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## The impact of disruptive technology on industry architectures in network industries

- WiMAX in mobile telecommunications

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ISBN: 978-87-648-0074-6

Udgivet af  
Akademia.dk I/S  
Skindergade 15  
1159 København K.

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**The impact of disruptive technology on industry architectures  
in network industries:  
- WiMAX in mobile telecommunications**

**Master Thesis Elaborated By:**

Martin Black Pedersen  
Stud.cand.merc. Int.Marketing  
CPR. No. 070280-xxxx

SUPERVISOR: XXXXXXXXXXXXX



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## 1 EXECUTIVE SUMMARY

Today, new technologies play a key role as the source of industrial dynamics as observed in recent debates over the new economy (Christensen and Maskell, 2003) or the information age (Varian and Shapiro 1999b). In particular in technology intensive industries I find that disruptive technologies tend to influence the way industries and firms within industries are organized (Jacobides and Winter, 2005).

It has recently been argued that we should think of industries as having architectures (Jacobides, Knudsen and Augier, 2006). This approach suggests that firms should be strategic as they face the architecture of their entire sector.

Recent ideas on co-specialization (Lippman and Rumelt, 2003 and Jacobides, Knudsen and Augier, 2006) have been proposed for leading the way in firms' attempts to shape the architecture to their advantage. Firms in network industries tend to co-specialize and in such settings the mechanisms of co-specialization (i.e. complementarity and mobility) play a key role in firms' ability to create and appropriate value (Jacobides, Knudsen and Augier, 2006). In essence, I observe that the explanatory power of industry architectures is strong in network industries.

I will present a case from the Danish wireless telecommunication industry, where new technologies are a central underpinning of industrial dynamics and where the workings of co-specialization can beneficially be applied to the networked economy underlying the industry in understanding the dynamics that transcends the telecommunications industry.

The new WiMAX technology presents a dilemma on many incumbents since the technological innovation at its best stands to become a replacement for fixed line services, and a highly competitive standard to wireless standards like 3G evolutions. While this new technology poses a threat to the entire telecommunication sector, I have chosen to give particular *attention* to the threat imposed to the mobile telecommunications industry and incumbent mobile network operators. The departure is an evolutionary perspective to the present "state of the art" conditions in the industry.

WiMAX is also called a next generation wireless network which means it is an All-IP network. Thus the All-IP structure in the technology represents a new way to link together the components of a mobile network. New entrants have found this technology a way to bypass traditional bottlenecks in the industry and in many ways the technology is a central underpinning pushing for a re-architecting of the industry (Pisano and Teece, 2007). I observe that the energy company Elro seems committed in setting up a nation-wide WiMAX



network till no later than 2010. Along with the company Danske Telecom they represent the key new WiMAX entrants into the industry.

In general it is observed that there exists a strong deflationary pressure on many of network operators' traditional activities. Essentially the main challenge for incumbent network operators will be to redirect resources and capabilities to the world of IP and the internet. This will have huge impact on the business model of incumbents and the boundaries of who can do what.

Fundamentally the open IP-interface will open-up the traditionally proprietary mobile telecommunications industry. Along with IP-interface the study will point at three other crucial interfaces for mobile network operators that are determining in the battle of who can do what and who gets what (i.e. air interface standards, licensing and pricing policies and the SIM-card). The case study finds that the structural wedge of IP could (at least theoretically) tip for the advantage of new WiMAX entrants, however this is unlikely in the immediate future since the open-IP interface changes the battle between the two major incompatible technologies (essentially HSDPA vs. WiMAX) into a rival's evolution (Varian and Shapiro, 1999). The situation thus becomes less tippy. This is founded in that the IP-interface is an excellent example in illustrating that complementarity does not necessarily limit mobility – this connecting interface is open to everyone. The case concludes that firms' capabilities in “connecting” to this interface will be decisive in future perspective.

The study is divided into a theoretical part and a case study. The theoretical part contains a research focusing on (1) the disruptive effects of technological change on firms' capabilities and industry structure (e.g. Tushman and Anderson, 1986, Henderson and Clark, 1990 and Christensen 1997). Further this research contains (2) an examination of the recent approach of industry architectures (Jacobides, Knudsen and Augier, 2006) and (3) a minor focussed study on network industries (Shy, 2001 and Varian and Shapiro, 1999). The case is the second major part of the study, which will centre attention to an examination of WiMAX in the Danish mobile telecommunications industry.

Signature: \_\_\_\_\_

Martin Black Pedersen



## 2 INTRODUCTION

Thesis problem statement

How do **disruptive technology** *impact* on **industry architectures** in **network industries**?  
- **WiMAX** in mobile telecommunication

In the above problem statement can be found four main components of this study, each component is stressed with bold. These components denote the major pieces or sections of this final thesis. The first line of the problem statement represents the theoretical part of the thesis, while the second line represents the case study, which separates the thesis into a theoretical and an empirical case part.

When I first started my study into this final thesis, I was aware of the highly dynamic environment that surrounds the telecommunication industry. My interest was based on the way in which the industry is constantly confronted with new technologies that change the way, we as consumers use telecommunication services and products.

Nevertheless, this final thesis is concerned with the challenge confronted on firms and the architecture of their industry. New technologies in particular impact technology-driven industries like telecommunications. There are multiple historical examples that illustrate how the telecommunication industry has been characterized by steady growth punctuated by “giant leaps” forward, usually when new technology is introduced<sup>1</sup>.

The industry, in particular, is being faced with the challenge of a constant need to respond to new technological innovations. WiMAX (worldwide interoperability for microwave access) certainly imposes a dilemma on many incumbents since the technological innovation at its best stands to become a replacement for fixed line services, and a highly competitive standard to wireless standards like 3G and Wi-Fi. New entrants are knocking at the industry back door seeing WiMAX as a way to enter the telecommunication industry. No doubt, incumbents are faced with multiple challenges when considering the potential effects on the industry by this new technology. WiMAX certainly pushes for a re-architecting of the industry (Pisano and Teece, 2007) and in general it is observed that there exists a strong deflationary pressure on many of telecommunication companies’ traditional activities. While this new technology poses a threat to the entire telecommunication industry, I have chosen to give my main attention to the threat imposed to the mobile telecommunications industry.

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<sup>1</sup> International Telecommunication Union, 2003, See appendix 19 for historical breakthroughs



This thesis will apply theory to the real world phenomenon of WiMAX in the Danish telecommunications industry. In that the use of theories is applied oriented it is not the intention to seek a strict verification or falsification of the applied theories. Therefore I have found it less essential to conduct a systematic critic of the theories that have been drawn in. However since the theory on industry architectures has recently been suggested, applying this theory to a real world phenomenon can be seen as part of a more general verification of the theory by finding empirical evidence that will verify the relevance of this approach. Thus with this case study I will add to the body of knowledge on this recent theoretical approach. That is, the case exploits the “*power of the example*” in contributing to the clarification of the theoretical part of the thesis’ problem statement. Thus in the conclusion I will try to conclude more broadly from my analysis of the case on how disruptive technology can impact on the industry architecture in network industries. In the theoretical part I will focus on deepening our understanding of how industry architectures are affected by new technologies and in general shade light on some of the keystones suggested by Jacobides, Knudsen and Augier (2006).

It should be noticed that the problem statement and the choice of theories imply that the voices of other theories are softened and that this selection also reduces or eliminates other approaches to enlighten the subject. However these “other” approaches could have been just as interesting and relevant as the approach that I have chosen.

Accordingly the purpose of this final thesis is to illustrate how changes imposed by disruptive technology can impact the architecture of an industry. In particular the telecommunication industry provides a classic example of a networked industry. Thus the premise is that architecture of the industry is influenced by the highly networked economy that lies beneath the industry.

The case will illustrate how a re-architecting of the industry and a new business model, nested within it, have emerged. These changes can be traced down to technological convergence (Stieglitz, 2003) processes that have fuelled the emergence of a re-architecting of the industry (Pisano and Teece, 2007). The WiMAX technology is a prime example of a converged technology and represents a new paradigm (Dosi, 1982 and Christensen, 1997) into the mobile telecommunications industry.

While I will take a broad systemic view of the industry (Dalziel, 2007 or Jacobides and Winter, 2005) the centre of attention will be focused on *incumbent* mobile network operators since the technology places a significant threat on these players and I find that these players are the central participants in a Danish context (se e.g. Skouby et al., 2003).

How these incumbent firms can respond to changes in the architecture of their sector and the re-definition of the nested business models is a central question for this thesis to answer. Jacobides, Knudsen and Augier (2006) propose that firms should actively participate in shaping the architecture to their advantage. I will pursue an analysis that will put light on the keystones upon which firms can actively shape the architecture to their advantage.



Within the strategic management literature, different theoretical paradigms exist. These different strands of literature all have proposed different road maps for answering the fundamental question in strategic management of how firms achieve and sustain competitive advantage (Teece, Pisano and Shuen, 1997). Industry architectures (Jacobides, Knudsen and Augier, 2006) provide explanations to shortages within industrial organization. While this can be seen as the departure of the approach - it has a much wider theoretical foundation in strategic management and provides a new base for how firms should assess their industry. Strategic management has never been confined to a narrow look inwards, new theoretical approaches often draw on ideas from outside the discipline. In this context, it is particularly pronounced with the architecture dimension of industry architectures, which draws on insights from the design literature (Baldwin and Clark, 2000, 2006).

By setting attention to incorporated links on technological innovation and network industries I have captured two central underpinnings in this recent approach. Technologies impact on firm and industry structures have been considered by innovation management theory and have made a solid footprint into the field of strategic management. Authors such as Tushman and Anderson (1986) have provided us with good basic knowledge of how new technologies impact industry structures. Their competence-anchored approach has inspired innovation management by revealing the different underpinnings of environmental change that new technologies can bring about. Highly inspired, the approaches of Henderson and Clark (1990) and Christensen (1997) centre attention to technological change that happens in processes and products (respectively). While disruptive technologies, in Christensen's (1997) terminology, mainly are defined by emphasizing the market positioning of the product, disruptive technologies also involve changes in technological processes (e.g. Henderson and Clark, 1990) and implies an impact on incumbents' competences (e.g. Tushman and Anderson, 1986) as highlighted in a conference paper by Thomond and Lettice (2002b).

Network industries capture some basic patterns which are highly emphasized in the approach on industry architectures. These overlapping patterns in particular emphasize the role of complementarities that may exist in production and in use. For example the interfaces or standards that may exist between these complementarities in the industry are highly emphasized. Further these patterns direct attention to firms' ability to capture value from innovation in a broader sense than that pursued by Teece (1986) (i.e. from the dyadic relation to industry-wide networks of relationships).

Competitive barriers have been emphasized in network economics while mobility (Jacobides, Knudsen and Augier, 2006) is the central unit of analysis in the approach on industry architectures. This shift in mindsets is important as we broaden the understanding of industries to a sector-wide construct.



While the above provides the main theoretical foundation of the study, strategic management's main obligation is to inform managerial practice and this can also be considered a central purpose of this final thesis.

The method conducted is straight forward as I will apply theory to a real world phenomenon. The case study is based on multiple sources of evidence: archival data, industry publications and manuals, research papers on the issue, company press releases, internet sites, annual reports, as well as readings on practitioner oriented books on WiMAX and wireless technology. White papers with different backgrounds have in particular been found at the WiMAX forum ([www.wimaxforum.org](http://www.wimaxforum.org)). Contributors on this platform mainly consist of corporations and scientific/non-scientific institutions.

Thus this case study is based on secondary data, which is data collected by people other than the researcher in question. While there is a lot of data and information out there, the reliability and validity of data is often masked by sources agendas. This is especially so in white papers and popular press oriented sources. This of course directs attention to the researcher's ability to find valid and reliable data<sup>2</sup>. However since the telecommunication industry is a widely studied arena in the scientific world, the cases' building blocks are based on solid scientific research from scientific journals<sup>3</sup>.

The remainder of the thesis is organized as follows. Section 1 first considers the causes of incumbent firms' adaptation to technological change and the impact behind new and disruptive technologies on industry structures and firms capabilities (Tushman and Anderson, 1986, Henderson and Clark, 1990, Christensen, 1997)). Secondly it considers firms' position with a system or value network that influences firms' adoption to technological change (Christensen, 1997, Hamel, 2000). Finally the section will consider technological change from the broader firms' perspective and how technological change can impact differently on actors along the value chain (Afuah and Barahm, 1995). Section 2 will work into the ideas proposed in the recent approach of industry architectures. First I will give a comprehensive overview of the proposed ideas. Then I will go into a related presentation of the value chain given that the value chain is a central concept in industry architectures. Next I will present ideas on how the value chain can change periodically and become split into pieces and eventually the pieces can melt together again (Jacobides and Winter, 2005). Thus the nature and degree of specialization of industry players are not static. Then I will work into the dynamics of industry architectures and the change that sectors and/or industries can undergo. Finally I will present the core of industry architectures – that is how to benefit from the architecture in terms of value creation and value appropriation. Thus value can essentially migrate with changes in the architecture of the industry.

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<sup>2</sup> Thus I have added an Internet Appendix; added since a small amount of data is collected from internet sources, such as company press releases and industry news channels, that is the validity of the data is confined to the reliability of the source.

<sup>3</sup>The primary example is the journal: Telecommunications Policy



Section 3 will first present a general introduction to network industries and then consider two major themes related to this study. That is, technology adoption with network effects and standard battles. This extensive literature review provides me with a solid theoretical platform for the case study.

Section 4 will present the case. First I will consider Fransman's (2002) model of the info-communications industry. This model provides an overview of the evolving architecture of the overall spanning info-communications sector. These organizational patterns of the sector endow me with a platform to "logic completeness". Then I will zoom in and consider the *current* organization of participants and of the institutional environment of the wireless sector. The next step will be to set the boundaries of the architecture (Danish wireless sector, wireless technologies and focus on the impact of WiMAX on incumbent mobile network operators)). After that I will describe the structure of architecture by setting focus on bottlenecks and interfaces in the architecture. Finally I will discuss the impact of WiMAX on the architecture of the Danish Wireless industry and its implications for incumbent mobile network operators.

It should finally be noticed that I will present an introduction to each of the four sections in this final thesis. That is, this introduction's main purpose was to guide the reader on a general level into the thesis.