Implementing Collaborative Process Management – the Case of Net-Tech

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EXECUTIVE SUMMARY

Businesses often do not succeed with the implementation of collaborative processes and research has not provided adequate help. The article provides a concept for services and standards to implement collaborative processes and describes experiences from its successful solution. The case of Net-Tech’s Elex analyses how Net-Tech realized a collaborative process management for its manufacturing operations. The case study shows a concept for implementing collaborative processes as well as its implementation as a “proof by demonstration”. Even if the solution has proven to implement collaborative processes in a network of over fifty partners in high-tech industry, more research is required towards generalization. Business managers might use the concept of the services and standards at Elex and the experiences of Net-Tech as guidelines when they are in a situation to decide on the implementation of collaborative processes.
ORGANIZATION BACKGROUND

Net-Tech provides networking solutions consisting of hardware such as switches, routers, and to a lesser extent, services. Net-Tech’s goal is to increase its market share and to stay more innovative than its competitors, i.e. global networking solution providers. It was not possible to realize a large growth in sales volume within a decade using internal production sites. The increase in production capacity was enabled by a virtual manufacturing strategy and nearly all production is outsourced to contract manufacturers. Together with component manufacturers, distributors and Net-Tech they form a manufacturing business network.

Net-Tech focuses on core processes such as design and marketing, and bundles the purchasing power of all manufacturing sites in negotiations with component manufacturers and distributors. Net-Tech no longer deals directly with its suppliers, but relies strongly on the performance of the business network.

All partners aim to perform as efficiently as if they were one enterprise, and share a common understanding of the manufacturing process. This standard supply chain process flow connects Net-Tech and its partners, and provides each partner with the supply chain data they need for manufacturing (Figure 1): initially Net-Tech creates a forecast and sends a version to each of its manufacturing partners. Members of the buying department at Net-Tech place purchase agreements or purchase orders with their manufacturing partners. The manufacturing partners perform the planning themselves, issue purchase orders to their suppliers and issue back sales orders as confirmation to the customers. The material flow starts with the component manufacturer who ships material against sales orders to distributors, contract
manufacturers and Net-Tech’s final assembly and test sites. A customer order at Net-Tech works as a trigger for the manufacturing process at a contract manufacturer. The contract manufacturer ships assemblies directly to Net-Tech’s customers or to Net-Tech stocks.

*Take in Figure 1*

Data are mainly transferred tier by tier in linear communication links from the customer to Net-Tech, contract manufacturer and backwards. In this cycle it took four to six weeks until a change in the forecast from Net-Tech became effective in delivery. With many partners not directly linked to Net-Tech, the company relies on the business network’s capability to solve any problems which arise quickly. In Net-Tech’s business network, the information systems and communication links for manufacturing are mainly designed to maintain the data flow as described by the standard supply chain process flow. For example, the master schedule and forecasts from Net-Tech are sent to partners via EDI through a value added network; purchase orders are also sent via XML using B2B software from TIBCO or WebMethods. Additional functions are provided by a supplier portal that contains manufacturing forecasts, booking data and build plans. It shows customer and product information (e.g. for shipping assemblies, sales projections) and lets partners post any current part shortages.
SETTING THE STAGE

Since some problems in lower tiers of its manufacturing business network remain undiscovered, Net-Tech suffers from part shortages. Besides high fluctuations in the demand signal, such inefficiencies in the supply chain are mainly caused by distorted and delayed or “disconnected” data, as Net-Tech puts it, between several tiers in the business network. The bullwhip effect, for example, describes how orders increasingly vary along the supply chain with increasing distance from point-of-sale and cause high inventory levels, part shortages and high production costs (cf. Lee et al., 1997). Net-Tech has identified over a dozen disconnects where data between the manufacturing partners are delayed or distorted, as two examples show:

- **Bill of material disconnect.** If a bill of material at a contract manufacturer shows a lower number of memory components (e.g. 16MB flash) than its counterpart at the component manufacturer, the bills of material are disconnected and associated forecasts differ.

- **Leadtime disconnect.** A switch consists of around 450 components. If leadtime data for a critical component at a component manufacturer show four weeks, while at a contract manufacturer and at Net-Tech the whole switch shows a leadtime of three weeks, then order fulfillment for a customer will be delayed.

If such disconnects are not resolved at an early stage, they lead to inefficiencies such as part shortages, high costs of expediting, excess inventory or line downs. In the worst case customers are dissatisfied and revenue is lost.
Only through data sharing and tight coordination can businesses create visibility in the business network and resolve disconnects (cf. Lee, 2002, 108). In this case businesses can choose between two options for sharing data: linear communication links that connect businesses with their first-tier suppliers and customers, or a central business collaboration infrastructure that allows all partners to collect and provide data at a central instance. Linear communication links are inadequate when it comes to achieving tight coordination in multi-tier business networks since they are vulnerable to delays in the data flow. High integration costs and a difficult deployment of incentives and policies are further weaknesses of this option.

Therefore, Net-Tech uses a central business collaboration infrastructure. This contains standards and services to enable collaborative processes and helps businesses to integrate systems, specify rules (e.g. for contracts), procedures (e.g. for dispute resolution) and regulations (e.g. for intellectual property protection) (cf. (Alt and Fleisch, 2001, 17f), (Bakos, 1998, 36f), (Österle, 2000)), (Figure 2):

**Take in Figure 2**

- Shared *standards* among the businesses involved are necessary in any communication and in the coordination of activities. Standards define how partners and services collaborate. Collaboration agreements detail each partner’s role, responsibilities and benefit. Process standards like RosettaNet Partner Interface Protocols (or PIPs, high tech industry), Chemical Industry Data Exchange (CIDX, chemical industry) or Collaborative Planning Forecasting and Replenishment (CPFR, retail) define activities in collaborative processes and are tailored to the
specific business problems. Data standards like ChemXML as part of CIDX, parts of RosettaNet, the Universal Product Code (UPC) or the European Article Number (EAN) detail the data these processes use. Standards for applications and information technology (like SOAP, WSDL, XML) enable realtime integration.

- **Services** fulfill coordination tasks. Vertical services support specific collaborative processes and use vertical applications to monitor, manage or optimize. Horizontal services are used across collaborative processes: business network planning services help to determine the right sequence of partners and standards in the business collaboration infrastructure, and to develop guidelines and manage ongoing communication with partners on benefits, requirements, etc. Business network enablement services establish connectivity between partners, map data, adjust systems and install security certificates. Business network operations services manage day-to-day data exchange and the systems necessary for integration, and provide customer support services. Services for enablement and operations are provided electronically and standardized over the Internet as WebServices (cf. Österle, 2000, 43f). This business collaboration infrastructure, known as Elex, is built from three vertical services, *Data Collection WebService, Exception Management WebService and Performance Reporting WebService*. These enable management of the collaborative manufacturing process between partners.

An example shows how Elex monitors disconnects with this management process (Figure 3): Net-Tech orders 500 TopSwitches XT from a contract manufacturer. One component of the switch consists of four 16MB Flash memory devices which are
made by a component manufacturer. The contract manufacturer issues a purchase order for 2000 16MB Flash memory devices to the component manufacturer. All these activities send additional messages to the data collection WebService. Net-Tech and the exception management WebService are thus able to monitor whether the component manufacturer has received an order (*unplaced purchase order disconnect*) or whether the component manufacturer has committed to delivering the quantity ordered (*supply/demand disconnect*). In the case of a disconnect, alerts are generated and sent to the partners involved in order to resolve the issue.

*Take in Figure 3*

Elex enables a collaborative process involving the partners in Net-Tech’s business network. When implementing this collaborative process, Net-Tech faced typical problems (cf. (Ross et al., 2001), (Minjoon et al., 2000, 412)):

- **Win-Win Requirement:** Reciprocal benefit is the prime motivation for partners to participate in collaborative processes, with lack of trust being the most important barrier. Both issues contradict buyer-supplier relationships that focus on squeezing prices (cf. Hoyt and Huq, 2000).

- **Heterogeneous Landscape:** Process models, data models and information systems differ between companies and limit “instant integration” capabilities. Despite the rapid advent of Internet technologies and the wide use of standard software, decades of isolated business models have left semantic islands with own standards and services, resulting in individual expectations and capabilities. RosettaNet,
CPFR or SCOR, which define process models and data, receive a great deal of attention but are not widely used (cf. Kling et al., 1996, 20f.).

- **Responsibility Gap**: Responsibility for the space between businesses is not reliably assigned. New issues for businesses like network outages, disruptions of syntactic or semantic data integrity or system updates affect collaborative processes. In contrast with internal processes, responsibilities have not been assigned and readily lead to conflicts (cf. Kumar and Diesel, 1996, 296).

- **Prohibitive need for resources**: The resources required for integrating partners exceed the capabilities of internal IT (cf. Dai and Kauffman, 2002, 63). At the same time, partners do not have such capabilities either. Consequently, the costs of infrastructure often exceed the benefit of realizing the first collaborative process with just one partner.

- **Security & Intellectual Property**: The intellectual property of collaborative process design and the exchange of information needs to be protected from competitors, but shared with partners. Exchanged messages contain confidential information that must be safeguarded against unauthorized access and operations must be fail-safe.

- **Many-to-many Connectivity**: Collaborative processes with one partner are a starting point. To reflect and improve existing flows of goods, information flows need to be optimized across several tiers and several partners. The problems above have to be solved several times over (cf. Le, 2002, 117).

Elex needed to address all these issues. One part of the problem was directly tied to the requirement to design and implement a process that would manage the disconnects in
the supply chain, analyzing supply chain data and managing the data collection. Elex was to address this issue with the three vertical services.

The other part of the problem was to manage collaboration with dozens of partners. Net-Tech would need to transform its business network. The company would have to convince each individual partner to participate, instruct them about their participation requirements, connect them to Elex and manage ongoing changes in operations. Additional horizontal services were to solve these problems.

**CASE DESCRIPTION**


**A. Collaborative process management**

Net-Tech wanted to control the three vertical services for process management of the collaborative manufacturing process. The company saw this as part of its core competence in managing its manufacturing business network. The specific knowledge of process management is a competitive differentiator and should not be shared with competitors. Net-Tech would manage disconnects and realize the first part of Elex with its own resources.

**A.1 Collaborative data collection**

The collaborative data collection WebService manages the way in which partners share information to achieve visibility on supply chain data. It ensures that data from partners can be translated into a joint data standard and is sent on a regular basis.
Standards for a data model and the collection process serve as guidelines with which partners must comply (Figure 4):

- **Data standards.** Only with a standardized data model can the exception management WebService conduct multi-dimensional queries and relate data from one partner to data from another. Like a dictionary, the data model defines valid data elements such as \texttt{CommitmentQuantity.ProductQuantity} and values.

- **Process standards.** For each partner the process standard defines messages that contain the data and the events which trigger their transmission. For example, a component manufacturer sends messages such as product master data, inventory status, open order status and advanced shipment notice to Elex.

The design of data and process standards was based on the standard supply chain process flow in Net-Tech’s business network. Another main input was the iHub milestone program of the high-tech standardization initiative RosettaNet (RosettaNet, 2002b). This defines a framework for information hubs (iHubs) in the supply chain. Partners in a business network would use an iHub of this kind for information exchange in planning, inventory, procurement, product data management and production (cf. RosettaNet, 2001). The program provides a set of partner interface processes (PIPs) for each of these five building blocks. A PIP governs the data model of a business message, the choreography of the message exchange and the use of XML to describe content (cf. RosettaNet, 2002a).

Net-Tech used these PIPS for Elex and supplemented them according to the requirements of its business network. Net-Tech and its partners built proprietary
solutions for alerts and reports, for example, since these efforts did not belong to the scope of RosettaNet. With a data collection WebService, Elex can establish visibility on supply chain data.

*Take in Figure 4*

**A.2 Collaborative exception management**

With an exception management WebService, Elex uses the visibility to support the collaborative exception management process which detects and resolves disconnects. For each possible disconnect, the WebService defines the data to be compared in order to detect a disconnect, alert criteria, the purpose of resolving the disconnect and the audience to be alerted. To detect a leadtime disconnect alert, for example, the exception management WebService compares the leadtime data of a certain product in the bills of material, end user product master, product master and manufacturer product masters (Figure 5). In the case of a disconnect, it generates an alert and starts a workflow that notifies the partners and provides them with alert data details and links to further information. It would notify a buying planner at Net-Tech, for instance, and provide him with all the necessary information to initiate the resolution. He would compare the messages, look for reasons that caused the differences in data and correct them collaboratively with the partners involved. The WebService keeps track of the status at the partners from the beginning until the disconnect is resolved.
A.3 Collaborative performance reporting

With the supply chain data visible at Elex, further analysis can also provide help in improving the performance of the business network alongside exception management. A WebService supports the collaborative performance reporting process. Net-Tech can continuously monitor the overall performance of the business network and conduct cross-partner analysis to identify best practices and bottlenecks in its supply chain. The performance reporting WebService analyzes data in several messages to generate prepackaged reports on demand, supply and forecast (Figure 6). In addition, Net-Tech is able to design and conduct its own queries. Being able to rely on this data means that Net-Tech and its partners can adjust the manufacturing process accordingly.

B. Collaboration management with Elex

The second part of the problem, as already indicated above, was to manage collaboration with dozens of partners, and horizontal services were seen as the solution. Here, Net-Tech’s perception was different. Collaboration management is distributed across several organizations, and partners’ IT skills and their adoption of new technologies vary (Lheureux and Kenney, 2003). Net-Tech did not have the resources for collaboration management and has not considered it as a core competence, so the company evaluated options involving external business collaboration infrastructure service providers. These have structural advantages because they focus all their attention on partner integration and are able to leverage
investments in integration technology for hundreds of trading partners in various business networks. Highly qualified people with integration skills are attracted by the service providers because they can offer them the greatest opportunity (Yates et al., 2000, 12f). By leveraging their investment, service providers promote standardization so partners can easily reuse their investments in RosettaNet, adapters and capabilities when working with one service provider in other business networks.

Net-Tech considered price, partners’ infrastructures and technology in its collaboration management options and out of a large number of providers finally chose Viacore as the partner to work with. The decisive factors in favor of Viacore were the maturity of its services, the functions provided, experience in high-tech industry and the performance of its services. Net-Tech can control each of the three services, participate as needed, and use its brand (e.g. on the internet-enabled provisioning console) to connect partners.

**B.1 Business network planning**

Viacore’s business network planning service supported Net-Tech as the initiating partner in planning implementation. This process comprises partner selection, development of agreements and guidelines, design of the system architecture, communicating with partners and collecting their feedback. For the purposes of partner selection, Net-Tech established criteria for prioritizing them. Instead of connecting over 2000 partners immediately as first planned, Net-Tech went with a global list of preferred suppliers that had a high share of Net-Tech’s material spend and possessed a landscape that promised a connection in the near future. In collaboration agreements Net-Tech defined how it would share responsibilities with its partners. Guidelines
specify process flows, activities, data and messages, system requirements, supported communication standards, security and quality requirements. They describe how partners would adjust their internal processes and systems for connection to Elex. Instead of limiting message formats and standards to RosettaNet and TCP/IP, which would have caused high costs and reduced a partner’s motivation to participate at an early date, Net-Tech decided to also support message formats such as flatfile, EDI and XML for the transmission of supply chain data. Based on these guidelines, Net-Tech and Viacore designed an information system architecture. This would collect the data from partners, perform analysis and support collaboration management. When communicating with its partners Net-Tech needed to motivate them to participate in Elex and collaborative process management, instruct them about their responsibilities and collect their requirements in order to adapt its Elex solution. For this purpose Net-Tech invites suppliers to two-day supplier summits and sends a monthly newsletter to its suppliers. In addition, each partner has a partner team manager who serves as a contact point for all questions regarding Elex participation.

B.2 Business network enablement

With the business network enablement WebService, Net-Tech and Viacore provided and continues to provide partners with the readiness to connect to the central business collaboration infrastructure Elex and to send supply chain data. To establish this readiness both sides of the connection need preparation (Lheureux and Kenney, 2003). On the hub side, Viacore configured hardware and software for Elex so that it matched the guidelines, e.g. for security and the different message formats. Viacore established escalation procedures and configured the software for partner enablement, prepared
testing mechanisms, e.g. to validate that data is compliant with the data model, and instructed support and operations teams.

On the partner side, the WebService helped and continues to help adjust a partner’s landscape so that they can send supply chain data as specified by the Elex guidelines. Some of Net-Tech’s partners had an adapter installed to send and receive supply chain data in XML messages from their inventory management or ERP systems. It was possible to connect these partners in three weeks. However, the majority of Net-Tech’s partners had a less advanced architecture and needed up to six weeks to establish a connection. In each case, representatives of the partner, the partner team manager from Net-Tech and provisioning engineers from ViaCORE conducted an eight-stage provisioning process that provided the partner with the readiness to connect to Elex (Table I).

In this process the partner qualified to participate, assessed their readiness to connect and provided data in the format required by Elex. They then connected to Elex in test mode, tested the supply chain data against the guidelines and connected to the production environment. Finally, they tested against the business rules (e.g. for response times) and received admission to go live in the production environment of Elex. To simplify the testing of a connection and limit the amount of time, the testing steps were supported by a virtual trading partner. This helped to test the quality of transport, data and processes plus the technical capabilities of a single partner step by step. As a result, it was possible to establish a connection between a partner and the hub without involving both sides simultaneously.
B.3 Business network operations

The business network operations WebService provides the Elex data collection WebService with supply chain data of that comply with the data model and generates supply chain visibility. To achieve this the service supports message communication and additional activities like the management of data integrity, change management and the capacity management of hard and software that prevent disruptions in message communication.

If a partner has adjusted its landscape according to the guidelines, it sends a message that contains supply chain data, as specified in the Elex PIPs and process standards, to the Elex business network operation WebService. The business network operations WebService then receives the message and authenticates it. If necessary, the WebService translates and transforms the message, e.g. from flatfile to the Elex data standard based on RosettaNet, so all data meet the Elex guidelines. The WebService verifies each message and assures its delivery to the data collection WebService. All communication is logged so that Elex has sufficient data for recovery or to clarify whether a message was sent and received in the correct format.

To prevent disruptions the WebService resolves diverse errors in data integrity (Table II). It continuously monitors the data quality of all incoming business messages and the data they contain. In a dynamic environment with multiple partners that have their own systems and distributed management of these systems, it is likely that some adjustments will have been made that violated the guidelines, or that unplanned disruptions influence a connection to the Elex and cause such errors in data integrity.
New partners often made minor adjustments that caused errors. The more mature the relationship became, the fewer the errors which occurred. Typically, a trading partner contributes to less than ten exceptions per month. The most common errors are duplication errors (when partners send messages several times) or validation errors (when a certificate is invalid). Transaction errors (RosettaNet errors) happen if a partner does not receive an acknowledgement for its PIP message in time. Application errors are the result of changes in configuration or can be related to bugs in the software. In the event of an error, operations support would contact the partner responsible giving them all the necessary information and advising how to adjust their landscape so that they meet the Elex guidelines again.

Planned adjustments in the business network can also cause disruptions in communication so in this case the WebService would guide the partners in the necessary adjustment to minimize errors in the network. Possible adjustments are the introduction of a new process that requires new data exchange or if a partner upgrades their internal infrastructure.

Another source of disruptions can be that hardware and software reach critical levels of usage. The WebService therefore monitors hardware and software capacity so that it can react to increasing message volumes.

Reports are generated for all activities, e.g. on message volume or major causes of errors.

Take in Table II
C. System architecture for supply chain visibility at Elex

When designing the information system architecture, Net-Tech and its partners implemented the data flow from distributed systems at partners to Elex along with the information processing required to detect errors in data integrity or to detect disconnects in supply chain data (Figure 7).

Large partners and Net-Tech had enterprise resource planning systems (ERP) with functions for product life cycle management (PLM), material requirements planning (MRP) and inventory management (IM). To exchange supply chain data between these functions within a business, partners used enterprise application integration systems (EAI). These systems could also be used to send supply chain data to Elex, e.g. in flatfiles. Some partners relied on additional solutions to communicate with partners such as B2B gateways that could send XML files, or else they worked with an EDI gateway and VAN provider to send EDI messages data to Elex.

Take in Figure 7

At the Elex end, three loosely coupled elements provided a high degree of flexibility (Table III):

- Comparable to an enterprise application integration system, a hub operating system received the data and provided functions to transport, validate, translate and design integration scenarios. It supported the communication methods as specified in the guidelines with partners.
- The infrastructure management application monitored message flows, data integrity and capacity with a command and control function that also supported
partner notification and error resolution. For connecting new partners it provided functions for partner enablement. It was independent of an application for specific collaborative processes such as supply chain management and only monitored whether an application would receive data as required.

- The supply chain management application aggregated supply chain data from several partners to support supply chain functions such as collaborative forecasting, planning and materials management. With an event management function it analyzed the supply chain data and generated alerts and reports (cf. El Sawy, 2001, 8). The application was integrated with the hub operating system to obtain supply chain data from partners.

Take in Table III

C.1 Hub operating system

To implement the data flow from partners to the data collection WebService, the hub operating system would need to process about 200,000 business messages per day, at peak times 100 RosettaNet PIPs/sec, and support different message formats and security methods – all at a reasonable cost. Off-the-shelf B2B solutions could manage the required message formats, but they could only support one certificate authority and process 2-3 RosettaNet PIPs/sec with one CPU. Over 30 CPUs and licenses would be needed to meet the requirements leading to software costs of at least USD 3 million. For this reason, Viacore developed a custom hub operating system that met all the requirements. To implement the data flow this included functions for transport (with messaging, addressing), business process management (with process scenarios,
process monitoring, event management), document translation and validation. The hub operating system could issue certificates and supported several (e.g. from Verisign, Viacore, SAT) to encrypt communication. Via an XML WebService interface it sent the supply chain data to a staging database as an input for supply chain analysis such as detecting disconnects. An archive logged all messages.

Administrative functions supported the management of partner profiles, interfaces, mapping tables and process scenarios to account for new partners or systems. The hub operating system supported connection testing with a virtual trading partner function. To ensure high availability, the hub operating system was installed at several sites worldwide.

C.2 Infrastructure management application

The infrastructure management application should manage disruptions in the data flow across multiple installations of the hub operating system. It must detect errors, provide functions for error resolution and support the enablement of partners.

As with the hub operating system, off-the-shelf B2B solutions lacked the necessary functions. They did not provide an efficient management console that permitted the management of several installations in one console, so each installation would have to be monitored separately and thus require additional support staff. Viacore developed a custom-built solution that was integrated with the hub operating system and is installed at its Operations and Support Center in Irvine, CA.

The infrastructure management application monitored the quality of the data flow in the hub operating system. For example, it monitored whether the response time of a participant was above normal, if a business message did not comply with the Elex data
model or if a security certificate was invalid. With an operations console, operations and support staff at Viacore could identify disruptions quickly and notify partners. This console also enabled the staff members to monitor the infrastructure capacity and react if it reached critical levels.

A provisioning console - as part of the application - supported partner enablement and the resolution of errors in communication level (Table I). For all activities in the provisioning process it provided instructions, descriptions, forms, documents and tracked completion of the steps (Figure 8).

Take in Figure 8

The provisioning console was a common platform that allowed partners, Net-Tech as the initiator and Viacore to oversee status, deadlines and responsibilities in the provisioning process. Partner team managers from Net-Tech could monitor the overall status of a certain partner in a summary and drill down to obtain detailed data (Figure 9).

Finally, the infrastructure management application helped Viacore to manage customer requests, e.g. if they needed a new security certificate or wanted to update their communication software.
C.3 Supply chain management application

The supply chain management application was to support the identification of disconnects in Net-Tech’s business network and management of their resolution. Net-Tech chose the Manugistics NetWORKS solution. It used the data from the hub operating system in the staging database and also extracted data from Net-Tech’s ERP system. The supply chain management application then analyzed the data on disconnects, and sent an alert notification to staff members at Net-Tech and the manufacturing partners involved. Net-Tech and its partners would collaboratively identify reasons for the disconnect and correct the data accordingly. In addition, Net-Tech could use the visibility on supply chain data provided by the supply chain management application to quickly identify alternative sources if one contract manufacturer suffered from part shortages. A major requirement was to integrate the supply chain management application tightly with the existing infrastructure at Net-Tech and its partners. For example, a contract manufacturer received email notifications on unplaced purchase order alerts. At the same time, however, their ERP system notified them about the disconnect and duplicate error messages like these were switched off.

CURRENT CHALLENGES/PROBLEMS FACING THE ORGANIZATION

The information system architecture, the services for collaboration management and for collaborative process management show how Net-Tech was able to transform its business network to participate in collaborative process management. In this transformation, which was mainly supported by Viacore’s planning and enablement
services, the company designed the new processes, convinced its partners and installed the necessary hardware and software as well as connecting partners to Elex so that they were able to send supply chain data.

Net-Tech developed the idea of a central business collaboration infrastructure to gain visibility on the supply chain at the beginning of 2000. In the third quarter of 2000 the company selected the Manugistics Networks for the supply chain solution, installed it, integrated it with Net-Tech’s ERP system and configured it so that it would detect disconnects. Viacore was selected in the first quarter of 2001 and seven pilot partners were connected.

Then in the second quarter of 2001, Elex started operations. Since that time, Elex has received supply chain data from all partners, provided Net-Tech with the visibility to detect disconnects so that Net-Tech can resolve them jointly with its partners and gain hints for further improvement. The services of business network operation from Viacore, and Net-Tech’s own services for data collection, exception management and performance reporting support the operation. In addition, the business network enablement service manages the ongoing connection of new partners. In the fourth quarter of 2003, a total of 59 partner sites (all out of a total of 16 contract manufacturer sites and 43 component manufacturer sites, accounting for 50-60% of the material spend) are now connected and send over 300,000 messages per day to Elex.

During transformation and operation Net-Tech was able to address the typical problems of collaborative processes with the provided services and standards:

- **Win-Win Orientation:** The Elex solution creates benefit for Net-Tech, its pilot partners and further partners. Net-Tech considered the knowledge and requirements
of pilot partners in the planning process. Partner marketing measures like monthly newsletters, supplier summits and support in the enablement process at the partner’s end have kept the partner informed and built trust. As an innovative business and an important customer for the companies involved, Net-Tech was able to achieve high speed in implementation and demonstrate the performance of the solution during the enablement. This has helped to gain momentum internally and at the partner’s end. Even if Net-Tech designed Elex to support unrestricted growth, it has also helped Net-Tech’s business network in an economic downturn. Despite all the positive effects of Elex and the analysis data it provides, Net-Tech has not conducted an ROI analysis. It would be challenging to measure and relate the improvements in cash-to-cash cycle time, inventory, asset turns, supply chain costs, value-added productivity to Elex and to show their monetary impacts.

- **Heterogeneous Landscapes.** The solution reduced heterogeneity in the required areas. For example, all partners share a common understanding of the standard supply chain process flow as well as how to resolve disconnects and errors, and partners send messages at events as defined in the Elex PIPs. In other areas such as message formats and security certificates, partners still have the option to use own solutions. 50% of the messages sent to Elex are flatfiles, 25% are RosettaNet messages, 25% are proprietary XML files. 1% of all messages are EDI messages, sent from a single partner via a VAN. Elex translates and transforms them into the Elex data model.

- **Responsibility Gap.** Responsibilities for resolving errors and disconnects are clearly assigned, and collaborative agreements define partners’ responsibilities. There are usually ten to twenty different errors and problems with data integrity per
day. Viacore works closely with partners to resolve these and manages the business network operations process. In the case of a disconnect Net-Tech contacts the partners and works with them to achieve a solution.

- **Prohibitive need for resources.** At Net-Tech only fifteen people on average were involved in building the solution. By working with an external service provider, it was possible to improve data quality and implementation speed. The experience gained from similar projects for collaborative processes suggests that to connect 60 partners, a do-it-yourself solution would take 36 months. Viacore and Net-Tech were able to achieve this goal in 9 months, and the methodology helps to build trust among the partners. The costs were lower than with internal resources from Net-Tech, since an external service provider benefits from economies of scale. Viacore, for example, can manage several business collaboration infrastructures with a single operation center and reuse procedures for several customers.

- **Security & Intellectual Property.** Collaborative agreements ensure that Net-Tech’s competitors have no access to Net-Tech’s process knowledge. The information system architecture and the operations service at Viacore are secured, and unauthorized parties are prevented from accessing the hub operating systems and the operations console.

- **Many-to-many Connectivity.** The use of open standards (eg. RosettaNet) allows partners to reuse their investment for collaborative processes with other partners. The services for planning, enablement and operation manage the connection of new partners. Many activities are automated or strongly supported by information systems, so the costs and resources needed to connect additional partners are low.
Elex has proven that it can successfully support collaborative processes at Net-Tech with its 59 partners and shows that many-to-many collaborative processes are real, affordable and create value. The case study cannot provide evidence for other contexts. The existence of projects to build business collaboration infrastructures at partners and competitors that run a complex business network with more than 50 partners like Motorola, HP and NEC at least show the relevance of collaborative processes and their implementation. The findings suggest that partners, initiators and business collaboration service providers for business collaboration infrastructures can learn from the Elex solution:

- **Other partners.** In order to participate, the costs of communicating with another business electronically must be lower than the benefit. Partners can increase the benefit and reduce costs by using one solution for multiple business relationships. Partners should push initiators to use open standards and ensure reuse of the solution. They should try to influence the process design at an early stage so that they can also increase their benefit and the problems of collaborative processes can be resolved. Existing partners of Net-Tech’s Elex solution may reuse significant parts of their solution to participate in similar initiatives and to communicate with many businesses since openness was a prime goal of the Elex solution. This use of industry-accepted standards like RosettaNet makes it attractive for other partners with similar backgrounds to connect to Elex and benefit from Net-Tech’s and Viacore’s experience in providing a solution for electronic communication.

- **Other initiators of business collaboration infrastructure in high-tech:** Initiators can focus on reengineering processes. They should first ask themselves if they have the business case and the power, e.g. through multi-billion dollar high-tech expenditure
and a complex supply chain, to lead an initiative for collaborative processes. They can reuse the RosettaNet standards developed by the iHub program, use Viacore’s services and similar supply chain management software. They should involve partners in the early stages of designing the collaborative processes so they can benefit from their view on the current inefficiencies in the process and increase the commitment of partners to adopt the solution later on. For transformation and operation they should rely on service providers to reduce risk, time and costs. In their evaluation, initiators should consider experience in high-tech industry, performance, infrastructure technology and price as critical success factors. By introducing the transformation in phases, all the partners involved can learn and quickly react to any problems which might arise.

- **Other business collaboration infrastructure service providers:** Business collaboration service providers should focus on lowering barriers for all participants and on growing the network. They should try to reduce the costs of participation by offering several connection methods so that businesses can reuse existing infrastructure. With the use of standards they can lower the costs of integration and reach more customers, establish more many-to-many collaborative processes and generate higher benefits through supply and demand-side economies of scale. Progress in technical concepts, like SOAP, WSDL and other WebService standards, reduces the cost of electronically integrating several activities from heterogeneous landscapes. However, service providers will have to take care of more problems including responsibility for error resolution. They must benefit, trust and guide initiators and partners in the transformation and operation of collaborative processes.
REFERENCES


Figure 1: Standard supply chain flow in Net-Tech’s business network

Figure 2: Business collaboration infrastructure for collaborative processes based on the example of Net-Tech
Figure 3: Identifying disconnects with the collaborative exception management process

Figure 4: Samples of process and data standards for Elex

Figure 5: Identifying alerts with Elex data based on the example of leadtime disconnect

Figure 6: Generating reports with Elex data

1 Distributor and customer are not shown for the sake of clarity
<table>
<thead>
<tr>
<th>Activities</th>
<th>Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Qualify</td>
<td>Submit legal agreement</td>
</tr>
<tr>
<td></td>
<td>Receive legal agreement</td>
</tr>
<tr>
<td>2. Readiness Assessment</td>
<td>Complete readiness assessment forms</td>
</tr>
<tr>
<td></td>
<td>Evaluate profile / create Statement of Work (SOW)</td>
</tr>
<tr>
<td>3. Integration</td>
<td>Integration plan and schedule</td>
</tr>
<tr>
<td></td>
<td>Install required software</td>
</tr>
<tr>
<td></td>
<td>Data analysis</td>
</tr>
<tr>
<td></td>
<td>Outbound data extraction</td>
</tr>
<tr>
<td></td>
<td>Data mappings</td>
</tr>
<tr>
<td></td>
<td>Inbound/outbound interface</td>
</tr>
<tr>
<td></td>
<td>Verify integration completion</td>
</tr>
<tr>
<td></td>
<td>Complete technical profile</td>
</tr>
<tr>
<td>4. Establish Connectivity</td>
<td>Review technical profile</td>
</tr>
<tr>
<td></td>
<td>B2B server working</td>
</tr>
<tr>
<td></td>
<td>Set up partner profile</td>
</tr>
<tr>
<td></td>
<td>Digital certificate setup</td>
</tr>
<tr>
<td></td>
<td>Install client digital certificate</td>
</tr>
<tr>
<td></td>
<td>Set up gateway/channels for test</td>
</tr>
<tr>
<td>5. Data Testing</td>
<td>Data validation testing</td>
</tr>
<tr>
<td></td>
<td>Volume test</td>
</tr>
<tr>
<td></td>
<td>Notification of connectivity</td>
</tr>
<tr>
<td>6. Final Channel Testing</td>
<td>OK to proceed with testing</td>
</tr>
<tr>
<td></td>
<td>Production testing environment</td>
</tr>
<tr>
<td></td>
<td>Final channel approval</td>
</tr>
<tr>
<td>7. End-to-End Testing</td>
<td>Business rules testing</td>
</tr>
<tr>
<td>8. Implementation</td>
<td>Set up channels in production environment</td>
</tr>
<tr>
<td></td>
<td>Go live</td>
</tr>
</tbody>
</table>

**Table I: Provisioning process, (Viacore, 2002)**

**Applications & Process Quality:**

*Transactions.* The collaborative processes in the business network required that a recipient confirmed receipt of a message by sending back an acknowledgement. Only if the sender received the acknowledgment in a certain period of time, could they consider the message received, otherwise they would have had to consider their trial unsuccessful. Process quality was measured by the time it takes a recipient of a message to acknowledge receipt.

*Exception Handling.* Viacore monitored data quality in multiple stages. In the event of an error it notified the partners. They needed to be capable of resolving the error, thus avoiding disruptions in the business network. Procedures for resolving errors were established.

**Data Quality**

*Transformation.* The data from the business messages data format must be reliably transformed into the applications format at the partner’s end. Mistakes in transformation threatened data integrity (e.g. they meant that partners interpreted quantities incorrectly and did not optimally allocate capacity).

*Translation.* Data must also be translated (e.g. between different part numbers used by partners). More than 100 part numbers might exist for a single component. If partners did not translate the data correctly, visibility was at risk and the exception management process failed.

**Transport Quality**

*Authentication and Non-Repudiation.* Partners made decisions based on the messages they received. They wanted to prove that a message sent from other partners had not been changed. Measuring SSL errors allowed them to check the quality of authentication and non-repudiation.

*Availability.* The business network worked if each partner was capable of sending and receiving messages and was available. Therefore, if the leadtime for a critical component was not available, overall leadtimes for assemblies could not be forecasted either. A rising volume of http post-requests allowed them to check the general availability of a Web server.

**Table II: Quality requirements of Elex data**
Figure 7: Implementation of the Elex concept in information systems
<table>
<thead>
<tr>
<th>Element</th>
<th>Functions</th>
<th>Description</th>
<th>Supported Processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application Architecture</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply Chain Management</td>
<td>Supply chain event mgmt.</td>
<td>The supply chain management application aggregates the supply chain data,</td>
<td>Data collection, Exception management,</td>
</tr>
<tr>
<td></td>
<td>Coll. forecasting</td>
<td>performs analysis, manages exceptions and generates reports.</td>
<td>Performance reporting</td>
</tr>
<tr>
<td></td>
<td>Coll. materials management</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Coll. planning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infrastructure Management</td>
<td>Partner enablement</td>
<td>The infrastructure management application provides tools for connecting</td>
<td>Business network enablement, Business network</td>
</tr>
<tr>
<td></td>
<td>Command &amp; control</td>
<td>partners and resolving alerts, and generates reports on hub usage.</td>
<td>operations</td>
</tr>
<tr>
<td>Integration Architecture</td>
<td>Validation</td>
<td>The hub operating system handles all business message communication from</td>
<td>Business network operations, Data collection</td>
</tr>
<tr>
<td></td>
<td>Translation</td>
<td>partners to Net-Tech.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Transformation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Security</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Table III: Elex application and integration architecture*

*Figure 8: Elex provisioning console – a partner view*
**Figure 9: Elex provisioning console – Net-Tech view**

<table>
<thead>
<tr>
<th>Partners</th>
<th>Data Expected</th>
<th>Planned Live</th>
<th>Provisioning Status</th>
<th>Data Validation</th>
<th>Next Step</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elpida Memory</td>
<td>200 - RosettaNet</td>
<td></td>
<td></td>
<td></td>
<td>Submit Legal Approval</td>
</tr>
<tr>
<td>Excelight</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td>Submit Financial</td>
</tr>
<tr>
<td>FCI</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td>Data Validation</td>
</tr>
<tr>
<td>Fonconn NWE</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td>Submit Financial</td>
</tr>
<tr>
<td>GSI Technology, Inc</td>
<td>1000 - RosettaNet</td>
<td></td>
<td></td>
<td></td>
<td>Complete Real Assessment</td>
</tr>
</tbody>
</table>

Legend:
- Green: On track
- Red: On hold
- Yellow: In progress
- Blue: Complete

Data Expected:
- DP/Day
- SI/Files, 2Y, 3Y, 5Y Services, 25% RosettaNet

Provisioning Status:
- Green: Data Validation
- Yellow: Partner Rend, Test/Run/Approved
- Red: Data Approved
- Blue: In progress

Note: Click on the partner name to do ALL STEPS.