WORKING PAPER No.207

A Framework for Analysing Innovation Capability Of Firms in Network Industries

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May 2003

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Abstract: Our understanding of innovation capability of firms in network industries is rather rudimentary. This paper uses dynamic capability building and innovation literature to propose a framework for innovation capability consisting of three dimensions: sensing capability, combinational capability and relationship capability. The impact of these dimensions on competitive advantage of firms and the measures underlying the dimensions are described.

Key words: Innovation capability, network industries, Sensing, Combinational, Relationship capabilities

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Introduction

Competitive advantage is the ability of a business to derive abnormal profits or rent in a competitive industry [1]. It is built out of the way the firm organizes and performs discrete activities of the value-chain. Innovation is important in sustaining a competitive advantage since it can represent rare, valuable, and potentially inimitable sources of competitive advantage [2]. The literature on innovation management contains numerous frameworks examining the community [3], product development process [4] and communities of practice [5]. Theories such as resource-dependence [6], information processing [7] and disciplined problem solving [4] are used to emphasize the role played by different agents (senior management, project leader, project team, government, suppliers and customers) in the innovation process and in its outcome. More recently, the resource-based view of the firm and its main theoretical derivations, such as the dynamic capabilities approach [8] and the knowledge-based theories of the firm [9,10] have been employed to analyze how organizations, individually considered or linked in networks, gain a better performance in the innovation process through their capabilities of integrating different pieces of knowledge [11,12,13]. To date, theories of innovation have been developed primarily on the basis of exploring technological innovations in manufacturing based industries [14]. Most studies of innovation capability have concentrated on product and process development capabilities [14,55]. There is evidence to suggest that firms undertake both technological and non-technological innovation and all such innovations lead to competitive advantage [16]. A growing number of researchers emphasize the need to adopt a broader definition of innovation and innovation capability in the competitive strategy research [16,17].

In recent years innovation in network industries has gained interest of academicians, researchers and policy makers. Examples of network industries include software, VCR, CD, music and many high-technology product industries. The restrictive focus on product and process capabilities framework may not be appropriate to understand the innovation capability of firms in network industries. Network industries exhibit some degree of public or regulated private ownership, high capital intensity, public goods dimensions and network externalities [18]. Network externalities arise when the benefits a user derives from a product increases as others use compatible product. Because of the strong positive-feedback elements, markets are especially prone to 'winner-takes-all' phenomenon. The demand-side characteristics makes it necessary for firms in these industries to adopt inherently dynamic strategies, including product versioning, rapid product development, direct relationships with users, and frequent partnering [19]. New generations of products, undermining existing market power, appear more frequently in these industries. Joint research and development is often essential to share the risks of innovation and to combine complementary technologies. Collaboration and later coordination on standards across geographical boundaries may be essential to allow

products to work at all. The role of networks, and linkages with complementary organizations is not sufficiently explored in the literature [17]. Innovation research has focused more on the characteristics of innovation and the role of new firms in the creation of new technology breakthroughs rather than developing models to facilitate and formalize the innovation process for existing firms in network industries.

The aim of this paper is to provide a framework for understanding innovation capability of firms in network industries. We begin with the conceptual framework, based on an extensive review of innovation and strategy literature (especially capability-based theories). This framework provides the background to understand how firms in network industries define and sustain an innovation, implementing unconventional strategies such as open source and open standards. Then we explore how various dimensions of innovation capability result in competitive advantage to the firm. Finally, series of measures that capture the underlying dimensions of the innovation capability are posited.

Innovation capability in Network industries: Conceptual framework

Henderson and Clark's [20] four types of innovations, based on specific changes in knowledge, most appropriately characterize innovations in network industries. In this classification, products are seen as systems composed of several components. Integration of various components based on rules and procedures that define input-out relationships is architectural knowledge. The design and manufacturing of components requires specialized component knowledge. Based on the innovation impact on these knowledge routines, they identify innovations as: *incremental, modular, architectural and radical.* Changes in a Software applications working on a DOS environment where internal inputs command gets changed is incremental, while additions of multiple modules doing various functions are added it modular. Incremental innovations improve component knowledge without any modifications to the architectural knowledge. Modular innovation requires extensions of component knowledge of one or more components, without affecting the associated architectural knowledge. If the interface linking the components of the Software, say the protocols change, then it is termed architectural. Architectural innovation happens when component knowledge remains unchanged, but changes accrue in architectural knowledge. Remote access networking (Internet) that displaced fixed access networking is an excellent example of radical innovation. Changes happen in both component knowledge and architectural knowledge change.

Sources of innovations in network industries could be external or internal. The capability (resource)-based view (RBV) of the firm [21,22] suggests that differences in firm performance are primarily the result of resource heterogeneity across firms. Firms that are able to accumulate resources and capabilities that are rare, valuable, non substitutable, and imperfectly imitable will achieve an advantage over competitors [2, 22]. Resources can be divided into physical, human and organizational assets [2]. Capabilities are capacities to deploy resources usually in unique combinations, to effect a desired end [23]. Dynamic capabilities [8] is an extension of RBV approach. It explores how valuable resource positions are built and acquired over time. Dynamic capabilities are rooted in a

firm's managerial and organizational processes, such as those aimed at coordination, integration, reconfiguration, or transformation [8,24], or learning [25].

In a network industry the external sources of innovations include national innovation systems, communities of practice, government and standard setting organizations. National innovation system include both 'things that pattern behavior' like norms, rule and laws (such as patent systems and technical standard) and 'formal structure with an explicit purpose' such as firms, industrial R&D laboratories, universities and public R&D institutes [26]. Community of practice is a group of people working and interacting in a domain of skills and techniques [5]. Professional associations, open source groups such as LINUX and skilled craft guilds are examples of work-related communities of practice. Communities of practice play a very crucial role in network innovations. They train and extend the knowledge base (number of programmers or engineers who can manage/program a particular software), thereby increasing the supply of these resources in secondary software service markets. The larger the number of trained programmers on a particular software/system, the larger would be the installations, features and complementarities [19]. International policy regimes, standard setting bodies and governments get involved in defining radical changes (infrastructure standard, for example CDMA VS TDMA). They enhance the viability of an innovation by signaling and supporting legislation, regulation and standardization efforts [27].

Internet is an excellent example of how government, communities of practice (academic, UNIX and network professionals), National science organizations such as NSF, standard setting organizations such as IEEE play significant role in developing and sustaining a radical network innovation [28]. In 1969, the Defense Department started the ARPAnet. That same year a Bell Labs hacker invented Unix. The Defense Advanced Research Projects Agency (DARPA) were faced with a problem on the ARPAnet. Older computers were being replaced and entirely new ones were being added. The diversity of hardware meant that there was no standard for sharing information. To bring in hardware compatibility, Unix was chosen as a standard because it had been proven to be portable across many different system architectures. As the ARPAnet developed, its new standards were integrated into the Berkeley distributions. TCP/IP was one of the new standards. The period from 1974 to 1978 saw four successively refined versions of the protocol implemented and tested by ARPA research contractors in academia and industry, with version number four eventually becoming standardized. By the mid-1980s, industry began offering commercial gateways and routers and started to make available TCP/IP software for some workstations, minicomputers, and mainframes.

The U.S. government, mainly ARPA, funded research and development work on networks and supported the various networks in the ARPA Internet by leasing and buying components and contracting out the system's day-to-day operational management. The U.S. government also awarded contracts for the support of various aspects of Internet infrastructure, including the maintenance of lists of hosts and their addresses on the network. Other government-funded groups monitored and maintained the key gateways between the Internet networks in addition to supporting the networks themselves. In

1980, the U.S. Department of Defense (DOD) adopted the TCP/IP protocol as a standard. By the early 1980s, it was clear that the Internet work architecture that ARPA had created was a viable technology for wider use in defense. Mandating the use of TCP/IP on the ARPANET encouraged the addition of local area networks and also accelerated the growth in numbers of users and networks. International networking activity was also expanding in the early and mid-1980s. Starting with a number of networks based on the X.25 standard as well as international links to ARPANET, DECNET and SPAN, the networks began to incorporate open internetworking protocols. Initially, Open Systems Interconnection (OSI) protocols were used most frequently. Later, the same forces that drove the United States to use TCP/IP--availability in commercial workstations and local area networks--caused the use of TCP/IP to grow internationally[28].

Not all innovations in network industries are architectural or radical. Most innovations in network industries are extensions of existing technological routines and developed to keep incumbent users locked into networks because of high switching cost [29]. For example, most software products are simply re-implementations of another idea. WordStar was the first microprocessor word processor, but it wasn't the first word processor - WordStar was simply a re-implementation of a previous product on a different computer. Later word processors (such as Word Perfect and Word) were re-implementations by other vendors, not innovations themselves. Lycos was the first on-line search engine, which became popular just as Netscape was launching its Internet browser. But Lycos' first-to-market technological leap was rapidly imitated. Yahoo! followed aggressively, providing a structured index into resources on the web. Both firms expanded product offerings by expanding the available web real estate, providing e-mail and website hosting, country localization, and news links. Based on an advertising model, both Lycos and Yahoo! generate revenue from advertisers rather than users. Google offered speedy concept based search with other services. And because there are few barriers to entry for competitors of Lycos, Yahoo! and Google, the first-mover advantage is likely to prove transient. Several major network (read software) innovations were first implemented as open source or free software projects, especially for those involving networks. Examples of innovations initially released as open software or free software include DNS, web servers, the first spell checker, and the initial implementation of lockless version management.

In network industries system and component compatibility are the levers around which innovation strategies are pursued [30,31]. Firms pursue modular innovations that enhance existing competencies, which affect only components and with no changes in the interface, thus reinforcing existing platforms [32]. For example, Adobe has consistently used third-partly developers to design and develop plug-ins that are integrated into the existing platform. Alternately firms pursue innovations through third-party complementary service providers or have extended (imitate and integrate) the capabilities of their products to include complementarities. For example, In ERP space incumbent players such as SAP, Baan use third-party middle-ware firms such as TIBCO to develop wrappers and adopters. Firms, especially new entrants may identify new business models that could bring about both system and component level changes.

In summary, innovations in network industries include technical (products and process), administrative (packaging, design and delivery) and market-making (intermediation, arbitrage and networking) activities [33]. Innovation is therefore related to market making, ability to recognize superior products and features, locking-in customers through effective training and upgrades and creating and sustaining incompatible systems [34]. Offering a bundle of products customized to satisfy most target group needs (e.g.AOL-Time Warner), locking-in customers by achieving de facto proprietary standard and maintaining and attracting complementary organizations (e.g. Microsoft) and pursuing strategic alliances aimed at achieving size, speed and scope in the market (e.g.-MCI) are well documented competitive strategies in these industries [35].

From the above discussions, it is apparent that innovation capability is related to: firm's ability to reconfigure/extend its resources and capabilities, and its ability to involve/link government, standard setting bodies and communities of practice. Firm's ability to commercialize an innovation may require that its internal resources be utilized in conjunction with the complementary resources of another firm. Complementary resource endowments have been noted as a key factor driving returns from alliances [36, 37, 38]. Firms pursuing an innovation-based competitive strategy would build and nurture these distinctive integration and appropriation skills. Building on the views of Lawson and Samson [39], innovation capability is construed as the ability to continuously transform knowledge and ideas into new products, process and systems for the benefit of the firm and its stakeholders. This is similar to Nonaka et.al. [40] view of knowledge creation, in which a firm is construed as a collection of resources (knowledge as one of these resources) employed by the organization to interact with its environment, and reshape the environment and itself (firm) through the process of knowledge creation. Reconfigurations can be made in a variety of product, market and resource management areas [41] such as a broader product mix, new product development, exploration of new markets and market segments, speed of response, outsourcing and resource leveraging, formation of strategic alliances. This approach is based on looking at innovation as a process and flow of knowledge, rather than a set of actions or outputs. In this paper , innovation capability is construed as being rooted in the organizational capabilities of integrating, storing and recombining the resources and knowledge coming from the market, and developing unique skills that support appropriation of these resources and knowledge. Looking at innovation as a knowledge process opens a new perspective on the interactions among innovation and creativity, and the emerging discipline of knowledge management. Figure 1 illustrates the capability-based innovation framework.

We propose innovation capability in a network industry consists of sensing, combinative and relationship capability. **Sensing capability** refers to the ability to sense the trends and events in the market. **Combination capability** is the ability to reconfigure and extend existing technological knowledge, products and processes that result in alterations of revenue streams and economic value of the firm. Finally **relationship capability** is the ability to cooperate with competitors for establishing standards (co-opetition), partners

for complementarities and develop extensive relationships with customers by implicit locking-in strategies. Following paragraphs discuss these in detail.

Sensing Capability

To be effective innovators, organizations should constantly scan the horizon for new opportunities to satisfy their customers [42]. Generating innovative ideas through environmental scanning is the starting point of organizational innovation and competitive strategy [43]. Market-oriented organizations learn about customers, competitors, and channel members in order to continuously sense and act on events and trends in present and prospective markets [44]. Successful businesses must sense the needs of their target consumers, respond to those needs with appropriate products or services and then think about ways to better satisfy consumers' needs. In some cases, it may be necessary for companies to reshape their offerings [45].

Studies on organizational capabilities, on the other hand, explore the processes through which market knowledge is gathered and integrated over time [46,47,12]. Organizational memory literature [47,47] offers the theoretical framework to explain how the market knowledge is stored and integrated inside the organization, in order to be used in different products, in different periods of time. Explicit (formalized, say models) and implicit knowledge about markets offers firms insights into avenues, assessment of their risk and identify possible set of profitable offerings. Sensing process can be subdivided into two basic modes: surveillance, and search. Surveillance refers to the activities of providing general knowledge to the information seekers concerning environmental conditions. The goal of surveillance is to develop an understanding or awareness about the environment, without any intent on making decision or problem solving. In a search mode, the firm senses the environment for data to find problem solution and to support decision-making. The information research is intensive and purposeful, and involves systematic collection, storage, and analysis of data. Relevant environmental data may not be readily available to meet the requirements of the information seeker. The search activities include data source identification, data creation, data retrieval, data organization and data analysis. Regardless of the sensing mode, the frequency and intensity of sensing depend on at least three factors. The availability of organizational slack resources, perceived relationship between the organization and its environment, and nature of environment the firm is facing. This learning process consists of information acquisition, distribution, interpretation and utilization of information about previous product development (experience and know-how), market trends and technology developments. Cohen and Levinthal [48] suggest a strong relation between organizational innovation and its learning processes, driven by its knowledge bas. Weick [49] assumes the importance of organizational intelligence, because without it an entity cannot learn, remember, and process information. The firms therefore resemble information-processing systems that process information from the environment for their uncertainty and complexity.

Building on the key learning processes suggested in the literature [2,8,11,12,50,51] sensing capability is defined as the capacity of the firm, relative to its competitors, to acquire, disseminate and use market information for organizational change. This

definition of sensing capability extends the concept of market orientation [52]. It is argued that firms possessing high levels of sensing capability not only learn from markets but also disseminate such knowledge within the firm. These firms integrate the facets of knowledge acquired into value-creating activities of the firm. Sensing abilities therefore is related to market-making opportunities, ability to lock-in and identify new business models (often for the old business). Sensing and responding to the development of the global economy, markets, industries, business models, and products/ services requires not just an analysis of individual competitors and industry structure but an analysis of the scalable, broadened capability formed by groups of suppliers [17]. Following the work by Iansiti and Clark [12], the selection of different sources of knowledge and the ability of interacting with them is rooted in a different ability from the one of integrating that knowledge in the organizational knowledge base in a way that makes that knowledge available for other uses. The ability to select different and new sources of market knowledge needs to be complemented with the capability of disseminating that knowledge inside the organization. This is what Iansiti and Clark [12] refer to as internal integration. This kind of ability is necessary not only to speed the product innovation process but also to store this knowledge inside the organization in order to be able to use it in different periods of time.

Combination Capability

The ability of the firm to generate new combinations of existing knowledge is what Kogut and Zander [9] have defined as a firm's combinative capability. Indeed, in many cases this knowledge is imperfectly shared over time and across people, organizations, and industries [53]; knowledge from one group of people or developed in an industry can solve problems emerging in other industries, in a different period of time. Thus innovation is the invention of new technologies, products and production processes, through the successful exploitation of ideas [15]. Innovation occurs when a business introduces new products or services to the marketplace, or adopts new ways of making products or services [54].

Product compatibility requirements in a market may require firms to share interfaces and standardization at component/sub-component level may restrict pioneering advantage. Kusunoki et al. [55] suggests three different knowledge layers underlying organizational capabilities. The first layer includes distinctive individual units of knowledge, such as patents, databases, functional knowledge included in a specific group of scientists/engineers. The linkages between different units of knowledge form a stable pattern or a configuration. The organizational capabilities' deriving from these stable configurations is the architectural capabilities. The third layer consists of the dynamic interactions in which individual units of knowledge are combined and architectural knowledge gets enhanced. Functional capabilities (mostly product and process enhancing) allow a firm to develop and extend its technical knowledge [23]. Manufacturing involvement is vital in terms of ensuring that a particular product can be produced but also in terms of the range of associated manufacturing responsibilities, including capacity, scheduling, technology processes, and inventory management. When manufacturing's involvement in the innovation process is not considered important,

failure results [56]. Another important breakthrough strategy that seeks to remedy, consciously or otherwise, the design/ operations divide caused by mass production is in the development of product platforms across divisions [57]. Platform based strategies allow firms to successfully extend both vertical and horizontal variety without adversely affecting the cost of variety. Ability to offer standardized and modular products offer modular innovation opportunities.

Often, in the network markets technical capabilities alone may not guarantee a sustainable innovation, especially in markets with low imitation barriers. Firms' resort to innovations in revenue streams, licensing/leasing options to increase the installed base and improved service options. For example, from August 1996 AOL paid for content to lure members. AOL would then make a portion of the hourly fees that users paid to access popular content. AOL changed its revenue model in December 1997, charging members flat fees and relying on advertising and transactions to make up for the lost hourly fees, it has been paring down its service to have fewer offerings that generally bring in more revenue. Recently, due to a total reliance on advertising and e-commerce dollars, Internet service providers (ISPs) and portals have been especially hard hit by the slide in money being spent on Internet advertising. Yahoo! has been the leading portal to aggressively pursue fee-based services as an alternative revenue source. As a result, the number of subscribers for its fee-based services increased by 308% in 2001 and the revenue generated from these services increased 125% in just one year, comprising a third of its overall revenue picture.

Relationship Capability

In many cases, a firm's ability to commercialize an innovation may require that its internal resources be utilized in conjunction with the complementary resources of another firm. A wide variety of assets, resources and capabilities are required to make innovations successful. Christensen [58] classifies innovative assets into: 1) scientific research assets 2) process innovative assets 3) product innovative assets and 4) aesthetic design assets. He argues that, while an emphasis on one of the assets is usually the case in most firms, innovations require the combination of more than one asset to be successful. Teece [38] discusses the importance of non-innovative complementary assets in making innovation a successful strategy for a firm. Exploiting external knowledge is a critical component of innovative activities [59]. Though in-house R&D and other forms of internally focused learning may be necessary, firms have to access external resources and modify them in order to develop the capabilities needed to respond to changing market conditions effectively. Collaborative linkages or "networking" improve the innovation potential of the organization [53]. External technology linkages are frequently employed strategic alternatives to internal R&D efforts in highly innovative firms. Fast-growing innovators are the most extensive users of external technological linkages. External linkages supplement the development of new products and processes of firms, especially small ones that tend to suffer a marked disadvantage in material and human resources required for technological innovation.

Hagardon and Sutton [53] argue that in highly dynamic environments, where continuous product innovation is necessary to survive, successful firms develop capabilities of knowledge brokering. They sustain a high pace of innovation by transferring ideas over time and across people, organizations and industries. Their ability as knowledge brokers depends on their network position that allows them to acquire, retain, and retrieve new combinations of information obtained through such a position. In network businesses affected by radical innovations, new standards, new converging technologies, cooperation among competitors is frequently related to competition among different "networks of innovators" that compete to seize market opportunities related to radical innovations, set new standards, and/or integrate existing businesses through converging technologies. Coopetition [60] is an alternative way to behave in the business, frequently undertaken by firms that have to manage emerging technologies in network industries (i.e. biotechnologies, information & communication technologies, electronics, semiconductors, etc.). Rao and Klein [61] argue that software firms are beginning to invest more in complementary assets in order to be able to derive the full benefits of their innovations. Sheen and Macbryde [62] show how collaborative structures pooled together complementary assets in research have resulted in the successful development of smart technology. Apple Computer Inc's alliance with Sony Corporation to manufacture Apple's Powerbook computers is an example of resources shared between competitors. The alliance between Apple and Sony linked Apple's capability at designing easy-to-use computer products with Sony's miniaturization capability, including the manufacturing know-how necessary to make compact products. Neither firm had the capability to develop the Powerbook individually [63].

Several of network innovations happen when technologies and institutional frameworks 'co-produce' each other [64]. Governments, standard setting bodies, firms and individuals define, standardize, and regulate the variety and selection of technologies. Tushman and Rosenkopf [65], define 'technological community' as the set of organizations that are stakeholders for a particular technology or product class. This includes suppliers, manufacturers, user groups, government agencies, standards bodies and professional associations. The technological community coevolves with the 'technology cycle' in a socio-cultural evolutionary process of variation, selection and retention. Specific innovation processes are at work in an innovation community. At level one, the critical process is problem identification, interpretation and sense making. At another level it is integrating several solutions and institutionalizing [3,27]. Institutionalization encompasses legitimization, regulation and standardization. Legitimization events include activities undertaken to publicize, obtain support and legalize product innovations. Regulations and standardization activities is a set of complex and evolutionary set of private and government initiatives such as public standards. Relational capability is defined as the firms ability to acquire technical and non-technical knowledge through external linkages, and to disseminate, unlearn and use such knowledge for organizational benefits.

SUN Microsystems pushing Java as a de facto industry standard is a classic example of relationship capability involving standardization process. Sun ported Java Development Kit (JDK) platforms as an open software operating system thereby allowing developer community to learn and develop applications running on it. As the number of applications and developer community prospered, it tied up with critical application server firms such as BEA to increase the choices customers have for J2EE application servers and to provide them with a trial license of BEA WebLogic Servers with its Solaris servers. Solaris is a key piece of the Sun ONE software portfolio designed to allow for the creation and delivery of Java Web services. SUN posited the pact as a technology J2EE alignment, offering it a product space against IBM and its WebSphere platform. In 1999 SUN submitted the Java technology to European Computer Manufacturers Association (ECMA) for formal standardization. ECMA is a Class A ISO liaison, and this relationship allows ECMA standards to be forwarded to ISO for adoption as international standards. ISO has adopted over 100 ECMA standards using this path. The International Committee for Information Technology Standardization (ICITS) of ISO approved Sun's application to become a "recognized submitter" of Java. The vote is a key win in a long campaign for Sun, which now can control much of what goes into the Java standard. Gaining status as an ISO standard would broaden Java's market because some government agencies and universities won't buy products unless they are based on ISO standards.

Innovation Capability dimensions and Competitive advantage

As stated earlier, sensing capabilities are rooted in the organizational processes of information acquisition, dissemination/interpretation, reconfigurations and extensions that are more systematic, thoughtful, and anticipatory than in other firms. These capabilities not only involve environmental scanning, but also organizational process to identify new opportunities [66]. Sensing capability offers pioneering advantage, strategic imitation, and portfolio innovation. Microsoft offers a good example of strategic imitation. Netscape lacking the experience to make Navigator 1.0 part of a whole package of Internet tools sidestepped the competition by offering its product as a stand-alone browser. By also distributing Navigator over the Web and using a new pricing model that essentially made it free, the startup was able to capture more than 60 percent of the market within two months of the product's release. Having released its Internet Explorer browser after Netscape had become the dominant player on the Web, Microsoft announced that it would follow Netscape's lead in supporting all popular Internet protocols (i.e., the rules computers use to communicate with one another on the Internet), even when they conflicted with Windows-based technologies. In June 1999 Microsoft realized that UNIX server markets were growing for mission-critical, sensitive systems, it pursued the option of restrictive compatibility with the key interface - Kerberos security protocol. Microsoft implemented Windows 2000 with its own, proprietary extensions to this protocol, an open, public protocol that was developed with U.S. taxpayers' funds. Microsoft's extensions to the Kerberos protocol mean that Kerberos-enabled Windows clients will lose some of their features when they interact with UNIX servers. Conversely, non-Microsoft clients will not be able to take advantage of the new security

tricks that Windows 2000 can do, thus providing a firm continued lock-in of customer base.

Combination capability offers extensions of product platforms, economies of substitution and extensions of economies of scope across platform generations. Knowledge complexity and knowledge fungibility are the cause of different forms of increasing returns that have significant and yet different effects on the organization of economic activity. Complexity matters when the production of new knowledge requires the combination of diverse and yet complementary bits of knowledge. Fungibility is found when some units of knowledge can be applied in a variety of different contexts, different products and different processes. If firms can spread the learning from one project to other, learning-by-doing is a major source of capability development [38,62, 67]. When knowledge fungibility matters, the greater is the variety of the activities that can share the same pool of knowledge and the larger are the possibilities to implement new technologies that lower unit costs. In this case the notion of joint-use seems relevant and hence the dynamics of economies of scope. The same knowledge can be applied to an increasing number of different activities with no or little duplication and wear costs [67]. Combinative capability requires an identification and retrieval of the knowledge previously stored and the synthesis of these facets of knowledge with new market knowledge to fit into new combinations.

Microsoft is an excellent example of how a firm sustains competitive advantage through combination capability. Starting in the mid-1980s, Microsoft began to espouse the role of graphical user interface (GUI) in personal computing, as GUIs could deliver on the promises of enhanced personal productivity and usability. It pioneered with to supply developers with a software platform that supports the specific vision. For GUIs, this was a new layer called Windows that ran on top of the existing MS-DOS operating system, and a set of development tools for building applications on top of the Windows layer. To promote use of Windows, Microsoft began selling a line of Windows-based applications, such as Word and Excel. These applications helped fuel consumer demand for the Windows platform and became the de facto interface style for third-party developers. And, of course, these applications eventually grew to become the single largest contributor to Microsoft's bottom line.

Recently Microsoft has been promoting its Web service platform .Net. This product, earlier codenamed Next Generation Windows Services (NGWS), contained the elaboration of new versions of the Windows system, Microsoft Office tools, Microsoft DNA servers, MSN services and also the Visual Studio programming package will use a new integrated client, which unites the dynamic WWW services of the MSN net, the content, .NET services construction elements and the service of the .NET tools, assuring complex, integrated conditions of the consumers' activity. MSN .NET will offer splendid access to the content and services of the independent producers and the widest range of tools based on the possibilities given by the .NET platform. Microsoft's three-pronged .NET strategy follows the same tried-and-true path used to establish Windows' dominance. Firstly, rally software developers with a vision for the future compelling enough to move them to adopt a new software architecture and set of tools. Second,

provide developers with a software platform that supports that MS-led vision, even if it takes a few iterations and massive investment to assure it is on par with or superior to competitors' alternatives. Finally, deliver a set of offerings built on top of the platform as a means to demonstrate to others what is possible (i.e., proof-of-concept), to discover and repair bugs and deficiencies in the platform, and to stake out the most potentially lucrative markets for oneself.

With .NET, a "Web service" Microsoft is espousing it to become the engine for business on the Internet. With .NET, the accompanying offerings are revenue producing "hosted services" running at Microsoft's data center, rather than shrink-wrapped products delivered on CD-ROM. These services will include adaptations of current products, such as Encarta and (eventually) Office; "premium" extensions to existing MSN online services, such as a personalized Internet-based music "radio channel"; adaptations of existing online fee-based services, such as bCentral; and an entirely new set of yet-to-be-defined services. These services, Microsoft hopes, will prove its new platform is ready for the most demanding of customers and will show developers how to make the most of it. However, they could also augment Microsoft's slowing PC software business with a steady, growing revenue stream from subscription and transaction fees.

Relationship capability offers strategic control of complementary and relationship assets that are required for growth. It also accentuates lock-in of customer base by extending service offerings and bundling of complementary services. Relationship capability also offers economies of scale benefits, especially for specialized or co-specialized complementary players, and thus increase the switching cost for the supply-chain partners. For relationship capability to lead to sustainable competitive advantage, two criteria must be met. First, the relationship must lead to some capability that improves the firm's economic performance. Second, that capability must not be available to other firms, or the advantage would not be sustainable. Improvements to a firm's competitive performance enhance its market position by either differentiating the firm in the eyes of customers or making it a low-cost producer. Examples of capabilities that help differentiate a firm might include superior customer service, unique product design, or excellent quality. Relationship capability offers firms to develop and control specialized or co-specialized complementary assets [38]. Verizon Communications and NorthPoint merged their digital subscriber line (DSL) businesses to form a premier broadband communications company dedicated to accelerating the delivery of high-speed data services nationwide. The DSL businesses were combined to create a "new" NorthPoint, positioning the company to rapidly scale its broadband service offerings and to deliver compelling benefits to consumers and businesses. The merged organization combines complementary assets -- Verizon's position in the consumer market and NorthPoint's presence with business customers -- to provide the scale to fuel growth and deliver the full benefits of high-speed connections. Table 1 presents the strategic value and competitive advantage derived from innovation capability dimensions.

Innovation Capability dimensions and measures

Sensing capabilities refer to the mechanisms and processes through which competencies are created, and capabilities in comparative market sensing and customer-linking are strengthened. The main idea is that the 'most distinctive features of market-making organizations are their mastery of market-sensing and customer-linking capabilities [8]. It can be analyzed and measured both in terms of creativity and timeliness of new products/services introduced to the market [47]. The *new product creativity* is the degree to which a new product is novel and has generative capacity (i.e., the potential to change thinking and practice) [47]. The *new product timeliness* 'is the extent to which new products are introduced during environmental conditions that promote their success' [47]. Several studies indicate that market-driven businesses create products that transform market needs [44,52]. Market orientation is defined as the process of generating and disseminating market intelligence for the purpose of creating superior buyer value [44, 52]. According to Slater and Narver [44], market orientation encompasses customer orientation, competitor orientation and inter-functional co-ordination. Customer orientation refers to the *extent to which customer is involved in product and process improvement, extent to which the feedback is used for continuous improvement and the processes employed to obtain the voice of customers into design, manufacturing and delivery.* Khan and Manopichetwattana [43] use a six-component variable that measures firm's *emphasis on technology/market planning, extent of formalization of the process, technology/market evaluation process and the criteria used, extent of external contact.*

The combinational capabilities are obtained through continuous learning driven by the processes of exploitation of things already known and exploration of new knowledge, of things that might come to be known [68]. Problem-solving routines [12] and problem creating activities [69] are the dimensions of combination capability-building processes. Combinational capability is measured based on *incremental product R&D capability, radical product R&D capability, incremental process R&D capability, radical process R&D capabilities, level of Technical Alliance Usage* [14], *extent to which knowledge routines are shared [9], sharing of knowledge and products across product platforms* [57] *over time and across people, organizations, and industries. Mechanisms to make these different persons interact, and recombine knowledge through interacting (number of gatekeepers and routines for making people share problems and solutions (frequent meetings, brainstorming sessions, job rotation/variety)* [70], ad *hoc structures in order to socialize the knowledge inside the organization such as Concurrent engineering* [9] are also included.

Relationship capability reflects the firm's capacity to learn through links and networks formed with external institutions and firms. *Integration capability with complementary and relationship assets* [23, 38], *ability to offer open (free) platforms* [31], *ability to build service revenues or complementarities on free product platforms, ability to influence standard setting, ability to obtain government support for standardization* [3, 27, 64] are the posited measures of relationship capability. Table 2 presents innovation capability dimensions and suggested measures.

Conclusions

This paper offers some first steps in assisting managers in conceptualizing innovation capability as an integrated construct, using it to enhance organizational learning about markets and creating a competitive advantage. We used existing literature about market development, lock-in, imitation and network industries to formulate a conceptual framework of innovation capability. This framework was given further substance by empirical evidence of case studies at large software firms. Integration of the cognitive and behavioral perspective, viewing innovation capability development as an organizational learning process about markets, offers a more holistic view on how managers may influence the innovations. Integration of these perspectives implies that information-processing activities need to be embedded in the very fabric of the organization.

The proposed capability-based framework suggests that a firm in network industry can achieve competitive advantage through the distinctive capabilities in its possession. These capabilities do not merely accrue to the firm but are consciously and systematically developed and nurtured by the firm's strategic leaders. Further research should be directed at the way market-oriented innovation capability can be implemented and/or improved within the organization. Innovation capability in network industries clearly involves multitude of complex variables. Our purpose in this paper was to provide a framework for analyzing innovative capability of firms in networked industries. The resultant framework demonstrates how sensing, combinational and relational capabilities contribute to innovation that can lead to strategic capabilities that are both valuable and hard to imitate. One key observation is that most of the pertinent dimensions (variables) have been, hitherto, examined by past researchers in isolation from the network industry literature and from a larger innovation perspective. Consequently, the relationships amongst the variables in network industries are not sufficiently explored. There is a need for empirical studies departing from an atomistic focus to more comprehensive investigation of innovation capability. To this end researchers should investigate the phenomenon at higher levels of integration. As in any relatively new area of theory building, there are a number of obstacles to surmount in translating theory to measurement and testing. The proposed framework is premised on the capability-based theory drawing heavily from the organizational learning approach to innovation. We advocate the theory-testing path to examine the theoretical relationships proposed using measurement methods, including structural equation modeling (SEM) techniques. More specifically, answers should be found to the following questions. What problems might occur when a firms tries to increase its level of market-oriented innovation capability? How can it solve these problems? What are the antecedents, obstacles and facilitators for implementing innovation capability development?

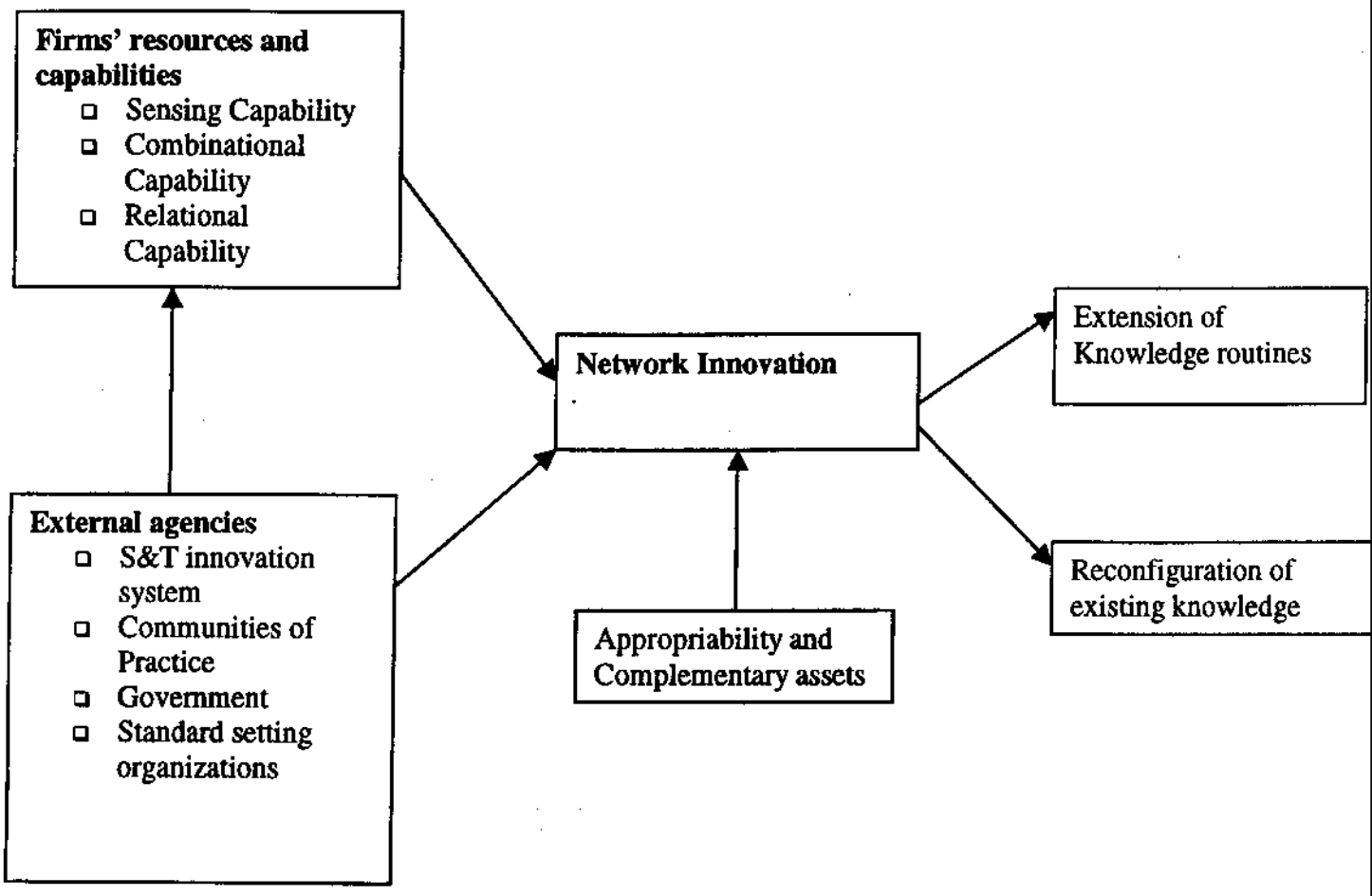

Figure 1: Network innovations and innovation outcomes

Table:1 Innovation capability dimensions and their impact

Capability dimension	Strategic Value	Sources of Competitive advantage
Sensing Capability	Strategic Imitation sensing and lock-in, reinforcement	Market development, pioneering advantage, latent needs, portfolio innovation.
Combinational Capability	Functional capability ▫ Manufacturing/service capability ▫ R&D New revenue streams and economic value in the marketplace	New product development, extensions of existing platform Extend Knowledge fungibility & Economies of scope Exploit economies of substitution
Relationship Capability	Complementary and relationship resources for growth, lock-in and control of ecology	Economies of scale Increase switching cost and coordination costs

Table 2: Innovation Capability dimensions and measures

Innovation Capability dimensions	Measures
Sensing Capability	Customer orientation, Partner (supplier) orientation Competitor orientation [44] Strategic planning, Market research [43] New product creativity, new product timeliness [47] Integration Capability [4,12]
Combination Capability	Functional capabilities [23] Incremental product R&D capability, radical product R&D capability, incremental process R&D capability; radical process R&D capabilities, level of technical alliance Usage [14] Knowledge combination capability [9] Platform strategy [57], economies of scope in knowledge assets, ability to store and retrieve unused knowledge through integrative mechanisms [69]
Relational Capability	Integration capability with complementary and relationship assets [23,38] Ability to offer open (free) platforms [31] Ability to build service revenues or complementarities on free product platforms [31, 23] Ability to influence standard setting [3, 27] Ability to obtain government support for standardization [27,64]

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