A new era in the B2B marketplace will be driven by network-level optimization offering many advantages over point-to-point relationships for vendors and customers.

Some recent integration hubs provide configurations that facilitate optimization beyond the buyer-supplier dyad provided by traditional point-to-point integration. We argue that coordination so far has been preliminary dyadic but that a new era of network-level optimization is possible, providing future benefits beyond dyadic coordination and optimization mechanisms through the use of integration hubs and B2B marketplaces.
In recent years traditional relationships in supply and demand have undergone a variety of radical changes. Firms have increasingly begun to realize that their performance depends on the competitiveness of the supply chain configurations in which they participate. Since the 1980s, the role of IT has been a substantial driver behind competition in many chains and industry networks, however the performance effects described were mainly dyadic (between two parties in a supply chain; for example, a supplier and a manufacturer or a manufacturer and a distributor) [11]. Now that infrastructures are in place to facilitate external systems integration (ESI), new technology provides opportunities beyond internal systems integration (ISI). Firms can begin building upon the capabilities gained during these efforts and focus on benefits beyond dyadic coordination and collaboration processes.¹

Recent technological advances such as enterprise application integration (for example, see Communications’ special section on service-oriented computing, Oct. 2002) allow firms to connect upstream supply management functions with downstream channel functions performed inside or outside their own firm. B2B marketplaces claim that major efficiencies are to be achieved by both buyers and sellers through the streamlining of communications, the support of collaboration and buying. Vertical industry-oriented B2B marketplaces and hubs, like Elemica in the chemical industry, Covisint in the automotive parts industry, or Transora and CPGmarket in the consumer packaged goods industry, can be seen as such collaborative efforts. The improvement of efficiencies is the main source of value created by these B2B marketplaces. For example, services that allow multiple companies to manage inventories, design products, and manage projects more effectively. Andrew et al. [1] predict that “collaboration services could represent 40–50% of the total revenues of the e-marketplaces that provide such services” this year. Gartner Group has also predicted that marketplaces providing collaborative services will be the focus that will create the most value, illustrated in Figure 1.

We define business network-level optimization (NLO) effects as performance benefits resulting from the calculation of efficiencies across firms within and between supply chains beyond the sum of the dyadic relationships involved. We argue that as a result of increased information exchange the network effects² go beyond simple collaboration effects. Instead, a key capability of these integration hubs results from the ability to have real-time, intercompany information available, which can then be used to monitor, exchange, and act upon in an integrated manner. Lee and Whang [6] refer to a related phenomenon they call “cross-chain monitoring.” Figure 2 illustrates this development.

We discuss the network-level optimization phenomenon itself, using examples, and then the requirements and needed to implement this. We conclude with a set of inhibiting factors and problems that might be encountered when implementing such a strategy. A detailed illustration will be given through the analysis of Elemica, a major integration hub in the chemical industry.

Beyond Information Exchange

The coordination of business processes is highly dependent on the ability of firms to coordinate flows of goods and information. While operations research and logistics have focused on the flow of goods, the fact that information can flow independently of physical goods in a supply chain has a significant impact on the coordination of transactions


²Please note these effects are different from positive network externalities, which refer to benefits purely related to the size of the network.
and relationships. Sharing of information is a principal component in supply chain integration [12]. Game-theoretical models advocate information sharing because of the subsequent augmentation of channel profits. Empirical research has demonstrated that information exchange not only confirms, but also increases the level of commitment of the channel partners. Cannon and Perreault show that business relationships characterized by information exchange yield better performance and channel member satisfaction. Exchange of information in a timely, effective way is a key driver of supply chain performance (for example, [4], [6]). However, despite all utopian predictions of information sharing, research has shown there are important inhibitors to information exchange that prevent firms from participating in collaborative efforts [7]. Factors inhibiting information-sharing in e-markets include information-asymmetry exploitation, trust and opportunism; and the inability of e-markets to facilitate selective information sharing.

**Dyadic Coordination: EDI and the Coordination of Interfirm Relationships**

Interorganizational systems, like electronic data-interchange devices (EDI), have permitted firms to exchange information on a more timely and frequent basis. Investment in EDI systems requires close coordination to achieve a certain degree of electronic integration. This coordination was always point-to-point and therefore involved considerable costs [8] and standardization problems [2]. Interfirm coordination, where proprietary information is being shared on a one-to-one basis could only be sustained by high transaction specific investments necessary to implement EDI systems. Apart from being costly, this one-on-one coordination through EDI had other disadvantages: it required a high level of dyadic coordination and standardization and was generally not interesting for smaller parties in the supply chain.

Information in many markets is a competitive item that is preferably shared only with a limited number of members. Sharing price or capacity information is often not advantageous to all parties in a supply chain or vertical market. For example, early electronic marketplaces disclosing price information to all participants of the network often caused sellers not to participate, as this transparency has led to price decreases or to disintermediation of downstream supply chain members.

Attempts to implement e-markets or other network approaches often failed due to institutional and power-related factors. In addition, it was difficult to demonstrate and allocate collective benefits to participating organizations. In industries where participants are involved in a high degree of interindustry trading, common investments in infrastructures, though sometimes viable, are often abandoned before the real benefits become clear. These e-markets did not provide for selective sharing of specific transaction data.

Connectivity through the whole supply chain can offer the possibility to considerably reduce costs associated with information asymmetry through the supply chain, like inventory-level reductions, collaborative planning and forecasting (CPFR). The introduction of EDI-based technologies most often involved two adjacent members in a supply chain management relationship and as such strictly involved dyadic coordination. However, “if business networks are to possess advantages beyond the sum of the involved dyadic relations, this must be due to considerations that take place within dyadic business relationships about their connectedness with other relationship” [1]. Nevertheless, conditions are often such that the real benefits can only be achieved by creating an exchange environment where firms not only look at their own outcomes but mainly to the joined outcomes. This means the relational environment (and not just transaction orientation) surrounding the exchange is a major determinant of the outcomes of collaborative agreements. For a better understanding of this phenomenon we present an example of a company exploring these network-based optimization capabilities.

**Case Description**

Elemica is a global network for the chemical industry, initiated in August 2000 by 22 large chemical companies and distributors. Although characterized
as an e-marketplace in some popular press publications, it is in fact a network or integration hub, which facilitates after-sales transactions [3]. Elemica becomes operative after a negotiated trading transaction is entered into the system. Matthias von Armandtsperg,3 Elemica’s Vice President of Marketing, notes: “Our own connectivity means that the SAP system of client A is directly integrated with the SAP system of client B and if the procurement manager enters his order it is passed on within a millisecond to the production-planning system of the other company. This level of integration is very intense. . . (S)ome of the investors first must operate their internal ERP systems before it makes sense to them to link externally. If they have not automated their internal process, it does not make sense if they receive an automatic order and than they have to punch in the information in manually.”

Companies throughout the world can electronically access the Elemica network via a single connection, using either established industry standards or a series of proprietary translations designed around individual enterprise resource planning (ERP) systems. Elemica’s business model is described in a company press release as “a single integrated end-to-end system to improve, contract and order management, fulfillment, and payment. [It] provides a way for its users to connect to a host of other companies using only a single electronic connection, avoiding the costs of setting up these connections on a one-to-one basis.”

Elemica is the only interfirm e-business initiative in the chemical industry not funded by venture capital. The 22 founders invested just over $100 million in the project.4 About 33% of all chemical products is used by other chemical companies: the sector’s biggest customer is the chemical industry itself. This high level of interindustry trading suggests there is a great deal of potential for industry-wide initiatives like Elemica.

Dyadic Collaboration through Elemica
Through ERP-to-ERP connectivity Elemica is able to serve as an integration hub, connecting parties and translating documents. Beyond plain connectivity, the network offers an integrated toolkit of CPFR applications enabling dyadic collaboration. According to Todd Imhoff, Elemica’s Vice President for Supply Chains: “The system would allow a supplier to input his forecast and a buyer to input his material requirements plan. By sharing that information, the two parties would be able to collaborate on forecasting a demand stream that is more accurate than either could arrive at alone. Once accomplished, the Elemica tool would allow both parties to collaborate on a replenishment plan. Right now, a planner must coordinate how to manually collect all of the disparate data streams necessary to develop a plan. What we will do is to automate the collection and organization of that data and populate it into a replenishment tool that operates between the buyer and seller. A replenishment plan is then generated, and the buyer and seller can collaborate on that plan. System users have the option of whether to generate an order from the replenishment plan or to store it as a forecast.”

Vendor-managed inventory (VMI) is another example of how advantage can be gained from dyadic collaborative approaches. Figure 3a illustrates how time-phased replenishment planning reduces bullwhip-type effects. (It should be noted this figure is not based on data gathered empirically but on estimates provided by Elemica.)

NLO and Collaboration
Our main argument—that there are benefits beyond dyadic coordination efforts made possible through interoperative data exchange—is best illustrated with the following examples:

Transportation optimization. A clear application of network-based coordination and optimization are the collaborative process-outsourcing possibilities available when enough members are connected to the network. Opportunities to optimize transportation and logistics arrangements are presented by Elemica’s alliance with Optimum Logistics. Elemica facilitates

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3Elemica’s 22 investors include Air Products and Chemicals; ATOFINA; BASF; Bayer; BP; Brenntag; Celanese; Chemcentral; Ciba Specialty Chemicals; Degussa; The Dow Chemical Company; DSM; DuPont; Mitsubishi Chemical Corporation; Mitsui Chemicals; Rhodia; Rohm and Haas; Shell; Solvay; Sumitomo Chemical; and Vopak.

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connectivity, documentation and data interoperability among shipper (seller), buyer, logistics service provider, terminals and warehouses, and so on. This way Elemica is clearly improving the clients’ use of their shipping resources. Chuck Gruber, senior vice president for Global Supply Chain and Logistics explains: “I think 30–40% of the trucks traveling around Europe are empty and we now have the capability to collaborate through our information network and optimize this by having our members collaborate. It means a big improvement. The challenges are obviously the density of the information, the critical mass of the network, and the real-time nature of sharing that information.”

Elemica is consolidating various sources of in-transit status messages to one place, creating visibility across all modes of transport and all regions in a standardized screen presentation. Jaco Fok, corporate e-business manager at DSM, one of Elemica’s member companies, contends: “I really believe in these logistic network-level optimization opportunities that Elemica is able to offer although there will often be cases where simple combination of truck loads is impossible because of security issues or expenses involved with having to clean a truck in Spain to transport a different load on the way back.”

Cash netting. The second example involves potential with cross-company payments within the network. Within the current network of Elemica with 35 of the largest chemical companies in the world participating, large numbers of invoices and payments are sent each day within the network. The costs of managing and executing these cross-company payments are huge. According to Kent Dolby, Elemica’s CEO: “Today when companies buy and sell from each other they then go through an invoice process and subsequently there is a payment process. The payment process may include some review of receipts and some review of either electronic or paper documents and eventually a settlement. Invoices are paid and cash is transferred. What I see in the future is the ability for Elemica to serve as a clearinghouse. We would actually do cash-netting at the end of the day. Where you ship so much, you receive so much. The value of shipments minus the value of receipts are either debited or credited to your account. There are no payment terms, there is no delay in the process, it is fully automated. What we are talking about is actually managing the data because it is the data that is the main source of errors when you get into claims and credits. If we can help manage an improvement in the data then we can also help manage the settlement of the accounts. That would be a tremendous benefit by taking non-value-added activities out of both the buyer and the seller.”

Inhibitors

There are several important inhibitors for the implementation of NLO. Common inhibitors to network optimization include:

Lack of scalability. Scaling up quickly is what adds value to the magnitude of the network optimization solution across a dynamic supply chain: the ability to quickly deploy process integration solutions involving many business partners while keeping costs down. When a solution is not scalable enough, such as when the additional costs of adding a partner or a product

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6 Personal interview with author on Nov. 6, 2002.

line are higher than the expected returns, this will be an important inhibitor to NLO effects.

**Lack of intercompany process standards.** Collaborative integration efforts require not only interoperability at the IT infrastructure level but also alignment at the business process level [9]. The last few years a number of intercompany standardization efforts have taken place that span a variety of supply chain processes (for example, Rosetta Net).

**Back-end integration challenges.** Companies have invested millions of dollars in ERPs that center around internal enterprise integration rather than external supply chain partner integration. The lack of integration of back-end legacy systems with middleware applications and ERP systems inhibits many firms to scale up their trading processes with multiple supply chain partners. When ordering, scheduling, and planning information cannot be transferred seamlessly across multiple tiers in the supply chain, optimization beyond the dyadic supply chain relationship will be difficult to achieve.

**Institutional factors,** including interfirm power, trust, and relational embeddedness, will determine the success of NLO. As usual, these factors most likely will be the most crucial inhibitors.

**Conclusion**

Solutions, like the ones discussed here, are starting to achieve optimization at the participating companies’ network level. Optimization of transportation, for example, was often done on a plant-by-plant basis but optimization can occur in some measure between tiers and between networks serving two tiers. Obviously, more work is required to explore the possibility of full network optimization of all tiers of the supply chain. The corporate log files kept at the hub allow for optimization of transportation, forecasting, and other logistic services across the participating firms and business partners. The real power of these hubs of the future lies in NLO and the coordination of logistic flows and transportation, far beyond dyadic tracking and tracing. Figure 3b illustrates the evolution discussed in this article.

Systems integration and seamless connectivity are obviously very important requirements before these NLO effects can kick in. Companies will not realize the real benefit of online trading or collaboration in the supply chain until they actually connect their back-end systems, which is difficult and expensive without a hub.

Interoperative data exchange, automatically translating the protocols, standards, and data formats used by one firm into messages recognizable by the other firms’ systems, is indispensable. Some degree of relational integration, involving business process adaptation beyond systems integration, and trust are prerequisites for NLO. Firms must have trusting long-term relationships with each other and with the B2B marketplace itself to allow members to penetrate this deeply into each other’s internal business processes.

NLO effects may provide real productivity and network performance gains beyond simple transaction cost reduction benefits, not only in the chemical industry but also in many other vertically organized industries. B2B exchanges focusing on aggregation and matching have not delivered what they promised and many have gone out of business in the last 3.5 years. Instead, new B2B marketplaces support business models focusing on value-added services around post-order support rather than presales online matching and aggregation, are becoming increasingly important. The real value of B2B marketplaces may not be in their matching, but rather in their collaborative capabilities. Integration hubs, with their potential business NLO effects, must prove their added value in the years to come. But as more companies convert their shared technology into shared processes, these effects will be increasingly scalable.

**References**


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