A Model of Network-Centric Organizations

WORKING PAPER

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VIJAY GURBAXANI
The CRITO Consortium
The Paul Merage School of Business
University of California, Irvine
949.824.5215 Tel.
vgurbaxa@uci.edu

ROBERT PLICE
Department of Information and Decision Systems
San Diego State University
619.594.6857 Tel.
rplice@mail.sdsu.edu

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Introduction

While the objectives of network-centric operations have been discussed frequently in the business press, there has been significantly less attention paid to developing a scientific understanding of these concepts. The aim of this report is to clarify and describe network-centric concepts and principles, and help companies move toward their operationalization.

Success is increasingly coming to companies that adopt a network-centric approach. In this approach, firms partner in *value networks*—an integrated collaboration of specialist companies, each providing complementary intermediate goods and services. Developing and partnering in these networks brings unique challenges. Consider that:

- Historically, companies have competed by adopting a competitive business *strategy* and executing effectively against the strategy.
- Today, with the advent of sophisticated information and communications technologies, companies have one more potent choice, that of competing via *structure*.

Strategy and structure should co-evolve in the face of ever-changing and more powerful information and communications technologies. To illuminate this challenge, theories of organizational economics are explored, and the impacts of network-related information technology on organizational outcomes are analyzed. The strategy perspective is then used to evaluate the network-centric organization in terms of value disciplines.

A network-centric organization can be thought of as the perfect realization of a *customer-intimacy* strategy. To maximize intimacy with each customer, a unique team of organizations should form. The team, or *value network*, should jointly possess capabilities that precisely match one customer's requirements. In a network-centric environment, then, an organization will belong simultaneously to a number of value networks—one for each product or service it is engaged in providing. Value networks can be differentiated according to their ability to extract *rents*; i.e., to provide a product or service that commands a high return. High-value networks are those with a competitive advantage stemming from the tacit knowledge they contain.

Findings and Management Imperatives

Our research shows that maximizing a network's value depends on facilitating the creation of tacit knowledge everywhere in the value network. This is inherently difficult because decisions are made individually, by organizations in the network, but actions are taken collectively. Although each individual firm in a value network has the ability to make decisions, it depends for its actions on things that take place externally to its own organizational boundaries.

We use the term *value-network leadership* to refer the active management of the tacit-knowledge core of a value network by the firm at the top of the network structure. This capability results in the same decisions that would be made if the entire value network—and all of the tacit knowledge contained in it—were resident in a single organization. The greater the value-network leadership exhibited, the more likely it is that the value network will function with the same superadditivity that would come about if all of its functions were internalized in one firm.

The extent of a firm's *individual* claim on the value produced by a network depends on its marginal contribution to that value. The strategy that will maximize a firm's individual contribution to the network's value, if it is at the root node in the network tree, is value-network leadership. For firms at the bottom of the network tree, a high value share can be claimed by being *value-network intimate*. This is a network-specific value discipline that focuses on exposing a tailored set of knowledge assets to customers.

The network-centric organization exists because of the unique set of capabilities—that is, knowledge assets—that it possesses. Putting these assets to work, to support the value discipline of a network, requires that the organization be explicitly aware of what its core set of capabilities are. Progress toward management focus on an organization's capabilities may be measured on scales that relate to the categorization and quantification of knowledge assets.

A key challenge for network-centric organizations of the future is to balance the requirements of value-network leadership against the proprietary nature of the firm's tacit and technical knowledge assets. If an organization restricts its knowledge to internal use, it will be precluded from membership in the high-value networks that characterize success. On the other hand, if it converts all of its knowledge to technical form and shares it with network partners, it destroys its very reason for existence under the bundle-of-capabilities view of the firm. The resolution of this dilemma lies in the nature of the network-centric organization as a dynamic, rather than a static, entity.

1. Introduction

In today's global environment, characterized by fierce competition and rapid technological change, agility, speed and a relentless focus on efficiency are critical to success. Innovative companies like Wal-Mart, Dell, Amazon, EBay and UPS are showing that survival in this environment requires new organizational structures, capabilities and skills. Success is increasingly coming to companies that adopt a network-centric approach. In this approach, firms partner in value networks—an integrated collaboration of specialist companies, each providing complementary intermediate goods and services. Value networks are linked by sophisticated business-to-business information systems that create and market end products or services to customers. Research at CRITO has shown that value networks achieve superior performance by exploiting the efficiencies that arise from the specialization and focus of the partners, while also benefiting from the synergies of the network. This business model has several key features: inventive value creation mechanisms, a redesigned value chain, strategic partnerships, network effects, informational economies of scale, scalability, and innovative pricing strategies. The optimal choice of business model depends not just on the capabilities of information technology and the Internet, but in large part on a company's existing assets and competencies, and of course, the characteristics of its industry.

Developing and partnering in these networks brings unique challenges. With the Internet infrastructure, specialized business-to-business software, and information standards (such as XML and RosettaNet in the electronics industry), companies are able to share information with partners better than ever before. However, as companies develop these partner relationships, they are confronted with crucial managerial and technological issues. First, they must select the companies that they want to partner with, then design and manage the strategic relationships, recognizing that each company is tying its destiny to the actions of its partners. Implementation of the technology platform and the information standards that will facilitate the effective integration of the partners in the network is a particularly challenging task. Moreover, the data and information sharing inherent in value networks raises significant problems related to the protection of proprietary process and product information.

Consider the observation that the value a company derives from its IT investment depends substantially on whether its customers, partners and suppliers make complementary technology investments. This means that a company's IT strategy can no longer come from purely internal sources; it must be developed in concert with its customers and suppliers. This increases the importance of strategic partnering to determine the appropriate technologies for achieving process integration and information standards to facilitate collaboration in a company's value network. Coordinated investment can result in a large payoff; on the other hand, individual approaches can result in a loss of control over a company's technology investment.

However, this degree of coordination is not only about technology. Achieving high returns from partnership requires a level of information and knowledge sharing that current management practices typically do not address. Should a company share sensitive product information with a supplier that also works with its competitor? Should a supplier be willing to share information about its inventory with its customers? Partnering in these networks requires the development of innovative strategic relationship arrangements that foster trust and collaboration to facilitate such sharing, but must be dynamic enough to be effective in the uncertainty of our times.

Historically, companies have competed by adopting a competitive business strategy and executing effectively against the strategy. Typically, companies did not make substantial changes to their organization structure; rather this evolved slowly over time. Today, with the advent of sophisticated information and communications technologies, companies have one more potent choice, that of competing via structure. We argue that new organization structures enabled by advanced information and communication technologies allow for tremendous gains in efficiency and productivity. In our current global, networked economy, companies have the option of migrating their business models to a more efficient network-enabled form. The essential argument for a move toward network-centric operations is as follows.

- Companies have historically owned or controlled aspects of their operations even when more efficient external suppliers of these products or services existed, because of the need to tightly coordinate related activities.
- Today, in the presence of advanced information technology capabilities, companies can achieve high levels of coordination without ownership and exploit the superior production capabilities or economies of scale and specialization of external suppliers.
- Even within a single company, the implementation of network-centric principles allows for significant gains in efficiency.

This is not to downplay the impact of strategy. Rather, it is to suggest that strategy and structure should co-evolve in the face of ever-changing and more powerful information and communications technologies.

While the objectives of network-centric operations have been discussed frequently in the business press, there has been significantly less attention paid to developing a scientific understanding of these concepts. The aim of this report is to clarify and describe network-centric concepts and principles, and help companies move towards the operationalization of these concepts. We believe that a scientific understanding of the subtle, but critical, interplay between information technology, organization structure and business strategy is essential for executives who need a robust knowledge base for transforming their companies into successful competitors in the networked economy.

2. Description of the future enterprise organization

2.1. Approach

In developing a definition and description of the future enterprise organization, we make use of multiple perspectives. These views can be categorized according to their antecedents in the fields of economics and strategy.

Figure 1 summarizes the plan of analysis. First, theories of organizational economics will be explored, and the impact of network-related information technology on organizational outcomes will be analyzed. This will lead to a proposed definition of the network-centric organization, which we will obtain by extrapolating trends in information economics their limits.

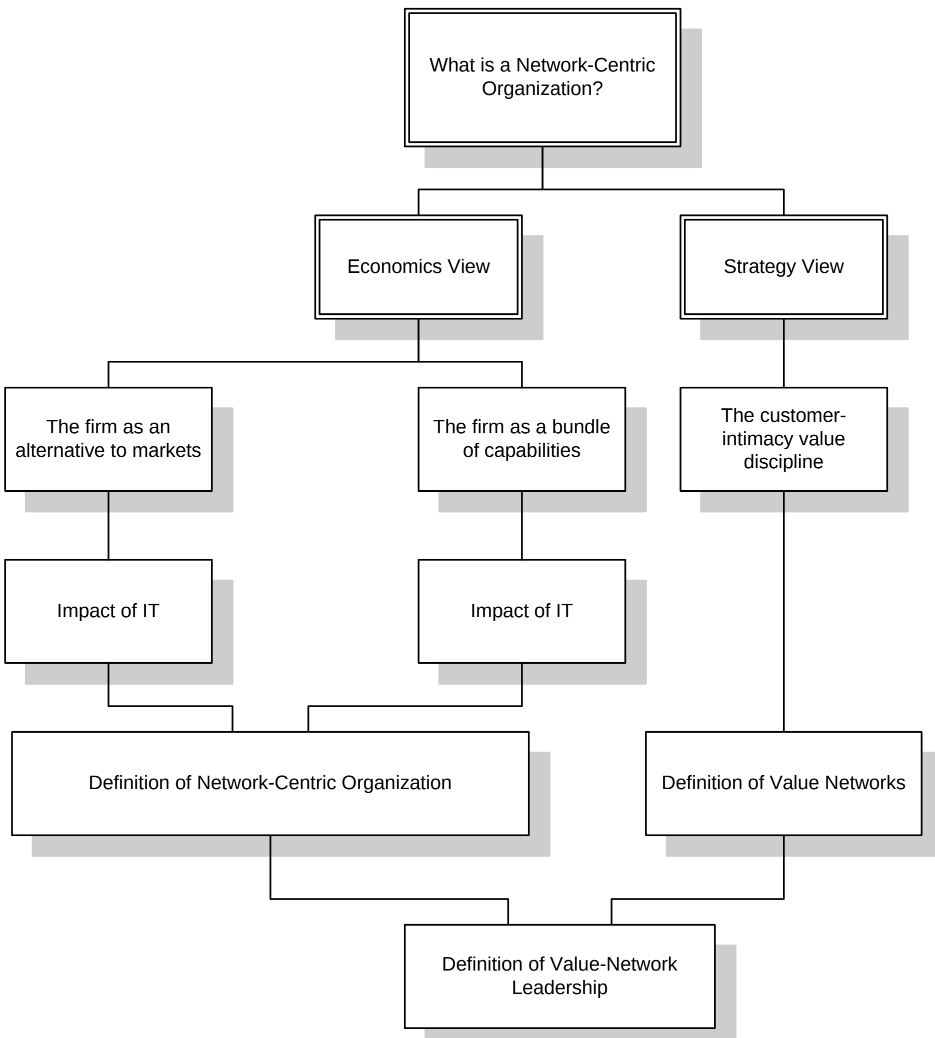


Figure 1. Plan of analysis

Next, we will use the strategy perspective to evaluate the network-centric organization in terms of value disciplines. This will lead to the concept of a value network: the basic unit of economic organization in the network-centric environment. Combining the economics and strategic views, we will derive the notion of value-network leadership. This concept will then allow us to develop operating principles that will maximize value in the network-centric future.

2.2. Economics view: Impact of IT on governance structure

2.2.1. The firm as an alternative to market-based procurement

The economic definition of an organization

Before we can develop a definition of a network-centric organization, we must think carefully about the basic economics of organizations, and indeed, about the very definition of an organization.

In microeconomics, the unit of productive activity is taken to be the *firm*. The tradition of firm-centered economic thought goes back at least to Adam Smith, who in 1776 famously expounded on the benefits of the *division of labor* in a pin factory. Smith argued that firms arise to take advantage of opportunities to increase workers' productivity beyond what they could achieve individually, and that the invisible hand of market forces will lead to unbounded increases in social wealth as firms are formed and dissolved in the course of competition. The long tradition of economic thought on these issues has resulted in multiple lenses through which we can view the construct of a firm.

There are many facets to our everyday notion of what constitutes a firm, or organization. One often-quoted definition is:

> . . . a legal entity – one that signs contracts with its suppliers, distributors, employees and often customers. It is also an administrative entity, for if there is a division of labour within the firm or, it carries out more than a single activity, a team of managers is needed to coordinate and monitor these different activities. Once established, a firm becomes a pool of learned skills, physical facilities and liquid capital. Finally, 'for profit' firms have been and still are the instruments in capitalist economies for the production and distribution of current goods and services and for the planning and allocation for future production and distribution.[1]

The first part of this definition aligns with the *transaction-cost economics* perspective. This point of view holds that firms are not strictly necessary for society to enjoy the productivity benefits from the division of labor, but they can offer relative cost advantages compared to dealing through markets. That is, firms arise to avoid the costs associated with market-based coordination. Once established, firms should internalize activities only when the costs of coordinating and monitoring them are less than the market transaction costs that would arise if they were acquired from external entities. The costs of transacting on markets include such things as searching for potential trading partners, exchanging product information, negotiating contracts, verifying contract compliance, and dealing with contract default. Some of these costs could be avoided if individual specialists were to form a permanent relationship and coordinate their efforts

[1] Chandler, A. D. (1992) "What is a Firm - A Historical Perspective," European Economic Review, 36, 483-492.

through a managerial hierarchy. Thus, the firm is a fallback alternative to markets, to be used under conditions of *market failure* (such as when markets are unduly expensive). The prescription regarding how much a firm should do internally versus externally represents a statement on the subject of *firm boundaries*.

Another important kind of market failure is the *holdup problem*: a circumstance in which two parties bargain asymmetrically, so that one can take advantage of the other when they engage in a market transaction. Examples arise in cases of *relationship-specific investments* and *incomplete contracts*. Suppose an automobile parts supplier must pay for a special die in order to fulfill a contract for body panels. The die is expensive, and has no use other than to make panels for a specific make and model of car. If the supply covers all possible contingencies of the relationship between the supplier and the car maker, the supplier can count on achieving a certain return on investment in the die. But, if the contract is incomplete—meaning that some unforeseen contingency might require renegotiation—the supplier will be liable to holdup. During renegotiations, the car maker can take advantage of the fact that the supplier cannot put the investment in the die to any alternative use. Anticipating this outcome, the supplier might be unwilling to make the investment in the first place, or might undertake expensive defensive measures to avoid a holdup scenario. The attendant inefficiencies could be avoided if the automobile manufacturer were to pay for the die itself and internalize the production of body panels. [2]

The *frequency* and *uncertainty* aspects of a transaction, in addition to its associated asset specificity, are positively related to the decision to adopt internal governance. A higher level of uncertainty regarding a transaction increases the necessity for adjustment and renegotiation after a contract has been entered into. In that case, a hierarchical arrangement, where a single entity has control over both sides of the transaction, will offer a smoother path to renegotiation and agreement. When a particular transaction is entered into frequently, the fixed costs of establishing the hierarchical governance structure can be more widely spread, further motivating the adoption of internal governance.

Information considerations, such as uncertainty about the availability of production inputs may cause firms to make suboptimal investment decisions if markets are used rather than internal governance. Because information flows more freely within a firm than between firms, if a firm were to buy one or more of its suppliers the resulting improvement in information would allow a more accurate supply forecast. Another information-related construct that has been related to firm boundaries is *agency* concerns. When it is difficult to measure or monitor some aspect of performance related to a production process, it may be optimal to perform the process within the firm rather than externally. For example, the sales function may best be performed internally when it is important for sales personnel to pay attention to long-term customer relation activities (which are hard to monitor) as well as current sales (which are easy to measure and compensate). On the other hand, in the fast-food industry the difficulty of measuring a

[2] Klein, B., R. Crawford and A. A. Alchian (1978) "Vertical Integration, Appropriable Rents, and the Competitive Contracting Process," Journal of Law and Economics, 21, 297-326.

local manager's efforts in staffing and controlling waste may lead to franchising rather than ownership of retail outlets.

One difficulty in applying these theories to practice is the lack of a clear distinction between what is internal to the firm and what is external. When governance is the sole criterion, the line is blurred by a host of employment, subcontracting, joint-venture and supply agreements that can extend a firm's management prerogatives well beyond the nominal limits of its authority. Some economists focus instead on the *property-rights* approach, in which the firm is defined as a set of non-human assets under common ownership. The analysis seeks to determine ownership allocations that are socially optimal, in the sense that they will produce the greatest output from the economy as a whole. While the property-rights view clearly resolves the question of what is internal to the firm and what is external, the *nexus-of-contracts* perspective declares that the defining characteristic of the firm is not whether interactions are governed by contracting, but the kind of contracts involved. Contracts within the firm tend to be open-ended, needing conscious administration, coordination and adaptation among the parties. Therefore, the firm is less a matter of ownership than of coordination. Taking these perspectives together, the question of whether an entity is inside or outside of a firm must be considered simultaneously along two dimensions: the degree of ownership integration the degree of coordination integration.

IT's impact on market-failure views

Although economists continue to refine and extend the theoretical underpinnings of the firm, our interest is in the impact of technology—information systems in particular—on the motivations for firms either to extend or reduce the number of activities that they manage internally. By focusing on these forces, we will be able to from a picture what a firm of the future might look like as technology continues to advance.

Table 1 lists the various market-failure theories of the firm discussed above, and summarizes the impact of technology on the forces that give rise to hierarchical, rather than market, governance.

Transaction costs

As the use of interorganizational computer systems to facilitate business-to-business transactions has accelerated, there has been a significant shift in the relative costs of doing business with outside entities, as compared to performing functions internally.

- A major benefit of online marketplaces, or B2B exchanges, is their ability to match buyers with sellers and reduce the search costs associated with external contracting. The use of online auctions in industry settings characterized by competitive conditions on both buying and selling sides of the trade has become commonplace for certain commodity products, but there are profitability considerations that may inhibit their adoption in other settings. Nevertheless, there is no question that various forms of electronic transacting, including private exchanges and general Internet-based search engines, have made it easier for smaller, specialized firms to make their capabilities widely known to potential business or trading partners.

- Covisint is an example of a B2B exchange that was initiated by major automobile manufacturers for the express purpose of reducing the costs of contracting with external suppliers. Covisint originally included an auction component for matching car makers with suppliers, but that has now been spun off into a separate facility. The primary benefits Covisint provides come from its role as a standard-setter and communications facilitator between the car makers and the thousands of firms that produce their inputs. The costs of negotiating and documenting contracts are reduced through the standardization of bid-and-procurement technical-requirements documentation. By using the B2B exchange to manage the negotiating process, automated tools can be applied to validate suppliers' bids and to help ensure that all requirements have been dealt with in the contract.

- Information technology can also closely link the information systems of a firm and the external entities with which it transacts. For example, WalMart has invested heavily in interorganizational information systems. These systems—together with matching capabilities that WalMart requires from its major suppliers—have enabled the retailer to monitor the performance of its suppliers in real time by giving it access to much of the same information that is available to managers in the external organization. This close binding of the buyer and seller information environments gives WalMart's management the ability to react to events *outside* the firm with nearly as much agility as to events *inside* the firm. Technology that permits firms to implement such systems reduces the importance of monitoring and verification costs as a motivation for hierarchical governance.

- Information technology can also be employed to mitigate costs associated with contract nonperformance and default. A distinguishing feature of B2B exchanges, compared to other interorganizational information systems, is that they offer the possibility that information can be collected centrally regarding all transactions undertaken between buyers and sellers. Both Amazon.com and eBay have used seller ratings to give buyers information about the past performance of potential trading partners. Such information sharing regarding reputation and competence can reduce the likelihood of contract default. Further advancements in B2B exchange functionality, combined buyer-seller interorganizational information systems, could be used to implement automatic monitoring of progress toward contract commitments, allowing the early detection and correction of performance problems. These trends suggest that technology will continue to lessen the importance of contract monitoring and default as a motivation for expanding firm boundaries.

From the evidence above, it is clear that information technology has the potential to keep reducing the magnitude of external transaction costs This trend suggest that transaction-cost economics will continue to decline in importance as an explanation for the existence of the firm.

Relationship-specific investments

Information-technology trends are also lessening the extent to which relationship-specific investments will influence the choice between internal and external organization.

- The Covisint B2B exchange, which standardizes information interfaces between buyers and sellers, exemplifies the role of IT in broadening the applicability of investments by outside suppliers. Without such standards, each carmaker would produce technical requirements specifications in its own format and following a purely internal engineering process. Covisint moderates these practices in two important respects. First, it encourages engineering teams within the buying organization to collaborate with potential suppliers throughout the design and development process. The suppliers thereby have an opportunity to influence the specifications such that common manufacturing equipment and techniques can meet the needs of all of their customers. Second, although suppliers must invest in IT capabilities in order to make their information systems interoperable with Covisint, once this is done they will be able to deal on an equal footing with any of the carmakers. Thus, B2B exchange technology, when tailored to the technical requirements of an industry, can reduce the level of supplier investment that is specific to a particular buyer relationship.
- Manufacturing technology itself is making investments more broadly applicable to producing a variety of products for multiple uses. Toyota has invested heavily in flexible manufacturing systems, and can intermix the production of different car models on single production line. Honda is similarly producing multiple car models on single production line in New York. Networked computers are also being integrated with machine tools to increase productivity and flexibility. Timken has used these capabilities in a new plant that can produce a variety of bearing products for different customers without requiring retooling. Timken's employees can modify the digital designs for a product and load the new specifications into the network of machine tools in a matter of minutes.

As technology trends continue, it is likely that investments in plant and machinery will become even less relationship specific, and that the proportion of supplier investment going to information capabilities rather than physical plant and equipment will continue to increase. These forces can be expected to reduce the effect of relationship-specific investments on the decision to acquire inputs internally rather than from a market.

Incomplete contracts, uncertainty, nexus-of-contracts

As firms strengthen their ability to collaborate and share information with their suppliers, the effects of uncertainty and incomplete contracts on the procurement decision can be diminished.

- Dell deals with a limited number of suppliers, but requires close cooperation and information sharing with each of them. The Internet has made it possible for both large and small suppliers to participate in information sharing networks. Dell has used this capability to shift the notion of the buyer-supplier relationship from a supply chain to a supply network. The real-time sharing of information has also changed expectations on the part of both buyers and sellers. They no longer enter into a contract with a fully specified set of obligations; rather, they continuously adjust the contract terms in response to real-time market conditions.

- As noted above, WalMart has implemented information-sharing networks with its suppliers that permit management to respond to external conditions on much the same basis as internal events. This erodes the nexus-of-contracts perspective of the firm, since the contracts with outside suppliers can be made open-ended in nature, much like internal contracts.

Supply-availability information

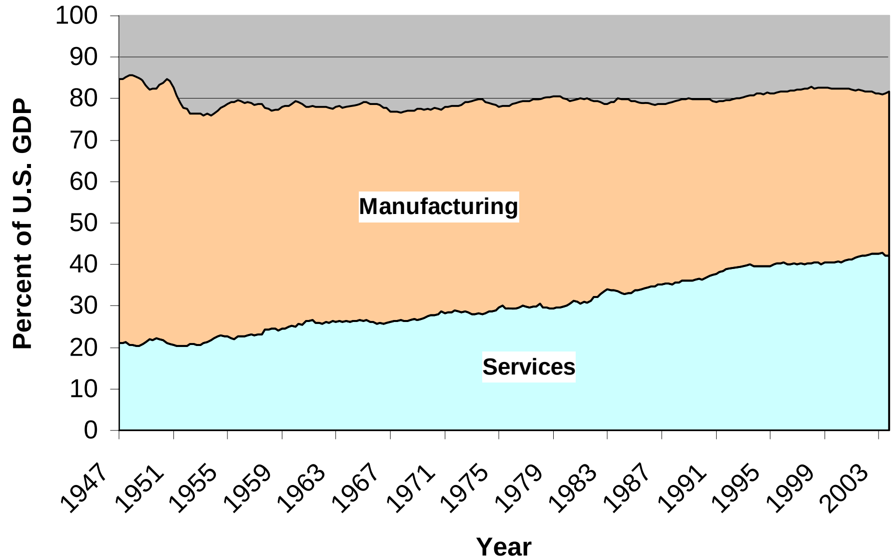
The use of interorganizational information systems has transformed the manufacturer-supplier relationship in a number of industries. The Internet has given rise to new opportunities to strengthen the information-sharing aspects of a trading partnership, so that internalizing the production of key inputs is no longer necessary in order to obtain timely supply information.

- Cisco management meets regularly with the CEOs of supply partners, planning for the strategic integration of their information systems. The goal is for Cisco and its suppliers each to plan ahead for the volume and timing of orders.
- Dell and WalMart, as noted above, each have closely linked their information systems with their suppliers, letting respond to changes in the availability of key inputs in real time.

Agency concerns, property rights

Agency theory predicts that the difficulty in monitoring performance of key production processes inside or outside of the firm will have an influence on the choice between hierarchical and market governance. Increasingly, however, technology is providing mangers with the means to track progress toward both short and long-term objectives, using consistent performance metrics.

- Enterprise resource planning (ERP) and enterprise application integration (EAI) tools are giving mangers an integrated view of the linkages between different aspects of an organization’s value chain. ERP systems integrate the view of activities within an enterprise, and EAI systems provide linkages across firm boundaries.
- Developed economies increasingly are dominated by service-based industries, which have relatively high investments in human and information-system assets (see Figure 2). Within the manufacturing sectors of developed economies, the investment in non-human assets is reduced by the use of flexible manufacturing technologies that achieve increased efficiencies from plant and equipment. Thus, non-human assets are decreasing in significance compared to human and information assets. Much of the asset value of large companies is in the form of intellectual, rather than physical capital, and there are indications that higher levels of such investments are correlated with high firm performance measures. As a result, the importance of the property-rights approach to analyzing firm boundaries may be expected to continue to decline.



Source: U.S. Bureau of Economic Analysis

Figure 2. Shares of U.S. gross domestic product

Summary

Technology is seen to impact each of the market-failure theories of firm boundaries. Moreover, the impacts are generally in the same direction: as technology improves, there are fewer reasons to expect that the firm will provide a superior means of governance, compared to markets.

2.2.2. The firm as a bundle of capabilities

If we were to form a picture of the network-centric organization of the future solely on the economic theories summarized in Table 1, we could imagine a limiting situation where all of the reasons for firms to exist are eroded away by advancing technology. We would then envision a network-centric future in which all governance would be conducted through markets. However, there is another theoretical perspective that must be considered, which has come to be known as the *capabilities*, or *resources,* view of the firm. Rather than focusing on the role of the firm in overcoming some deficiency or cost attached to the market-based alternative, the firm is seen as a repository of a unique set of resources, acquired over time. Human resources, especially, tend to increase in value as personnel gain knowledge and experience.

Each firm has particular strengths that arise from the unique historical path it has followed, and the way in which surplus resources will be put to use will depend on those strengths, or *capabilities*. The firm's routines and capabilities are held to be *superadditive*, in the sense that the firm as a unit can accomplish more than the sum of the skills of its personnel. Part of the firm's base of capabilities is due to the individual skills it possesses, and another part is due to its organization: the way the skills are linked together.

Table 1. The firm as an alternative to markets

Economic Theories	**Technology impacts**	**Examples, illustrations**
Transaction cost economics	• Search costs reduced by electronic markets • Negotiating costs reduced by adoption of industry standards for information interchange • Verification and monitoring costs reduced by real-time data linkage • Contract defaults reduced by information sharing	• Auction markets • Covisint • WalMart • Amazon.com • eBay
Relationship-specific investments	• Move to open systems, standards-based collaboration • Flexible manufacturing	• Covisint • Toyota • Honda • Timken
Incomplete contracts, uncertainty, nexus-of-contracts	• Information transparency enables closer cooperation • Open-ended contracts can be better managed with external suppliers	• WalMart • Dell
Supply availability information	Integration with supply chain	• Dell • WalMart • Cisco
Agency concerns, property rights	Improved monitoring Information economy reduces importance of non-human assets	• ERP, EAI • Services-based economy • Intellectual property rights

Figure 3 illustrates the idea of superadditivity with respect to a simplified model of serial production processes. In this example, five steps are involved in deriving a firm's end product from its production inputs. Suppose that steps one and two have a low degree of interdependence. That means that the algorithms needed to perform them can be understood in isolation from each other, and there is no need for personnel performing step one to interact with those performing step two. Separate performance of these steps—perhaps by different organizations—would be a viable option, and would produce a result equal to that obtainable if the steps were performed together in a single organization. Steps three and four are taken to be superadditive, due to a high degree of interdependence between them. The superadditivity condition implies:

1. that the choices made and actions taken by people performing step three will influence or limit the choices available to those performing step four, and vice-versa; and
2. that the knowledge needed to perform steps three and four cannot be written down and transferred easily from one organization to another.

When both of these conditions obtain, the combined performance of the steps within a single organization will have an outcome that is *different* and *better* than if the steps were performed separately. Thus, the boundaries of the firm are constrained: they should not collapse beyond the point where they encompass the set of superadditive activities.

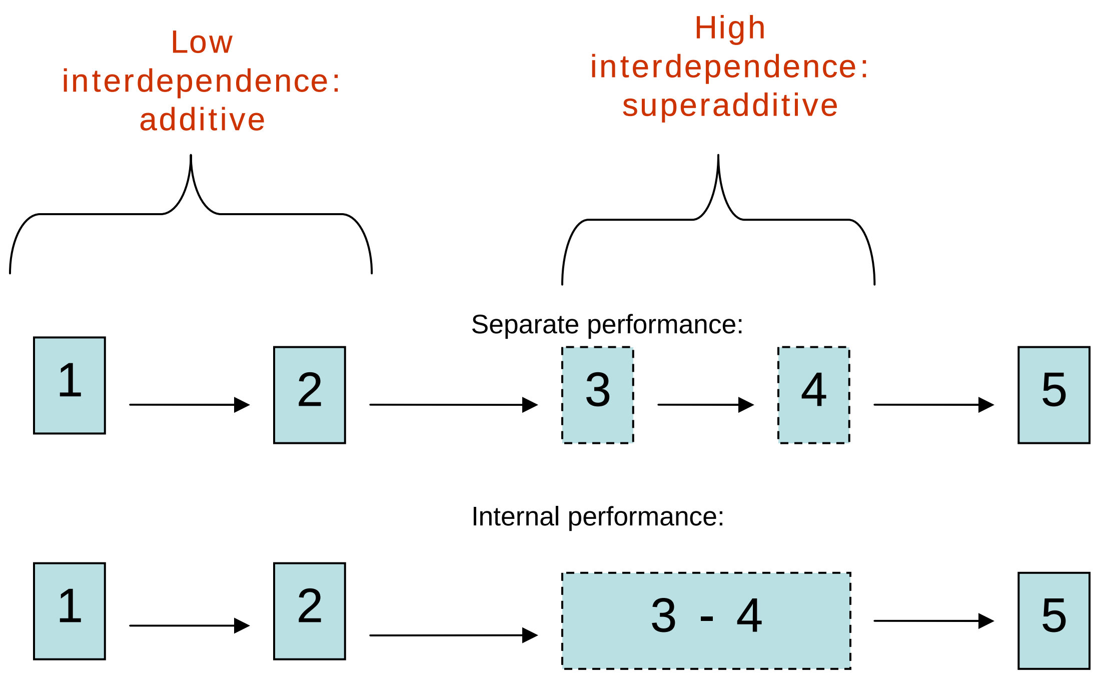


Figure 3. Superadditivity of processes

These observations lead to another way of viewing a firm's resources; namely, to equate them to *knowledge*. In philosophy, it has long been observed that knowledge comes in two types: that which can be written down and transferred easily, and that which is difficult to articulate. The terms *technical knowledge* and *tacit knowledge* will be used to distinguish them. Technical knowledge, by definition, is capable of being stored in a data base and transferred easily between firms. Therefore, processes requiring only technical knowledge will not be superadditive, and could be performed by separate organizations. Tacit knowledge, on the other hand, is *idiosyncratic:* it arises from the *joint* history and experiences of the people who make up the organization *as a whole*. Because it is difficult (that is, costly) to codify and transfer, tacit knowledge results in the *superadditivity* of processes. Subdividing a process that requires tacit knowledge will result in inferior performance, because tacit knowledge is jointly—not individually—held. The sum of the tacit knowledge held by parts of a subdivided organization will not equal that of the combined organization, because any subdivision eliminates at least some joint history and experience.

IT's impact on capabilities view

The capabilities view of the firm, then, holds that the intrinsic core of an organization is a function of the tacit knowledge that it holds. In the short run, this tacit knowledge will not be known to others, and it therefore gives the organization a competitive advantage. In the medium or long term, however, knowledge that was idiosyncratic to a particular organization's experience will tend to become widespread. Repetition, observation and repeated attempts by others to replicate an organization's success will eventually erode the uniqueness of a firm's capabilities.
Information technology has an important role to play in this process and in the applicability of the capabilities view to networked environments. The impacts of IT can be considered along two dimensions.

- Interorganizational computer systems can allow project teams to share technical knowledge across firm boundaries, and to interact with trading partners on a real-time, ongoing basis during various stages of production. B2B exchanges such as Covisint represent early attempts at fomenting the sort of collaboration and cooperation across firm boundaries that can allow members of separate organizations to cooperate in many project activities. In this sense, a *collaborative* B2B exchange is a step toward a superadditive interorganizational information system. As time goes on, the joint history and experience of the buyers and suppliers who collaborate through the exchange can give rise to tacit knowledge that is not held within the boundaries any one organization. In terms of Figure 3, the tacit knowledge to perform steps three and four may be embodied not in a single, permanently constituted organization but in a collaborative *network* of organizations.
- Ongoing practice and research in the area of *knowledge management* can maximize the use of tacit knowledge and accelerate the transition of knowledge from the tacit form to the technical form. Two strategies for managing knowledge in current use are *codification* and *personalization*. A codification approach seeks to convert as much knowledge as possible into technical form, and to make sure it is available within the process environments that it can positively influence. The personalization approach is focused on bringing together people who possess the tacit knowledge that is resistant to being codified. A combination of these strategies is appropriate. The codification strategy limits an organization's dependence on key personnel (who eventually will exit the firm). The personalization strategy requires the organization to give explicit attention to its tacit knowledge resources, and to play an active role in facilitating the creation of new tacit knowledge rather than leaving the process to chance.

2.2.3. An economics-based definition of the network-centric organization

Having noted the influence of technology in defining the boundaries and operations of an organization under two economic views, we are in a position to propose a definition of the network-centric organization of the future. The concept is due to following trends.

- With respect to the view of the firm as an alternative to markets, advancing information technology tends to *erode* firm boundaries, leading to an empty intrinsic core at the limit.
- With respect to the view of the firm as a bundle of capabilities, knowledge-management technology tends to *strengthen* the intrinsic core of the firm. At the same time, interorganizational information technology gives rise to superadditive network effects, so that the firm's core capabilities tend to achieve their maximum value only when combined with the capabilities of other organizations.

Extrapolating these trends to their limits provides a picture of a network-centric organization. It has the following characteristics:

1. It is characterized by the idiosyncratic, tacit knowledge that it holds. Intellectual property, rather than physical assets, defines the core of the organization. It is good at doing certain things because it has the knowledge needed for superior performance. This knowledge was acquired over time, through experience, and cannot easily be learned by others.
2. It uses markets to acquire inputs and to perform processes that are not dependent on its unique store of tacit knowledge. In managing its knowledge assets, it actively seeks to transform knowledge from tacit to technical form. Once accomplished, this permits processes that were previously performed internally to be acquired from markets. At the same time, it seeks to manage actively the creation of new tacit knowledge. As part of this effort, it may choose to internalize processes in the short run that could be done externally, so that in the medium or long term the added experience will produce new tacit knowledge.
3. It maximizes the value of its knowledge by operating within networks, along with other organizations. By so doing, it can claim not only the value obtainable individually from its own tacit knowledge but also a share of the excess value from the network's joint tacit knowledge, which is superadditive over the network's membership.

2.3. Strategy view: the customer-intimacy perspective

2.3.1. The customer-intimacy value discipline

Another way to view the network-centric organization is in terms of how it presents itself to its customers. The term *customer intimacy* is used to refer to the strategy of a firm presenting a unique face to each customer. A customer-intimacy value discipline makes each trading partner feel as if its requirements are exactly matched by a firm's offerings. If it were possible to pursue this strategy to perfection, no two customers would see a firm in exactly the same way: they would each be offered capabilities that precisely match their needs, and nothing else.

A network-centric organization, with the characteristics specified above, can be thought of as the perfect realization of a customer-intimacy strategy. In Figure 4, Firm A is depicted as having relationships with a number of customers, to which it sells, and a number of suppliers, from which it buys. The needs of each customer will be unique.

Therefore, to maximize intimacy with each customer, a unique team of organizations should form. The team, or network, should jointly possess capabilities that precisely match one customer's requirements.

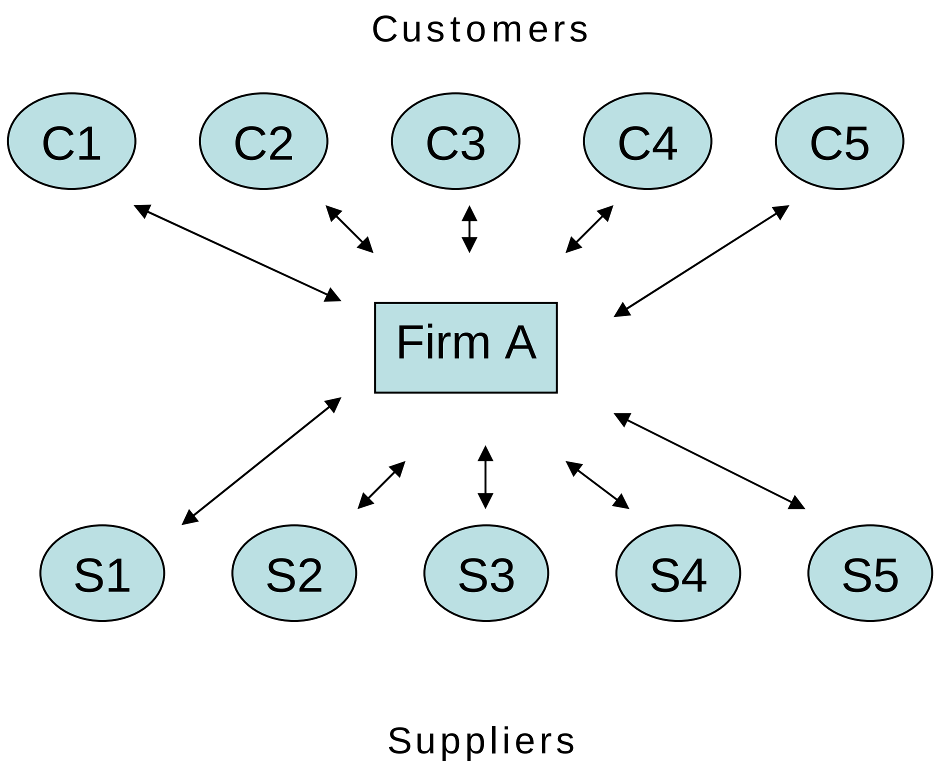


Figure 4. Network relationships

2.3.2. Value networks

In a network-centric environment, then, an organization will belong simultaneously to a number of networks—one for each product or service it is engaged in providing. In Figure 5, two possible networks to which a firm might belong are shown. On the left, Firm T sells a final consumer product, and thus is at the root node of a tree-structured network topology. On the right, Firm B supplies a component capability or product, and thus is shown at a bottom node in the topology. We will apply the term *value network* to interorganizational relationships that can be represented in a tree-structured topology of this type.

2.3.3. Maximizing the organization's claim on value

For an organization to maximize its individual profitability, or claim on value, it must do two things.

1. It must belong to high-value networks; i.e., networks that can charge a high price for their output.

2. It must claim for itself a high share of the rents flowing to the value networks to which it belongs.

Value networks can be differentiated according to their ability to extract *rents*; i.e., to provide a product or service that commands a high return. High-value networks are those with a competitive advantage stemming from the tacit knowledge they contain. The high-value network as a whole can do something better, more innovatively, with better quality, or with more reliability than could be accomplished by any competing network, and thus can charge a higher price for its output. The differentiating features of the value network can be referred to as either as *product leadership* or *operational excellence*. Networks that display product leadership are constantly innovating, never allowing a competitor to outdo them in features, quality, or capabilities. An operational excellence value discipline, on the other hand, uses the network's superior dependability and quality as a lever to extract high rents.

We will focus on these objectives, and develop specific guidelines for a network-centric organization of the future to follow in order to maximize its claim on value.

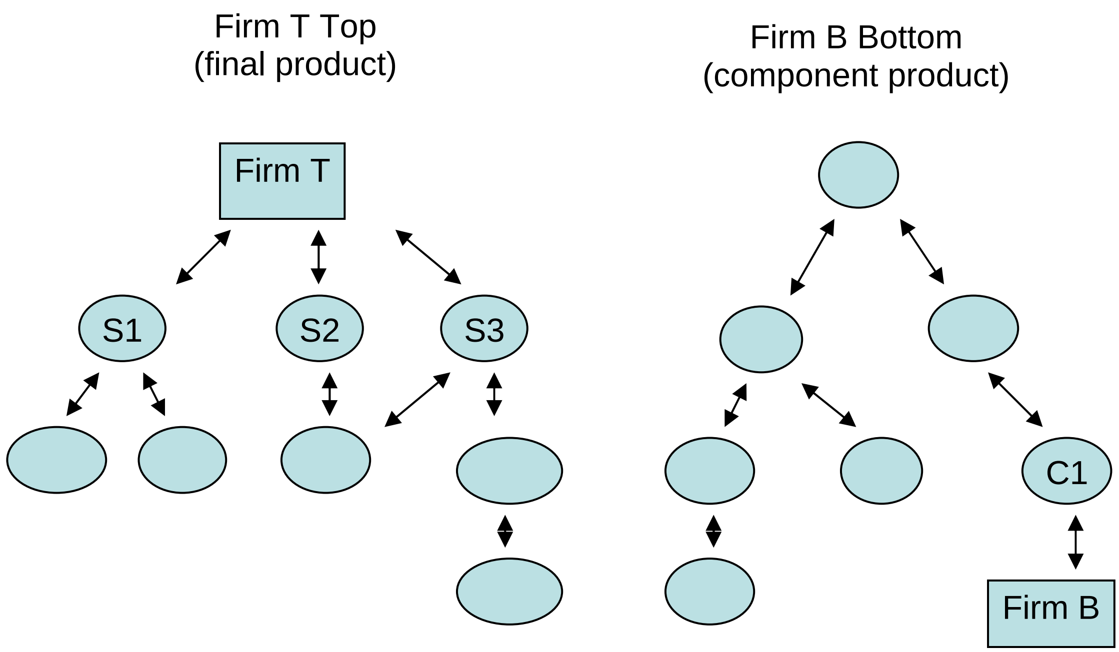


Figure 5. Value networks

2.4. Knowledge in a network-centric environment

2.4.1. Knowledge creation and acquisition

The alternative positions an organization might occupy in a tree-structured value network, such as illustrated in Figure 5, have an impact on the strategies it should follow to maximize its claim on value. To understand how this difference comes about, it is necessary to think explicitly about how knowledge is created in value networks.

Figure 6 depicts the core idiosyncratic, tacit knowledge residing within an arbitrary Firm A. Such knowledge exists because of the joint experiences of the firm's human assets. The right-hand side of the figure illustrates aspects of the knowledge-creation process, modeling experience in terms of decisions, actions, and outcomes. Each time a decision is made, the firm has an opportunity to take a corresponding action and observe the result. The fusion step indicates that the store of tacit knowledge is updated by reflecting each decision against an observed outcome. Whether or not the outcome is favorable, the knowledge core of the firm is built up, over time, by the memory of outcomes that have resulted from decisions taken in the past.

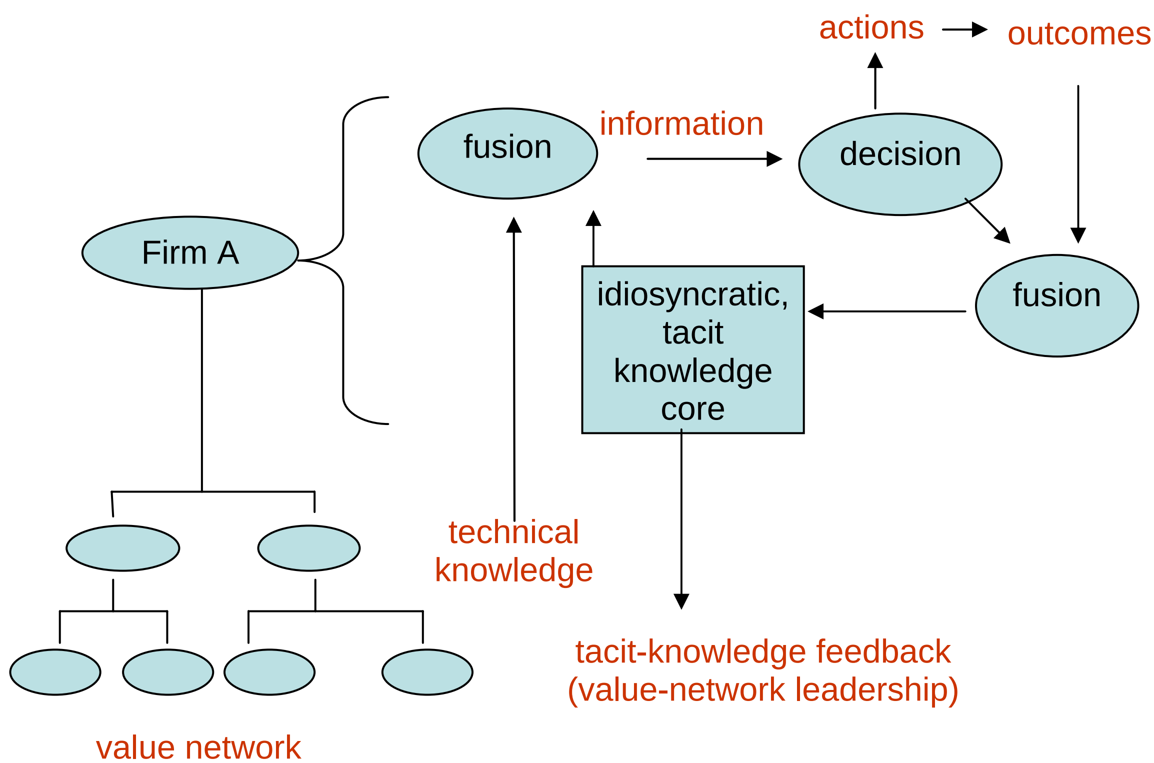


Figure 6. Knowledge creation and diffusion

Figure 6 also illustrates the inputs to the decision-making process. Decisions are based on *information*, which is defined as the fusion of technical knowledge with tacit knowledge. There is an implicit positive directionality to each of these inputs; that is, the more complete and relevant the technical and tacit knowledge the better the decision, where *better* means that the decision is more likely to result in a favorable outcome.

In a network-centric environment, the data that supports the decision-making process comes not only from an organization's internal activities, but from activities performed by the other organizations in the supporting value network. Such data takes the form of technical knowledge that can readily be shared in real time by interorganizational information systems. As illustrated in the diagram, the supporting technical knowledge flows upward through the value network, allowing Firm A to make decisions based on variables that are both internal and external to its own boundaries.

As noted above, if the value network depicted in Figure 6 is to charge a high price for its output, it must exhibit product leadership or operational excellence. Such value disciplines cannot be realized individually: value disciplines depend on the value network *as a whole* gaining an improved store of tacit knowledge as a result of each decision taken by the firm that occupies the root node in the tree. If only Firm A, at the top of the value network, were able to update its tacit knowledge core as a result of its decision-making process, then the ability of the value network to follow its selected value discipline will be restricted. Because the value network's joint tacit knowledge is superadditive over its membership (see Section 2.2.3), higher value could be claimed by the network if each member were able to update its tacit knowledge from the outcomes that firm A observes.

2.4.2. Value-network leadership

As noted in Section 2.3.3, if an organization is to maximize its individual profitability, it must first join high-value networks. Maximizing a network's value, as we have just observed, depends on facilitating the creation of tacit knowledge everywhere in the network. This means that there is an inherent difficulty in maximizing a network's value, due to two characteristics of the network-centric environment.

1. *Decisions are made individually, by organizations.* As illustrated in Figure 6, an organization applies the data available from internal and external sources and, using its core tacit knowledge, makes decisions regarding products and processes.
2. *Actions are taken collectively, by networks.* Although each individual firm in a value network has the ability to make decisions, it depends for its actions on things that take place externally to its own organizational boundaries. That is, a firm can decide to do anything it wants, but it can actually do only those things that the underlying value network can perform.

If the value-network as a whole is to be optimized, then, there must be a way to jointly optimize the decision-making process. That is, Firm A in Figure 6 must make the same decisions that would be made if the entire value network—and all of the tacit knowledge contained in it—were resident in a single organization. Furthermore, if the value-network is to follow its value discipline, the tacit knowledge of the network as a whole must be constantly updated as outcomes are observed by Firm A. The value of a network will not be maximized unless the knowledge-creation process is actively managed. We use the term *value-network leadership* to refer the active management of the tacit-knowledge core of a value network.

In Figure 6, the tacit-knowledge feedback arrow represents value-network leadership. To illustrate with a simplified industry example, suppose that Firm A is an aircraft manufacturer and the firms below it are suppliers of subassemblies. Let us say that engines are supplied by Firm E and wings by Firm W. Suppose further that product leadership requires the development of a commercial aircraft with either a longer range or an increased passenger capacity. Which choice should Firm A make? If Firm A produced its own engines and wings, it would consider the myriad tradeoffs and cross effects: choices made in engine design constrain the wings, and wing-design choices constrain the engines. Engines and wings together constrain both the range and passenger capacity of the aircraft. The eventual decision could be made with the benefit of tacit knowledge regarding wings, aircraft, and the interactions between them.

In a network-centric environment, however, Firm E has no tacit knowledge of wings, and firm W has none regarding engines. Both firms will—in the absence of active management by Firm A—produce an inferior result. Engine-design decisions would be made without knowing the interactions on wings, and vice-versa. Only Firm A has the tacit knowledge of how the suppliers' design choices interact. If Firm A is able to

a) convert this tacit knowledge to technical form and transmit it to its suppliers, and

b) enable its suppliers to interact across organizational boundaries as if they were part of a single firm

it can obtain the optimal outcome from its eventual decision. This two-part definition of value-network leadership recognizes that no matter how good an organization might be at codifying tacit knowledge, there will always be some left that defies conversion to technical form. Therefore, the network will achieve full superadditivity only when individuals can operate across firm boundaries.

The greater the value-network leadership exhibited by Firm A, the more likely it is that the value of a network will be maximized. The goal is to allow the value network to function with the same superadditivity that would come about if all of its functions were internalized in one firm.

3. Enabling concepts and technology

3.1. Operating principles and culture

3.1.1. Objective

We are now in a position to make statements about the operating principles that a network-centric organization should follow in order to maximize its claim on value. As noted in Section 2.3.3, this involves two aspects: maximizing the value of networks to which it belongs and claiming for itself a high proportion of that value. We propose that the principles a firm should follow depends crucially on whether it occupies a node at the top or the bottom of a value network, in the sense of Figure 5. In reality, in a network-centric world an organization is simultaneously at the top of a one value-network subtree and at the bottom of another subtree of the same network.

3.1.2. Creating high-value networks

<u>Alternative value disciplines</u>

In Figure 7, the two strategy goals of maximizing the network's value and maximizing the firm's share are shown, interacted with the position of the firm relative to a value network (or, more generally, a subtree of the value network).

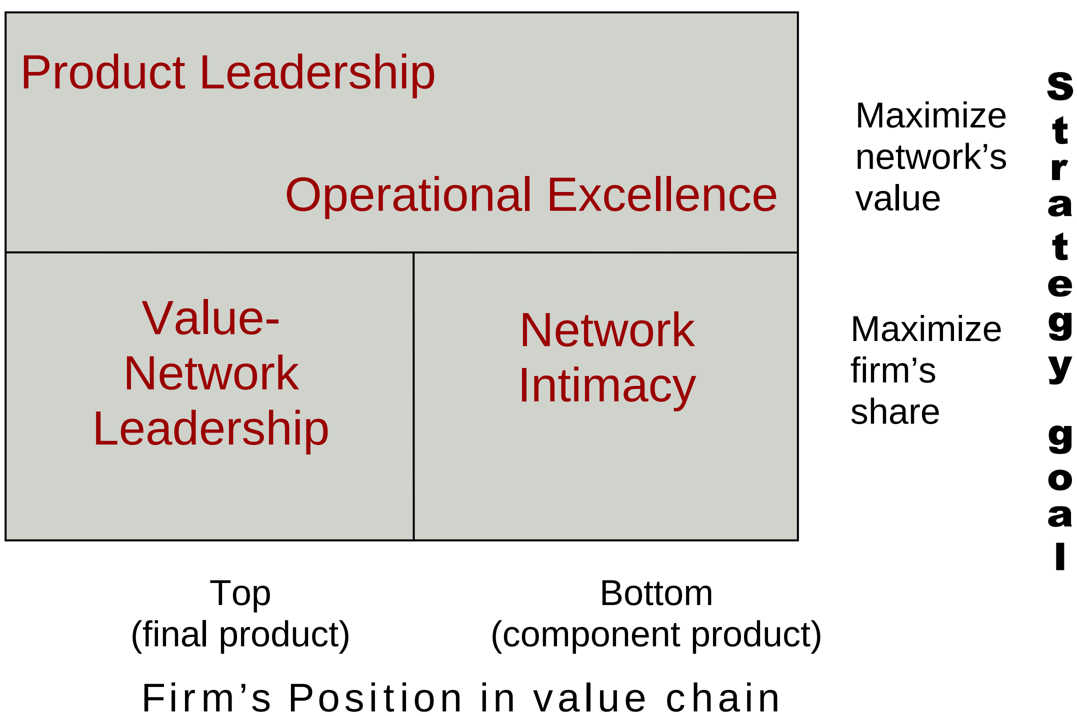


Figure 7. Aligning strategy with value network

A value network's overall return depends on its success in following its chosen value discipline. Network centricity itself represents the realization of customer intimacy; therefore, a given value network will distinguish itself from its competition be following either a product-leadership or operational-excellence value discipline.

When a network follows a product-leadership value discipline, the firm at the top of the value-network tree will control the product-leadership qualities of the network as a whole. Through its decisions, it must seek to keep the network ahead of the competition by constantly reinventing and innovating. It pursues the objective of making sure that it always belongs to a network that offers the highest-quality and most cost-effective products and services. Although all of the organizations in the value network must contribute to the joint achievement of product leadership, the ultimate decision-making authority regarding what products and services to produce rests with the firm at the top. To illustrate this, the product-leadership value discipline choice is shifted left, toward the top-level firm, in Figure 7. Product leadership begins at the top of the network, and flows down to the lower-level nodes; a firm at a lower level cannot advance the product-leadership qualities of the network beyond the limits set by the firms above it.

When a value network achieves distinction through operational excellence, it does so through the individual efforts of firms at every level. The decision-making authority for operational excellence is dispersed, and rests as much with firms at the bottom nodes of the network tree structure as with those at the top. For the network as a whole to be operationally excellent, each firm in the value-network tree must execute its individual role with the utmost quality, consistency and reliability. Operational excellence begins at the bottom of the network, and flows upward. That is, a firm at a higher level cannot advance the operational-excellence qualities of the network beyond the limits set by the firms below it, because the network's product as a whole is only as excellent as its weakest component. To illustrate this, operational excellence is shifted to the right, toward the bottom-level firms, in Figure 7.

<u>Impact on operations and culture</u>

The first operating principle for a network-centric organization to follow, then, is to maximize the value of the networks to which it belongs by

a) explicitly choosing the value discipline that the network is designed to follow, and

b) aligning its operations and culture with the chosen value discipline.

The cultural differences between a firm executing a product-leadership strategy and one using an operational excellence strategy are considerable.

- Product leadership requires that a network's members constantly reevaluate their assumptions, their operating procedures, and their products. They do not cling to long-held assumptions about the best way to do things; rather, they continuously seek improvement. They do not hesitate to make their own products or services obsolete. They assume that a better mousetrap will eventually be invented, so they want to be sure that they—not their competitors—are the ones to invent it. The culture is one of revolutionary change.

- Operational excellence requires doing one thing consistently and repeatably. Members of operationally excellent networks will focus on learning best practices and embedding them throughout their organizations. They work tirelessly to make marginal improvements in the quality, reliability and timeliness of their output. The culture is one of evolutionary improvement.

In a network-centric environment, it is crucial for organizations to join networks—and to occupy positions in those networks—that align with their culture and operations. This means that firms whose strengths play to the product leadership value discipline should occupy the top node of value networks that focus on innovation, and firms that are operationally excellent should join—at any appropriate level—networks that focus on consistency and reliability.

3.1.3. Claiming a high share of the network's value

The extent of a firm's *individual* claim on the value produced by a network depends on its *marginal contribution* to that value. That is, by what amount would the network's value be diminished if the firm were to be replaced by its next-best competitor? A firm can claim, as its share of a value network's total profits, the amount by which the network would be worse off if the firm chose to leave.

As shown in Figure 7, the strategy that will maximize a firm's individual contribution to the network's value, if it is at the root node in the network tree, is value-network leadership (see Section 2.4.2). By making the network function as if its tacit knowledge were embodied in a single organization, a firm distinguishes itself from other firms that might replace it in the network structure. This means, specifically, that the firm must be relentless at converting tacit knowledge to technical knowledge and delivering it to its partners in the network. It must also direct the interaction between network members, so that superadditivity of processes can be achieved.

Firms at the bottom of the network tree can claim a high value share by being *value-network intimate*. This is a network-specific value discipline that is similar to customer intimacy, but that focuses on exposing a tailored set of knowledge assets, rather than products and services, to customers. When an organization is value-network intimate, it knows what stores of technical knowledge it possesses, and it is willing to invest in the technology and management needed to integrate its technical knowledge with that of other network members, as shown in Figure 6. Firms at the bottom of the network tree do not direct the interactions with other network members, but if they are value-network intimate they are able to expose exactly the set of technical knowledge assets that will support decision-making in the network.

3.2. Technology requirements

3.2.1. General

We have based our analysis of network centricity on a projection to the future. The projection, in turn, is based on the assumption that information technology will continue to evolve, and will eventually support the value discipline of value-network leadership. There are two ongoing trends in information and knowledge-management technology that will need to be extended and improved before the network-centric future described here can become a reality.

3.2.2. *Linking technical knowledge bases*

The knowledge-management technology of codification is aimed at improving organization's ability to express and record technical knowledge, and, by so doing, to facilitate the conversion of knowledge from tacit to technical form. Efforts are directed at data-base structures that manage an organization's experiential information, and toward search engines that are capable of locating and presenting information relevant to the context of ongoing activities.

To become facilitators of a network-centric world, such technology must advance to the extent that project personnel will interact with a knowledge-management system automatically and effortlessly as part of their daily activities. In addition, the technology must advance to the point where standards and security are in place to permit the sharing of technical knowledge across organizational boundaries without compromising an organization's proprietary knowledge base.

3.2.3. *Facilitating tacit-knowledge creation*

The second knowledge-management strategy, *personalization*, is aimed at identifying personnel who have the individual backgrounds that will give rise to superadditivity when combined on a project team. Generalization of this approach across industries is difficult, and it may never become automated to the extent of codification approaches. Nevertheless, the ability of organizations to understand and deploy their human assets in project environments that span firm boundaries is a key element of success in a network-centric future.

4. Management imperatives and metrics development

4.1. Capabilities focus

The network-centric organization exists because of the unique set of capabilities—that is, knowledge assets—that it possesses. Putting these assets to work, to support the value discipline of a network, requires that the organization be explicitly aware of what its core set of capabilities are.

Progress toward management focus on an organization's capabilities may be measured on scales that relate to the categorization and quantification of knowledge assets. Examples of such metrics might include:

- *Capabilities assessment*. Can the capabilities required to perform each of the firm's activities be expressed in terms of specific knowledge assets? Firms must explicitly recognize and manage their knowledge assets in a network-centric environment.
- *Alignment.* What proportion of a firm's activities relate to its stated capabilities? Activities that do not relate to particular knowledge assets of the organization will not correspond to high-value networks in a network-centric environment.
- *Value disciplines.* Does the firm have an explicitly stated value discipline for each of the project activities in which it is engaged? Different management strategies and organizational cultures are appropriate for different value disciplines.
- *Knowledge codification.* What is the percentage growth of a firm's technical knowledge base over a period of time? The conversion of tacit knowledge to technical form is one of the keys to value-network leadership.
- *Knowledge personalization.* What proportion of a firm's human assets is identified in terms of the tacit-knowledge dimensions they embody? The ability to link internal human assets with those of other organizations in a network is the second key to value-network leadership.

4.2. Value-network leadership vs. proprietary knowledge

The successful organization, in a network-centric world, will be one that is both able to join high-value networks and to claim a high share of that value for itself. The analysis above provides strategy guidance toward achieving these aims.

Value-network leadership is a key requirement of high-value networks. Such leadership is characterized by active knowledge management, and by forcing the utilization and creation of tacit knowledge to extend beyond organizational boundaries.

An important challenge for network-centric organizations of the future is to balance the requirements of value-network leadership against the proprietary nature of the firm's tacit and technical knowledge assets. If an organization restricts its knowledge to internal use, it will be precluded from membership in the high-value networks that characterize success. On the other hand, if it converts all of its knowledge to technical form and shares it with network partners, it destroys its very reason for existence under the bundle-of-capabilities view of the firm.

The resolution of this dilemma lies in the nature of the network-centric organization as a dynamic, rather than a static, entity. True knowledge management is as much about creating new stores of tacit knowledge as about converting tacit knowledge to technical form. To retain relevance in a network-centric world, a firm must be relentless in pursuing the creation of tacit knowledge, by deploying its human assets in contexts that both leverage and update past experience.