

**NETWORKING AS A MEANS TO STRATEGY CHANGE. THE CASE OF  
OPEN INNOVATION IN MOBILE TELEPHONY**

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## **ABSTRACT**

The purpose of this article is to investigate how innovation networks can be used to deal with a changing technological environment. This study combines different concepts related to R&D collaboration strategies of large firms and applies these concepts to R&D alliance projects undertaken by Nokia Corporation in the period 1985-2002. The research methodology is a combination of in-depth semi-structured interviews and a large scale quantitative analysis of alliance agreements. For the empirical analysis a distinction is made between exploration and exploitation in innovation networks in terms of three different measures. As a first measure, the difference between exploration and exploitation strategies by means of the observed capabilities of the partners of the contracting firms is investigated. The second measure is related to partner turnover. We argue that in exploration networks partner turnover will be higher than in exploitation networks. As a third measure, the type of alliance contract will be taken; exploration networks will make use of flexible legal organizational structures, whereas exploitation alliances are associated with legal structures that enable long-term collaboration.

The case of Nokia has illustrated the importance of strategic technology networks for strategic repositioning under conditions of change. Nokia followed an exploitation strategy in the development of the first two generations of mobile telephony and an exploration strategy in the development of technologies for the third generation. Such inter-firm networks seem to offer flexibility, speed, innovation and the ability to adjust smoothly to changing market conditions and new strategic opportunities. These two different strategies have led to distinctly different international innovation networks and have helped the company in becoming a world leader in the mobile phone industry and have enabled it to sustain that position in a

radically changed technological environment. This study also illustrates that Nokia effectively uses an open innovation strategy in the development of new products and services and in setting technology standards for current and future use of mobile communication applications. This article presents one of the first longitudinal studies, which describes the use of innovation networks as a means to adapt swiftly to changing market conditions and strategic change. This study contributes to the emerging, but still inconsistent, literature on explorative and exploitative learning by means of strategic technology networks.

## **INTRODUCTION**

For firms, one way of dealing with the pressure of highly competitive environments and short-life cycles, of in particular high-tech products, is to collaborate with other firms for the development and manufacturing of new products. More and more companies have incorporated strategic technology alliances in the core of their technology strategies. The increasing use of strategic technology alliances has led to the establishment of elaborate inter-firm networks in which firms team up in order to generate new products and technologies. In this article these collaborative innovation processes are referred to as “innovation networks”, since business firms seem to have constructed a network of firms around them with which they develop a wide variety of new products over longer periods of time. Innovation networks are particularly important in industries where technology changes rapidly and product life cycles are short.

This study focuses on international innovation networks of firms that develop ICT technologies. Today’s large-scale enterprises are competing in a global economy that challenges firms to organize their innovation network in such a way that the firm remains competitive. Since these innovation networks are by no means accidental, they will change the internal organization of large business firms, the industrial relations among business firms, and potentially industry structures. This study focuses in particular on international innovation networks of Nokia, which succeeded to become a world leader in the development and manufacturer of mobile telecommunications. The main research question of this study is to investigate to what extent innovation networks facilitate adaptation to a changing business environment. This research question is explored by means of two sub-questions:

- With whom, why and on what does Nokia collaborate on product development?

- How does Nokia use networks to explore new or exploit existing capabilities for the transformation of its business?

This study combines different concepts related to R&D collaboration strategies of large firms and applies these concepts to R&D alliance projects undertaken by Nokia Corporation in the period 1985-2002. This study contributes to the emerging, but still inconsistent, literature on explorative and exploitative learning by means of strategic technology networks. The findings of this study can also help managers of other companies in the ICT industry to refine the collaboration strategies of their companies.

### **EXPLORATION AND EXPLOITATION IN INNOVATION NETWORKS**

The exploration of new possibilities and ideas is amongst others associated with search, experimentation, risk taking and innovation (March 1991). According to Granovetter (1973), new ideas and possibilities often arise from interaction with partners (alliances) in different lines of business, since these companies will give access to a different knowledge base. Thus, firms pursuing an exploration strategy for product development will often establish alliances with partners they infrequently partner with (so-called weak tie partnerships (Granovetter 1973)). Exploration is often characterized by opportunistic behaviour and enables a firm to bridge two distinct networks of firms, thereby benefiting from the resources of both networks (Burt 1992). In this article, 'weak ties' are defined as collaborative agreements with a new partner company, usually outside the core technological field in a different sub-sector of the industry (see Table 1). Partners that are characterized as weak ties will have a lower commitment in the partnership than strong ties (Burt 1992; Williamson 1975; 1981a; 1981b; 1985). An indicator for low commitment is a low frequency of

collaboration. When companies work together on only one project, a ‘one-time partnership’, the commitment is presumed to be low (see Table 1). According to Koza and Lewin (1998), the level of commitment is also depending on the particular types of strategic technology alliances. Non-equity alliances, of which mainly joint development agreements and joint research pacts are considered in this article, are assumed to express lower commitment (see Table 1). These strategic technology alliances are non-equity relationships, meaning that the resource input is not equally spread among the partners.

--- Insert Table 1 ---

Exploitation of existing knowledge and capabilities on the other hand is associated with refinement, selection, production and execution (March 1991). An exploitation strategy is aimed at strengthening and broadening basic knowledge of established technologies and products. Maximizing the number of ‘strong ties’ will in this case enrich basic knowledge of established technologies and products (Krackhardt 1992). An indicator of ‘strong ties’ in the context of this analysis is the number of existing partners, usually in the same (core) technological field (see Table 1). The result will be a network of related and similar firms with which longer-term relationships will be maintained. The firms in this network are highly diversified and produce a wide range of related but different products. Since the intensity and the reciprocity of the relationships of strong ties is higher than those of weak ties (Granovetter 1973) the level of commitment in exploitation strategies will presumably be higher than in exploration strategies (Krackhardt 1992). The high frequency of partnerships will therefore be used as an indicator of high commitment (see Table 1).

Exploration and exploitation outside firm boundaries is used in this article to investigate a possible paradigm shift from closed to open innovation systems. In the closed system, large companies hired the best researchers and engineers for the technologies involved and firms protected those inventions with intellectual property rights. Those people discovered all application opportunities of technologies themselves and also all subsequent new products and services were developed in-house and served the company to enter the market first and win (Chesbrough 2003). The open innovation approach is complementary to the collaboration approaches discussed above (e.g. DeBresson and Amesse 1991; Faems et al. 2005; Hagedoorn and Duysters 2002; Küppers and Pyka 2002) in the sense that Chesbrough (2003) also argues that innovations are increasingly a result of a collaboration efforts with other parties. Open innovation also means that a firm has to coordinate, in a flexible way, a large portfolio of innovation projects and assess their value (Chesbrough 2003; Faems et al. 2005). The system is referred to as open, because the boundaries of the product development funnel are permeable. Some ideas from innovation projects are initiated by other parties before entering the internal funnel; some other projects leave the funnel and are further developed by other parties. However, Chesbrough (2003) highlights some specific characteristics of open innovation systems that are sometimes overlooked in other approaches. First, Chesbrough (2003) argues that the value of a portfolio of innovation projects is difficult to estimate and subsequently, that the value of patents is very uncertain (see also Faems et al. 2005). Second, the real value of patents or inventions does not lie in the patent itself but in the specific business model a firm employs to commercialize the associated innovations, i.e. commercially viable technologies, products and services. Third, cooperation is not seen as a solution to all innovation problems, but as part of the portfolio in which

some projects are carried out by the single firm and other projects are carried out in cooperation with other firms (Chesbrough 2003). Hence, there are many different modes of innovation processes, like outsourcing, spin-offs, spin-ins, etc., which may be viable in different innovation projects and circumstances. Thus, an open innovation system may result in a complex network of relationship with other organization, serving different purposes in different periods.

As suggested above, exploration and exploitation strategies are not just internal to the firm. Alliance networks are often used to support these strategies. In spite of the vast body of literature on strategic technology alliances, only very few articles focus particularly on the use of networks for exploitative or explorative learning (for exceptions see e.g. Ahuja and Lampert, 2001; Hagedoorn and Duysters, 2002; Rowley et al., 2000). There is growing consensus in these few contributions that firms pursuing a strategy of exploration for product development are most likely to establish alliances that are characterized by ‘weak ties’ (Granovetter 1973). ‘Weak ties’ in this context imply that companies exhibit low commitment to their alliances and team-up with non-familiar partners. When exploring a particular new technology, companies may not want to enter into inflexible forms of alliances, because they do not know whether the technology will prove to be useful to them. They want to have the opportunity to abandon the alliance at any given moment (Duysters and De Man 2003). Strong ties, characterized by intimate, recurrent and trustful relationships, on the other hand are helpful in the case of an exploitation strategy (Krackhardt 1992). In order to exploit knowledge and make the most of established technologies and products intensive relation with partners are a prerequisite. Exploitation requires intensive knowledge exchange and the creation of economies of scale. Both can be achieved by means of strong ties and much less so in weak ties, because only strong

ties have the requisite intensity for this. Hence, exploration strategies lead to lower-commitment R&D alliances in new technological capabilities, since the focus is on learning new ideas from new partners. Exploitation strategies on the other hand will lead to high-commitment alliances in existing technological capabilities (Koza and Lewin 1998). In the literature some scattered empirical evidence is found on this matter. Hansen et al. (2001), Afuah (2000) and Rowley et al. (2000) found strong evidence that the value of strong and weak ties depends on the type of learning and the external environment. Rowley et al. (2000) showed that strong ties are particularly effective for exploitation purposes and less for effective for exploration. The need for weak ties has been shown to be particularly high under conditions of rapid technological change where the need for explorative learning is highest (Afuah 2000).

## **METHODS AND DATA**

In this article, the use of innovation networks as a means to drive strategic change is investigated. In particular, the focus will be on Nokia's use of its innovation network to deal with changing environmental and strategic conditions.

### *Research methodology*

The research methodology is a combination of in-depth semi-structured interviews and a database analysis of alliance agreements. Both the nature and evolution of innovation networks are examined with an empirical analysis of patterns of strategic technology alliances over time. The data on R&D collaboration were taken from the MERIT-CATI database on strategic technology alliances and a similar alliance database composed by the Centre for Global Corporate Positioning. Although these forms of technological collaboration constitute only one of many possible forms of

R&D partnerships, strategic technology alliances are accepted as useful indicators of collaborative behaviour of firms with regard to the development of new products and services (see for instance Hagedoorn 1995). The distinction between strategic technology alliances and other types of partnerships that the alliances in the database used for this research are primarily related to technological collaboration. Therefore, the transfer of technology and joint undertaking of research is part of the alliance agreement (Duysters and Hagedoorn 1993).

An analysis of overall patterns alliances in the global ICT industry will reveal that innovation networks occur and evolve over time. However, such an analysis may not provide insight into how firms use innovation networks to adapt to a changing business environment, which is the main purpose of this study. For a more in-depth assessment of innovation networks the focus is limited to firms in the ICT industry only and in particular to one large, multinational corporation and its technology-sharing partners. The case study is exploratory rather than explanatory, which means that the case study is used to validate theory rather than explain historical events (Yin 2004: 138).

### *Measurement*

For the measurement of exploration and exploitation in innovation networks, a similar methodology as discussed in Dittrich et al. (2004) is applied. Empirically, a distinction is made between exploration and exploitation in innovation networks on three different measures (see Table 2). As a first measure, the difference between exploration and exploitation strategies by means of the observed capabilities of the partners of the contracting firms is investigated. Companies that follow an exploration

strategy will look for partners with distinctly different capabilities. On the other hand, companies pursuing an exploitation strategy will search for companies with similar technological capabilities. Exploration strategies lead to an innovation network consisting of partners in new technological areas and exploitation strategies to an innovation network of partners in similar technological areas. This is in line with findings of Benner and Tushman (2002) and Ahuja and Lampert (2001) who refer to local versus distant search, i.e. searching for capabilities close or distant to the focal firm's current skills and capabilities.

--- Insert Table 2 ---

Second, in exploration networks partner turnover will be higher than in exploitation networks. Exploration requires access to a diversity of knowledge and a continuous scanning of new technological opportunities. As these opportunities often arise outside existing partners, partner turnover will be high. Exploitation requires intense collaboration, which takes considerable time to build up, and benefits will accrue only after long-term collaboration. Consequently, exploitation networks will have a higher proportion of the same partners over time than exploration networks (Kale et al. 2000; Rowley et al. 2000).

Third, high partner turnover also means that exploration networks will make use of flexible legal organizational structures, whereas exploitation alliances are associated with legal structures that enable long-term collaboration. The flexibility, speed and learning opportunities associated with non-equity agreements by far outweigh the benefits associated with stability and improved commitment, associated with equity

agreements. Equity agreements, therefore, seem to be less well equipped to deal with strategies of exploration (Duysters and Hagedoorn 2000; Spekman and Isabella 2000). Exploration networks are assumed to have a high proportion of non-equity alliances, whereas exploitation networks will have a larger proportion of equity alliances in them (Koza and Lewin 1998).

In an attempt to take the discussion on exploration and exploitation to a higher level a longitudinal development view on companies is included to show how alliance networks are used for strategic change. To find out whether companies actually use and adapt their network when entering a period of strategic change, various network measures will be studied for the particular case of Nokia. In the late 1980s and 1990s Nokia was one of the forerunners in mobile telephony. During the late 1990s Nokia tried to maintain its prominent market position in the development of 3<sup>rd</sup> generation mobile telephony, changing from an exploitation strategy towards an exploration strategy. This makes Nokia a particularly interesting case for studying whether Nokia's innovation network changed accordingly, using the network measures as stated in Table 2.

#### *Data sources*

In order to investigate the significance of Nokia's innovation networks in detail, five exploratory semi-structured interviews were held in the period 1999-2001 with four experts on Nokia's alliance strategy and the Finnish ICT industry; one interview was held in 2001 with Director Partnership Process at Nokia Group, one interview was held in 2001 with a Senior Researcher at the Government Institute for Economic Research (VATT) and one interview was held with a Researcher at the Research

Institute of the Finnish Economy (ETLA). Two preliminary interviews were held in 1999 and 2000 with the Head of Department Industrial Affairs at the Confederation of Finnish Industry and Employers (TT).

For the database analysis, two databases on strategic technology alliances were used. From the Cooperative Agreements and Technology Indicators Information System of MERIT (MERIT-CATI database), all cooperative agreements on ICT related technologies, products, software and services from the period 1985-1996 are selected, which resulted in a sample of nearly 2,500 strategic alliance agreements. These agreements are defined as common interests between independent industrial partners, which are not connected through majority ownership. In addition, only those collaborative agreements have been collected that contain some arrangements for technology transfer or joint research (Duysters and Hagedoorn 1993). Mere production and marketing agreements have been excluded. The focus is on technology cooperation and a combined innovative activity or technology transfer is at least part of the agreement.

The data collected by the Centre for Global Corporate Positioning (CGCP database) was collected in a similar way as the MERI-CATI database and has been used for collecting data of the period 1997-2002 (see <http://www.cgcpmaps.com>). The CGCP database contains information on alliances of a large number of firms, of which data have been gathered from public sources, mostly available on the Internet, and maintained continuously. Data from the IT sector have been traced from 1996 onwards. Telecom data has been entered by Telecom Paper, a specialist company dedicated to providing information about the telecom sector. Descriptions include

starting date, form of the alliance and goal of the alliance. When available, financial details have been included in the description as well.

## **RESULTS**

### *The make-or-buy decision at Nokia Corporation*

Nokia developed as a company by a number of mergers and acquisitions (M&As) of other firms with more or less related but different business activities. M&As as well as strategic alliances are a means to obtain required externally available capabilities (Barney 1997; Wernerfelt 1984). Albeit M&As are still important, Nokia is gradually shifting its focus from M&As to alliances as a means to strengthen their core capabilities, and divesting and refocusing its business activities instead of diversifying business activities.

Although the terms core competence and core capability are frequently used in the literature, a clear definition is not always provided (Duysters and Hagedoorn 2000). A manager at Nokia Group defines the company's core competencies to be in three fields: mobile handsets, network technology and middleware. Nokia used to produce a multitude of products, ranging from rubber boots, toilet paper to radio technology and televisions (in a company called Salora), but has refocused to mobile and radio technology only, with additional network technologies, like switches, routers and modems, and standardized software platforms. The cable division, as many other divisions, has been divested, just like Nokia has now completely left the paper and rubber industry behind (see also Ali-Yrkkö 2001: 24-29).

When decisions are made on the development and manufacturing of new products, the critical element in this rapidly changing technological environment is

speed, according to a manager at Nokia Group. The decision to collaborate or not on product and software development strongly depends on two basic questions. First, will Nokia be able to produce the technology fast enough to do it alone? Second, does the company have the necessary competencies to produce it in a short time period? If the answer to both questions is negative, the company will decide on some form of collaboration or outsourcing with a company that can produce that component fast enough.

If the new product is core to Nokia, i.e. in the domain of mobile telephony, the company will produce it internally without collaborating or outsourcing. Products within the core competence can be produced better, faster and more efficiently internally and alone than in collaboration with other companies, according to a manager at Nokia Group. In line with the concept of exploitation (March 1991), Nokia is exploiting its technological capabilities for the development or extension of existing technologies for existing markets. However, it is remarkable that the largest production volume of mobile phones is still in high-wage countries such as Finland, Germany and the USA. Nokia's production is more efficient in these high-wage countries, since mobile phones are Nokia's core technology that needs highly skilled labour for the production process. Labour costs are then of less relevance, though mobile phones are also produced in low-wage countries such as Hungary, Brazil and Korea.

Products outside the core, which Nokia refers to as "context", are usually outsourced. This is for instance the case with network elements. Nokia buys them from SCI, Flextronics Finland and Elcoteq Networks Oyj, since they can produce them much more efficiently and there are no economies of scale for Nokia in producing them internally. The structure of these agreements differs from strategic

partnerships in product development, since they are mere buyer-supplier contracts. When looking for complementary products, such as integrated circuits, Nokia will simply buy them from e.g. Texas Instruments instead of producing them internally. In case after-sales services are needed, Nokia will look for a partner with a large network of local stores and a good local brand name. The company will collaborate with this local partner instead of setting up an after-sales service network.

The generic strategy decisions to determine whether new products fall within the “core” or “context” competencies of the firm are subject to continuous evaluation. The core competence of Nokia may change over time, which could lead to the decision to outsource production of products that is now considered to be in the core competence of the firm. This has been explicitly mentioned a real possibility by the company itself as well as by researchers in the field. Ali-Yrkkö (2001: 24) notes that “Nokia has reinvented itself so many times that it seems almost impossible to forecast what kind of structure or competencies Nokia will have in five to ten years time”. If a new technology in mobile telephony comes up and some other company than Nokia produces it, the firm will collaborate with them and outsource for that particular technology. For now, Nokia perceives itself still as the best manufacturer in mobile telephony, so anything related to this field will be produced internally without any form of collaboration. However, collaboration will become more important in the future, not only in terms of the number of collaboration but also in terms of the volume of production, according to a manager at Nokia Group. Crucial elements are speed and flexibility of production. In the current technological environment, no single company is powerful enough to define the market alone. Therefore, going alone is not the wisest thing to do.

Accessing new markets is a way of enhancing the performance potential of firms (Hamel and Prahalad 1994; Schumpeter 1942). There are several ways a firm can expand its production line. First, a firm can access a new geographical area to set up production facilities and accommodate a new client base, located a different country from the one(s) a company has other client bases. Second, a company can expand the production process by entering an entirely new product market. Above, it is discussed how M&As can be a means of acquiring competencies that are new to the firm. However, this tool cannot be used when the new product line is new to the industry.

For Nokia, it used to be important to collaborate for accessing new geographical areas. Without collaboration, local production would be impossible due to the restrictions that the local governments make in terms of market access by foreign companies. Collaboration for market access was essential for entering the mobile phone and network technology markets in China, and Brazil, but also in Australia. The local or national authorities or government required Nokia to nationalize their production facilities abroad. This nationalization process usually meant that (part of) a local manufacturer took care of the production process or that a local company sold the products in the name of Nokia. For many foreign entrants, this was the only way to sell their products to the local market. Since Nokia is a global company now, with access to almost every thinkable market, collaboration for this type of market access is not that important anymore, or at least much less important than a few years ago.

For accessing a market that is new to the company as well as to the industry, collaboration may be the only tool to achieve that. This strategy can be referred to as the exploration of new opportunities (Koza and Lewin 1998; March

1991). Nokia typically joins forces to create a new market, for instance with other mobile phone manufacturers like Ericsson, Siemens and Motorola. Market creation was the main goal for entering the joint venture Symbian in 1998. In order to avoid market fragmentation, standardization consortia with other companies in the same line of business, the core business activities, are set up (David and Steinmueller 1995; Egyedi 1999; Hawkins 1999; Schmidt and Werle 1998). Companies in a consortium jointly create a market for a new product and set the standard for that particular technology. Once the installed base is large enough, any new entrant will have to deal with the standard technology that has been jointly agreed upon. SyncML, for instance, is the leading open industry standard for universal synchronization of remote data and personal information across multiple networks, platforms and devices. The SyncML Initiative was initiated in 2000 by Nokia and sponsored by Ericsson, IBM, Lotus, Matsushita, Motorola, Nokia, Openwave, Starfish Software and Symbian, and is supported by hundreds of leading wireless companies. Another example would be the Location Interoperability Forum (LIF), where companies from all layers of the value chain (i.e. service providers, network providers, network technology manufacturers, etc.) are involved, since all companies in the value chain will have to work with the platform. As a result of the LIF, Nokia together with CMG Wireless Data Solutions, Ericsson/Sony Ericsson, Comverse, Logica, Motorola and Siemens have collaborated on the interoperability of Multimedia Messaging Services. For market creation, Nokia perceives collaboration in these standardization consortia of increasing importance.

In order to make these types of relationships work, Nokia has to be able to rely on its partners for on-time delivery. Furthermore, Nokia expects partner-companies to continuously develop and renew products to be supplied. According to a Nokia manager, the challenge is to monitor whether partner-companies do not take the

relationship with Nokia for granted. Especially in relation with end-to-end types of products, Nokia needs other companies that will process partially finished products into a new, marketable end product. This marks the border between a supplier contract and a strategic alliance. The former are contracts for components that are considered commodities, the latter are (sometimes exclusive) agreements for the joint development of components or end-user products. The general trend is that Nokia shifts from pure sub-contracting in production, to manufacturing partnerships, to R&D sub-contracting and ultimately to R&D partnerships. This means that the firm boundaries between Nokia and its partner-companies are gradually fading.

#### *Exploitation and exploration in innovation networks at Nokia Corporation*

Internationalization has been a dominant trend in the Finnish ICT industry from the late 1980s onwards and Nokia has been a trendsetter for the industry as a whole (Keil et al. 1997). In the period of the first technological trajectory in mobile telecommunications, in the early eighties, Nokia has established itself as a manufacturer of mobile phones by adopting the NMT standard initiated by Ericsson. During the second technological trajectory, Nokia gradually caught up with Ericsson and became a dominant manufacturer of mobile phones. Based on the MERIT-CATI database, however, collaboration with Ericsson was not found in the period 1985-1996 (see Figure 1). The collaboration with other mobile phone manufacturers is restricted to licensing of technology with Motorola (and Tandy) and a 4-year joint venture for R&D on cellular communication with Alcatel, AEG and Standard Elektrik Lorenz (SEL). In this 12-year period, Nokia only engaged in 25 alliances, mostly in bilateral agreements. Of those 25 agreements, 14 were joint development agreements, six were licensing and technology sharing agreements and five were joint ventures.

Though there is some joint R&D subject to these strategic alliances, which may indicate an exploration strategy (Koza and Lewin 1998), most of the agreements involve the development of mobile telecommunication technology. This indicates a tendency towards an exploitation strategy (March 1991), since existing capabilities are used for the development or extension of existing technologies for existing markets. One cross-licensing agreement is of special interest. In 1993 Motorola and Nokia engaged in a cross-license agreement, which allowed the exchange of all future GSM contracts.

--- Insert Figure 1 ---

Nokia had many more alliances in the period of 1997-2002 than in the previous period (Figure 2). The period 1997-2002 marks the beginning of the third trajectory of mobile telecommunications, the development of UMTS technologies. In this period, Nokia had 48 strategic alliance agreements, of which 25 were joint development agreements, 16 co-production contracts, six joint ventures and one a standardization consortium. In contrast with the GSM trajectory, Nokia has many joint R&D agreements on relatively new technological capabilities with weak ties (Granovetter 1973), i.e. with partners it did not collaborate before. A good example of an exploration strategy is a joint development agreement with Nordea Bank and Visa International. The companies started a pioneering pilot to test and verify mobile payment services based on dual chip technology. In this case, a relatively new market is explored with an extension of existing technologies and the development of new software development. In line with Koza and Lewin (1998), this would indicate an exploration strategy.

--- Insert Figure 2 ---

In 1997, Nokia and Ericsson engaged in a joint development agreement on W-CDMA, the first strategic alliance that Nokia has on one of the forerunner technologies of UMTS. Another important agreement is the joint venture between Nokia, Ericsson, Motorola, Psion, Siemens and Matsui to form a company called Symbian. This joint venture is aimed at creating a common operating system for wireless information appliances, for it will develop open standards. Shareholding of this joint venture is as follows: Psion has a 26.6% stake, Ericsson/Sony-Ericsson, Motorola and Nokia each have a 20% stake, Matsushita owns 8.4% and Siemens 5%. In line with the use of innovation networks (as discussed in Krackhardt (1992), Koza and Lewin (1998), March (1991)), Nokia exploits its existing technological capabilities through a network of strong ties, namely mobile phone manufacturers, for the development of new products for an existing market.

Thus, in the beginning of the third trajectory Nokia collaborates intensively with competing mobile phone manufacturers such as Ericsson, and Siemens, whereas Nokia hardly collaborated with its competitors in the period 1985-1996. This seems to indicate that Nokia was driving the first two technological trajectories and therefore did not need the complementary competencies of other mobile phone manufacturers. With the rise of a new technology in the third trajectory, joint development of commonly accepted (open) standards is needed. For that reason the partnerships with competitors is essential. An example of a joint development agreement that involves standard setting is a strategic alliance with the Japanese NTT DoCoMo. Nokia and NTT DoCoMo cooperate specifically in promoting open mobile

architecture for WCDMA-based third-generation mobile communication services in areas such as browsing, messaging and application execution (see Figure 2). Another example is the agreement between Nokia, CMG Wireless Data Solutions, Ericsson/Sony Ericsson, Comverse, Logica, Motorola and Siemens, with which the companies have founded the Interoperability Group for the Multimedia Messaging Services. These two large consortia demonstrate that Nokia is still in the forefront of mobile technology, but needs partners to co-develop and define standards (David and Steinmueller 1995; Egyedi 1999; Hawkins 1999; Schmidt and Werle 2001).

When comparing the two last trajectories on the capabilities that are searched for in innovation networks, it becomes clear that especially software development has become more important for Nokia (see Table 3). In the period 1985-1996, more than half of all alliances were on telecommunications and almost one-sixth on both software and microelectronics. In the period 1997-2002, however, almost half of all alliance agreements were on software development and more than one-third on telecommunications. Following March (1991) and Koza and Lewin (1998), this indicates that exploration of new capabilities, in this case software development, has become more important in the third trajectory of mobile telecommunications.

--- Insert Table 3 ---

Nokia engaged in many strategic alliances in both the second and third trajectory of mobile telecommunication technology, though the nature of the innovation networks in the two consecutive trajectories seems different. When comparing the two periods, the proportion of new partners in the third trajectory turns out to be extremely high.

More than 90% of the partners in the period 1997-2002 are new compared to the period 1985-1996 (see Table 4). This indicates that Nokia mainly searched for weak ties (Granovetter 1973), rather than strengthened its relationships with strong ties (Krackhardt 1992). Though some of the partners are still in mobile telecommunications, like Ericsson, Matsushita, Motorola and Siemens, many new areas are being explored. A good example this is the collaboration with Nordea Bank and Visa Card on secure payments over mobile phones (see Figure 2). The search for new partners in new technological capabilities indicates that exploration has dominated Nokia's networking strategies (Burt 1992; Granovetter 1973; Khanna et al. 1998; Koza and Lewin 1998; March 1991).

--- Insert Table 4 ---

A change in networking strategies can also be seen from a change in the proportion of non-equity versus equity agreements (see Table 5). Comparing the second with the third trajectory reveals that non-equity agreements have become slightly more important for Nokia than equity agreements. According to Koza and Lewin (1998), this indicates that exploration has become more important than exploitation in the third trajectory.

--- Insert Table 5 ---

The results of the above analysis of innovation networks suggest that Nokia is predominantly embedded in international innovation networks and not so much in local innovation networks. Another interesting outcome of the analysis of innovation

networks is that the formal network with other important players in the different trajectories of mobile telecommunications, like Ericsson, does not seem important. However, the history of the development of mobile telecommunications suggests that especially these networks have been crucial for the position of Nokia in today's mobile phone market.

## **DISCUSSION AND CONCLUSIONS**

The case of Nokia has illustrated the importance of strategic technology networks for strategic repositioning under conditions of change. Such inter-firm networks seem to offer flexibility, speed, innovation and the ability to adjust smoothly to changing market conditions and new strategic opportunities. Nokia's use of exploration and exploitation strategies has led to distinctly different international innovation networks and has helped the company to become a world leader in the mobile phone industry and has enabled it to sustain that position in a radically changed technological environment. This study also illustrates that Nokia effectively uses an open innovation strategy in the development of new products and services and in setting technology standards for current and future use of mobile communication applications. Nokia is on its way to become a networked organization and Nokia's management sees this organization structure as the future of R&D and production for many high-tech large and small companies.

Both from the results of the semi-structured interviews and the database analysis, it is clear that Nokia has extensively used networking strategies for the development of new products. In the third trajectory of mobile telecommunication, exploration strategies were more important than exploitation strategies. This was demonstrated with the shift towards alliances on new technological capabilities

(March 1991; Koza and Lewin 1998), notably software development, with partners that were new to Nokia (Granovetter 1973).

The results show that Nokia has become a company embedded in both local and international innovation networks. The supplier-network no longer consists of simple sub-contracting or outsourcing relationships. The supplier-buyer relationship has been transformed to a networking relationship where the boundaries between Nokia and its supplier have faded away. This type of networking is the kind of embeddedness that Granovetter (1985) saw as a relationship based on trust and information sharing, rather than a formal contract. Since Nokia has many relationships of this kind and also has many R&D alliances with competitors, Nokia effectively uses an open innovation strategy in the development of new products and services and in setting technology standards for current and future use of mobile communication applications. This seems to be in line with Chesbrough's (2003) conception of firms acting under an open innovation paradigm. Nokia is on its way to become a networked organization and Nokia's management sees this organization structure as the future of R&D and production for many high-tech large and small companies.

This is one of the first longitudinal studies, which describes the use of innovation networks as a means to adapt swiftly to changing market conditions and strategic change. The use of a combined quantitative and qualitative approach has generated a number of internally consistent and potentially important findings. More research is however needed to evaluate the external validity of the current findings.

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Table 1: Four dilemmas of exploration and exploitation

Exploration	Exploitation	Indicator
Search for new technological capabilities	Broaden existing technological capabilities	Partners inside versus outside core competence
Search for 'weak ties'	Strengthen 'strong ties'	New versus existing partners
Opportunistic behaviour/low commitment	Trust/high commitment	One-time versus reciprocal partnerships
Establishing non-equity agreements	Establishing equity agreements	JDA and JRP versus JV and RC

Adapted from Dittrich (2004)

Table 2: Network characteristics for exploration and exploitation strategies

	Exploration	Exploitation
Partners' capabilities	Partners with non-similar technologies	Partners inside current business
Type of partner	New partner	Known, familiar partner
Alliance type	Non-equity alliance	Equity alliances

Table 3: Search for capabilities in innovation networks

	1985-1996	1997-2002
Computers	1 (4 %)	2 (4 %)
Software	4 (16 %)	22 (46 %)
Telecommunications	13 (52 %)	17 (35 %)
Microelectronics	4 (16 %)	1 (2 %)
Other	3 (12 %)	6 (13 %)

Source: MERIT-CATI (1985-1996); CGCP (1997-2002)

Table 4: New partners in Nokia's innovation network

	<i>1985-1996</i>	<i>1997-2002</i>
Number of partners	39	52
New partners	n.a.	48
Proportion of new partners	n.a.	92.31%

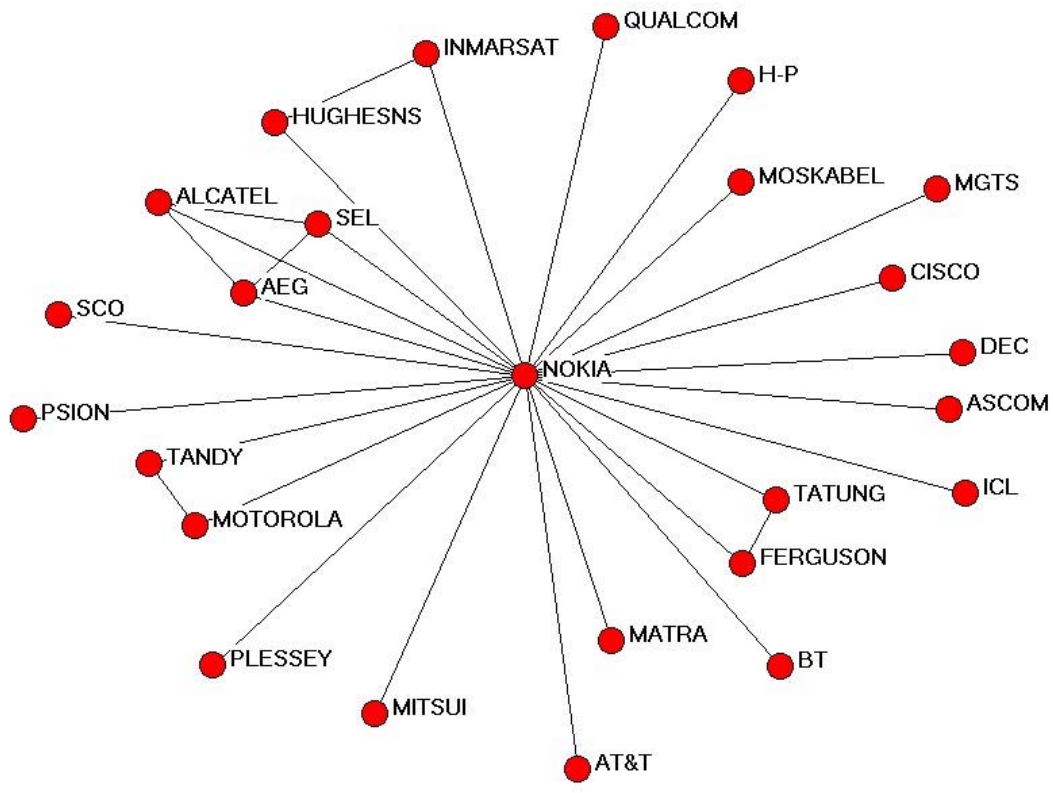
Source: MERIT-CATI (1985-1996); CGCP (1997-2002)

Table 5: Non-equity versus equity agreements

	<i>1985-1996</i>	<i>1997-2002</i>
Non-equity agreements	20 (80 %)	42 (87 %)
Equity agreements	5 (20 %)	6 (13 %)

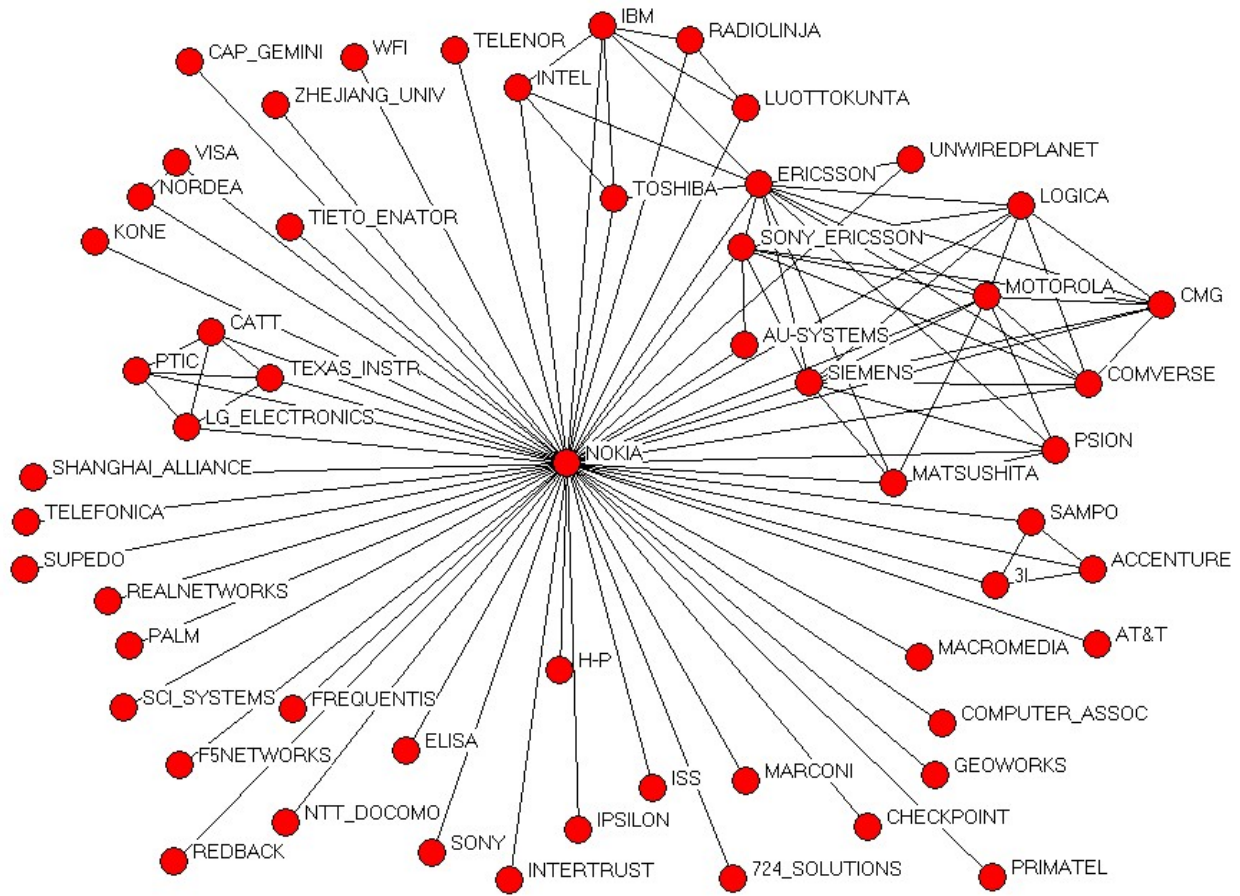
Source: MERIT-CATI (1985-1996); CGCP (1997-2002)

Figure 1: Nokia's innovation network in the NMT and GSM trajectory



Source: MERIT-CATI (1985-1996)

Figure 2: Nokia's innovation network in the UMTS trajectory (1997-2002)



Source: CGCP (1997-2002)