Clusters, Competition, and “Global Players” in ICT Markets: The Case of Scandinavia

John E. Richards
Stanford University

July 2001

The Stanford Institute for Economic Policy Research at Stanford University supports research bearing on economic and public policy issues. The SIEPR Discussion Paper Series reports on research and policy analysis conducted by researchers affiliated with the Institute. Working papers in this series reflect the views of the authors and not necessarily those of the Stanford Institute for Economic Policy Research or Stanford University.

* Stanford University
Clusters, Competition, and “Global Players” in ICT Markets: The Case of Scandinavia

Abstract

This paper examines the emergence of Scandinavia as a global center for wireless telecommunications. As in other papers in this volume, the paper suggests that access to large and growing demand pools, focusing on ICT segments that lack strong incumbents, the presence of English-speaking technical talent, and the advantages of being “out of town” were critical drivers of Scandinavia’s success. At the same time, Scandinavia suggests the importance of public policy, firm-building and firm strategy, and the role of being not only “out of town” but also from a “small town” in the emergence of ICT clusters. However, Scandinavia is different from other clusters in that it reflects the success of a very small number of large global firms rather than the widely distributed entrepreneurial growth witnessed in Silicon Valley. In short, the success of Scandinavia is primarily a story of the success of Nokia and Ericsson. Scandinavia is also interesting because, once established, leading firms in the cluster have explicitly attempted to harness success in hardware parts of the value chain to establish leadership in emergent wireless software and services markets.

1 John E. Richards is an IGCC eConomy Project Fellow and former Director of International Computer Services research at the Stanford Computer Industry Project. He is currently an associate at McKinsey & Company.
1.0 Introduction

Creating new “high tech clusters” was a growth business in the 1990s. Government policy-making and executives looked to Silicon Valley for the “magical cocktail” to get the virtuous cycle of entrepreneurship, innovation, growth, and rent capture up and running. Hyperbole about the new economy, declining barriers to entry, network effects, and how the internet—or the network—changes everything thus propelled an explosion in a set of top-down, government-directed regional and national policies designed to build the next global high tech cluster. Despite billions of dollars in subsidies and focused attention aimed at building these high tech clusters, the success of these efforts has been mixed. Taiwan is a global leader in PC components and in IC manufacturing.\(^2\) Singapore has emerged as the Asian hub for hard disk drive manufacturing and process design.\(^3\) India and Ireland have had mixed success—on the one hand building strong services and localization capabilities yet on the other hand less successful in building globally branded firms capable of capturing significant producer rents.\(^4\)

The success of Scandinavia in wireless telecommunications is largely viewed as a “cluster” success story. Scandinavia is home to two of the leading firms in wireless hardware, Ericsson and Nokia, each with more than 30% of the global market in their core business (infrastructure and handsets, respectively). With the highest wireless usage levels in the world, the region’s carriers have also been in the vanguard of firms developing wireless data software and services.\(^5\) Indeed, viewing extensive wireless usage at home as a key competitive advantage, Scandinavian carriers are increasingly viewing the local market as a test market for establishing leading positions globally. Telia, for example, has set up a subsidiary (Indiqu, based in San Diego, Calif.) to develop and sell wireless software and services for global carriers based on learning in the Swedish home market. The success of the hardware vendors and carriers has also created both the funding and local skilled labor (technical and managerial) for the emergence of the entrepreneurial culture and start-ups that characterize Silicon Valley. Thus, although the region is dominated by the two leading firms, the last few years have witnessed the emergence of a number of mini-clusters of start-ups and MNC development centers—outside Stockholm in Sweden and Oulu in Finland—that serve as entrepreneurial centers for wireless technology.

The story of why Scandinavia was successful in creating a new global cluster is in many ways consistent with other chapters in this volume, but there are important variations as well. Scandinavia is similar to other clusters in four respects. First, access to and interaction with large and growing demand pools—the European Union (EU) GSM wireless market in the 1990s—was a key facet of the success of Scandinavian firms. Second, focusing on nascent ICT segments that were technologically new enough that no incumbent could dominate it enabled Scandinavian firms to establish strong technological

\(^3\) McKendrick, Doner, Haggard, 2000.
\(^4\) Arora, et.al., 2000.
\(^5\) Like other European wireless carriers, Scandinavian carriers have experienced slower than expected consumer adoption of data services and associated rollout of 3G networks, which has raised challenges for the region’s carriers. See The New York Times, “Chief Executive Leaving Finnish Phone Company,” June 12, 2001.
positions and then build the global scale and brands necessary for continued success. Scandinavian firms also benefited from the presence of multiple standards in the U.S. and Japan and the strong connection of other European equipment vendors with the state-owned PTTs, all of which conspired to stifle the emergence of truly global competition in wireless infrastructure, handsets, or services. Third, Scandinavia benefited from the advantage of being “out of town” and the associated lack of focused attention (from incumbent ICT vendors) on the demand pools targeted by Scandinavian firms in the early stages of wireless technologies. The final similarity with other clusters is the presence of technically skilled English-speaking labor. Coupled with early deployment of ICT, the presence of English-speaking technical labor meant that Scandinavia had the skilled labor necessary to build new technical solutions and sell this technology in world markets.

Scandinavia also suggests a number of variations from other clusters, however. First, Scandinavia success in wireless can at least partly be attributed to the role of public policy—but not public policy in the traditional top-down, policy directive sort of way. In short, public policy in the form of standards-setting (the GSM standard was set by the EU in 1988) was a key step in establishing the market necessary for Scandinavian firms to achieve the scale necessary to compete in world markets. Importantly, public policy played less of a traditional European top-down “national champion” role and more of a Japanese-style role—that is, set rules for market competition and let the market decide on winners. Thus, although the EU dictated that carriers adopt a technical standard, the EU did not intervene to protect established suppliers (e.g., the traditional equipment suppliers to the PTTs), but rather let network operators (e.g., buyers) decide on suppliers. Second, Scandinavia suggests the importance of firm strategy and old fashioned firm-building, and in particular business unit strategy and the managerial capabilities required to build a successful global firm. The success of Scandinavia has been primarily driven by the success of two firms—Ericsson in Sweden and Nokia in Finland. The success of Scandinavia is thus more like Redmond than Silicon Valley or Israel—driven by a small number of firms rather than a larger number of smaller entrepreneurial start-ups (a la Silicon Valley). Nokia in particular demonstrates the central role of firm strategy in the Scandinavian cluster: Nokia transformed itself from an old industrial conglomerate selling everything from rubber boots to computers into a company focused exclusively on wireless telephony. The focus, growth, and success of Nokia—in size, managerial talent, and R&D capabilities—into a global firm is critical to the Scandinavian story. And being not only “out of town” but also from being drives at least part of the global orientation and basic firm-building orientation of Nokia from a “small town.” That is, firms in the region had to have global (or at a minimum, European) aspirations simply because the small size of the home market forced both governments and firms in the region to forego “national champion” efforts. In Nokia’s case, for example, executives understood as early as the late 1980s that success in telephony (and electronics before the firm focused) would require success in global as well as national and regional markets.

Finally, Scandinavia suggests that focusing on a completely new technology (as opposed to niche

---

6 Technically, the European Conference of Postal and Telecommunications Administrations (CEPT) set the GSM standard, and the European Telecommunications Standards Institute (ETSI) was responsible for GSM standardization, but the EU dictated that European PTTs deploy networks based on the standard.

7 On Japanese vs. European policy interventions, see Bresnahan and Malerba, 1997.

within existing ICT markets) may be more successful in creating new clusters than strategies focused on building capabilities in ancillary markets and then “moving up the value chain.” In contrast to a number of other clusters, Scandinavia focused on an emergent technological niche with few ties to other ICT technologies. To be sure, wireless telephony was related to traditional fixed line telephony—but largely via common buyers rather than common technologies. Scandinavian firms thus had to interact with a limited set of complementors (particularly in the days when wireless telephony meant wireless voice). This meant that success in wireless handsets or infrastructure did not immediately create direct competition with leading vendors in established ICT segments. In contrast, Taiwan—to take just one potential example—focused on PC-related peripherals and IC fabrication, niches that required extensive interaction with largely U.S.-based complementors. Of course, betting on new technologies brings “market risk” as well as “competitive risk,” but the case of Scandinavia suggests that the reduced competitive risk may be worth the bet on markets.

The rest of the paper is organized as follows. The next section provides a brief overview of the Scandinavia “cluster,” including a snapshot of the leading local firms, funding trends, the role of U.S. and European MNCs in the region, and the emergent set of startups in the internet software and services space. The third section briefly examines the implications of competitive dynamics in ICT markets for new entrants from “out of town” clusters. The fourth section examines the success of Scandinavia in wireless technologies and its implications for the ability of late entrants to capture economic rents in global ICT markets. The final section concludes.

1.0 The Scandinavian Cluster

The Scandinavian cluster is focused around the two leading firms in the region—Nokia and Ericsson—but the region is also home to a growing number of startups and an increasingly diverse and rich set of MNCs. Moreover, the past few years have witnessed rapid growth in venture funding focused on wireless technologies in the region, so continued firm growth is likely. Despite the growth in funding and the significant number of wireless startups, in practice Nokia and Ericsson dominate the cluster. For Ericsson, the major focus of activity is around Stockholm, where the company mainly maintains its headquarters. For Nokia, the focus of activity is two-fold—first in Espoo (north of Helsinki) where corporate headquarters are maintained but also in Oulu, where significant R&D takes place.

In Finland, the ICT cluster (broadly defined) employed roughly 75,000 people in 1998, with Nokia accounting for about 21,000 (slightly less than 30 percent of the total). According to estimates, Nokia also accounted for an additional 14,000 people through its first-tier subcontractor firms. Although Nokia is head and shoulders above other firms in Finland, there is also a set of small leading vendors as well as a spate of startups. Comptel, for example, has a leading position in the global market for subscriber management solutions for operators, while Tecnomen was the first to develop a unified messaging system and is a leader in advanced network services. Among the startups, perhaps the best known is Iobox, a provider of localized content services to multiple mobile platforms that was named one of Red Herring’s 100 most important companies in

---

2000. In the end, however, Nokia drives the majority of employment and revenues in the Finnish part of the Scandinavian cluster. Comparing the two largest telecom employers in Finland—Nokia and Sonera (the former PTT) is illustrative. In the first quarter 2001, Nokia had revenues of EUR 8.01 billion, roughly four times Sonera’s fiscal year 2000 revenues of EUR 2.06 billion. Likewise, a closer look at Oulu—which in Wired, Red Herring, and elsewhere in the popular press is cited as a Silicon Valley-esque hotbed of entrepreneurial innovation—reveals the central role of Nokia: Nokia accounts for approximately 5000 of the 8000 high tech jobs in the area, and many of the approximately 150 small companies founded in the incubator units of Technopolis (the publicly listed incubator that houses startups in the region) depend on work outsourced from Nokia.

In terms of the Swedish cluster, it is centered on Stockholm, where Ericsson serves as the core of a cluster with more than 200 wireless startups (another ~100 wireless startups are elsewhere in Sweden). The largest concentration of IT companies is located in Kista Science Park north of Stockholm. Established in the 1970’s, there are currently ~650 ICT companies with ~27,000 employees there. At the heart of Kista is Ericsson: the firm was one of the first companies to move in to the Science Park, and has doubled its workforce in Kista over the past five years. In the Stockholm area broadly defined, Ericsson also plays a leading role in terms of ICT employment: of a total of 90,000 people employed in the Stockholm area in ICT (10% of the total workforce), around 20% work for Ericsson. At the same time, however, Kista is home to a large number of other leading firms, and is thus much more diversified in terms of employers than Nokia’s home turf. Over the past few years, this growth in firms has been driven in part by the explosion in startups (see Figure 1) and in part by the explosion of investments by the major leading ICT firms in the region. In 1998, for example, Nokia itself opened a development center for base stations in Kista Park, where they now employ ~300 engineers. In 1999, Microsoft acquired Stockholm-based Sendit, now called Microsoft Mobile Internet, and employs roughly 200 people there as the base for Microsoft’s wireless internet development. Yet Ericsson is still at the core. For example, Microsoft and Ericsson have formed a joint venture, Ericsson Microsoft Mobile Venture, to collaborate on wireless internet software and services, while Hewlett Packard and Ericsson jointly own Ericsson Hewlett-Packard Telecommunications (EHPT), a JV focused on delivering convergent applications to telecom service providers.

As in other clusters, the success of the Stockholm area has been at least partially driven by the presence of technical labor and strong local educational institutions. In

---

11 Yahoo Finance.
12 Technopolis (then called Oulu Technology Park), was the first science park in the Nordic region when it was founded in 1982. Funded by the Oulu City Council and built on land adjoining the University campus and the state scientific research institute VTT, there were approximately ten companies involved in the Park when it was founded. Technopolis was listed on the Helsinki Stock Exchange in 1999.
13 When consultants, sub-contractors and suppliers that are depending on Ericsson, the figure becomes even higher.
Kista, one of the factors that has contributed to the success of the area is the establishment of Electrum, a technical research center at the end of the 1980’s. More recently, in 2000, the Royal Institute of Technology in Stockholm opened an ICT university in Kista, with a stated goal of becoming Europe’s largest ICT university (a goal of more than 12,000 students by 2010). 15 2001 also witnessed the opening of a new ICT university in Goteborg—developed in cooperation with Volvo, Saab, and other companies—focused on applying ICT to vehicle safety and emissions. Kista—and Stockholm more broadly—have also been effective in harnessing the talents and finances of leading ICT vendors for joint R&D initiatives. HP, for example, has for several years been conducting wireless research at the Kista-based Internet Research Institute (IRI), a joint venture with the Swedish Institute of Computer Sciences (SICS). Likewise, since 1999, Sun Microsystems has worked with Uppsala University in a research program focused on next generation computer systems.

In sum, Ericsson serves as the nucleus of the Wireless Valley around Stockholm, and is critical to the major developments in wireless technology taking place in the region. Ericsson has played—and continues to play—a lead role in both wireless standards definition and the emergence of software and services based on these standards—including Bluetooth (where Ericsson has been instrumental in the Bluetooth Special Interest Group16), Symbian (Ericsson is a ~30% owner of the Ericsson-Motorola-Nokia-Psion-Panasonic joint venture), and the GPRS Application Alliance. 17 Ericsson is also well poised to play a leading European role in the rollout of 3G, and to date is the largest supplier of 3G network equipment. Ericsson’s strong position stems from its technical prowess and the resultant ownership of more 3G patents than any other company (45 of the 172 most important patents). 18

The broad product and technological footprint—especially as compared to the narrow focus of Nokia—means that the Swedish cluster is both more entrepreneurial and more broadly deployed across the wireless value chain than the local economy around Nokia. In particular, whereas most startups and/or smaller firms are closely tied to Nokia and the handset business in Finland, the entrepreneurial focus around Stockholm is focused on both infrastructure and handsets, as well as software and services more broadly. This has produced both more diversity but also a significant number of small focused firms with early leadership positions in their respective niches (including Wireless Solutions, Roaming Factory, Aspiro, Northstream, Pipebeach, Satsafe, Melody Interactive, Room33.com, Telelogic, and Mobile Media Group).

In addition to the local firms, Scandinavia is also increasingly home to a diverse and rich set of MNCs from other ICT value chains. In particular, the last few years have witnessed an explosion in investment by leading ICT firms from the U.S. and Europe in the region. The position of Nokia and Ericsson as global leaders in their respective segments has thus attracted the attention—and investment—of leading firms in ICT

16 The Bluetooth Special Interest Group is a private international body with more than 2500 members committed to the use of a single Bluetooth technology.
17 The GPRS Application Alliance is an industry alliance, including leading firms such as IBM, Oracle, and Palm, focused on pushing the advancement of applications based on GPRS.
18 If patents added by Telia are added, Sweden owns ~1/3 of total 3G patents. See *Sweden: The Wireless Valley*, 2001.
segments not directly tied to wireless. In short, Scandinavia has been successful in attracting talent, investment, and ancillary services on a global level.\textsuperscript{19} In Stockholm, for example, the list of who has opened joint ventures or development centers there reads like a Who’s Who of global ICT leaders (see Table 1).\textsuperscript{20}

<table>
<thead>
<tr>
<th>Company</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microsoft (U.S.)</td>
<td>Mobile Internet—for mobile internet applications, and Ericsson Microsoft Mobile Venture (JV)</td>
</tr>
<tr>
<td>Intel (U.S.)</td>
<td>Wireless competence center and e-Business solution center</td>
</tr>
<tr>
<td>Nortel (Canada)</td>
<td>R&amp;D in mobile communications</td>
</tr>
<tr>
<td>Motorola (U.S.)</td>
<td>Development center for wireless applications and services</td>
</tr>
<tr>
<td>IBM (U.S.)</td>
<td>Wireless Internet Center</td>
</tr>
<tr>
<td>Oracle (U.S.)</td>
<td>Wireless R&amp;D and joint project with Ericsson and Telia</td>
</tr>
<tr>
<td>Hewlett-Packard (U.S.)</td>
<td>Wireless R&amp;D and joint project with Ericsson and Telia</td>
</tr>
<tr>
<td>Andersen Consulting</td>
<td>Global center for WAP applications and services</td>
</tr>
<tr>
<td>RSA Security (U.S.)</td>
<td>Development center for secure wireless communication</td>
</tr>
<tr>
<td>Compaq (U.S.)</td>
<td>Wireless Competence Center and eCommerce Knowledge Center</td>
</tr>
<tr>
<td>Nokia (Finland)</td>
<td>R&amp;D in mobile communications infrastructure</td>
</tr>
<tr>
<td>Cambridge Technology Partners  (U.S.)</td>
<td>Global Wireless competence center</td>
</tr>
<tr>
<td>Siemens (Germany)</td>
<td>R&amp;D center for wireless applications</td>
</tr>
<tr>
<td>Sybase (U.S.)</td>
<td>Test center for wireless applications, strategic alliance with Ericsson (mobile banking)</td>
</tr>
<tr>
<td>Sun Microsystems (U.S.)</td>
<td>Wireless Center of Excellence</td>
</tr>
<tr>
<td>EDS (U.S.)</td>
<td>Mobile Center of Excellence</td>
</tr>
<tr>
<td>CapGeminiErnst&amp;Young (France)  and Cisco (U.S.)</td>
<td>Joint competence center for 3G wireless systems</td>
</tr>
</tbody>
</table>

These investments by global players in existing ICT segments imply that Scandinavia has the local talent, expertise, and set of incumbent firms in the wireless space that make it a place with unique knowledge and capabilities. In building these capabilities, Scandinavia has thus become a place where firms in other ICT segments “must have a presence.”

2.0 Clusters, Firms, and Competition in Global ICT Markets

\textsuperscript{19} On the flipside, Nokia and Ericsson have established R&D centers in key U.S. wireless locations (Silicon Valley, San Diego, Dallas) to stay abreast of technological development elsewhere. As one Nokia senior vice-president noted about Nokia’s decision to locate an R&D center in San Diego (near Qualcomm) in 1992, “being in proximity where new technologies such as CDMA are developed helps to speed up the process of turning new technological innovations into competitive products.” See Business Wire, “Nokia to license Qualcomm’s CDMA digital cellular technology,” April 13, 1992.

\textsuperscript{20} Data for Table 1 from ISA, 2000.
Understanding the drivers of the growth and maintenance of ICT clusters requires understanding the market conditions confronted by any new entrant. In short, clusters are made up of firms, and firms must sell products, capture market share, define standards, create new technology, etc. And capturing significant global rents in most ICT markets requires that firms capture a significant share of the global market and become “global players.” As noted in the introduction and evidenced in the chapter on Cambridge in this volume, UK, mere growth in the size of the ICT sector will not necessarily lead to the creation of substantial opportunities for continued growth unless one or more firms are able to stake out a leading position in world markets. Firm-building—and in particular the building of globally successful firms with leading positions in important ICT segments—is thus essential for the creation of new clusters. This is true because on the way to becoming global players these firms build the necessary scale, recruit and develop talent, create local funding, and attract the attention of complementors in neighboring segments—and thereby become the core of new ICT clusters. Qualcomm in San Diego, Nokia and Ericsson in Scandinavia, Oracle in Redwood Shores, Intel and Cisco in Santa Clara, and Microsoft in Seattle all fit this pattern.

If a small number of very successful companies are central to the creation and maintenance of clusters, then it makes sense to understand competition in today’s ICT markets, and in particular how and why companies create and capture value in these markets. Although the economics and competitive dynamics of ICT markets are relatively well known and are explored in detail elsewhere, it is worth briefly outlining the landscape facing potential new entrants. Two features are worth noting: (1) the presence of U.S.-based incumbents with strong competitive positions, and (2) vertical competition. Taken together, these two features mean new entrants will face strong competitors and complementors with close ties to U.S. demand. This is critical because ICT is used in large complex systems, which means that the technologies of new entrants must be linked with and work with existing ICT solutions. In short, new entrants are compelled to cooperate with technologically powerful and strategically active complementors with strong ties to U.S. demand. Rents to non-U.S. entrants will thus be determined, to a considerable degree, by their ability to cooperate and compete effectively with U.S.-based complementors. All this means that new entrants must become global players with a strong vertical competitive position, or expect U.S. incumbents to erode their rents. Unfortunately, the ability of new entrants to establish strong vertical positions, particularly new entrants from outside the U.S., is no simple matter. Three challenges loom particularly large.

First, co-invention in ICT means that close interaction with leading edge buyers and complementors is a key component of translating technical innovation into commercial success. Understanding the requirements of customers and complementors—and the interaction between these players that produce such understanding—is thus crucial to success. Moreover, vertical disintegration means that most firms concentrate on a very

---


22 It is important to note that my argument applies only to industry segments that are vertically organized around a particular vertical competitors (e.g. Oracle, Microsoft, etc.). There are a wide set of ICT segments, most noticeable services, that provide general purpose skills that are not tied to any particular vertical players. These markets are not characterized by the dynamics that are germane to my argument.
small piece of the overall ICT value chain. Getting your technology built into the technology plans of complementors is thus a critical strategic objective. Being located—or having research and development centers—in Silicon Valley is thus almost a prerequisite for growth and rent capture on a sustainable basis. Yet, given the significant share of U.S.-based demand in most ICT markets—and the close connections of existing ICT suppliers to this demand—this cuts against the success of new entrants.

Second, both direct (e.g., shared knowledge across companies/individuals within a region) and indirect network effects (e.g., the presence of skilled inputs, notably finance and labor) mean that established ICT clusters have advantages that are difficult to match by would-be clusters. Accessing talent and services can to some degree be done virtually, as the software services industries of India, Ireland, and Israel suggest. But these firms largely provide programming services rather than globally dominant firms with branded products.23

Finally, firms in established ICT clusters, particular the U.S., benefit from the extensive deployment and use of general purpose ICT. This means that U.S. firms can leverage the existing general-purpose ICT investments to move quickly to capture customers, scale, and networks of partnerships. Although non-U.S. firms are free to enter U.S. markets, a range of simple, practical facts—differences in culture, business practices, personal networks, access to U.S.-based funding, etc.—make this more problematic for non-U.S. firms.

2.1 Implications for New “Global Players” and the Creation of ICT Clusters

The previous section argued that current landscape in ICT markets cuts against the ability of new entrants to capture significant global rents in ICT markets and thereby create new global clusters. Is there any hope for late entrants to capture global rents and create new ICT clusters? If yes, what should firms and governments do to increase the likelihood of success?24 The presence of a number of important success stories—Scandinavia, San Diego, Virginia, Israel—suggest that it is indeed possible for new entrants to capture global rents, become new “global players,” and thereby create new ICT clusters. The question is thus not if it is possible but how to do it. My answer to this question revolves around two factors.

First, new entrants must focus on attacking markets that lack strong incumbents with existing strategic advantages. That is, new entrants should go after novel or emerging markets that lack established incumbents and accompanying well known technological and competitive landscapes. In telecommunications, for example, Scandinavian firms focused on wireless telephony—a market that lacked strong incumbents with strong technical advantages and close customer connections.

Second, widespread local deployment of ICT is a key driver of local demand, and hence a critical part of enabling the co-invention that is essential to creating rent-capturing global players. In Scandinavia, for example, rapid penetration of wireless telephony services in the 1980s and 1990s not only provided incentives for hardware and software firms to enter the local market, but also provided local demand to prod suppliers

23 On India, see Arora, 2000.
24 On the other hand, government efforts may have little to do with “naturally” occurring differences in technologies and the emergence of globally dominant firms.
to continually innovate to address buyer’s needs. The move to digital networks and 3rd
generation wireless—and the range of services enabled by greater bandwidth-only
promise greater opportunities for firms with strong ties to demand pools at the leading
edge of wireless. Rapid and widespread deployment of ICT (in this case wireless
technologies) is thus essential to translating technical innovation into commercial success
and ultimately global players.

The first step for new entrants is thus to build innovative applications of ICT that
are distinct from established supply chains. The second step is to take advantage of local
demand to spur commercialization of these initial technical innovations. If local
deployment is sufficiently broad to enable the new entrant to use the local market to test
the market and achieve sufficient scale, the next step is to sell to buyers in other markets
with similar demand profiles. Note that I do not say enter global markets. Targeting users
with demand profiles that make use of your distinctiveness is more important than willy
nilly global expansion. Targeting these buyers will increase scale and scope and is likely
to contribute to significant learning about other markets and applications for your
technology, and at the same time lock-in users to your particular solution.

Over time, more diverse buyers are likely to seek out the new entrants
technologies and/or the new entrant will expand into markets that draw the attention of
established incumbents. At this point, two things can happen. First, one of the incumbents
elsewhere may grow interested and respond either competitively or by purchasing the
product. This is the fate of Mirabellis in Israel, for example (messaging software provider
bought by AOL). Or incumbents in established ICT markets can react competitively. If
the established incumbent wins this bout of vertical competition, the new entrant may or
may not survive, but in either case will face much-reduced margins (e.g., rents). If the
incumbent either loses the bout of vertical competition or does not respond (for whatever
reason), if the market opportunity is significant enough we can see our second outcome—
the emergence of complementors and ancillary services located proximate to the new
global player. With any luck, the location of the new entrant will emerge over time as a
new ICT cluster—a center for talent, funding, ancillary services, and complementary
firms focused on the ICT segment initially targeted by the new entrant.

To summarize, technological discontinuities—in part driven by raw technical
advance and in part driven by the process of co-invention with new demand pools—
provide the opportunity for new entrants to become global players in de novo value
chains. If local talent and demand can create and deploy innovative ICT on a local and
global basis that serves the needs of a demand segment that is underserved by existing
supply chains, the first conditions for creating new global players have been created.
Success by new entrants, however, is likely to provoke vertical competition from
incumbents in established value chains. The outcome of this bout of vertical competition
will depend on the two key drivers of success in ICT markets—technical innovation and
close ties to customers—and is not predictable ex ante.

---

25 As I noted below, local demand is not essential for success. Rather, the ability to access demand is
critical, and this can often be done better locally (for a bunch of mundane reasons like language,
culture, proximity). However, as the success of Israel and other clusters have demonstrated, accessing
demand can also be done over great distances.
3.0 Scandinavia: From a Small Home Market to a Global Cluster

Scandinavia’s emergence as a global ICT cluster focused on wireless telecommunications is one of the most striking illustrations of how and why new clusters emerge. Scandinavia has a far higher penetration of wireless telephony than the U.S. (or elsewhere), Scandinavian equipment providers are the heavyweights in the industry, and much of the innovation around wireless data and wireless internet services is emerging in Scandinavia. Although it is not preordained that the leading Scandinavian players will emerge victorious from the current global competition to set standards and define protocols for wireless software and services (DoCoMo vs. Qualcomm vs. Microsoft vs. Symbian vs. Nokia), Scandinavia has still come closest to creating the conditions necessary for the emergence of self-fulfilling virtuous cycle of innovation driven by the direct and indirect networks effects created by the first wave of successful innovation in wireless hardware.

At a high level, the story of Scandinavia is straightforward: Nokia and Ericsson gained dominance in wireless handsets and infrastructure, respectively, over the 1990s while widespread wireless deployment created extensive local demand and exposed Scandinavian carriers to the potential of wireless voice and data services earlier than in other geographies. While high domestic rates for wire line data services led to an early focus on innovation around wireless data and related services, a common European standard (GSM) created a market large enough to allow Nokia and Ericsson to gain the scale necessary to take on global rivals elsewhere (e.g., Motorola in the U.S. and the leading Japanese vendors). Today, Scandinavia boasts robust local talent, including an extensive set of development centers of U.S.-based incumbents from existing ICT segments, close connections to the major centers of global demand, a significant set of ancillary services (in particular venture capital), and an entrepreneurial focus on innovation across all segments of the wireless value chain.

A more detailed look at how Scandinavia emerged in the early 1990s and expanded beyond wireless hardware reveals a more interesting story, however. In particular, a closer look reveals the importance of public policy, the importance of firm-building and business unit strategy (in particular the external orientation of Scandinavian firms and their focus on a nascent markets), and the importance of focusing on a completely new technology—as opposed to a niche connected to existing ICT markets—in the successful emergence of the Scandinavian cluster.

3.1 Scandinavia and wireless telecommunications

Although Scandinavia is well known as a global cluster for wireless telephony, how the cluster emerged and what are the implications for other nascent clusters is less well understood. The purpose of this section is to examine the emergence of Scandinavia as a global cluster to illustrate three issues. First, the key role played by public policy, specifically the GSM standard, in reducing marketplace uncertainty—and at the same time the key role played by the lack of public policy elsewhere. Second, the success of Scandinavian firms in both global markets and in becoming the core for a wireless cluster in Scandinavia demonstrates how focusing on nascent technologies and industries that lack leading incumbents can be a winning strategy. Third, the success of Scandinavia in building a global hub for the wireless industry—not just a leading global firm in wireless hardware but the entire wireless value chain—underlines the importance of accessing cutting edge demand for setting in motion the “virtuous cycle” that can lead to the emergence of new global clusters in ICT.
3.1.1 The GSM Standard

The GSM standard is interesting for two reasons—the strong role player by public policy in producing European winners in wireless telephony and the misguided application of this outcome to current public policy debates over 3G wireless. In terms of the role of public policy in producing new global players in 2G, one of the interesting things about the GSM standard is that government standard-setting in one vertical layer in the industry—the air interface standard used by wireless carriers—produced global winners in a different vertical layer—wireless equipment. As we shall see in more detail below, the EU defined the GSM standard in the late 1980s in response to widespread dissatisfaction with the disparate set of standards that characterized first generation networks across Europe. In short, industry participants realized that the country-specific standards of first generation wireless networks had raised the costs of equipment (multiple standards meant equipment vendors were unable to reach scale and drive down unit costs) and also frustrated users (who were unable to roam between country-specific networks). In defining the GSM standard, however, neither European governments nor the EU dictated outcomes on the equipment side—that is European governments did not put in place the sort of national champion strategies that had created national equipment vendors associated with the PTTs in the major European countries. Rather, public policy in the GSM case was more akin to public policy Japanese-style: the EU put in place marketplace rules and then let the market decide on winners.

The second key lesson of the GSM standard is the “lesson” of GSM in the current debate over who will define the technological trajectory, protocols, and standards of 3G services. In short, one of the key—and often overlooked—pieces of the success of European vendors in GSM hardware was the lack of established incumbents with clear technology bets at the time of the definition of the GSM standard. That is, the GSM standard put in place something analogous to domestic competition in Europe: there were multiple hardware vendors in first generation wireless networks, none of these providers were advantaged by the GSM standard, and the Scandinavian firms captured the lion’s share of the marketplace in competition with (mainly) other European vendors. So the winners in GSM emerged out of a standards-setting process that created competition among vendors. Today, the “lesson” of GSM—that using public policy to define standards can produce European winners in 3G technologies—overlooks the critical point of the GSM that produced the Scandinavian success—the presence of multiple competitors and the fact that the GSM standard was not defined with the technological bets of any particular incumbent in mind.

As cellular telephony emerged as a possibility in the early 1980s, most of the European countries pursued their own local cellular solution. NMT 450 in the Nordic and Benelux countries, TACS in the U.K., Radiocom 2000 in France, RTMI/RTMS in Italy and C-Netz in West Germany. 26 None of these solutions were remotely compatible with each other. In addition, these incompatible standards emerge at the end of a disappointing decade for European telecom equipment vendors, and the fragmented local markets created by these incompatible standards were seen as major driver of the decline in competitiveness of EU telecom vendors. In particular, although the worldwide telecommunications equipment industry grew rapidly between 1978 and 1986, the EC

26 See http://www.gsmworld.com/about/history_page3.html
share of global exports declined from 40 to 20%. Analysts credited this decline to the fragmentation of the European market. In contrast to the U.S., which combined a flexible choice of standards with a large base of users that followed IBM and AT&T protocols in computing and telephony, Europeans countries lacked the integrated telecommunications starting point that would be equivalent to AT&T or integrated computing firm analogous to IBM. This meant that European PTTs duplicated R&D efforts, and the myriad licensing and approval type policies within Europe stymied trade. This inefficiency also had serious implications for the cost of telecommunications in Europe: between 1989 and 1989, telecommunications equipment was 80-100% more expensive in Europe than in the U.S.

European PTTs and the European Commission thus identified a compatible and open cellular infrastructure as a requirement for European competitiveness in the nascent wireless market. This was true for two reasons. First, local solutions severely limited scale economies in equipment, both in terms of R&D and manufacturing. Second, incompatible standards greatly reduced the utility of cellular services for users, especially business users that required cross-border roaming. This was particularly problematic given the fact that big business traditionally accounted for about 80% of total telecommunications equipment purchases.

In this environment, a pan-European digital standard seemed a logical outcome: it would enable European equipment manufacturers the scale to compete against their U.S. rivals, would enable service providers to offer users more compelling services, and at the same time (if the standard was digital) would address spectrum capacity issues. Yet agreeing on standards—particularly in a world of state-owned monopolies used to complete control over their markets—was no easy task. Nonetheless, the Conference des Administrations Europeennes de Postes et Telecommunications (CEPT), the European standards-setting organization comprised of the PTTs of each of the 26 European countries, established the Groupe Speciale Mobile (GSM) in the early 1980s to establish the specification for a pan-European digital network. In 1984, the GSM project received the support of the European Commission, and in 1985 West Germany, France, and Italy signed an agreement for the development of GSM. In 1986, the U.K. joined the agreement. Meanwhile, the rapid growth of cellular telephony throughout the early 1980s meant that demand for spectrum was increasing even faster than expected, and by the mid-1980s most players in the industry realized that a new digital standard was necessary to support continued growth.

For network infrastructure and handset manufacturers, the problem in moving to digital technology was that the large R&D costs associated with a new technology that had no guaranteed market. That is, there was significant risk associated with R&D and other investments for a new digital wireless standard that might not be accepted beyond the individual state markets. In particular, given the limited size of the home markets controlled by each individual PTT, the large investment required to move to a new standard were not economically feasible absent a single European market.

---

27 Mobile Telecommunications in Europe, HBS case no. 9-589-112.  
28 Mobile Telecommunications in Europe, HBS case no. 9-589-112.  
In 1986, pressure from France and West Germany ultimately led the European Commission to bring the GSM initiative to the Heads of State meeting in December.\(^{31}\) This initial introduction quickly led to an EC Directive in 1987 that called for limited services launch in 1991, rollout in all major cities by 1993, and linkage of all networks in 1995. In September 1987, network operators from thirteen European countries (and fifteen operators in all) signed a Memorandum of Understanding on GSM committing them to the GSM vision.\(^{32}\) Following the transfer of responsibility for the GSM standard to the European Telecommunications Standards Institute (ETSI) in 1989, the GSM 900 specifications were published in 1990. In 1991, at the ITU’s Telecom conference in Geneva, a pilot GSM network was successfully demonstrated. Although slightly delayed due to problems with terminal specification, GSM networks were finally launched in the second half of 1992. Early entrants were Denmark (two operators), Finland (two operators), France, Germany (two operators), Italy, Portugal (two operators), and Sweden (three operators). In parallel with initial country launches came moves to establish roaming agreements across borders, with the first agreement coming in June 1992 between Telecom Finland and Racal-Vodafone (U.K.).

Importantly, these quasi-governmental decisions and the creation of government-led consortia on GSM were creating the market conditions that made GSM an appealing choice even for operators that were free to choose alternative air interface standards. That is, for operators in European countries that had the potential to launch non-GSM mobile services found the advantages of GSM compelling. In the U.K., for example, the U.K. Department of Trade published a discussion document in 1989 called “Phones on the Move” that advocated the introduction of mass-market mobile communications in the 1800 MHz band—in contrast to the 900 MHz band called for by the GSM standard. In the end, however, this potential splinter actually strengthened the GSM momentum when new operators in the U.K. decided to use the GSM specification—slightly modified due to the higher frequency—in their services offerings.\(^{33}\)

Despite the slight delay in launch, GSM was the first to market of the second-generation digital cellular technologies (TDMA launched late in 1992 in limited markets, PDC launched in limited markets in 1993, and CDMA launched in 1995). Driven by the fact that GSM was the standard for second generation mobile telephony is Europe, GSM grew very quickly. GSM broke the 1 million subscriber barrier in 1993 while TDMA and PDC lacked meaningful subscribers and CDMA had not yet launched. By 1994, there were more than 1.5 million GSM phones in use worldwide.\(^{34}\) This early GSM lead continued throughout the 1990s; although CDMA grew faster than GSM from 1995-1999 (776% compound annual growth rate vs. 111% for GSM), GSM was far and away the global leader in subscribers by the end of 1999.

*Insert Figure 2, GSM vs. other technologies subscribers.*

What does the runaway success of GSM tell us about the ability of new entrants to capture rents and create new clusters in ICT markets? Three points are salient. First,

\(^{31}\) http://www.gsmworld.com/about/history_page6.html

\(^{32}\) The signatories were: France, Germany, Italy, Sweden, Norway, Denmark, Finland, Spain, the Netherlands, Belgium, Portugal, Ireland, and two from the U.K.—Cellnet and Racal-Vodafone. See http://www.gsmworld.com/about/history_page7.html.

\(^{33}\) http://www.gsmworld.com/about/history_page10.html.

\(^{34}\) *Philips Business Information*, PCS News, July 21, 1994 (no. 15, Vol. 5).
traditional national champion strategies to create demand for local ICT vendors is the not
the only potential public policy tool for creating new clusters. Scandinavian firms were
successful precisely because the EU and member states got out of the business of picking
winners. EU governments could have defined the GSM standard in way that advantaged
the technology of incumbent telecom vendors, for example. Instead, the EU defined a
standard that did not advantage one or more existing vendors, and let competition dictate
ultimate marketplace outcomes.

Second, the story of GSM illustrates the ability of government standards setting to
reduce marketplace uncertainties facing local firms. The scale required to be successful in
many ICT segments often represents a significant share of the total global market, which
of course means a local firm must capture a significant share of the international market
to reach scale. And market entry in the first place requires that firms believe that the
global market will be large enough to enable reaching scale. Fragmented standards,
unclear technological trajectories, multiple small markets— all these cut against decisive
bets on new technologies or solutions. Under this situation, even dramatic wins are likely
to generate limited value creation if a firm bets on what ends up being a small, local
market technology. All this means that entrants from large domestic markets with defined
technical standards are advantaged vis-à-vis rivals from smaller markets.35 One avenue
for public policy to be effective in enabling local firms in global ICT markets is thus to
use standards setting as a way to reduce marketplace uncertainties.

Finally, the story of GSM illustrates the key role played by luck. In short, an
important part of the GSM policy story is that Europe agreed on the GSM standard, set
marketplace rules, and thereby encouraged firms to make decision bets on a particular
technology. An additional important part of the story, however, is that it was probably not
enough for Europe to settle on the GSM standard—in particular the success of the
European firms probably also required that the U.S. not adopt a standard. If the U.S. had
also adopted GSM or a completely different (but uniform across the U.S.) standard the
wireless story might have turned out differently. In other words, a little luck was
involved: agreeing on the GSM standard was good policy, but its local industrial benefits
were at least partly derived from the lack of standards-setting public policy across the
ocean.

3.1.2 Firm-building and business unit strategy: Going after nascent markets

In the late 1980s, Nokia was a faltering European conglomerate bleeding red ink.
Today, it is one of the ten most valuable companies in the world, and vies with Vodafone
for the title of Europe’s most valuable company. The success of Ericsson in wireless
infrastructure, although in some ways less dramatic than Nokia’s makeover, suggests a
similar lesson: new entrants—and governments seeking to create new clusters around
these new entrants—would do well to focus on fast-growing emergent markets and shed
aspirations to take on established competitors in their core markets. More specifically, as
we shall see in the next section, new entrants and their government supporters would do
well to focus on completely new technologies that are not simply complementary niches
to existing ICT segments. The success of Ericsson and Nokia in building global firms
also suggests the importance of having global aspirations—and hence the importance of
being not only “out of town” but from a “small town.” This section illustrates these points

35 The reason for smaller domestic markets—fragmented standards or product markets—is irrelevant.
with two episodes: (1) the success of Nokia and Ericsson in wireless hardware, and (2) the success of these firms to leverage their success in hardware in establishing the Wireless Access Protocol (WAP) as the standard for wireless data.

3.1.2.1 Nokia and Ericsson in Wireless Hardware

The success of Nokia and Ericsson in wireless hardware is one of the international business success stories of the 1990s. Their success, however, was not pre-ordained nor even expected. In handsets, they faced serious competition from Japanese consumer electronics firms as well as traditional U.S. suppliers. In infrastructure, the major European and U.S. suppliers were well positioned with both technology and customer relationships to continue to dominate there home markets. Their success thus attests to potential for firms that are not dominant in current value chains to capture global rents by successfully executing old-fashioned firm-building and business unit strategy, and in particular focusing on emergent markets and allocating the resources necessary to become global leaders in their chosen space.

In the U.S., AT&T and Motorola were the first to focus on mobile telephony, and two firms were responsible for inventing mobile telephony in the U.S. in the early 1970s. AT&T served as the de facto supplier for most of the cellular infrastructure to the Regional Bell Operating Companies (RBOCs), while Motorola focused on international markets as well as taking sales from AT&T whenever possible. When mobile telephony emerged as a real possibility in the early 1980s, however, AT&T did not consider wireless to a significant market—it believed that the market would be small and mainly serve high-end executives who could afford the high rates and would be willing to carry the bulky phones. AT&T thus focused on its existing customers (demand pools) and concluded that these demand pools would be unlikely to be large users of wireless services. AT&T did supply wireless infrastructure to the RBOCs, AT&T did little to target the nascent market, and did not set its sights on the international market. As early as 1990, AT&T was aware of the potential failure to focus on the emergent global market for wireless equipment. In 1990, Tom Powers, head of AT&T’s mobile operations, noted, “We are still learning the rules of the game. We are just not in the position to spot the opportunities. We may yet regret that.”

AT&T was not alone in its failure to target the wireless market, and the other major telecom providers—Nortel, Siemens, and Alcatel—made similar mistakes. In particular, these firms fumbled the ball in the transition from proprietary national analog systems to the second-generation GSM standard. Ultimately, missteps by the established incumbents ultimately left Motorola and Ericsson as the only two global players focused on the cellular infrastructure business. By 1990, Ericsson and Nokia, along with Motorola, dominated the market for wireless infrastructure, while Motorola, along with European and Japanese vendors, dominated the market for handsets.

The focus of Nokia on wireless technologies represented a significant departure for the company. Prior to the late 1980s, the company was an industrial conglomerate with a diverse set of holdings, and more than 20% of its revenues came from basic industries (e.g., rubber, paper and pulp). In the late 1980s and early 1990s, however,

36 This dynamic is similar to the product-level dynamics described by Christensen in his work. See Christensen, 1997.

Nokia sold off money-losing businesses, and focused exclusively on mobile telecommunications. In 1988, Nokia sold 15 companies with more than 6,000 employees, and overall revenues shrank roughly ten percent. In 1991, Nokia went even further when it sold Nokia Data to Fujitsu (ICL)—a significant move given that Nokia Data had accounted for more than 20 percent of total revenues in the late 1980s. Despite the selling spree (driven at least in part by the need to restructure given the downturn in the Finnish economy given the collapse of the Soviet Union), Nokia also made selective acquisitions to bolster its’ mobile telephony business, including Technophone, a mobile phone manufacturer in the U.K., for example.  

When Jorma Ollila (CEO) and Olli-Pekka Kallasvuo took over the reins at Nokia in 1992, the emergent focus on wireless technologies and a commitment to global leadership became even more apparent. In late August 1992, for example, Nokia corporate legend has it that Ollila wrote four words to describe Nokia’s goals: “Focus, Global, Telecom-Oriented, High Value-Added.” Ollila also put in place an organization that matched both the global requirements of the business but also made logistics management and customer contact linchpins of the Nokia business. In 1992, for example, Nokia launched an internal IT study to improve process management and the logistics systems of the company. Out of this study came a commitment to build corporate process from a customer point of view, with a particular focus on (1) product development and (2) customer commitment (e.g., order fulfillment). Commitment to rapid product innovation, coupled with design flair and control over the system design (e.g., not relying on commodity chipsets from vendors, but forcing vendors to build chipsets to Nokia specs), thus became the cornerstone of Nokia strategy in the 1990s. At the same time, Nokia built close ties with major customers and sought to anticipate their needs even as it invested in market-development (e.g., developing new products and services not demanded by the carriers). Nokia’s close customer focus paid particular dividends as telecommunications deregulation took hold in the 1990s, and Nokia’s lack of association or close ties with incumbents enabled it to quickly build ties to new entrants. In the early 1990s, for example, Nokia was among the first equipment vendors to establish relationships with the new operator entrants across Europe, including Orange in the U.K. and E-Plus in Germany. Today, Nokia’s focus on design and continued control over the system design—even as it outsourcing components and even some final product assembly to other clusters examined in this book—have enabled Nokia to continue to capture build market share from other global rivals even as it maintains margins on its latest generation models.

Ericsson following a similar yet less dramatic tact: long strong in switching technologies, Ericsson focused on its core competencies and added mobile infrastructure as a key component to its overall switching solution. And although global deregulation opened up new market segments in the early 1990s, Ericsson remained focused on a select number of segments, particularly outside its home turf. Indeed, one key part of the Ericsson attention to wireless telephony markets was the realization that targeting core markets of established ICT incumbents was unlikely to be a winning strategy. In 1992, for example, Ericsson announced that it would not go after the North American

transmission equipment business and would instead focus on North American Central Office switches and cellular systems.\textsuperscript{41}

Early entry and focus thus benefited Nokia and Ericsson at the expense of their larger, more established telecom equipment competitors. In 1991, the first GSM call was made in Finland using a Nokia phone and a Nokia-equipped network, and in that same year Nokia agreed to supply GSM networks to nine European countries.\textsuperscript{42} In 1992, an agreement with Nippon Idou Tsushin (IDO) made Nokia the first foreign firm to design mobile phones for the Japanese markets.\textsuperscript{43} In 1994, Nokia was the first hardware vendor to supply hand-portable phones for all the major digital transmission standards (e.g., GSM, TDMA, Japan Digital, PCS).\textsuperscript{44} And in 1995, Nokia became the first foreign firm to supply handsets to Japan’s NTT DoCoMo. Although less dramatic given the historic strength in switching, Ericsson also emerged as a global leader in wireless infrastructure in the early 1990s, and by 1995 had more than 40\% of the global wireless infrastructure market,\textsuperscript{45} about four times the market share of AT&T.\textsuperscript{46}

In sum, by the mid-1990s, Ericsson and Nokia had emerged as the leading wireless handset players not just in Europe but globally. In 1996 Ericsson became the largest handset vendor with 34\% of handset shipments in the U.S., followed by Nokia (28.8\% of shipments) and Motorola third (8\% of shipments).\textsuperscript{47} In 1999, Nokia edged out Motorola for the title of global leader in handset sales with 27\% of the market compared with 17\% for Motorola (Ericsson was third with 11\%). In the U.S., Nokia was even more dominant—capturing 34.5\% of the market, followed by Motorola (23.1\%), Qualcomm (12.0\%), and Audiovox (11.8\%).\textsuperscript{48} Meanwhile, Ericsson consolidated its position as the leading supplier of wireless infrastructure. In the 2.5 G market, for example, Ericsson is the global leader with more than 50\% of total GPRS sales.\textsuperscript{49}

\subsection*{3.1.2.2 The WAP Protocol}

The second example of the importance of firm strategy, international orientation, and going after nascent markets is the efforts of Nokia and Ericsson to establish the Wireless Access Protocol (WAP) at the standard for mobile data functionalities on thin clients. By the mid-1990s, there were a number of vendors working on the “thin-client” problem.\textsuperscript{50} Nokia promoted a Narrow Band Sockets (NBS) solution and the Tagged Text Markup Language (TTML). Ericsson was pushing the Intelligent Terminal Transfer Protocol (ITTP), while a startup in Silicon Valley, Unwired Planet, pushed ahead with the

\begin{thebibliography}{9}
\addcontentsline{toc}{chapter}{References}
\bibitem{42} Steinbock, 2000.
\bibitem{44} Steinbock, 2000.
\bibitem{47} EDGE, on and about AT&T, Cellular Phone Market, March 3, 1997.
\bibitem{48} Newsbytes PM, January 17, 2000.
\bibitem{50} The thin client problem is how to use small phones with limited processing power and battery life to take advantage of internet functionalities.
\end{thebibliography}
Handheld Device Markup Language.\textsuperscript{51} Faced with the potential that multiple standards would fragment the industry, these three firms, along with Motorola (the other industry giant) set about defining a single standard. Ultimately, these discussions led to the creation of the WAP Forum in June 1997. The goals of the WAP Forum were four-fold: (1) bring internet content and advanced services to handheld devices, (2) create a global wireless protocol; (3) submit specifications for adoption by relevant standards bodies, and (4) enable applications to scale across a variety of transport types and devices.\textsuperscript{52} In short, the purpose of the WAP Forum was to develop a protocol that comprised the best of all three competing proposals noted above, establishing WAP as the global standard, and gain acceptable for WAP standards in the relevant standards bodies.

Establishing the Forum was the first step. Defining the protocol was the next piece of the puzzle, which was accomplished with the release of Version 1.0 in 1998, followed by Version 1.1 in June 1999 and Version 1.2 in January 2000. With a standard up and running, the next step revolved around recruiting other ICT vendors to accept the WAP standard and build their technologies around it. Here, the participation of the three leading cellular phone manufacturers (with combined global market share of 59.9\% in 1998)\textsuperscript{53} and their ability to drive WAP as the de facto standard made recruiting easier than in other standards-setting contexts. By February 1999, there were more than 90 members of the WAP Forum, including Symbian, Siemens, Intel, France Telecom, NEC, IBM, Qualcomm, T.Mobil, SBC, DoCoMo, AT&T, Sony, Sprint, Vodafone, and Telia. By February 2000, there were more than 300 members, including Microsoft, that encompassed more than 95\% of the global handset market and included more than 150 million subscribers.\textsuperscript{54} Today, WAP is the standard for thin client solutions.

The success of WAP underscores three dynamics: (1) moving quickly into nascent segments that lack powerful incumbents, (2) the ability of leading players to leverage dominance in one segment into neighboring segments, and (3) the importance of being global for success in segments that depend on technical standards-setting. The first two are related in practice and revolve around the ability of strategic incumbents in existing ICT segments to move quickly to establish leading positions in nascent value chains in neighboring segments—particularly nascent segments closely related to their core markets. I have already noted the importance of attacking markets that lack strong strategic incumbents. The second point is that going after markets that lack strong incumbents is a solid strategy for success, but going after markets where you have strong strategic position in neighboring segments is even better. This is true because bouts of vertical competition will break out between winners in neighboring segments of the value chain once winners in individual segments emerge. In computing, we have witnessed the success of Microsoft in defeating rivals in Office productivity software, based at least in part on the strong Microsoft OS position. Today, we are currently witnessing the same dynamic in enterprise applications, as Oracle seeks to leverage its strong position in database software to defeat rivals in applications that run on these databases. We expect similar vertical competition in the wireless arena, no doubt between incumbents in

\textsuperscript{51} www.wca.org/sbc/sld006.htm
\textsuperscript{52} http://nbs1.ntu.edu.sg/ht/p3/sld008.htm
\textsuperscript{53} Motorola had 24.5\%, Nokia has 19.9\%, and Ericsson had 15.5\% of the global handset market in 1998. See Wall Street Journal, October 19, 1998.
\textsuperscript{54} http://nbs1.ntu.edu.sg/ht/p3/sld010.htm
established ICT segments and the new entrants with their roots in wireless. The first bout revolved around defining an open versus closed standard—a battle that the leading hardware vendors successfully won. The third dynamic illustrated by WAP is the global or dead mandate of current ICT markets. In short, any technology whose return depends on technical standard setting or coordination with other technologies will likely need to be global to succeed. If there is a national variant, Minitel or Japanese PC operating systems, for example, it is likely to be swept away by a version of a global standard. Moreover, leading firms will move to re-enforce incentives for consumers to go with the leading solution, even if the industry is nascent.\(^{55}\)

All of this suggests two things about leading global firms and associated clusters. First, firms must be strategically active to capture an on-going stream of rents, and hence build a self-sustaining cluster. The OS for handhelds and associated protocols threatened to erode the margins of the core hardware business of Nokia and Ericsson, and hence having an open standard that they largely control—WAP—was critical for safeguarding the core market from commodification of their hardware businesses. Second, firms must be global players, not regional winners. This is true because bouts of vertical competition are likely to be global, and U.S.-linked incumbents in established ICT markets will bring global resources to bear. Given the importance of MNCs as buyers and the large size of the U.S. market, being tied to U.S. demand is necessary for new entrants to win the inevitable bout of vertical competition. In short, clusters must be home to global leaders to generate substantial opportunities for continued growth and capture of global rents.

One final note on WAP: its success in the first round of competition does not guarantee its success in the second. This is particularly true as the emergent round of competition is emerging as a battle of distinct standards and approaches to wireless data more broadly.\(^{56}\) On the one hand, NTT DoCoMo’s iMode services—and associated standards—are ahead of the game given early market entry in Japan, and are advantaged by significant cash and investments abroad, including slightly less than 20 percent ownership of AT&T wireless. A second contender is Microsoft, which continues to push a Windows CE as the alternative to Palm in the PDA market and is set to launch a major wireless phone initiative in the near future (including, if rumors are correct, a Microsoft-branded phone). Coupled with .Net and Microsoft strength elsewhere in computing, there is little doubt they will be a real contender. And there are also additional efforts by Qualcomm, Sun, and a myriad of other startups. As the focus and value of wireless shifts from hardware to software and services, the strategic position of the Scandinavian vendors is weaker than in the initial bout of standards setting. In short, given the strong strategic positions of the contenders—either in computing or in geographies outside Europe where the Scandinavia vendors have less muscle—the success of WAP if far

---

\(^{55}\) Although the business model for WAP is not entirely clear (e.g. Nokia and Ericsson are not currently charging for their WAP browsers), at a minimum the open WAP standard means that the hardware makers are not subject to hold up problems by an independent OS manufacturer. Moreover, most expect that leading members of the WAP Forum will have advantages in WAP applications and services markets.

\(^{56}\) The discussion that follows is not intended to be exhaustive. There are myriad players in the space and the strategies of the leading firms are complex. Microsoft, for example, has a micro-browser that Ericsson has agreed to use on their phones. Likewise, Nokia has its’ own OS for services that could be considered an alternative to Symbian, which is yet another contender. Given the complexity, my discussion is illustrative only.
from clear. A clear global winner—either iMode or Microsoft—would create real concerns about the long run success of the Scandinavian cluster as the center of global wireless markets.

3.1.3 Local demand and the cluster benefits of focusing on a completely new technology

The previous section argued that moving quickly to stake out global positions in nascent ICT segments is a potential winning strategy for new entrants. In a number of the other clusters examined in this book, these nascent ICT segments have been niches complementary and closely tied to existing ICT segments—PC peripherals and fabrication in Taiwan, software and related services in Israel, India and Ireland. As I noted earlier, however, by definition targeting niche segments with close ties to existing ICT segments leads you into competition with established incumbents (if you are lucky, and growth in your niche is sufficient to attract the attention of incumbents!). This section seeks to make two points about this dynamic. First, interacting with demand is critical for translating technical innovation into commercial success, and it is often easier to interact with demand if it is local. Second, the success of Scandinavia in building a successful cluster with the necessary talent and ancillary services to capture rents on a sustainable basis suggests the advantage of focusing on completely new technologies rather than extensions of existing ICT segments. Put differently, focusing on a whole new value chain that is not in competition with existing ICT segments leaves you more subject to market risk (will the market develop?) but less subject to competitive risk from incumbents.

3.1.3.1 The importance of interacting with demand

More often than not, new ICT segments emerge from technical innovation that opens up the possibility for new commercial applications. Yet translating technical innovation into commercial success, particularly global commercial success, is as much about technical innovation as it is about firm and market-building (e.g., sales and marketing, CRM, distribution). Translating single product success (e.g., a new router, a new handset design, a new software application) into a pipeline of products and services is the prerequisite for translating product success into a firm capable of delivering sustainable growth and industry leadership over time. The final step for late entrants—and for the clusters they are associated with—is to create a “virtuous cycle” of funding, innovation, and global marketplace success that is characterizes a mature cluster. This “virtuous cycle” is at the core of today’s mature Silicon Valley.

Creating new ICT clusters is a difficult task, however. The first reason is that successful ICT firms are generally organized around a single core product—a router, a software program, etc., and translating success in a single product into a sustainable product pipeline is difficult. It is one reason, for example, that relatively few software firms ever reach the $1 billion revenue mark. A second reason is that there must be sufficient talent and funding to enable new firms to emerge around the leading firm in a would-be cluster, and there must also be sufficient managerial talent to grow these firms

57 There are other potential drivers of new commercial applications for ICT; changes in regulatory rules are probably the most obvious.

into successful businesses on world markets. In San Diego, for example, the success of Qualcomm has spawned a vigorous local economy around wireless technologies. It is too early to tell whether or not this emergent hub will grow into a sustainable global ICT hub, but business leaders in San Diego worry that a shortage of good managerial talent may limit the region’s global competitiveness. Both of these reasons mean that multi-firm centers are more likely to acquire the talent and necessary expertise (e.g., venture capital, management talent and associated personal networks, links to leading ICT firms elsewhere) needed for global ICT clusters. If creating one new global player is difficult, creating two next door to each other is even more challenging.

Yet Scandinavia managed to do exactly this—create a multi-firm center of innovation with two new global players. How? At least part of the answer is the presence of local demand in the region. That is, one critical piece of the success of Scandinavian firms in establishing their leading technological positions in wireless was the ability of these firms to work closely with and get feedback from local demand. This is not to say that truly local demand is essential to interact with buyers (this can be done virtually or at a distance, as the success of Israeli firms in internet security demonstrate), nor is it to say that local demand is a requirement for long-run success (as evidenced by the ability of Taiwanese foundry players to continue to capture value despite long distances to their U.S.-based customers). Nonetheless, local demand in Scandinavia was essential in providing both product feedback and the necessary demand pool to get Scandinavian firms a key advantage vis-à-vis other wireless equipment vendors.

Figure 3 provides an overview of wireless telephony penetration in the major markets of the world. The story it tells is straightforward: wireless telephony came first to Scandinavia, and the region still maintains a significant lead over the rest of the world (in terms of penetration). There are a number of potential drivers of the high levels of penetration in Scandinavia. At least part of the reason behind the high penetration levels in Scandinavia the role of early network standardization and deployment. As I noted above, first generation wireless telephony relied on a series of proprietary standards—most states had their own distinct standard that made it impossible for wireless phones from one nation to work in another. In Scandinavia, however, states built and launched a single cellular (NMT) system that worked throughout Scandinavia and the Benelux countries. Part of the reason for early adoption may have also been the high cost of fixed line services. Finally, simply geography—wide open rural spaces that make fixed line deployment expensive—may have also played a role.

Whatever the reason, a critical mass of wireless users emerged early in Scandinavia. These users played a central role in pushing regional suppliers to innovate quickly and make technological advances commercially useful and available. One of Nokia’s key strengths has been its’ ability to rapidly rapid technological progress into rapid product innovation—and in particular products that are met with immediate and widespread consumer adoption. Understanding how users are likely to use phones—and designing them and getting them to market quickly—is thus at the core of Nokia’s success. More broadly, widespread local deployment and use of wireless technologies have been a key ingredient for the process of co-invention—the interaction between buyers and sellers of technology—that is critical to translating technical advances into commercial success.

Scandinavian firms have also moved to take advantage of widespread deployment as they move into wireless software and services. Sonera, for example, is seeking to leverage widespread wireless use into applications and services. Likewise, Ericsson is
seeking to move into a variety of wireless e-commerce applications, including banking, while Telia has launched joint ventures with leading U.S.-based software vendors to offer new software for wireless devices. Scandinavian firms now view penetration and wireless use in their home markets as one of their core assets in global competition. And they are now alone, as U.S.- and European-based computing and telecom incumbents have opened centers in Scandinavia in the hopes of accessing this local demand to better understand how wireless applications and usage will change their core markets (see Table 1 above).

3.1.3.1 The cluster benefits of focusing on a completely new technology

One of the major similarities of the clusters examined in this book is that they tend to be tied to firms and/or ICT segments that are complementary to existing ICT segments. A related point is that clusters can thrive by focusing on niches that are not covered by leaders. Taken together, these points imply two options for new entrants and potential clusters: (1) firms can focus on niche segments closely tied to existing ICT value chains, or (2) they can focus on completely new technologies that are only distantly related to existing ICT segments. Scandinavia, in focusing on wireless, chose the latter, and has been successful in creating a thriving cluster that appears—at least at the moment—capable of capturing rents on a sustainable basis moving forward. This section suggests that the success of Scandinavia in building a successful cluster rests at least in part on the advantages of focusing on completely new technologies rather than extensions of existing ICT segments. Incremental steps are less risky but are more likely to results in modest gains; while big bets are risky yet hold the potential for big payoffs.

When Nokia and Ericsson “bet the company” on wireless telephony in the late 1980s and early 1990s, it was by no means sure the wireless would take off. Indeed, there was greater uncertainty about wireless as a segment than other segments that were more closed tied to existing ICT segments. In particular, the problem with wireless was that in the late 1980s demand was growing but could hardly be considered large, nor was continued growth guaranteed. Indeed, there was considerable debate over the limits of wireless growth—AT&T decided not to aggressively go after wireless precisely because it expected demand growth to be limited! So a bet on wireless entailed market risk—that is the risk that the market would not develop—as well as competitive risk—the standard risk faced by firms in all competitive markets.

Of course, wireless did take off, and Nokia and Ericsson were well positioned to capture a significant share of the economic value created by this growth. But the bets were made and firm capabilities built prior to the explosion in demand. Just like Sun Microsystems was well positioned to benefit from the explosion of the internet given its investments in industrial strength computing, so too were Nokia and Ericsson in wireless. As in the case of Sun, luck also played a role for Scandinavia: it turned out that wireless became such a huge opportunity, and that the widespread deployment and lower prices of wireless voice and data services have led to an explosion in interest in wireless software and services more broadly. Thus, today, Nokia and Ericsson are poised to become global leaders in the wireless telephony broadly defined, not just hardware. Over the next few years, the move to digital networks and 3rd generation wireless—and the range of services enabled by greater bandwidth will only increase the size of opportunities that these firms are well positioned to capture. Ericsson has established itself as the leading provider of 2.5 and 3G infrastructures, while Nokia is increasingly providing software services for mobile internet applications. In 2000, for example, Nokia rolled out the Nokia Artuse Messaging Platform, the Nokia MAX Platform, and a range of other wireless internet
services that enable wireless services providers to quickly deliver full service branded portals to their users.\textsuperscript{59} Nokia is also concluding strategic agreements with a range of leading internet software companies to extend Nokia’s reach into wireless data services. In May 2000, for example, Nokia inked a partnership with Inktomi to integrate Inktomi products into Nokia solutions and cooperate on the development of infrastructure software and applications for 3G networks.\textsuperscript{60}

The sheer size of the opportunity provided by wireless has also been critical in moving Scandinavia from the home of Nokia and Ericsson to a global ICT cluster for wireless. Two facets of this are worth noting: (1) the growth of ancillary services and capabilities (in particular the presence of managerial and technical talent and the growth of funding), and (2) attention and investment from global players in other ICT segments. On the first, the growth of ancillary services and the presence of English-speaking talent has been critical in driving an explosion of startups to put Scandinavia on the map as the core of the global wireless markets. And, as in mature Silicon Valley, the local talent and financial pools created by the earlier success of the two major hardware vendors now provide the talent and ancillary services necessary for early entry and success in wireless data and related services. In terms of funding, for example, venture capital in Sweden grew to EUR 600 Billion in 2000, up from EUR 56 Billion in 1997 (a compound annual growth rate of \textasciitilde120\%).\textsuperscript{61} This explosion of funding, coupled with the continued success of the two leading firms in the core markets (wireless hardware) and continued leadership in wireless usage, has created a diverse and rich wireless landscape that promises a talent base and demand pool unmatched anywhere else in the world. Scandinavia has also attracted attention and investment from global players in other ICT segments that need to stay abreast of or participate in advances in wireless technologies. Put differently, Scandinavia has been successful in attracting talent, investment, and ancillary services on a global level.\textsuperscript{62} In Stockholm, for example, the list of who has opened joint ventures or development centers there reads like a Who’s Who of global ICT leaders (see Table 1 in Section 2 above).\textsuperscript{63} Scandinavia has thus become a place where firms in other ICT segments “must have a presence.”

This is in contrast to the bets made by others clusters in PC-related segments. To be sure, for example, Singapore generated significant returns on its investment in hard-disk drives. Similar stories could be told for Ireland (the EU home for MNCs, software localization), India (offshore software services and localization), and Taiwan (PC peripherals). These nascent clusters have no doubt generated significant wealth creation and have been successful in creating significant local ICT opportunities. But these

\textsuperscript{59} Business Wire, “SBC Communications signs agreement with Nokia to provide Wireless Application Protocol (WAP) service, July 25, 2000.


\textsuperscript{61} ISA, 2000.

\textsuperscript{62} On the flipside, Nokia and Ericsson have established R&D centers in key U.S. wireless locations (Silicon Valley, San Diego, Dallas) to stay abreast of technological development elsewhere. As one Nokia senior vice-president noted about Nokia’s decision to locate an R&D center in San Diego (near Qualcomm) in 1992, “being in proximity where new technologies such as CDMA are developed helps to speed up the process of turning new technological innovations into competitive products.” See Business Wire, “Nokia to license Qualcomm’s CDMA digital cellular technology,” April 13, 1992.

\textsuperscript{63} Data for Table 1 from ISA, 2000.
clusters have been less successful in generating the local talent, funding, ancillary services, and investment in capabilities from other global incumbents than Scandinavia. That is, a combination of factors—leadership in a core ICT segment, the presence of cutting edge users, and extensive funding and talent to push continued innovation—set Scandinavia apart from other nascent clusters. This suggests that these clusters are at a minimum of a different type, and may also suggest something about their ability to capture value on a sustainable basis.

global cluster.

4.0 Conclusion

The Scandinavian experience underscores the importance of global firms in the creation of ICT clusters. In short, one strong path to the creation of an ICT cluster is the emergence of local firms that are dominant in a given segment of global ICT markets. Scandinavia also suggests the critical role in focusing on nascent ICT segments that lack established incumbents, and close interaction with large demand pools. Of course, the Scandinavian story also reminds of the importance of luck: the initial bet on wireless could easily have turned out to be a limited opportunity; the billions of dollars spent on interactive TV remind us that many “sure-bet” ICT technologies never actually materialize into sizable market opportunities.

For would-be clusters and the firms therein, my main conclusion is that focusing on nascent ICT segments completely independent of existing ICT segments may be more successful in creating clusters than focusing on small niches closely tied to existing ICT segments. To be sure, focusing on a niche that are closely tied to existing ICT segments can be effective at building local capabilities and generating economic growth. However, the path from “tied cluster” to an independent and sustainable cluster is less clear absent innovation away from established ICT segments. Moreover, Scandinavia demonstrates that it is possible to create new global players with the ability to capture significant economic value via the creation of new supply chains delivering distinctive technology—technology not directly connected with established ICT segments.

My analysis suggests two additional conclusions. First, public policy can play a critical role in the development of clusters. In particular, although conventional demand-management policies (a la national champions) may be discredited, the role of the GSM standard in enabling European firms to achieve economies of scale and limit marketplace uncertainty suggests that public policy can be an effective tool. However, the GSM case must be understood in the proper context—it was not a case where governments defined a standard that served as barrier to entry for international competitors and protected a select set of players. Rather, the GSM standard put in place a standard for a market—a market that was large enough for leading continental players to achieve the scale necessary to compete globally—but then allowed the market to determine the winners. Thus, public policy was not protectionism in disguise, but rather “market-creating” in the sense that it established a large enough single market to enable European (as it turned out the winners were Scandinavian, but this was not pre-ordained) to reach scale and be competitive in global markets.64

64 For an argument that suggests foreign participation in U.S.-led research efforts is useful because it strengthens the ability of U.S. firms to define global standards, see Michael Borrus, “Foreign
The role of public policy in the GSM, and the potential role for public policy in the context of 3G, is often misunderstood, however. In particular, many analysts note that the “lesson of GSM” is that standards-setting can be an effective tool for European firms to build global leadership. Although partly true, this ignores one critical fact of the GSM story that is different today: the GSM standard was defined in a world where different firms had different first generation analog standards, and were thus not advantaged by the definition of the GSM standard. Put differently, GSM was agnostic on winners. The two elements of the GSM standard were thus: (1) top-down standards setting by the EU and (2) competition between (largely European) vendors in equipment based on this standard. In contrast, the current debate about 3G standards lacks this second component. That is, the standard for 3G as defined provides clear advantages for the winners in 2G—Nokia and Ericsson. In defining the standard in this way, however, this limits competition within the standard.

A second problem with the extension of the “lesson of GSM” to 3G is the increasingly global, as opposed to continental, nature of competition in wireless. In particular, GSM helped facilitate the success of the Scandinavian firms at a time when competition in wireless de facto stopped at the water’s edge. Thus, although the Scandinavian players were successful in all three markets, they were strongest in Europe. However, as data services have emerged over the past few years, distinct variants of 2G services emerged in Japan, the U.S., and Europe—reflecting their differences in regulatory structures, standards for 2G, as well as the competitive positions and strategies of the leading carriers in each market. As we move to 3G, however, it is increasingly the case that software and services players will increasingly be competing on a global basis with the handset manufacturers, while infrastructure providers will increasingly face competition from global winners in wire line data equipment. In short, 3G is likely to dramatically erode the “water’s edge” as a competitive asset for the Scandinavian players. Only time will tell if the success of GSM in enabling the creation of global winners in Scandinavia will be repeated in 3G.

My second conclusion is that deployment of ICT across all sectors of the economy is critical to making initial firm success translate into more sustainable—and potentially more widespread—marketplace success. Scandinavian firms were successful in wireless technologies because they focused on nascent markets that were left alone by leading global firms elsewhere. Yet a critical piece of this success was interacting with local demand that facilitated the translation of technical innovation and commercial applications. Of course, as I noted above, interaction with buyers can be done virtually, as the success of Taiwan, Singapore, and Israel all amply demonstrate. However, in developing completely new value chains that are independent of existing ICT segments, a key competitive advantage is likely to be local demand that does not exist elsewhere. That is, a key competitive advantage of Scandinavian firms was the presence of local demand that enabled them to take advantage of the process of co-invention. It may have been possible to be tied to European or U.S.-based demand, but this would have taken away at least some of the advantages (time to market, etc.) of the Scandinavian firms. Likewise, the Scandinavian firms have explicitly noted the competitive advantages provided by local demand as these hardware vendors seek to move into wireless software.
and services for 2.5 and 3G. The widespread use of wireless across these societies is thus a key competitive asset for Scandinavian firms (and is considered as such by both Scandinavian firms and the host of U.S.-based ICT firms that have set up centers in Scandinavia to “have a presence there”). Local demand (made possible by extensive ICT deployment across the society) has thus been critical in enabling the success of Scandinavian firms, which in turn has been essential to creating the venture funding and the talent pool necessary to create and propel the cycle of further investment, new firm creation, new innovation, and new global firms. Absent widespread deployment, it is possible that the creation of commercial applications from technical innovation—and the attendant creation of new local firms, high paying jobs, etc.—might have taken place somewhere else. There are plenty of European firms from existing ICT markets that rely on joint ventures with Silicon Valley-based firms to generate new commercial applications, for example, and at least part of the value generated by the ventures accrues to Silicon Valley-based firms (and the Silicon Valley cluster more broadly). In the wireless example, however, the flow is the reverse: U.S. based incumbents in existing supply chains are locating centers in Scandinavia to take advantage of local talent and knowledge. At the core of this fact is the presence of cutting edge demand and the attendant co-invention capabilities of the cluster.
Bibliography


Bresnahan, T. and Shane Greenstein, “Technological Competition and the Structure of the Computer Industry”, The Journal not necessarily lead to the creation of substantial opportunities for continued growth—unless one or more firms emerges from these startups to stake out a leading position in world markets. of Industrial Economics, Vol. XLVII, No. 1, March 1999.


Business Wire


CIO Enterprise Magazine


The Financial Times

Gartner Group


Invest in Sweden Agency (November 2000), “IT Sweden in facts and figures.” (Presentation)


Mobile Telecommunications in Europe, HBS case no. 9-589-112.


*PCS News*


*The Wall Street Journal*
Figure 1: Wireless Subscribers by Technology