with manufacturers that we feel are not producing handsets with the unique features and functions.

The above case also showed that there is a fundamental difference in the nature of collaborations between MNOs and handset producers before and after the introduction of new mobile network services by MNOs. As presented in sections 6.2 and 6.3, the close interactions with MNOs in the early stage of the mobile handset industry provided handset producers with a variety of valuable data on customer demands such as

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[165] *Businessweek*, 'On the line with Sprint PCS's president', http://www.businessweek.com/stories/2002-03-26/on-the-line-with-sprint-pcss-president, accessed 29/12/2014.

preferences on form factors, user interfaces and user-friendly functions. MNOs played an important role as sources of innovation while producers implemented these ideas as innovations to meet users' requirements. In this context, the relationship between producers and users in the early stage can be described as a 'von Hippelian producer–user relationship' (von Hippel 1998). With the emergence of mobile network services by MNOs on the basis of advanced network technologies, however, the dyadic relationship between producers and users significantly changed. In order for 3 Italia to launch a new DVB-H service, for instance, it needed to have concurrently organised solution providers and to have developed a service platform through which subscribing customers would be allowed to utilise digital contents. In doing so, it was MNOs that strategically selected the appropriate software modules and solutions from among those available from the market. Samsung and LG were then required to develop (customised) handsets that reflected hardware requirements and incorporated software modules designated by 3 Italia in order to enable handsets to deliver 3 Italia's new (MNO-specific) DVB-H service.

The main logic behind this collaboration is that both producers and users invest their financial and human resources concurrently for a certain period, fully committing to a collaborative project. In this case, resource investments from both parties are highly relation-specific in the sense that handsets produced are only compatible with this specific mobile service, which is also able to be delivered only through these customised handsets. In other words, MNOs' services and handset manufacturers' handsets are highly co-specialised, as explained by Teece (1986). The development process is also highly interconnected, both sides being required to understand their complementarities and create and nurture inter-organisational routines and capabilities –

these capabilities are called 'relation-specific skills' by Asanuma (1989). Considering the need to reconfigure organisational routines to cope with the change from von Hippelian to Teecean collaboration, the dynamic capabilities are of essence (Eisenhardt & Martin 2000; Teece et al. 1997). In this way, the bilateral relationship between handset manufacturers and MNOs can produce a 'joint competitive advantage' (Jap 2001) through this co-specialisation. Therefore, this bilateral relationship between producers and users can be described as a 'Teecean producer–user relationship' (Teece 1986).

In return for this co-specialisation, MNOs generally guarantee a financial return to handset producers by the guaranteed purchase of a certain quantity of shipments at a cheaper price than that of the market but one that is high enough for manufacturers to make profits[166]. In return, handset producers are obligated to deliver on time and if not, they are subjected to heavy contractual penalties. If the handset model becomes popular, users subsequently place a second order and manufacturers are able to make considerable profits based on economies of scale.

The existence of such collaborative projects also seemed to change the rules of competition in the industry. Prior to new mobile network services by MNOs, the competition was mainly among handset manufacturers, e.g. Nokia vs Motorola or Ericsson. With new mobile network services, however, competition occurred between standardised handsets made by Nokia without (or with fewer) MNO-specific services on the one hand, and customised handsets made by handset manufacturers in support of MNO-specific services on the other. Nokia kept pursuing WAP in the early 2000s and

[166] As in the case of 3 Italia, however, the guarantee of 1st tier MNOs was nominal.

its own software platform 'Symbian', and even its application store 'Ovi' in the late 2000s, as a means of promoting its globally compatible (not network-specific) handsets, leaving MNOs on the periphery as simple 'network providers'. In this sense, competition in the industry occurred not between Nokia and other handset manufacturers but between Nokia and MNOs with the support of handset producers – the competition was about 'who takes the lion's share in the mobile telecommunication industry'. Nokia's refusal to join in the 3 Italia's DVB-H service was just one of a series of conflicts between Nokia and MNOs across borders. Therefore, attempts to understand the competition in the mobile handset industry without the consideration of MNOs seem destined to fail.

Another theoretical consideration is needed in that this co-specialisation process examined theoretically by Teece (1986) seems to work in a different fashion in the mobile handset industry compared with other industries. This seems mainly due to the industry's short product life cycle and highly segmented market structure.

Short product life cycle is likely to entail two contrasting aspects that relate to opportunistic behaviour. In the mobile handset industry, both producers and users are committed to each other for a relatively short period (six to twelve months). These bilateral commitments are then renewed with a subsequent contract if the foregoing project has been completed to the satisfaction of both parties. In this case, the probability of opportunistic behaviour on the part of either partner seems to be higher between contracts because of the absence of an ongoing commitment that allows either side to depart if a better deal is available elsewhere. The probability of opportunistic behaviour within the contract period, however, seems lower because of the desire for renewal (or at least the option of renewal) and the limited gains that can be made by opportunism within the period.

Highly segmented market structure poses absence of exclusiveness in the international context and loose exclusiveness within the same local market owing to a short product life cycle. Since handset markets are highly segmented across each other's borders, mobile services by one local MNO do not compete with those by foreign MNOs, and therefore handset producers are allowed to commit to similar contracts with foreign MNOs. Even if MNOs compete in the same local market, they do not mind as long as handsets with similar functions by their competitors arrive late (generally three to six months) in the market[167]. For example, Vodafone Italy launched a DVB-H service in December 2006 that was similar to that of 3 Italia, following the latter's success, and its handset providers were identical to those for 3 Italia, namely Samsung (P940) and LG (KU950). Without hesitation, a project leader of the LG DVB-H project commented during interview, 'This is possibly due to a short product life cycle of the industry. In three to six months, MNOs promote other user selling points (services) with different handsets.'

In this context, the co-specialisation between producers and users in the mobile handset industry is shallow compared to other industries where the bilateral relationship lasts a long time and opportunistic behaviours within the relationship may matter. The fundamental difference in the shallow type of co-specialisation is that producers serve multiple users not only across borders but also in the same market over time. Accordingly, the capabilities required of a producer to carry out this shallow co-

[167] Interview with a marketing manager in LG.

specialisation may differ from those required to carry out a conventional (deep) co-specialisation. Producers in the former have to be equipped with wider technical capacity than those in the latter to serve various sets of requirements from multiple users. Producers in the shallow co-specialisation will also have to promptly transfer relation-specific skills from one user to other users – these skills are called ‘interface capabilities’ by Yasumoto and Fujimoto (2006).

The conventional argument within the literature on firm boundaries seems rather deterministic. If technical changes diminish with the stabilisation of product architectures, firms will align their boundaries as a means of competing in the most efficient way according to their capabilities. However, according to what is being presented in this thesis, research is still needed on perspectives that go beyond firm boundaries. As shown in the mobile phone industry, fierce competition exists on the issue of ‘who takes how much’ among industry participants like suppliers, producers, and especially intermediary users. Collisions between these actors each pursuing maximum profit may establish multiple ‘industry architectures’ (Jacobides et al. 2006) that exist concurrently and compete each other. The multiplicity of industry architectures creates a market opportunity for Korean emergent leading firms in the mobile handset industry.

6.5 Influence of the MNO-oriented model on Korean handset manufacturers

The previous section has described how the bilateral relationship between Korean emergent leading firms and MNOs shifted from a von Hippelian to a Teecean producer–user relationship. This section considers positive and negative aspects of this dyadic relationship and explores the influence of this relationship on Korean handset manufacturers in comparison with Nokia and Motorola. In addition, it presents how Korean handset manufacturers transformed their development structure to serve a variety of MNOs utilising diverse networks across borders.

6.5.1 Two facets of the close relationship with MNOs

From the Korean manufacturers' perspective, a close relationship with MNOs entailed both positive and negative aspects, as discussed in Chapter 2 and 4. The advantages for manufacturers from co-specialisation include the role of MNOs as additional sources of innovation and access to the complementary resources and knowledge of MNOs. These advantages have successfully created joint competitive advantages which have helped Korean emergent leading firms to incrementally overcome uneven development between technical and marketing stages.

On the other hand, the reliance on MNOs also brought several disadvantages for the manufacturers. First, MNOs demanded hardware and software customisations, resulting in additional R&D costs and difficulty in attaining economies of scale; Korean producers must have set their prices at lower profit margins to reflect the superior access of MNOs to the end-users of mobile telephones. Second, MNOs' downstream resources enabled Korean handset manufacturers to save on investment in brand awareness in the near term. However, this largely deferred an investment that they would have to undertake later, unless they were willing to continue indefinitely to be disadvantaged in terms of their bargaining power against MNOs. Perhaps more importantly, the technology development trajectory might have been shaped for the benefits to MNOs at the expense of the benefits to manufacturers and end-users as explained in Section 4.3.4. Last not the least, a misreading of the market demands by MNOs sometimes brought a heavy blow to manufacturers, since MNOs may substitute another supplier because of the limited duration of supply contracts.

The marriage of Verizon Wireless and LG since the early 2000s provides a good example of both facets – the synergies and traps – of this type of business strategy. By reflecting Verizon's demands and providing a new handset exclusively customised for Verizon, LG had enjoyed high market shares in the US handset market since the early 2000s; LG had effectively piggybacked on Verizon's brand. When Verizon misread market demands by overlooking the high preference of customers for smart phones, however, the tables were totally turned. Sales of LG in the market plummeted due to its feature phone-oriented development capacity while Verizon promptly switched its handset suppliers to other handset manufacturers like Samsung and High Tech Computer Corporation of Taiwan (HTC), both of whom had anticipated the rapid expansion of the smart phones market.

6.5.2 Impacts of the close relationship with MNOs

Table 6.7 shows the number of new handset models introduced, unit sales, handset shipments per model with market shares by major handset vendors in the GSM/WCDMA handset market[168] from 2001 to 2009. The table shows that Korean handset manufacturers have been producing a greater diversity of handsets than Nokia

[168] Unlike GSM/WCDMA handsets, the certification process of CDMA handsets is mainly managed by each CDMA network operator, and therefore unfortunately there is no community or website available to provide the information on the number of CDMA handset models introduced in a specific year by each vendor.

and Motorola. For example, Samsung produced 28 different GSM/WCDMA models in 2003 for a 9.8% market share and 119 in 2009 for a 19.2% market share. By contrast, Nokia introduced 26 and 44 models for market shares of 42.2% and 45.1% respectively in the same years[169]. This contrast becomes even greater if LG is compared to Nokia: the number of handset shipments per model from Nokia exceeded approximately ten million while that from Korean manufacturers was at best two million. Apart from Samsung in 2002, Korean handset manufacturers did not exceed two million units per model, as indicated in the Table 6.7.

Table 6.7 Number of new handset models, sales, handset shipments per model and market shares by companies in GSM/WCDMA

(Rows: model numbers, million units, million units per model, market share)

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009
LG	1	11	12	22	36	36	33	50	54
	0.3	2.2	6.1	18.4	24.5	25.9	41.8	55.8	80.7
	0.30	0.20	0.51	0.84	0.68	0.72	1.27	1.12	1.49
	0.1%	0.8%	1.8%	3.8%	3.9%	3.2%	4.5%	5.6%	8.5%
Samsung	11	11	28	33	54	77	81	96	119
	14.2	22.8	33.8	58.0	76.2	88.1	130.4	161.9	181.6
	1.29	2.07	1.21	1.76	1.41	1.14	1.61	1.69	1.53
	5.6%	8.3%	9.8%	12.0%	12.0%	10.9%	14.1%	16.4%	19.2%
Motorola	8	14	32	32	27	14	27	29	25
	40.8	37.4	38.4	68.5	110.8	169.3	115.7	69.8	28.9
	5.10	2.67	1.20	2.14	4.10	12.09	4.29	2.41	1.16
	16.2%	13.5%	11.1%	14.1%	17.4%	20.9%	12.5%	7.1%	3.1%
Nokia	5	17	26	21	35	32	40	36	44
	98.2	117.2	146.0	178.7	244.2	329.4	427.8	463.6	426.1
	19.64	6.89	5.62	8.51	6.98	10.29	10.07	12.88	9.68
	39.0%	42.3%	42.2%	36.9%	38.4%	40.7%	46.2%	46.9%	45.1%

Source: number of new GSM/WCDMA handset models counted by author from GSM Arena, www.gsmarena.com, and sales and market shares derived from Strategic Analytics.

[169] Considering the strong bargaining power by CDMA MNOs and corresponding low open market share in the CDMA handset market, the gap between the Korean and other foreign manufacturers is expected to be wider if figures from the CDMA market are also included.

The average number of handset shipments per model by major companies indicates the burden on Korean manufacturers from the development of more handset models in comparison to Motorola and Nokia; producing each model may have entailed additional R&D costs for Korean handset manufacturers. On the other hand, Nokia, having sold roughly ten million units per model, provided itself with the potential for greater profits originating from economies of scale.

6.5.3 Contract-based development structure

Increased involvement of MNOs in the mobile handset industry in the post 2G era led Korean emergent leading firms to transform their development structures, from a von Hippelian to a Teecean producer–user collaboration. This is similar to what Day (1994) described about the case of the Corning, Inc. division that manufactures fiber optic products. It had to cope with the transition of market demands from standard to more customised products. Accordingly, the main customer group for Korean emergent leading firms shifted from end-users to MNOs (intermediary users), and Korean emergent leading firms adopted contract-based development, which is fundamentally different from the mass-production structure that firms like Nokia had pursued.

Under this contract-based development system, it is MNOs that decide which handsets with which functions will be introduced when in the market, and handset manufacturers develop these handsets accordingly. From the product planning stage onwards, both sides collaborate with each other. Handset manufacturers provide their product roadmap with concepts of new handset models and new deliverable functions, and MNOs may request handset manufacturers to make proposals to serve their network service roadmap or may directly designate specifications of new handsets to handset manufacturers. However, not all MNOs have the power to dictate full customisations. MNOs are generally categorised according to their capacity of monthly shipments and only 1st tier MNOs are served under this logic. During my interview, a marketing manager at LG explained the criteria for 1st tier MNOs:

> A full customised (including hardware and software) handset model generally requires R&D costs of around $5 million. To attain break-even point, at least 200,000 units should be guaranteed. But not many MNOs can afford this. MNOs such as SK Telecom (Korea) and Verizon (US) can do this. We call them 1st tier MNOs. Second tier MNOs like Movistar in Latin America have capacity to guarantee only 20,000 units and MNOs that we call 'others' normally order 5,000 to 10,000 units at best. Therefore, all the R&D resources and organisational structures are arranged to efficiently serve 1st tier big buyers in Korea, US, Japan and Europe. To keep a good relationship with 1st tier MNOs, we sometimes deliver handsets regardless of break-even point on numerous occasions. Or if we expect that they would not be able to purchase break-even point units for a new model, we may convene 2nd or others using similar networks of 1st tier MNOs and collectively receive orders from them ahead of development to fill the break-even point gap[170].

After serving these 1st tier MNOs, handset manufacturers then market these handsets to 2nd tier or lower MNOs. These medium and small MNOs are generally allowed for limited hardware and software customisations, which would cost around $0.5 million (one tenth of full customisations). Using similar logic, the guarantee of around 20,000 units would be needed for an order of country-adapted customised handsets. There are two main reasons behind limited customisations for 2nd and lower tier MNOs. Firstly,

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[170] The characteristics of the MNO-oriented organisational structure in the Korean handset manufacturers were visible in their production lines as well. Two operator-exclusive lines were operating (four lines for AT&T and one line for NTT-Docomo, so that MNOs could exclusively supervise assembled handsets) when the author visited the Pyongtaek production line of LG on 03/03/2011.

these MNOs do not have enough market capacity to order full customisations. Secondly, these smaller MNOs do not have the same sophisticated technical capacity to designate new functions to handset manufacturers as the 1st tier MNOs. In fact, they rely on 1st tier MNOs' knowledge and generally accept what 1st tier MNOs have already designated without much modification. However, a break-even point is not the only factor that Korean emergent leading firms consider when they deal with small MNOs, and there is flexibility within their MNO contracts. A marketing manager in LG said:

> We both [handset manufacturers and MNOs] are experts in the industry and understand each other's situation well. If small MNOs cannot guarantee the break-even point units for 'A' handset, asking for a higher price would be reasonable. But in general, MNOs may offer package deal on buying a less promising 'B' handset together with us or provide considerable marketing subsidies to offset our country-adaptation costs. We know how to compromise and make deals for ourselves.

He added the reasons why LG continues to do business with 2nd tier or lower MNOs:

> LG's approach was that we make enough profits from big buyers like SK Telecom (Korea), Verizon (US) and Hutchison (Europe). In the meantime, we tried hard to establish a new relationship with other big buyers such as Vodafone and T-Mobile. One year, we developed five to ten models for just 50,000 to 100,000 units for Vodafone. We did business prioritising on 1st tier MNOs. But, we still need 2nd tiers and others because their orders can [i.e. enable us to] share R&D costs and various other fixed costs. As long as they can meet the break-even point, we take their orders.

Bargaining power and technological capacity of MNOs and handset manufacturers, and the degree of customisations, are interconnected factors in constructing the contract-based development of Korean emergent leading firms.

6.6 Summary

The chapter has mainly dealt with how Korean emergent leading firms overcame their uneven development between technology and marketing stages based on their collaboration with MNOs, and correspondingly how this has affected the development systems of Korean emergent leading firms.

The first part of the chapter has shown that Korean handset makers first dominated the domestic CDMA handset market based on their first movers' advantage, and they continued their successes in the global market, entering the US CDMA handset market. However, the chapter has also shown that they employed either an ODM or co-branding strategy, which is different from OBMs in the domestic market. Despite their technologically competitive handsets, their weak brand presence in the US handset market led Korean handset manufacturers to collaborate with US MNOs in return for market access, which was fundamentally different from the approach adopted by global players such as Nokia and Motorola. The chapter has demonstrated that Korean emergent leading firms stayed between stages 4 and 5 in terms of co-branding with MNOs while they kept at stage 5 in terms of technological leadership due to their collaborations with MNOs (Hobday 1995b).

The chapter has further illustrated that the collaborations between Korean emergent leading firms and MNOs evolved from a von Hippelian to a version of the Teecean producer-user relationship with the case of the world's first DVB-H mobile TV service launched by 3 Italia with the support of Samsung and LG. The example has shown that Korean emergent leading firms successfully obtained new market opportunities by fully dedicating their development resources to 3 Italia whereas Nokia adhered to its DVB-H business model. The success of the project not only brought profits from the initial contract with 3 Italia to Samsung and LG but also enabled them to win subsequent DVB-H contracts with other Italian MNOs such as TIM and Vodafone.

The chapter has also demonstrated that the co-specialisation studied by Teece (1986) operates in a different fashion in the mobile handset industry compared to other industries; this difference is due to the short product life cycle of mobile handsets and their highly fragmented markets, a phenomenon described in the thesis as shallow co-specialisation. The chapter has also highlighted that an analysis of firm boundaries based on the capabilities view (firm level) cannot properly explain the dynamic competitions in the mobile handset industry mainly due to the existence of MNOs as intermediary users.

The last part of the chapter has shown the downside of the co-specialisation between Korean emergent leading firms and MNOs. Although co-specialisation with foreign MNOs has helped the globalisation of the Korean emergent leading firms in that it has compensated for their lack of marketing resources, it has also brought about a heavy burden of customisations, leading to the loss of economies of scale. The chapter has explained how Korean emergent leading firms accordingly have transformed their market approach from customers (end-users) to MNOs (intermediary users) and implemented contract-based development.

The next chapter discusses one of the organisational solutions that Korean emergent leading firms have adopted to overcome the strategic dilemma originating from their close relationships with MNOs.

7. UTILISATION OF CONTRACT DEVELOPER ORGANISATIONS[171]

7.1 Introduction

The previous chapter showed how Korean handset makers have grown as global players, and it emphasised their relationships with MNOs, starting from von Hippelian collaborations and evolving to Teecean co-specialisation. Based on early success in the domestic market, the Korean handset makers managed to penetrate the first foreign export market (US CDMA handset market). Due to the innate weak brand awareness of emergent leading firms, however, they heavily relied on sales through foreign MNOs under either ODM or co-branding arrangements. Although the strategy adopted by Korean emergent leading firms had advantages, it also had disadvantages. On the one hand, their strategy enabled them to secure a foothold in foreign markets with lower investment on the downstream side. On the other hand, however, their close relationship with MNOs called for relation-specific investments by Korean manufacturers in return for the use of their partners' complementary assets. This also resulted in an increase in the number of handset models that Korean handset manufacturers had to develop for their customers and incurred the contract-based development structure that was shown in Chapter 6; the chapter showed that the uneven development between technological and marketing capacity drove Korean emergent leading firms to evolve in a different fashion from their leading competitors.

This chapter investigates how Korean handset makers reconciled the upsurge in

[171] As far as the author is aware, the concept of a 'contract developer' (CD) is new to the literature. The content of most of this chapter, therefore, was obtained from interviews with LG and its CD employees.

development activities resulting from their collaborations with MNOs. Turning the focus of the analysis to the upstream side, it identifies a new form of outsourcing organisation which in this thesis is called the 'contract developer' (CD); the observation is put forward that while foreign competitors like Nokia tend to outsource the production (assembly) stage of low-end models to specialised assemblers (Anderson & Jonsson 2006; Porter & Paija 2011), Korean handset makers in fact tend to outsource the development stage of low-end models to their CDs. The chapter highlights the emergence of CDs for Korean OBMs and specifically exemplifies LG's manoeuvring of its CDs through its global strategic model of the 'Shine Phone'. By chronologically tracing the dynamics of the division of labour between LG and its CDs, this chapter infers that CDs for Korean handset makers on the upstream side played a significant role under the contract-based development structure of Korean emergent leading firms from the downstream-side co-specialisation.

The chapter is organised as follows. Section 7.2 begins with the definition of CDs for handset manufacturers and their role in the value chain of the industry. Section 7.3 provides a detailed history of the emergence of CDs in the Korean mobile handset industry, and the circumstantial factors that have promoted their emergence in terms of both demand and supply. It also shows examples of CDs and their development projects for Korean OBMs. Then, Section 7.4 examines how Korean handset OBMs search, supervise and nurture their CDs under their outsourcing strategy for handset developments.

Section 7.5 sets out how the division of labour between LG and its CDs changed during the introduction of LG's global strategic model, the Shine Phone, and its diverse variations during the three years between October 2006 and October 2009. It also examines the main reasons behind outsourcing decisions for each model. Based on the findings from the previous sections, Section 7.6 discusses the role of CDs in the globalisation of Korean handset OBMs.

7.2 Definition of a CD for Korean handset OBMs

This section introduces the definition of a CD and identifies its distinct role in the value chain of the mobile handset industry.

7.2.1 Contract manufacturer, design house and CD

The utilisation of a contract manufacturer or electronics manufacturing service company has been very common in the electronics industry since the emergence of the global production network (Ernst 2002). The term ‘contract manufacturer’ refers to a company that specialises in manufacturing electronic components or assemblies for various OBMs, the latter providing the architectural designs or formulae and specifications for the former (Sturgeon 2001). Likewise, the utilisation of contract manufacturers in the mobile handset industry is also very common, especially by Western handset companies such as Nokia and Motorola. Leading contract manufacturers in the mobile handset industry include Foxconn and Flextronics, the annual company sales of which amounted to $139 billion and $25 billion respectively as of 2014[172].

In addition, a ‘design house’ is a firm that designs and develops its own products like an

[172] *Manufacturing Market Insider*, ‘Inside the contract manufacturing industry’, http://mfgmkt.com/wp-content/uploads/2015/04/March-2015-revised.pdf, accessed 13/09/2015.

ODM but which does not have production facilities (Imai & Shih 2007). In this regard, design houses are to contract manufacturers in the mobile handset industry what fabless companies are to foundry companies in the semiconductor industry. Therefore, a design house possesses intellectual property from product development and has rights to designate vendors for components; in the mobile handset industry, a design house is a relatively small company compared to an OBM.

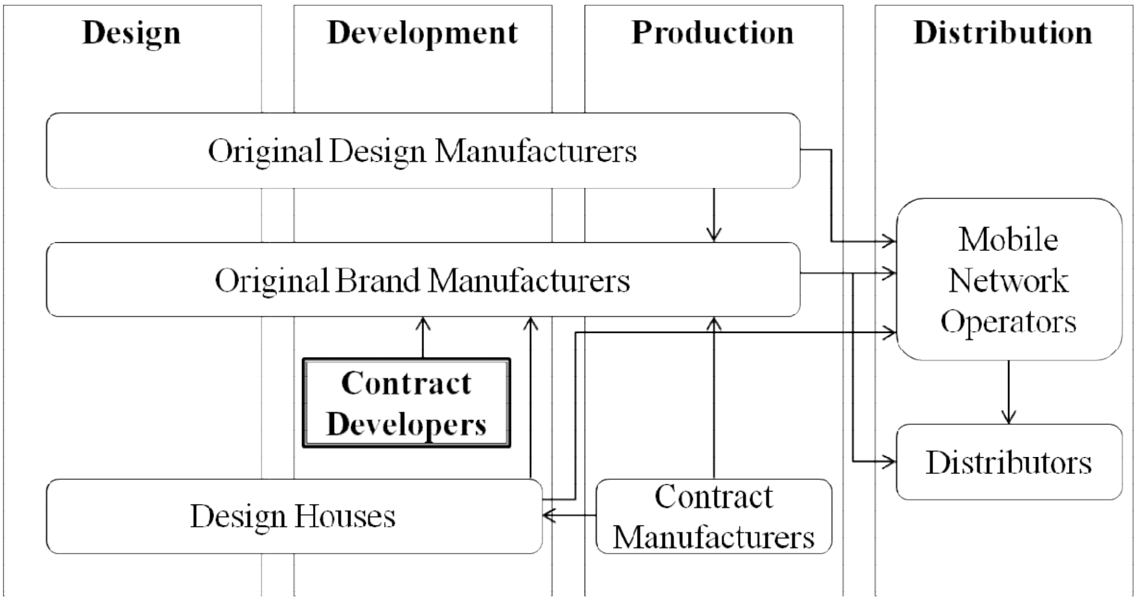
Drawing on the concepts of contract manufacturer and design house in the electronics industry, we conceptualise a new type of organisation that provides specialised services for developing electronic products like a design house (which does not assemble like a contract manufacturer) but which is based on an OBM's original design/blueprints like a contract manufacturer (which does not own design/blueprints like a design house). As the service provision from this new organisation pertains to development instead of only design or manufacturing (or assembly), in this thesis this new form of organisation is labelled a 'contract developer' (CD). Therefore, a CD is defined as a company that is specialised in providing electronic product-development services to one specific OBM[173], which in turn provides architectural designs and specifications for a CD.

7.2.2 Role of CDs in the value chain of handset manufacturing

There are four different kinds of firm organisations in the mobile handset industry pertaining to the development of mobile handsets: design houses, CDs, ODMs and OBMs, as shown in Figure 7.1. The role of CDs in the value chain of the mobile handset

[173] Unlike the situation where one contract manufacturer generally serves multiple customers, it is assumed that each CD serves a single OBM customer due to the confidential and firm-specific nature of product development.

industry is clearly traced down to the development stage of a mobile handset for OBMs; each CD takes orders from one specific OBM, and therefore the development capabilities of CDs are highly asset-specific to the development process and resources of their counterparts. In addition, OBMs own all the intellectual property from the CDs' development process and designate vendors for hardware components and software modules that are used for handset development. CDs are not allowed to develop their own handset models (and this is clearly noted in their contracts with their OBMs[174]).



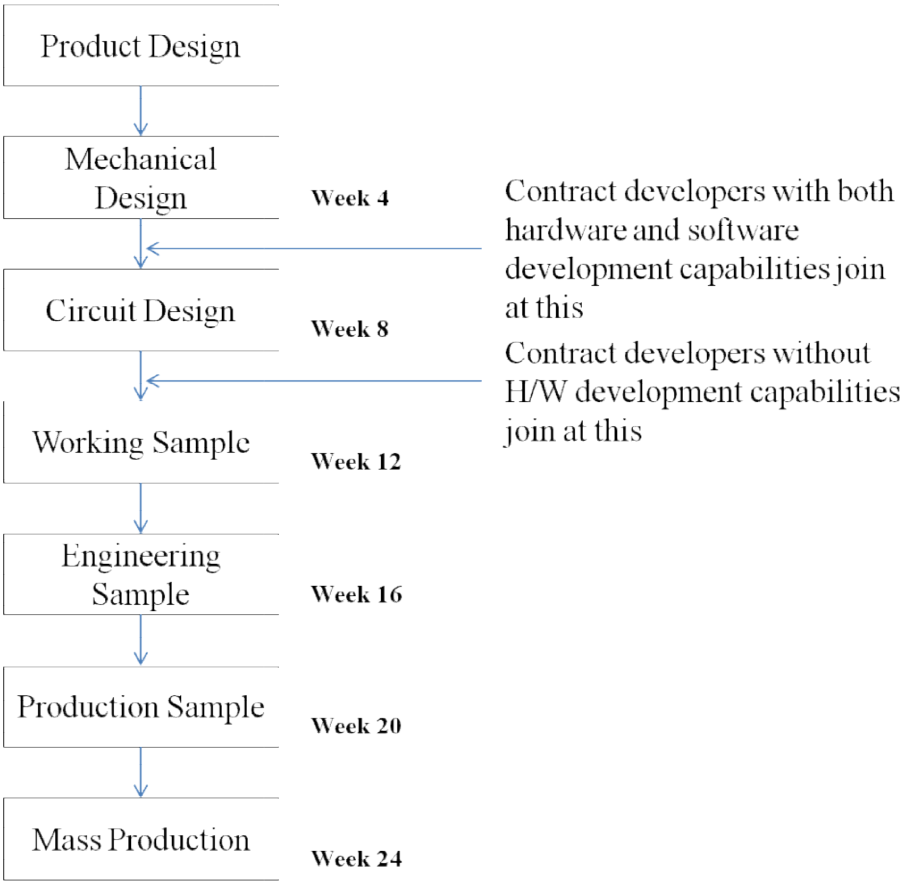
Source: author's elaboration based on interviews with engineers of CDs.

Figure 7.1 The role of CDs over a value chain of the mobile handset industry

Interviews with industry participants disclosed that the timing of the involvement of CDs in the development process varies according to their capabilities, as shown in Figure 7.2. Some have capabilities for both hardware circuit design and embedded software development while others have capabilities for the latter only. As seen in

[174] Interviews with engineers of CDs.

Figure 7.2, CDs with both capabilities[175] can start from the circuit-design stage immediately after OBM handset makers plan for a new handset and finish the mechanism design. However, the role of CDs without hardware circuit-design capabilities includes only software development through working-sample to mass-production stages, and excludes the circuit-design stage.



Source: author's elaboration.

Figure 7.2 CDs' responsibilities over a handset development process

When CDs are fully staffed with both hardware and software engineers, handset development outsourcing by handset manufacturers is composed of three main tasks: circuit design and hardware calibration, protocol stabilisation, and software integration

[175] Among 30 CDs for LG, only five were this type of CD. They included AM Telecom, Teleworks, Yujeong System, Infobank and H Telecom (interview with an engineer at Teleworks).

development work. The first task is for hardware engineers to decide the location of each component on a circuit board in a handset after the mechanism design is finished. The second task is to test wireless performance for voice quality, connectability and data transfer as well as the functions of the LCD display, performance of camera module, etc. after surface-mounting of all the hardware components on the main printed circuit board. Moreover, in order to acquire the desirable voice quality and data communication, the engineers must also adjust and stabilise the protocol stack which governs communication between their developing mobile handset and the base stations of a network operator. The third and last task is for software engineers to develop embedded software for operating systems, software modules and the user interface, and to integrate them. They also modify the original handset software of OBMs with country-specific menus and functions, a process which is commonly known as ‘country adaptation’[176].

7.3 Emergence of CDs for Korean handset OBMs

This section explains what circumstantial factors led over time to the emergence of CDs for Korean handset makers from the perspectives of both demand and supply. Several interviews with employees in CDs disclosed that there are two distinct groups of CDs according to their company histories and, in fact, these two groups began their CD business at different times. The following two subsections describe these two waves of emergence of CDs for the Korean OBM makers, and the difference in origins and market circumstances behind them.

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[176] Interview with an engineer of a CD.

7.3.1 First wave of the emergence of CDs for Korean OBMs: hike in software development activities, demand side (early 2000s)

The early origins of CDs for Korean handset manufacturers can be found in firms that worked together with handset manufacturers on the development of software modules in a handset[177]. Initially, these companies participated in the co-development of diverse software modules for a handset system. In the early 2000s, Korean handset makers fell short of engineering manpower due to rapid growth of market share and a hike in the requests for customisations and diverse models by foreign MNOs. During my interview, a handset developer in LG recalled, 'At the time, we were really successful. We were not surprised at the creation of a new development team in each week'.

While they increased in-house resources as much as possible, they also sought the assistance of external firms. They were, however, highly concerned with the leakage of knowledge and information on new handset models during the development process. Given the short life cycle of the mobile handset industry, information regarding a company's new handset model with new functions could inadvertently reveal the blueprint of its future R&D and market plans. As an alternative to entirely outsourcing the handset development process to unfamiliar ODM firms, the Korean handset makers recommended that their software module developers should plan to widen the scope of their business profiles and act as handset development outsourcing companies for their prime contractors. As they were already working closely with their handset makers, these software module developers seized this opportunity to diversify[178].

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[177] Ibid.

[178] Interview with a team leader at a CD.

Managerial issues for Korean OBMs with the first wave of CDs

The first wave of the emergence of CDs called for collaborative efforts between CDs and OBMs, simply because outsourcing a development process was new to both organisations. It took a while for new CDs to learn, comprehend and assimilate the knowledge that OBM handset makers had accumulated so far regarding the entire handset development process. A team leader in LG in charge of outsourcings mentioned,

> Because we never had CDs before, we had to set up a new fostering system for CDs within our company, searching and evaluating candidates, mentoring CDs and supervising outsourcing projects. The fostering system was finally settled in early 2003, around a year and a half after the first agreement on contract development in late 2001.

7.3.2 Second wave of the emergence of CDs for Korean OBMs: collapse of Korean ventures as design houses[179], supply side (mid 2000s)

In the mid 2000s, a group of Korean venture companies that had operated either as ODMs or as design houses approached the Korean handset OBMs to become their CDs. The question that arises here is: why did this group relinquish their independence and offer to become CDs for Korean OBMs? The following section explains the context in which Korean small ventures decided to take this step.

Burden on Korean ventures to license protocol stack software and software solutions

Handset makers were required to make an initial payment of $2 to 3 million for

[179] The collapse of small Korean handset ventures can be interpreted as an industry 'shakeout' in the mobile handset manufacturing industry. For a detailed discussion of shakeout, see Klepper and Simons (2005).

licensing protocol stacks and as annual software maintenance fees[180]. On top of that, handset makers also needed to invest considerable sums of money on application software modules incorporated into feature phones in conjunction with functional convergence and mobile data services. Such applications included WAP browser[181], Graphic User Interface[182], MP3, mobile TV and firmware update solutions[183].

Therefore, handset makers had to initially invest $5 to 6 million ($4 to 5 million for GSM) and an additional $100,000 to 200,000 annually for maintenance costs, in exchange for protocol stacks in the case of CDMA[184]. In addition, they paid running royalties for using software solutions. As large handset manufacturers normally opted to pay a discounted one-off fee for licensing based on their production scale, small-sized handset ventures struggled to compete against them due to the lack of economies of scale. The handset manufacturing business gradually became viable only for firms that could acquire economies of scale.

Retreat of Korean ventures from the Chinese market due to fierce competition[185]

Since the announcement of GSM as its 2G standard in 1994, the Chinese local handset market had been dominated by Motorola and Nokia with more than 70% of market share until the late 1990s. In order to curb imports and encourage local makers, the

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180 *Cellular Monthly*, 'Adoption of flash technologies by handset makers', 09/2005.
181 Most of the value added services such as M-commerce, Video On Demand/Music On Demand, Location Based Service are provided through a WAP browser. Key browser developers include Nokia (Finland), Openwave (US), Teleca (Sweden) and Access (Japan).
182 Portable Network Graphics and Flash are popular solutions used for graphic user interface.
183 When software solutions embedded in a handset have software errors, firmware updates can be done over the air. These solutions are called Firmware Over-The-Air (FOTA). Key players include Innopath (US), Bitfone (US), Redbend (US) and Insignia (US).
184 All the data for licensing fees and royalties here came from *Inews24*, 'Handsets full of royalties', http://news.inews24.com/php/news_view.php?g_serial=108238&g_menu=020300, accessed 26/12/2014.
185 The history of the Chinese local handset market is generally based on Imai and Shih (2007).

Chinese government implemented a quota system for importation of finished handsets. Both foreign manufacturers set up joint ventures with state-owned telecommunication equipment makers Capitel and Eastcom. However, these joint ventures merely implemented the assembly process, which left no room for local makers to acquire handset development capabilities.

In response, the Chinese government proclaimed in early 1999 'Decree No. 5', which allowed only licensed makers to produce and market mobile handsets in China. All foreign major handset makers were unaffected by this policy as they had successfully acquired licences through joint ventures. However, in practice this policy had two significant impacts. Firstly, it restrained Korean and Taiwanese venture companies (either ODMs or design houses) from penetrating the Chinese market due to the limitation on licences. Secondly, Chinese local firms were given licences to enter the handset market, but the majority of them had diversified from parts of the electronics industry such as pagers and did not have the capabilities required for handset development. Therefore, the policy provided an incentive for Chinese local makers with licences to collaborate with foreign venture companies who had expertise in handset development.

Through collaborations, Chinese local makers began to accumulate handset capabilities by sourcing designs, knock-down kits (semi-assembled kits), and sometimes finished handsets from various ODMs and design houses mainly from Korea and Taiwan. Rather than competing against dominant foreign giants, these firms marketed their handsets to areas such as small cities and the countryside, where people did not recognise foreign brands and did not have enough buying power to purchase high-end handsets. It proved to be very successful and examples of these local firms include Bird and True China Lion (TCL).

However, these local firms' successes – based on the relationship between Chinese local makers and Korean design houses – did not last long and gradually deteriorated mainly due to the emergence of Taiwanese design houses and Chinese local design houses. Chinese local makers preferred Chinese local design houses to Korean design houses for three main reasons: the high cost of Korean engineers, insufficient adaptation of Korean design houses to local requirements, and a lack of trust on knowledge spillover. During my interview, a team leader in a CD also explained,

> During the development process of mobile handsets for Chinese MNOs, lots of knowhow got transferred to Chinese side. They [Chinese firms] easily acquired circuit board designs of our handsets and also recruited many Korean engineers. It did not take long for us to lose our competitive advantages.

Therefore, Korean handset ventures were squeezed out of the Chinese market by Taiwanese design houses and Chinese local handset companies such as Ningbo Birds, TCL and Zhongxing Telecommunication Equipment (ZTE). As a result, most Korean ventures such as Telson, Sewon and Bellwave, had filed for bankruptcy by 2004[186].

Managerial issues for the Korean OBMs with the second wave of CDs

The second wave of the emergence of CDs was quite different from the first. As shown in the previous subsection, most new CDs in the second wave had previous experience in handset development either as ODM handset makers or design houses. Once they had

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[186] A former Korean design house engineer complained about their knowledge leaking to Chinese design houses via Chinese handset makers (*Cellular Monthly*, 'Crisis for mobile handset ventures', 01/2005).

decided to become CDs for Korean OBM handset makers, it did not take much effort for them to customise their capabilities to their OBMs[187]. By the time the second group of CDs had emerged in the mid 2000s, the Korean OBMs had established their management systems for CDs as well.

7.3.3 Examples of CDs for LG (2001–2011)

At the time of the research, LG-related CDs were generally situated either close to LG's R&D Centre in Gasan Digital Complex or their assembly line in Pyongtaek. The number of employees varied from 30 to 50 and sometimes up to 140, depending on the size of company. For example, AM Telecom, the biggest CD for LG, employed around140 engineers (as of April 2011). Approximately five to six of LG's CDs were equipped with more than 100 engineers. This section examines two example CDs for LG, one from the first wave of CDs and the other from the second wave.

Teleworks: from a design house to a CD

Teleworks was a typical case of a firm which became a CD for Korean OBM handset makers after failing to survive competition in the Chinese handset market. Teleworks was founded in May 2004 as a design house specialising in GSM handset development, with a workforce of 15 engineers, five hardware engineers and ten software engineers[188].

When it was founded in 2004, Teleworks, like other handset venture companies, targeted the Chinese handset market but failed to acquire a contract from the Chinese

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[187] Interview with a manager of an outsourcing development team at LG.
[188] Interview with a team leader at Teleworks.

handset market. Seeking a viable option, Teleworks decided to become a CD for LG and asked to be put through LG's verification process. It only took a month for LG to verify the technological capabilities and financial status of Teleworks. The verification process began in August 2004 and both companies agreed to a contract by September 2004. Ever since then, the workforce of Teleworks has gradually increased as LG has grown in the global handset market. Teleworks first increased its workforce to 30 in 2005 (15 hardware and 15 software engineers) and by 2007 when LG had caught up with Sony Ericsson, it was increased to 50. Teleworks again expanded to 80 in 2008 when LG overtook Motorola, then to 100 in 2009, to 120 in 2010, finally to140 in March 2011. The increase of manpower at Teleworks coincided with LG's financial performance.

Infobank: from a multimedia messaging service–client programme provider to a CD

Infobank was originally founded in 1995 as a software company specialising in mobile messaging services. Its other business areas included interactive media services, mobile payment systems and smart phone applications as well as contract development of a handset. Following the recommendation of LG, Infobank started its contract development work with three engineers in 2001 when the Korean MNOs commercialised the CDMA 1x network. At the time, Infobank was obtaining an order for embedding the multimedia messaging service client programme into a handset for LG, and it considered contract development work to be a good opportunity, as it was looking for new business[189].

[189] Infobank's annual reports between 2007 and 2010 for the Korean Financial Supervisory Service and an interview with a team leader of Infobank.

The main senior engineers in the handset contract development section of Infobank were recruited from Samsung's handset business. At the time of the research, Infobank mainly undertook LG projects for 2nd tier CDMA MNOs in North America, Israel and some Latin American countries. The company participated in software integration activities only due to the CEO's personal preference for software and it hired other CDs when needing hardware calibration activities in handset development projects[190].

7.3.4 Example of handset development projects given to a CD from LG

The annual reports submitted to the Korean Financial Supervisory Service by Infobank provide some general characteristics of contracts carried out by CDs. Table 7.3 lists most of Infobank's handset development contracts with LG between 2007 and 2009[191].

Some commonalities can be drawn from the table. All these MNOs operate CDMA networks and the same MNOs appear repetitively. Most projects carried out by Infobank were mainly for CDMA MNOs in Israel, Canada, the US, Mexico and Venezuela[192]. On the one hand, the size of budget and the length of the projects vary significantly. The budget shows a 20-fold difference from $56,000 to $1,112,000, and projects lasted from 2.5 months to as long as 12 months. According to a team leader of a CD, these differences were mainly the result of different amounts of customisation that local MNOs had requested and the release schedules of the MNOs. He also added that the

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[190] Interview with a team leader of a CD.

[191] From the interview with a team leader of a CD, it was confirmed that some of projects were omitted from the annual reports.

[192] During my interview, a team leader of a CD said that LG generally allotted projects in one country to two to three CDs (multiple sourcing).

budget of a project was predetermined by forecasted man-month inputs based on an assumption over the level of difficulty and length of the project[193]. For example, a project was unlikely to require much engineering workforce if a 2nd tier MNO had wanted the same model that was released for Verizon because this type of project only needed simple software-based country-adaptation development. In this case, the budget of the project was comparatively low.

Table 7.1 List of Infobank's handset development contracts with LG (2007–2009)

Project duration (year, month, day)	**Model and operators**	**Budget ($1,000)**
2007.09.01–2008.03.31 (7 months)	CX8800 (Canada)	652
2007.08.01–2008.01.31 (6 months)	PX8350 (Israel)	465
2007.03.01–2008.02.28 (12 months)	UX275 and others (hardware)	403
2007.10.01–2008.02.28 (5 months)	PX8700 and others (hardware)	110
2007.10.01–2008.04.15 (7.5 months)	PX8700 (Israel)	380
2007.12.01–2008.04.30 (5 months)	MX8550 (Mexico)	470
2008.01.01–2008.08.15 (7.5 months)	CX9100 (Canada)	580
2008.02.01–2008.06.15 (4.5 months)	CX8700X (Canada)	106
2008.03.01–2009.02.28 (12 months)	CX10K and others (hardware)	670
2008.03.01–2008.06.30 (4 months)	CX260V (Canada)	366
2008.03.01–2008.09.30 (7 months)	CX9700 (Canada)	608
2008.03.01–2008.10.15 (7.5 months)	CX10000 (Canada)	1,112
2008.04.07–2008.11.06 (8 months)	CX8560 (Canada)	568
2008.08.25–2009.1.24 (5 months)	RD9700 (India)	300

[193] LG sometimes adjusted the budget according to real man-months invested by Infobank. In order to cross-check the input of man-months, LG sometimes checked Infobank's engineers' bank accounts (interview with an engineer of a CD).

2008.10.01–2009.03.15 (5.5 months)	MX9700 (Mexico/Venezuela)	430
2008.10.21–2009.01.31 (3 months)	CX260PC (Canada, PC)	80
2008.11.17–2009.02.15 (3 months)	MD3500(Venezuela, Movistar)	56
2008.11.17–2009.01.31 (2.5 months)	AX840 (North America, Alltel)	85
2008.12.16–2009.07.31 (7.5 months)	CX9200 (Canada, Telus/Koodo)	590
2008.07.01–2008.11.15 (4.5 months)	CX9100X (Canada)	122
2008.12.01–2009.07.31 (8 months)	CX700 (Canada, Bell)	570
2008.12.01–2009.09.15 (9.5 months)	220C (North America, Tracfone)	806
2008.12.22–2009.03.15 (2.5 months)	CX11000 (Canada, Telus)	610
2009.02.01–2009.08.31 (7 months)	LG100C (North America, Tracfone)	332
2009.03.23–2009.10.31 (7 months)	LGCX9600 (Canada, Telus)	498
2009.07.13–2009.11.15 (4 months)	LG9600 (North America, ACG)	285
2009.09.01–2010.04..15 (7.5 months)	LH8600S (Korea, LGT)	329
2009.09.14–2010.04.15 (7 months)	CX230 (USA, Virgin)	527
2009.09.14–2010.06.15 (9 months)	LG231C (North America, Tracfone)	461
2009.11.01–2010.02.28 (4 months)	SH860S (Korea, SK Telecom)	172
2009.11.01–2010.08.31 (10 months)	LG511C (North America Tracfone)	545
2009.11.16–2010.04.30 (5.5 months)	LG230 (North America, ACG)	250

ACG (Associated Carrier Group) are a group of small network operators in Northern America sourcing mobile handsets together to pursue economies of scale.
Source: retrieved from Infobank’s annual report 2009 and 2010 for the Korean Financial Supervisory Service, dart.fss.or.kr.

7.4 Management of CDs by LG: OBMs' point of view[194]

By 2004, three years after LG had first utilised a CD, LG collaborated with 24 different CDs to enable it to cope with the development of various new handsets. Although the number of CDs working for LG plummeted dramatically to 11 companies within a year due to LG's poor performance in 2005, by 2011 the number had increased to more than 30 companies as LG regained its global market share by overtaking Sony Ericsson and Motorola.

7.4.1 LG′s management of CDs

All of the CDs were managed by LG's outsourced development group composed of eight engineers[195]. The main objectives of the group included the management of all outsourcing to software developing suppliers as well as contract handset developers. In particular, the group searched for new CDs, trained them and supervised projects outsourced to them. When the group needed to hire new CDs, it searched for appropriate candidates with the support of the headquarters' procurement team, which was in charge of negotiating and sealing contracts with CDs. At the end of each year, they were evaluated by LG based on the projects that had been carried out in the previous year, and the contracts were renewed between LG and the CDs depending on LG's level of satisfaction.

In the mid 2000s when there were numerous candidates waiting to become CDs for

[194] The content of this section is mainly based on the results of interviews with a manager of outsourcing development in LG and a support manager of subcontractors in LG.

[195] Although Samsung utilised a similar number of CDs (20–30) to LG, Samsung's counterpart to the LG group comprised around 20 personnel as it ran twice as many projects as LG.

Korean OBMs, LG and Samsung even assigned two different CDs the same project – generally low-end handset development – in order to confirm the CDs' capabilities[196]. When the project was half completed, LG or Samsung selected the developer that demonstrated the better potential and allowed it to finish the project, while they let go of the less competent developer. However, the rule has since changed into a rule of sole developer for a project.

There were project managers under each laboratory in LG and four to five project leaders under each project manager. The project leader administered the in-house models and the outsourced projects run by CDs. For example, an in-house team with one project leader developed a new handset for the European market while CDs did the same for the South American market.

Hiring engineers for CDs was also controlled by OBM makers. LG annually notified the CDs of the approximate number of engineers required in each development area (hardware and software) for a subsequent year so that CDs could adjust their manpower accordingly. The CDs normally had a high turnover rate of employees – almost 30%[197]. In case LG wished to cut down on the workforce, the CDs reduced the number of employees by not re-hiring for vacant positions.

Although the role of CDs was originally supposed to be turnkey-based handset development, Korean OBM handset makers started to utilise engineers from CDs in an ad hoc fashion. They sought to utilise such engineers as a buffer for their own engineers.

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[196] This kind of forced competition by Korean handset OBMs also occurred to antennae supplier firms (Interview with an engineer of an antennae supplier firm).

[197] Interviews with engineers in Yujeong Systems and Teleworks.

For example, at times they wanted to develop a handset using in-house engineers for the hardware and CDs' engineers for the software. At times, they even asked for a couple of software engineers to fill in-house vacancies. In addition, if there was a female engineer at LG requiring maternity leave, the position was temporarily filled by an engineer from one of the CDs[198]. In other words, on top of turnkey-based handset development projects, Korean OBM handset makers utilised the workforce of CDs, sometimes certain individuals, sometimes certain groups and sometimes entire development teams. This flexible workforce sourcing offered an opportunity for cost advantage and flexibility on managing human resources in OBM makers. This unique mode of sourcing engineers was only possible because the workforce of CDs were fully specialised in both hardware and software developments for each OBM handset maker.

To enable CDs to fully support the shortage of LG's development resources, the capabilities of CDs had to remain sophisticated and be improved constantly. LG provided engineers in CDs with ample opportunities to participate in LG-organised training programmes[199] for in-house LG engineers[200]. Most training instructors were senior researchers at LG while a few were university professors. Training places were first allocated to LG's own engineers, but if spaces remained, they were open to engineers from CDs. If there were insufficient spaces left for engineers from CDs, their senior engineers were invited to take part in programmes and they were then in turn required to train their juniors.

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[198] Interview with a director at a CD.

[199] Some examples of internal education programmes include the Android software academy, the design-of-radio-frequency module and software development for the Smart Phone.

[200] Similar instances were studied in terms of replication of organisational capabilities of suppliers by Sako (2004) based on the Japanese automakers.

7.4.2 Allotment and main criteria for handset development outsourcings

When a product portfolio was confirmed for the next business year, all development projects were categorised into four different groups: premium, high-end, mass or very low-end tier, depending on the difficulty of projects, price and profit, and the importance of the ordering client/customer. Afterwards, handset manufacturers allotted the workload for internal engineering resources into projects and finally, they considered outsourcing options with their pool of CDs. The heads of each laboratory decided which project was to be allotted to which CD, in collaboration with the outsourcing management group.

The main criteria used by handset manufacturers in deciding whether to develop in-house or to outsource were the level of technologies involved in projects and the importance of their relationships with MNOs and distributors. If a new handset model was categorised into a premium or high-end category and required sophisticated and novel technologies, in-house development teams would generally be chosen. In addition, an in-house development team carried out the project if the new model was requested by a major 1st tier MNO such as Verizon and Vodafone. General sequential criteria[201] for the decisions behind contract development for a handset model were as follows.

(1) The handset should not be a strategic core model incorporating new technologies.
(2) It only required slight modification such as country adaptations, scenario modifications and functional changes.

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[201] There was a slight difference between LG and Samsung. LG tended to use CDs only for middle- and low-end handsets. On the other hand, Samsung sometimes utilised its CDs for some high-end handsets.

(3) It was to be categorised into middle or low-end segments and therefore low profits were expected.

(4) It had been requested by major MNOs with Samsung's or LG's brand but low sales were expected.

(5) It had been requested by small MNOs.

(6) It was for the open market with MNO-specific functions removed.

Until 2005, these principles had worked well. When LG struggled to compete in the global market, particularly due to the success of Motorola's RAZR, LG decided to decrease the number of CDs instead of reducing the number of internal developers. The number of CDs utilised by LG plummeted to 11 in 2005, compared to 27 in 2004. As LG had to maintain internal engineering resources for the near future, it allocated internal resources to low-tier projects as it struggled to acquire orders from MNOs and distributors. In this case, CDs played the role of a buffer of development resources for LG, an outcome that was similar to what was expected to emerge from the decision to outsource; this is an example of 'concurrent sourcing' as explained by Parmigiani (2007).

7.5 Platform models, their variations and the division of labour with CDs: the case of the Shine Phone by LG

This section investigates how Korean handset manufacturers coped with managerial issues to develop various handset models for different MNOs globally within a relatively short period of time. It specifically focuses on the division of development labour of new handset development projects between an OBM's internal development teams and its CDs, and the reasons and factors behind decisions to outsource when handset producers introduce platform models and their variation models onto global handset markets. In order to do that, the second wave of LG's 'Black Label' series, the case of the Shine Phone, is highlighted.

7.5.1 Concept of the Shine Phone and in-house development of its first model[202]

In November 2005, LG introduced onto the Korean domestic market its first global strategic model, the 'Chocolate Phone', under the brand of the 'Black Label' series. It was distinguished by a touch-sensitive illuminating control pad and sleek slider design with chocolate-coloured casings. It quickly became very popular in the domestic market and many global MNOs subsequently showed their interest. The sales of the Chocolate Phone reached 10 million units in April 2007 and surpassed 20 million units overall[203]. Encouraged by the early success of the Chocolate Phone and pushed by the short life cycle of the industry, LG started to prepare for the second strategic model of its 'Black Label' series in March 2006, targeting October 2006 for a launch of the new model onto the Korean domestic market.

Amongst dozens of ideas proposed by the LG design centre, the concept of the Shine Phone was chosen by the director of the Mobile Communications R&D Centre. The Shine Phone design came with novel functions, colourful design and materials. However, the initial concept of the Shine Phone that came from top management was rejected by engineers, due to technical difficulties and their estimates of the required R&D time to implement the concept. From the engineers' perspective, the concept of

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[202] Unless otherwise indicated, most of this section is based on: *Korean Economy Magazine,* '5% of improvement is impossible but 30% of innovation is possible', January 2007.
[203] *Business Watch*, 'The hit story of Chocolate Phone', http://www.bizwatch.co.kr/pages/view.php?uid=7607, accessed 8/8/2014.

the Shine Phone was unachievable with respect to all three important factors in developing a new handset: quality, cost and delivery. At the time, it was 'common sense' in the handset industry that metal was inappropriate as a casing material on the grounds that it obstructed the quality of radio frequency communication at internal antennae[204]. Moreover, it was obvious that the change of production line from plastic moulding to one for metal processing would cause an increase in production costs. Finally, the most important cause for apprehension was that only six months were given to the development team.

Despite concerns from the engineers, the director of the Mobile Communications R&D Centre decided to proceed with the Shine Phone project, taking full responsibility himself[205]. General specifications of the first Shine Phone were confirmed. Unlike conventional handsets, it would reinforce notions of solidity and durability; by using stainless steel instead of plastic as a casing material, it was anticipated that it would capture customer popularity[206]. It would also adopt a mirror-effect LCD screen as a front display, which would reinforce the model-branding messages of being bright and reflective. In addition to a two-megapixel camera and an MP3 player with 1 GB memory, it would also first feature a vertical scrolling key on the bottom of the front screen.

The main task for the development team other than the conventional handset development process was to find a metal processing firm which could handle a

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[204] Internal antennae in modern phones were equivalent to extendible antennae in early analogue phones.
[205] This kind of 'crisis construction' has been very common in the Korean business context. See Kim (1998) for detailed explanation.
[206] The first mobile handset adopting a metal case was Motorola's RAZR phone.

precision of 0.01 mm rather than the conventional 0.1 mm. Many companies that specialised in home appliances made metal casing for their products but 0.1 mm precision was sufficient for these applications. However, the handset industry demanded a higher-order precision. None of the plastic casing suppliers for LG at the time could join the project as they did not have previous experience in processing metal. LG decided to co-develop the metal casing with a casing supplier for its Home Appliances Division and designated Kwangsung Electronics[207] as its partner, which supplied exterior aluminium mouldings to LG, Sony and Panasonic, amongst others. For three months, LG along with Kwangsung co-developed the metal processing technology required for a precision of 0.01 mm. Financial support from LG for Kwangsung reached $1 million. Finally, they were able to develop a new ‘press processing and laser welding/etching process’ for metal casing, an entirely different manufacturing process from the conventional injection moulding technology used for manufacturing plastic cases[208]. At the last stage, WS M&P[209] also participated in the project to ensure commercial production of stainless steel casings guaranteeing an acceptable level of electro-magnetic shielding and radio sensitivity.

Other technical barriers included the development of a scroll key and a camera module. To keep the upper deck in the slide type of Shine Phone within a slim 4.3 mm thickness, Panasonic in Japan developed a magnetic-type scroll key rather than a mechanical one and LG Innotek also came up with a thinner camera module. In the meantime, engineers

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[207] This company later changed its name to Global Kwangsung (GK).

[208] *Kyunghyang News*, ‘Example of symbiotic cooperation: Shine phone’, http://ruliweb.daum.net/news/view/MD20061120182208634.daum, accessed 8/8/2014.

[209] Woosung Mouldings and Plastics Co., which used to produce a plastic casing for wired telephones and car/home audio systems, diversified into a handset casing business in1999.

in Lab 1[210] of the Mobile Communications R&D Centre had almost resolved the issues of quality of radio communications and the stability of wireless signals stemming from the stainless casing through various improvements in the mobile handset system[211]. Eventually, after six months of an exhaustive development process, the design centre's proposed concept was implemented as a new stylish handset by integrating all the new technologies.

In October 2006, LG introduced the first Shine Phone, V420[212], onto the Korean domestic market as originally planned. It was a CDMA Evolution-Data Optimized (EV-DO) platform model based on Qualcomm's MSM6500 chip. In addition, it was a slide-type handset with dimensions 98.6 x 50.6 x 13.8 mm (119 g), as shown in Figure 7.3, and featured a 2.2-inch 262k colour mirror-effect LCD display, two-megapixel Complementary Metal-Oxide-Semiconductor (CMOS) camera and MP3 player with 1GB internal memory, and 128 polyphonic chip. It soon became a very popular model selling 1,500 units a day within 15 days in the Korean market[213]. This first Shine Phone became a reference for various ensuing models.

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[210] At the time, the Mobile Communication Division of LG comprised four handset development groups: Labs 1 to 4. Lab 1 was in charge of all handset models developed for the Korean domestic market; Lab 2 took charge of GSM-based handsets for European, South American and Asian markets; Lab 3 was in charge of developing handsets for North American markets; Lab 4 was designated as a 3G (WCDMA) handset developer for the company (interview with an engineer at LG).

[211] One of the improvements was a new signal reception algorithm called 'Tango' (*Inews24*, 'Review: LG-SV420', http://m-talk.inews24.com/php/news_view_mtalk.php?g_menu=380200&g_serial=236361, accessed 8/8/2014).

[212] There were three MNOs in the Korean domestic handset market. Handset manufacturers normally provided three variation models for each MNO, which mainly differed in their MNO-customised user interfaces. The rule for naming a model was that LG added S for SK Telecom, K for Korea Telecom, and L for LG Telecom before V420 (which was the model number for the Shine Phone). For example, LG introduced SV420, KV4200 and LV4200 at the same time in October 2006 with user-interface customisation for three MNOs in the Korean market. However, this thesis refers to V420 only rather than SV420, KV4200 and LV4200.

[213] *Hankyung Plus*, 'LG Shine Phone, popularised', http://www.hankyung.com/news/app/newsview.php?aid=2006110210018, accessed 8/8/2014.

As described above, the R&D activities for the first Shine Phone were conducted by LG in-house engineers in collaboration with its component suppliers. Firstly, the quality of radio communications was achieved through the efforts of in-house engineers in Lab 1 during the project. The processing technology for metal casing was successfully developed through cooperation between LG and its component suppliers from the Home Appliances Division. In addition, several components were successfully developed for LG by specialised handset component suppliers.

Source: http://www.idknet.com/mobile/phones/1415.html, accessed 21/03/2011.

Figure 7.3 The original Shine Phone

There was no room for CDs in the first global strategic model of the second Black Label series Shine Phone. All the R&D activities were conducted by LG's Mobile Communications R&D Centre and therefore new skills and knowledge derived from the

R&D activities in this project remained within this part of the company.

7.5.2 Introduction of subsequent platform models onto the market without the CDs' involvement

Since the introduction of the first Shine Phone, V420, three other platform models arrived on the global market: global GSM model KE970, 3G model KU970 for Vodafone, and the first clamshell-type model VX8700 for Verizon.

The first CDMA platform model V420 was followed by the first GSM platform model KE970[214] in January 2007, the latter model being compatible with the GSM network with GPRS and EDGE technology. Reflecting the characteristics of the European handset market, KE970 was introduced onto the European market, starting in the UK and eventually moving to mainland Europe, particularly France, Germany and the Netherlands. For the first GSM model of the Shine Phone, for reasons similar to V420, development was undertaken only by in-house engineers in LG's Lab 2. Lab 2 had shared some previous experience with Lab 1 during the development of V420. However, the development of KE970 was considered as a totally separate project from V420 in the company[215]. This is because not only were the characteristics of radio communication for a GSM network different from those for a CDMA network but also KE970 was developed based on an Infineon baseband chip (PMB8876) and its software. Many interviewees at LG made it clear that handsets using different wireless networks can be declared as absolutely different handsets in terms of technical structure, even

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[214] ME970 is identical to KE970 apart from supporting bands. The former supports tri-bands of 850, 1800, 1900 MHz, three GSM bands in North America while the latter supports tri-bands of 900, 1800, 1900 MHz, three GSM bands in Europe. The same applies to KE770 and ME770.

[215] Interview with a handset engineer at LG.

though they may appear to be the same to the customer. When asked about the collaboration between Lab 1 and Lab 2, a handset engineer at LG stated:

> Despite the same look from [the] customer's perspective, a different network based on a different baseband platform simply means a different handset to engineers. We share some tips but they are miniscule.

In the meantime, Lab 4 at LG created the first 3G version of the Shine Phone, KU970. As an exclusive version for Vodafone, one of the biggest global MNOs, KU970 was introduced onto the market in May 2007 across Asian countries (e.g. Singapore), Australia and Europe by Vodafone. While supporting the 2G GSM network, KU970 could also utilise the 3G network High Speed Downlink Packet Access (HSDPA), which allowed KU970 to make video calls with an additional (front) video camera. Although KU970's hardware features were similar to those of KE970, they were totally different in handset engineers' perspective. Firstly, the user interface of KU970 was fully customised for Vodafone. 'Vodafone Live!', the 3G wireless data service promoted by Vodafone, was also embedded in the system. In terms of hardware, KU970 was integrated based on Qualcomm's 3G chipset MSM6280 compatible with the GSM network. Likewise, Lab 4 at LG took charge of the development of the handset as it required in-depth knowledge and experience of 3G network and wireless communications.

For the last global platform model, the first North American CDMA Shine Phone model, VX8700, arrived in the market in April 2007 through the biggest US network operator, Verizon Wireless. VX8700 was developed based on the CDMA EV-DO platform and using the same MSM chip from Qualcomm as in the original Shine model V420.

However, it was Lab 3 instead of Lab 1 that carried out the development project for two reasons. First of all, VX8700 entailed a form factor change from the original model, V420, transitioning from slide to clamshell type, which presented challenges for LG regarding hardware calibration activities. Moreover, as with KU970, VX8700 also had to encompass many new software features for Verizon, which resulted in a heavy workload for LG in terms of software customisation. As the first clamshell-type Shine Phone, VX8700 consisted of many exclusive features and services by Verizon. For example, it was equipped with Verizon's regional services such as VZ Navigator and the Chapperone internal GPS module, and supported V CAST music and video services through Verizon's EV-DO network. In addition, the 'Get It Now' feature, with which one could download alert sounds, ringtones, themes, background images and screensavers, was also embedded in the handset. Over and above the sophisticated capabilities required to develop VX8700 under the banner of Verizon, LG had to provide full resources for the handset development as Verizon was one of LG's most important customers.

These four different early models (V420 for Korean CDMA, KE970 for GSM, KU970 for Vodafone WCDMA and VX8700 for Verizon) introduced by LG can be categorised as platform models from the perspective of product development resources invested. These handset models were later utilised as the basis for the development of variation models that followed. The important fact is that each original platform model was developed independently even within LG amongst Labs 1 to 4[216]. Under the circumstances, no task in the platform model projects was given to CDs. These projects were new to in-house engineers in LG's Mobile Communications R&D Centre and LG

[216] Interview with a handset engineer at LG.

also needed to internalise all the experience and tacit knowledge originating from these new projects. In addition, all customers of these platform models belonged to the most important MNO group (1st tier) to LG. A handset engineer at LG argued:

> We [in-house engineers] always take on first, new, and difficult tasks so that we learn and accumulate knowhow.

7.5.3 Evolution of variation models with little involvement of CDs

Based on the above platform models, LG started to produce diverse models, modifying them in terms of form factor, features (mainly adding new features but sometimes downgrading them), and customisations for network operator services.

Following the platform models, LG announced two bar-type variations of a Shine Phone, KE770 (from KE970) in April 2007 and LC3600 (from SV420)[217] in August 2007. With the form factor modification from slide to bar type, several features had been downgraded in these models in order to lower the bill of materials (they were targeted at the mass-tier handset market). In addition, LG outsourced the development of both models to one of their CDs, AM Telecom[218]. With regard to two projects, LG incrementally increased the responsibility of AM Telecom. For the first bar-type project (KE770), LG let its in-house engineers get involved in the core development of a radio module while AM Telecom undertook software development activities. As the change of form factor normally requires some degree of calibration among hardware components in a radio module, which in turn heavily affects voice-call quality, LG did not delegate the job to its CDs. In the second bar-type project (LC3600), on the other hand, AM

217 Exclusively for LG Telecom.
218 As mentioned earlier, AM Telecom was capable of both hardware and software development.

Telecom took full responsibility for it as a turnkey project.

By incorporating a terrestrial DMB, LG also released two Shine Phone models featuring a mobile TV, B630 in May 2007 and its form factor-changed model (clamshell-type) B250 in October 2007. Both variation projects of B630 and B250 were carried out by the in-house group (Lab 1) who developed V420 to execute a terrestrial DMB module addition and modify a form factor. When asked about why CDs were not utilised for those projects, an handset engineer replied:

> Both projects involved hardware-oriented development activities. Therefore, it would be more efficient for the same team to implement as the main task of those projects entailed calibrating radio modules to secure voice-call quality.

Two other variation models served LG's 1st tier MNO customers, AT&T and NTT-Docomo. First, LG released CU720 in November 2007 for AT&T, the North American GSM/WCDMA network operator. Then, in March 2008, LG also introduced the Japanese version of the WCDMA Shine Phone, L705iX, exclusively for NTT-Docomo in an attempt to make headway in the Japanese market. These handset models, originating from the 3G platform model KU970, were heavily customised by Lab 4 for AT&T and NTT-Docomo from both hardware and software perspectives. Such customisation included a video call module, eMusic and Napster for AT&T, and Freedom of Mobile Multimedia Access (FOMA)[219], and 1-seg, the Japanese version of mobile terrestrial TV, for NTT-Docomo[220]. By the release of L705iX, LG was able to take care of most of its 1st tier network carriers.

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[219] FOMA is the brand name of NTT-Docomo's 3G network services based on WCDMA technology. It was the first commercialized 3G service and was launched in October 2001.

[220] *Reinado*, 'Pioneering of LG in Japanese handset market', http://reinado.egloos.com/2455550, accessed 27/03/2011.

For 18 months, introduction of the original Shine Phone models and their variations by LG continued globally across various MNOs and markets. During this time, LG mainly utilised its internal development resources in the support of the development of platform models and their variation models incorporating functional and form factor changes while keeping the stylish and savvy image under one brand name, Shine Phone. However, two exceptions to the involvement of CDs for low-tier variation models were also observed, one being partly and the other fully outsourced. Those projects focused on form factor changes to bar type, which is generally considered a feature of the low-end handset. AM Telecom, one of LG's CDs joined in two bar-type Shine model projects, KE770 and LC3600, and mainly supported software development for LG.

Until this phase, the role of CDs for handset OBMs seems to have been quite limited. Not only had CDs participated in a small number of projects but also their role in the development of Shine Phone models looks to have been highly peripheral to core R&D activities carried out by LG's in-house engineers. However, CDs began to emerge and take a central role from late 2007, in serving the development of variation models for 2^{nd} tier MNOs and low-tier models with 1^{st} tier MNOs.

7.5.4 Variation models carried out mainly by CDs

From autumn 2007, one year after the introduction of platform models, LG started to prepare for variation models serving 2^{nd} tier MNOs and low-tier models for 1^{st} tier MNOs.

From April to August 2008, LG announced three variation models of the platform model VX8700: PX8700, CX8700X and MX8700 for Israeli, Canadian and Latin American network operators respectively. These MNOs had been considered as 2nd tier MNOs for handset manufacturers as they were generally able to purchase one tenth of the quantity that 1st tier MNOs could. Infobank, one of LG's CDs who had several years of experience in conducting a country adaptation for these MNOs, carried out all three projects under the supervision of LG's model leader[221]. These projects took roughly six to eight months each and the team leader of the Infobank commented:

> As I recall, they were all very ordinary country-adaptation projects. The MNOs really loved the Shine Phone for Verizon (VX8700) and they wanted the model the way it was for Verizon. Therefore, customisations for those MNO models in both hardware and software perspectives were minimal. I do not remember a single major issue during those projects.

In the meantime, LG provided two last variation models to 1st tier MNOs, SK Telecom in Korea and AT&T in the US. In the Korean market, SV570 (Shine II) was announced for SK Telecom in May 2008. At the time, SK Telecom specifically requested of LG a middle-priced 2G (CDMA EV-DO rather than 3G WCDMA), which should inherit features of the original Shine Phone. In order to meet SK Telecom's request, LG adopted a cheaper polycarbonate plastic casing rather than a metal casing for SV570. LG was able to meet SK Telecom's desired retail price of $319[222] signifying a middle- to low-tier handset, by downgrading several hardware and software modules and outsourcing the development work as a turnkey project to Yujeong Systems[223].

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[221] The model leader in LG did not conduct R&D activities and only supervised projects carried out by CDs.

[222] The original Shine Phones for SK Telecom, KTF and LG Telecom were priced $451, $396 and $451 respectively (http://review.cetizen.com/lg-sv420/view/1/1281/review, accessed 27/03/2011).

[223] As earlier mentioned, Yujeong Systems was equipped with both hardware and software development capabilities.

In October 2009, LG announced its final Shine variation, GD710, with the tag of Shine II. This model was requested by AT&T as middle- to low-tier handset while maintaining the stylish image associated with the Shine brand. While GD710 inherited most of the features of the original AT&T Shine Phone CU720, LG strategically decided to appoint one project leader to run this project using its in-house engineers to install radio functions and the Universal IC Card (UICC)[224]. However, the rest of the development activities were delegated to H Telecom, one of LG's key CDs.

At this stage, the level of the CDs' involvement in variation models of the Shine Phone became much more salient than in the previous stage. While corresponding to 2nd tier MNOs and low-tier handsets for even 1st tier MNOs, most development tasks were allocated to CDs – rather than in-house engineer teams in LG – on the condition that the work was conducted under LG's supervision.

From October 2006, LG introduced a total of 15 different platform and variation Shine Phone models onto the global handset market, serving all technology platforms of CDMA, GSM and WCDMA for the next three years[225]. The Shine Phone also went through several form factor changes, transforming from slide to clamshell and bar type according to MNOs' requests or LG's own strategies. It lengthened its life with the Shine II variation models by targeting the middle- to low-tier market. Financially, the Shine Phone was also very successful in the global mobile handset market. The sales of

[224] UICC is a chip card ensuring the security of personal data used for mobile devices in GSM/WCDMA networks.
[225] Assuming one year as a normal handset's life cycle in the market, the Shine Phone stayed on the market for four years.

the Shine Phone reached five million units in November 2007[226] and ten million units in November 2008[227], becoming LG's second ten-million seller after the Chocolate Phone. The total sales are estimated at 13.5 million units[228].

Table 7.2 summarises all the original models based on the concept of the Shine Phone and its variation models. It presents release dates, original platforms and the division of labour between LG's in-house teams and CDs, along with the reasons behind their decisions.

Table 7.2 Original Shine Phone (V420) and its variation models

Model number	**Release date (year.month)**	**Platform/ variations**	**In-house/ outsourcing***	**Reasons behind decisions**	**Notes**
V420	2006.10	CDMA Platform	In-house (Lab 1)	1st EV-DO model	Slide, CDMA For Korean MNOs
KE970 (ME970)	2007.01	GSM Platform	In-house (Lab 2)	1st GSM model	Slide, GSM
KE770 (ME770)	2007.04	Form factor change from KE970	Partly outsourced to AM Telecom	Low price tier	Bar, GSM with radio function in-house (Lab 2)
VX8700	2007.04	Form factor and UI change from V420	In-house (Lab 3)	1st clamshell model & for 1st tier MNO	Clamshell, CDMA For Verizon
SV490	Cancelled	Form factor change from KU970	In-house (Lab 4)	Form factor change only	Clamshell, WCDMA
B630	2007.04	Terrestrial DMB added to V420	In-house (Lab 1)	No software change from V420	Clamshell, CDMA For Korean MNOs
KU970	2007.05	3G Platform	In-house (Lab 4)	1st WCDMA model	Slide, WCDMA For Vodafone

[226] *Hankookilbo*, 'LG Shine sold five million units', 28/11/2007.
[227] *Etnews*, 'LG handsets, Chocolate phones sold 20 million units, Shine phones sold 10 million units', 24/11/2008.
[228] LG Electronics homepage, LG Cookie phone becomes fifth ten million seller, http://www.lge.co.kr/brand/bestshop/product/FrontBoardDetailCmd.laf?actcode=BESTSHOP_PROD_NEWS&mncode=NEWS&seq=10641, accessed 9/8/2014.

LC3600	2007.08	Form factor change from V420	Outsourced to AM Telecom	Low price tier	Bar, CDMA For LG Telecom
B250	2007.10	Form factor change from B630	In-house (Lab 1)	Form factor change	Clamshell, CDMA
CU720	2007.11	MNO customisation from KU970	In-house (Lab 2)	Model for 1st tier MNO	Slide, WCDMA For AT&T
L705iX	2008.03	MNO customisation from KU970	In-house (Lab3)	Model for 1st tier MNO	Slide, WCDMA For NTT-Docomo
PX8700	2008.04	Country adaptation from VX8700	Outsourced to Infobank	2nd tier MNO	Clamshell, CDMA For Israel
SV570	2008.05	Shine II, fewer software functions and cheap hardware components	Outsourced to Youjung System	Low price tier	Shine II Slide, CDMA For SK Telecom
CX8700X	2008.06	Country adaptation from VX8700	Outsourced to Infobank	2nd tier MNO	Clamshell, CDMA For Canada
MX8700	2008.08	Country adaptation from VX8700	Outsourced to Infobank	2nd tier MNO	Clamshell, CDMA For Latin America
GD710	2009.10	Shine II, similar to CU720 with plastic case	Partly outsourced to H Telecom, LG as a project leader in charge of radio and UICC	Low price tier	Slide, WCDMA For AT&T

* Lab1 was in charge of handset development for the Korean market (CDMA), Lab 2 for GSM models in European/South American and Asian markets, Lab 3 for North American market (CDMA), and Lab4 for 3G handset development (WCDMA).
Source: Author’s elaboration.

7.6 CDs and their role in the globalisation of Korean handset manufacturers

In order to cope with the surge of handset models emerging from the close relationship with MNOs, Korean handset manufacturers adopted a new outsourcing strategy, utilisation of CDs. The question here is: ‘What advantages did CDs bring to Korean handset OBMs?’

The ostensible advantage was cost. Korean OBMs were able to utilise external engineers as if they were in-house personnel but with considerably lower labour costs.

During the interview, a manager of outsourcing development in LG said these costs were reduced to roughly 70%. In addition, the skills and experiences of engineers in CDs were highly tailored towards their Korean OBMs and specific MNO customers through multiple joint development projects. Therefore, the use of CDs provided Korean OBMs with the advantage of cost reduction coupled with high confidence in the skills of the CDs.

If we also include MNOs in the picture, the existence of CDs plays a considerable role in the globalisation of Korean OBMs than just simple cost efficiency. For Korean OBMs, supplying customised handsets was not a key challenge as far as huge buyers are concerned, such as network operators in North America and Europe. These big operators were able to guarantee large volumes of initial handset purchase, which could offset their development costs. However, it seems it was not easy to serve small (2^{nd} tier or below) MNOs asking for customised handsets. They lacked the scale in demand that was required to guarantee the volume with which handset manufacturers could reach break-even point. In this case, the cost advantage from CDs was vital for Korean firms to expand their globalisation and secure market shares, because they were then able to compete in small markets against manufacturers like Nokia (who do have the advantage of economies of scale).

Some manufacturers addressed this issue with an ODM strategy. However, this sort of strategy for Korean emergent leading firms has its own set of challenges that need to be addressed. When asked about why LG did not utilise ODM as much as other foreign makers did, a manager of an outsourcing development group at LG confessed:

> I think we [LG] were not confident of our capacity to supervise ODM projects, especially with foreign ODM makers. We prefer to work with Korean counterparts.

Under the MNO-oriented development structure of Korean emergent leading firms, time management in handset development project is critical. If OBMs fail to deliver customised handsets to an MNO in time, they have to pay hefty compensation as a penalty to the client. Unlike unlocked handsets, the development process of customised handsets also involves close collaboration between handset developers and network operators as they incorporate various operator-specific functions and services, a fact that has made Korean emergent leading firms prefer CDs to ODMs.

Utilising CDs allowed Korean emergent leading firms to enter relatively small foreign markets based on the business model of co-specialisation with MNOs. Therefore, if co-specialisation of the Korean handset OBMs with big foreign MNOs prompted their first globalisation mainly to big markets, forward specialisation of CDs to Korean OBMs helped the second globalisation to small markets. In conclusion, the existence of CDs for customisations gave Korean OBMs cost savings on development and a leverage for negotiating with non-1st tier MNOs, which helped the expansion of the coverage of Korean OBMs.

7.7 Summary

This chapter has been mainly concerned with how Korean emergent leading firms dealt with different cost structures in handset production from other foreign companies, and has built upon the findings reported in Chapter 6 – that these firms' successes were due to their close inter-firm relationships with MNOs. In order to break through the development burden arising from co-specialised assets for MNOs, the chapter has described how Korean handset manufacturers outsourced a development stage rather than a production stage (assembly) to so-called 'contract developers' (CDs) – a move that was contrary to outsourcing trends in foreign handset manufacturers. Table 7.3 summarises the differences in outsourcing strategies and their implications for Korean and foreign handset manufacturers.

Table 7.3 Different outsourcing approaches originating from the gap in brand power

Companies	**Nokia**	**Samsung, LG**
Distribution	Mainly through own distribution channels	Reliant on network operators
Strongholds*	GSM oriented, ODM for CDMA market	Starting from CDMA markets, expanding to GSM markets
Outsourcing	Outsourcing production (assembly) of low-end handsets to contract manufacturers	Outsourcing development of low-end handsets to CDs
Advantages	Cost advantages by platform, component sharing Production efficiency	A variety of product portfolios Delivery of MNO-specific services Co-development, co-marketing and co-branding with local MNOs
Disadvantages	Simple product portfolio Limited MNO-specific services	Development burden due to handset customisations for local MNOs

*CDMA – generally operator-market dominated; GSM – open-market dominated.
Source: Author's elaboration.

First, the chapter has investigated why Korean OBMs decided on new strategies suitable for their production structure, i.e. the adoption of CDs. The chapter has also covered the definition and role of these CDs and outlined the generic divisions of labour between OBMs and these subcontractors.

Second, the chapter has delved into the two waves of emergence of CDs for Korean handset OBMs. The first wave was initiated in the early 2000s, when Korean OBMs rapidly expanded their presence in foreign markets, and the convergence in mobile handsets gave rise to massive workloads. The first group of CDs emerged mainly from firms that had already been working in collaboration with handset OBMs as software module suppliers at the time, and later diversified into the aforesaid business. The second wave, however, was mainly the ramifications of labour reallocation due to industry shakeouts. This second group of CDs came from small and medium ventures (originally ODMs or design houses) during the mid 2000s, after they failed to secure their intended market shares in both domestic and foreign markets due to pressure from both global and local Chinese players. Therefore, unlike the first group, they were very experienced in handset development.

Third, the chapter has closely examined how Korean handset OBMs searched for and fostered new CDs, and managed and distributed subcontracts with them. The chapter has also shown how Korean OBMs practiced this outsourcing strategy by examining the case of LG and its series of Shine Phone models. Lastly, the chapter has concluded with the argument that these CDs – whose capabilities were highly specialised towards their clients' resources – resulted in not just an advantage of low labour costs for Korean OBMs, but more importantly a means of lowering the break-even point for making customised handsets. Korean OBMs could therefore widen their market shares by accepting orders from small network operators who formerly had lacked the scale in demand for customised handsets.

8. CONCLUSIONS

This chapter recapitulates the main findings of the research and draws out theoretical and empirical contributions to knowledge regarding the transition process of emergent leading firms. In addition, in the last section, some of the limitations of the research are discussed and suggestions are then offered as to what further research might be useful to build upon the findings of this thesis.

8.1 Research questions and main findings

The principal aim of the thesis has been to contribute towards the knowledge of the transition processes in the emerging stage of new industries where emergent leading firms in late-industrialising economies seek to reach two frontiers, the first being to achieve technological leadership and the second to establish market autonomy. In this regard, this thesis addressed the following set of questions:

(1) When emergent leading firms in latecomer economies pursue a 'dual frontier' of technology supremacy and market autonomy, how do they reconcile uneven development within technologies and between technology and marketing stages within an organisation?

(2) How does the fact that emergent leading firms enter the newly emerging market rather than mature markets affect their pursuit of a dual frontier? In addition, what is the role of inter-firm collaboration in their pursuit of a dual frontier under these market conditions?

In order to answer these questions, the thesis has investigated the Korean mobile handset industry during the eras of 2G and 2.5G using case studies on two emergent leading firms: Samsung and LG. Based on theoretical guidelines from the literature on the catching-up process and the boundaries of a firm, the thesis presents the following three main findings as responses to the questions that have underpinned the research.

(1) The thesis demonstrates that opportunities of 'access to foreign technology' can emerge not only for emergent leading firms that seek to compete directly with technology frontier firms but also for emergent leading firms entering the embryonic stage of new industries, albeit if some conditions are met. The Joint Development Project between Qualcomm and its Korean counterparts, described in Chapter 5, showed that although a technology frontier firm had not fully reaped the benefits from its nascent technologies, competition to achieve a dominant compatibility standard among its peers created an opportunity for emergent leading firms to acquire licences for cutting-edge, although not well-developed, technologies.

However, whether or not the licensee firm could have commercialised the technologies and later survived in the market for the long term was entirely in the hands of the technology licensee. This was because the foreign technologies that were licensed were technically incomplete and commercially unproven at the time of technology licensing. Therefore, in similar circumstances, external sourcing and the subsequent pursuit of in-house efforts of R&D for commercialisation of nascent cutting-edge technologies could be viable options for an emergent leading firm attempting to enter the top tier of international competition. In such a case, however, it should be stressed that the licensing process is not a substitute for, but is a complement to, the considerable amount of in-house R&D effort that is still required to follow technology licensing, effort that poses high risk and uncertainty for the emergent leading firm.

(2) The disengagement from either OEM or ODM contracts with previous partners need not be interpreted as requiring the acquisition of sophisticated marketing capabilities (i.e. OBM-level capacities) – an extension of the boundary of emergent leading firms. As shown in Chapter 6, some MNOs are able to play the role of previous OBM partners (as intermediary users) in advanced markets. In particular, these participants have played an important role with regard to market requirements in certain industry settings such as the mobile handset industry. In the cases examined here, the MNOs' continuous collaborations with the Korean handset manufacturers have not only provided a consistent source of demand in each local market but also served as a guarantor of quality (Jacobides et al. 2006). Due to the inter-firm arrangements, the nature of competition in the mobile handset industry fundamentally changed from the Korean handset manufacturers vs foreign giants on the one hand, to allies of Korean handset manufacturers and MNOs vs foreign handset manufacturers on the other hand. In this new competitive structure, the co-specialisation of development efforts between the Korean handset manufacturers proved to be a successful substitute for the activities/procedures/strategies of earlier OEM/ODM contracts.

(3) The utilisation of technology licensing and co-development during the emergent leading firms' transition did not come without cost. While inter-firm collaborations between Korean handset manufacturers and foreign MNOs provided Korean firms with successful mechanisms for complementing their lack of brand recognition and distribution channels, they brought upon both sides a very large burden in terms of

customisation developments. The point here is that the needs of emergent leading firms for complementary assets drove them towards a different path for penetrating foreign markets, which in turn shaped the idiosyncratic cost structures in emergent leading firms' handset production systems and led these firms to derive an indigenous organisational solution (i.e. contract development organisations), as shown in Chapter 7.

Based on these main findings, the thesis addresses how emergent leading firms pursuing the dual frontiers of technology supremacy and market autonomy competed head to head with leading technology firms (i.e. directly confronting them), overcoming the innate characteristics of 'uneven development' not only in the scope of technical knowledge but also in filling the gaps between technology development and marketing stages.

One important issue with respect to Nokia should be noted here. Throughout the thesis, Nokia has been shown continuously as being completely opposite to Korean producers. However, by no means does the thesis argue that the strategy of Nokia was wrong and the strategy of Korean manufacturers was right, or vice versa. In fact, both Nokia and Korean manufacturers have thrived in the world mobile handset industry over the time period considered in this thesis. Nokia remained the most prosperous handset manufacturer until the emergence of the iPhone by Apple[229]. The results of this thesis imply that the differences in marketing capabilities among companies have led to the

[229] Ironically, Apple's strategy regarding the iPhone was similar to that of Nokia during the multi-functional phone era in terms of customisations. Apple did not provide customisations to MNOs. Instead, Apple made its market entry to each country with signing an exclusive deal with non market-leading local MNOs (e.g. AT&T in the US in June 2007, SoftBank in Japan in July 2008, and Korea Telecom in Korea in November 2009).

different strategies for market entry and accordingly to different boundaries of the firm. This issue is discussed further below.

8.2 Theoretical contributions

This section considers to what extent the findings of this thesis augment current theories on the catching-up process and boundaries of the firm.

8.2.1 Literature on catching-up and transition processes

The thesis contributes to the literature on catching-up and transition processes of latecomer firms in two areas.

(1) Building on Soete (1985) and Perez and Soete (1988), the thesis identifies the emergence of windows of opportunity for international technology transfer even at the emerging stage of a new industry. Because these technologies are technically incomplete and commercially unproven at the time of technology licensing, the thesis stresses that the capacity of technology licensee firms to recognise technical and market potentials of new technologies and to realise them also matters.

(2) The thesis moves from the previous intra-firm perspectives to inter-firm perspectives in addressing the pursuit of a dual frontier. Focusing on the issue of overcoming uneven development between technology and marketing capabilities within emergent leading firms (Hobday 1995b), the thesis concludes that one channel for pursuing the dual frontier involves close inter-firm interactions in terms of development resources with upstream suppliers (the CDs) and in terms of downstream capabilities with intermediary

users (the MNOs). The thesis demonstrates that an extension of firm boundaries through inter-firm arrangements with upstream suppliers and downstream distributors can provide an alternative organisational solution to compensate for the lack of capabilities of firms seeking leadership positions.

8.2.2 Literature on boundaries of the firm

The thesis also contributes to knowledge on boundaries of the firm.

(1) It adds to the theory of industry organisations a new form of an outsourcing organisation, namely contract developers (CDs). A CD is defined as a company that is specialised in providing electronic product development services to one specific OBM.

(2) The thesis extends the theory of the boundaries of the firm in that inter-firm arrangements can create a 'quasi' extension of firm boundaries in terms of development resources (the CDs) and in terms of downstream capabilities (the MNOs) and can shore up the competitive advantages against a firm hierarchy or a market mechanism.

(3) Building on Teece (1986), the thesis further deepens our understanding of a specific type of a co-specialisation process, so-called 'shallow co-specialisation', in the context of a short product life cycle and in the absence of exclusiveness in a market.

(4) The results of the thesis indicate that the capabilities view of the boundaries of the firm should include marketing capabilities in the analysis, in addition to technological capabilities. The thesis shows that firm heterogeneity in marketing capabilities results in

different strategies for market entry which create different cost structures, and that resolving the resulting organisational tensions may lead to different boundaries of the firm.

(5) The thesis suggests that the literature on boundaries of the firm based on a capabilities view needs to anticipate possibilities for extending the firm boundaries through virtual or contractual arrangements. This result complements the observations that competitions among industry participants with regard to the division of profits (who takes how much) sometimes dictate the division of innovative labour (firm boundaries) and create the multiplicity of industry architectures (Brusoni et al. 2009).

8.3 Empirical contributions

The thesis provides a detailed explanation of an emergent leading firm's pursuit of a dual frontier within the evolution of the mobile handset industry that suggests how technologies, products and services of the industry have changed and how the industry participants correspondingly have responded in terms of their boundaries and competitions. It also provides a detailed project-level account of product development in the mobile phone industry that illustrates how innovations were introduced, how changing market relations created important tensions in the cost structures of development and how these were resolved within a firm organisation. Therefore, the thesis offers empirical contributions to the literature at a level which is not often examined despite its relevance for technological competition. These contributions have several implications for technology and innovation management.

(1) The thesis shows that windows of opportunity for international technology transfer can emerge at the embryonic stage of a new technology paradigm for emergent leading firms. However, technical and market potentials of these technologies are highly uncertain. In this regard, emergent leading firms should retain and nurture the capacity to evaluate potentials and carry out the commercialisation of the technologies if their aim is to reach the dual frontier of technology supremacy and market autonomy.

(2) In addition, considering the nature of the uneven development within technological bases and between technology and marketing capabilities, emergent leading firms should explore opportunities to extend firm boundaries through inter-firm collaborations with both upstream suppliers and downstream distributors. Some of the conditions for the emergence of these opportunities are identified in this thesis; two key mechanisms utilised have been co-specialisation for developing handsets and co-branding for marketing handsets.

(3) In the case of mobile handsets, the existence of MNOs as intermediary users has played a vitally important role in the pursuit of the dual frontier. MNOs lie between handset manufacturers and end-users and have played a variety of roles as innovation and financial intermediaries over the course of the industry's evolution. In the 2G era, MNOs mainly were the source of innovations and guarantors of quality for mobile handset manufacturers, but from 2.5G onwards they began to take on a dominant role in delivering MNO-specific mobile data services to end-users. The thesis shows that MNOs strongly controlled the whole process from handset design and development through to marketing, deciding which handset designs with which functions were to be introduced when in the market. This fundamentally changed the rules of competition in

the mobile handset industry from one handset vs another handset to a handset with standardised services vs a handset with MNO-specific services. This created market opportunities only for producers that were willing to invest relation-specific assets and deliver customised handsets to MNOs' requirements under the contract-based development system. These issues offer a variety of empirical insights that promote an understanding of the dynamic competition in the mobile handset industry.

(4) Under this industry competition structure, the thesis further elucidates in detail how Korean handset manufacturers successfully resolved the cost structures of handset development created by changing market relations. It illustrates that Korean manufacturers concentrated their in-house development resources on projects that produced learning and knowledge while outsourcing projects that were run-of-the-mill to external CDs. The utilisation of CDs was a new organisational solution to resolve the contract-based development cost structures of Korean handset manufacturers. The thesis also shows that two waves of CDs emerged from the unique relationships between Korean chaebols and their suppliers and from labour reallocation due to the industry shakeouts. The division of development labour between Korean manufacturers and CDs presents new empirical insights to practitioners interested in outsourcing solutions.

(5) The thesis also distinguishes between shallow co-specialisation and conventional (deep) co-specialisation in the context of the mobile handset industry where the product life cycle is comparatively short and exclusive inter-firm relationships are also short-lived. Therefore, the conventional co-specialisation based on long-term contracts does not exist. In this type of industry, the thesis argues that firms have to serve multiple customers at the same time by co-specialising with local companies with knowledge of

end-users. They need to develop capabilities not only to recognise and fulfil local company demands but also to transform these relation-specific capabilities into more general capabilities that enable them to address other markets to avoid lock-in of capabilities to specific end-use markets (Yasumoto & Fujimoto 2006).

8.4 Research limitations and further research issues

From the viewpoint of generalisation, the research limitations of this thesis are primarily located in the methodology. The research design of the thesis is based on a study of a single industry with focused case studies of two particular firms. The use of this type of research methodology involves the 'situated particularities' of the specific case studies, and whilst these are helpful in explaining the outcomes that the thesis examines, they may restrict the extent to which the empirical findings can be applied more generally. Therefore, the specific attributes of the Korean mobile handset industry should be carefully taken into account if the insights of the thesis are to be applied and extended to other countries and industries; further research using cases from other countries and industries would enhance the extent to which any theoretical and empirical lessons drawn from this thesis could be applied more generally.

In addition, it is acknowledged that the case studies carried out in the thesis are highly centred on the Korean market players. As motives of, and intentions of activity of, non-Korean market players were validated mainly through indirect methods such as interviews with Korean competitors and secondary industry documents, the absence of 'symmetrical' evidence from non-Korean market players needs to be borne in mind, and the use of interviewee opinion about important issues regarding costs and partner intentions must be taken at 'face value' but may be re-examined if more complete evidence were to emerge. Thus, some of the evidence presented in this thesis must be considered with some reservation and qualification, particularly with regard to the motives and strategies of non-Korean actors (such as Qualcomm and foreign MNOs).

Considering these limitations, some further lines of research are suggested. The first comes from the industry attributes of the mobile handset industry. One may argue that the industry setting of the mobile handset industry is idiosyncratic in terms of the existence of intermediary users like MNOs, and thus the results of the thesis may be industry-specific and difficult to draw upon when considering theoretical and empirical lessons that can be applied more generally to other industries. However, intermediary users are found in other industries as well. For instance, the digital set-top box industry has an industry structure similar to the mobile handset industry in that, in addition to an open market, it has a closed market where producers market their set-top box to local broadcasting companies (intermediary users). There exist two internationally competitive Korean companies in this industry: Humax and Samsung. Humax is a Korean set-top box producer with sales of $1 billion and 4.2% of the world market share, ranking fifth in the world (2009 data)[230]. Therefore, this industry would serve as a potentially useful research case to test the theoretical and empirical implications presented in this thesis.

[230] The set-top box industry is highly decentralised in comparison with the mobile handset industry. Top market sharer Pace took 8.4% while tenth-placed Coship took 3.0% of the world market share (Bizinfo, http://www.bizinfo.go.kr/download?path=/addfile/form/&filename=%B1%E2%C8%B9%BA%B8%B0%ED%BC%AD_01.hwp&realfilenm=1303372496182.hwp, accessed 2/4/2015).

A second line of research could be formulated from extended discussions on the producer–intermediary-user collaborations. It would be instructive to consider why Japanese handset producers failed to take advantage of their close producer–intermediary-user relationships to become globally competitive manufacturers in the same manner as their Korean counterparts (and as described in this thesis). Although Sony Ericsson maintained a ranking in the world market of around fourth and fifth between 2002 and 2009 (the dates within the scope of this thesis)[231], the presence of other Japanese manufacturers in the world handset market had become almost invisible. These manufacturers have had similar local market settings characterised by strong operator dominance. In fact, the level of MNO dominance and the adoption of sophistication in handset functions far exceeded those of Korean handsets in Japan. Whang and Hobday (2011) attributed the isolation of the Japanese market from the world market to the local 2G standard (PDC) and other peculiar local demands, which in turn led to the capabilities of Japanese producers being highly specific to Japanese MNOs.

However, efforts to internationalise by both Japanese MNOs and handset manufacturers were highly visible. Several Japanese MNOs (which later merged to become KDDI) indeed adopted CDMA as a second domestic 2G standard, and NTT-Docomo also quickly adopted WCDMA as its 3G standard to avoid the so-called ‘Galapagos’ phenomenon, a reference to an isolated ecosystem. In addition, Sanyo and Kyocera have been two CDMA handset manufacturers actively engaged in the US CDMA handset market, and Sharp and NEC were the first handset vendors of global MNOs’ WCDMA mobile data for Vodafone and Hutchison respectively. It is therefore puzzling how a

[231] Most of the market share was the inheritance of Ericsson, not of Sony.

similar framework of inter-firm producer–intermediary-user relationships in Korea was (luckily) able to evade the partner-specific capability building trap that seems to have limited these Japanese companies. Further research on the case of the Japanese handset industry aimed at providing clearer insights into our knowledge of mechanisms and consequences of inter-firm producer–intermediary-user relationships would be very helpful.

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