Peer-to-Peer Information Systems - An Enabler of Collaborative Planning, Forecasting and Replenishment

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Abstract

The emergence of technologies enabling low cost electronic communication and information sharing has made inter-company collaboration one of the most discussed topics in logistics today. Collaboration offers significant advantages, but large-scale implementation of collaborative business models, such as Collaborative Planning, Forecasting and Replenishment (CPFR), has proven difficult. Although technology is only part of the challenge of implementing collaborative processes, it has been subject of much attention recently. This is do to the emergence of electronic marketplaces, especially in the consumer packaged goods sector, that aggressively market themselves as the way for companies to attain large-scale CPFR.

In this paper, the support for CPFR offered by electronic marketplaces as well as distributed, peer-to-peer, information systems is discussed.

Keywords: Collaborative Planning, Forecasting and Replenishment (CPFR), electronic marketplaces, peer-to-peer information systems

Introduction

In recent years, the concept of inter-company collaboration has received much attention both from practitioners as well as academics. Although supply chain integration and collaboration are not new ideas, the emergence of technologies that enable low cost electronic communication and information sharing have made them more attractive than ever (Cross, 2000; Graham & Hardaker, 2000; Stein & Voehl, 1998).

Collaboration certainly is a powerful concept. Through improved information sharing and better coordination of supply chain activities, collaborative business models make it possible to both lower cost and improve customer service (Stank & al., 2001; Stein & Voehl, 1998). The suggested benefits of inter-company collaboration include decreased inventory levels, more predictable order cycle times, elimination of redundant activities, increased product availability and increased sales (Stank & al., 1999a; Stank & al., 2001; VICS, 1999).

Perhaps the most visible undertaking in the area of collaborative business processes and electronic information sharing is the Collaborative Planning, Forecasting and Replenishment (CPFR) model developed by the Voluntary Interindustry Standards Association (VICS) and adopted mainly by consumer packaged goods companies. CPFR offers guidelines for developing shared processes that enable trading partners to do joint planning and demand forecasting as well as to synchronize their material flows according to end-customer demand (Sherman 1998; Stank & al. 1999b; VICS, 1998).

To date, several companies have set up CPFR pilots, and positive results have been reported. Wal-Mart, for example, achieved a 2 % improvement in retail store in-stock, a 14 % decrease in store-level inventory as well as a 32 % increase in sales and a 17 % increase in retail turns in their CPFR project with Sara Lee Branded Apparel (VICS, 1999). Likewise, an increase from 84 % to 96 % in in-store product available together with a 14 % increase in sales and no change in inventory levels were achieved in a pilot between Kimberly Clark and Kmart (Hill, 1999).

Although pilot implementations of CPFR have produced promising results, it is important to keep in mind that the vast majority of pilots have been limited in scope. Typically, the implementations have only involved one product category and two or few trading partners. This means that the impact of the pilots on the companies' performance has not been significant. Benefiting from collaborative business processes usually requires involving a larger proportion of products and trading partners (Stank & al., 1999b). However, the small number of successful implementations of CPFR company-wide or with several trading partners indicates that taking the step from pilots to large-scale implementations has not been easy. Significant obstacles, ranging from the lack of trust between trading partners to the lack of scalable solutions, need to be overcome before the promise of CPFR can be realized (Bowersox & al., 2000; Frantz, 1999).

Requirements Presented by Collaborative Planning, Forecasting and Replenishment

Companies have encountered several problems in trying to implement Collaborative Planning, Forecasting and Replenishment.

One of the cornerstones of CPFR is the sharing of information concerning, for example, end-customer demand, upcoming promotions, and sales forecasts (Quinn, 1999). Without information sharing, no collaborative processes can be developed. However, when companies are faced with the necessity of sharing information, fundamental issues concerning trust and power arise. Some supply chain parties are reluctant to share what they consider to be sensitive information because they fear that the information may leak, or that the information may be used against them (Bowersox & al., 2000). Others, on the other hand, feel that being the only party having access to certain information, such as end-customer demand, gives them power in the supply chain – making this information available to others could lessen this power. Finally, in some situations, trading partners have difficulties sharing information because their internal processes do not correspond and, in some cases, cannot produce the necessary data. For example, several grocery retailers find it impossible to produce item level forecasts for all of their tens of thousands of products, which obviously forms a significant obstacle for CPFR type collaboration.

Another cornerstone of CPFR is joint processes. Creating shared processes is, however, much harder than simply sharing information. Several companies have had to face the fact that what works in small-scale pilots may not work when there are several trading partners and large numbers of products involved. Nabisco, for example, admits that it still does not have a scalable enough solution despite being one of the early companies to start CPFR piloting (Frantz, 2000). Therefore, significant scalability, i.e. support for several users, rapid implementation and easy integration with different types of existing systems, need to be required of collaborative processes and supporting tools.

Furthermore, the lack of common standards for sharing the type of information needed for CPFR is today slowing the development down (Angeles, 2000).

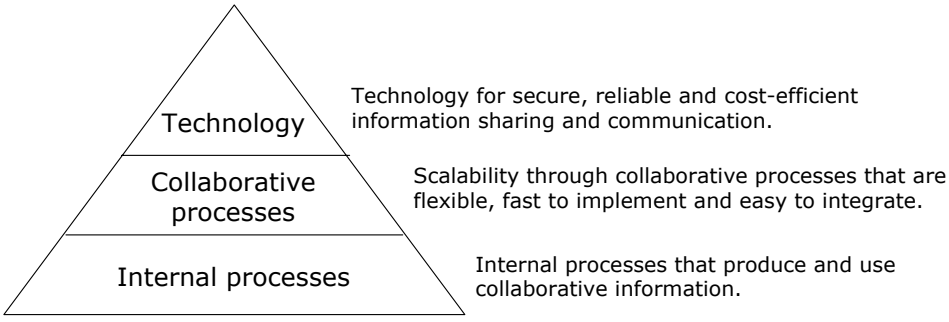

Figure 1. Inter-company collaboration builds on high quality internal processes as well as scalable collaborative processes that can be made efficient using electronic communication technology.

When looking at the requirements that collaboration presents (Figure 1), it becomes clear that technological issues form only a small part of the challenge of implementing large-scale CPFR. Despite this, it has been subject of much discussion. Different companies have chosen different approaches in building the infrastructure for collaboration, often relying on internet or extranet

solutions. In addition, especially in the consumer packaged goods business, electronic marketplaces have aggressively marketed themselves as solutions for CPFR.

From the problems facing companies implementing CPFR, the following requirements on the technological infrastructure can be derived:

- Control and security: Companies should be able to control what information is shared with whom and be able to rely on the security of the information sharing.

- Scalability: The technological infrastructure has to support collaboration with a large amount of trading partners, large and small, and a large amount of products. In addition, the technology should offer easy integration with different types of existing systems.

- Standardization: The technology should use open standards in order to allow the network of collaborating trading partners to grow rapidly.

Next, two rather different technological solutions will be evaluated based on these criteria. We will start by examining the emerging electronic marketplaces and their support for collaboration, and then we will look at a distributed, peer-to-peer, implementation.

Electronic marketplaces - a centralized solution

Recently, a significant number of electronic marketplaces, or so-called exchanges, have emerged. These marketplaces differ in what goods they trade (manufacturing inputs vs. maintenance, repair and operating inputs) and in what types of sourcing they support (buying based on pre-negotiated contracts vs. spot sourcing). (Kaplan & Sawhney, 2000). Despite these differences in focus, the different marketplaces offer their customers quite similar services. The core business of the marketplaces are the order matching services, such as catalogue orders (the buyer selects a fix-priced item from a catalogue), dynamic pricing (the marketplace matches orders real-time based on bids and quotes that come into the marketplace), auctioning, and requests for proposals (detailed specifications are put on-line and bids are consolidated and compared). Some marketplaces also offer requisition and routing approval (requests can, for example, be routed to the right manager for approval), financial settlement of orders, and content management (e.g. converting and maintaining catalogue information). In rare cases, also logistical fulfillment services are included in the offering. (Morgan Stanley Dean Witter, 2000).

Lately, several electronic marketplaces have started expanding their scope to include not just simple transactions, but also more complex collaborative activities, such as joint design, fulfillment, and coordination that supply chain parties engage in. The development has, however, not been very rapid.

<u>The situation in the consumer packaged goods sector</u>

In the consumer packaged goods sector, there are currently four large electronic marketplaces: Transora, WorldWide Retail Exchange (WWRE), CPGmarket.com (CPG), and GeneralNetXchange (GNX). Transora and CPG have been founded by suppliers, whereas WWRE and GNX have been founded by retailers. Electronic marketplaces are a new phenomenon in the consumer packaged goods industry – the first of these four large exchanges started their operations in early 2000. This means that many consumer goods companies are currently thinking about whether they should join an exchange, and which exchange they should, in that case, choose. Due to the business model being so new, the exchange activities are also still rather limited. Some auctions have been conducted, and this is where the most visible results have been attained. In addition, the exchanges are developing capabilities for catalog hosting and catalog based business. However, all of the four large exchanges have announced that they will implement "CPFR capability" this year.

What are then the pros and cons of using electronic marketplaces for transactions as well as for support for collaboration?

Advantages and disadvantages

The electronic marketplaces offer a centralized way of doing business. As far as basic business transactions, such as orders, auctions or requests for proposals, are concerned, the approach offers several advantages. Electronic marketplaces make it possible for small companies that cannot afford expensive EDI links to conduct business electronically (Angeles, 2000). In addition, electronic marketplaces offer efficient matching of demand and supply by making it easy to involve several, often anonymous, players in the trading process. It lowers the barriers for sellers to participate in bidding as well as expands the group of potential customers, and it offers buyers an opportunity to get a better price as well as expands the group of suppliers they can do business with. A disadvantage is the problem of keeping information, such as product and price information included in catalogs, up to date. Changes to the information need to be explicitly communicated by the company to the party administrating the marketplace; otherwise, transactions will be based on outdated information.

When examining electronic marketplaces from a CPFR point of view, the points mentioned above remain valid, but there are also some new aspects that need to be considered. Suggested benefits of using exchanges as an infrastructure for CPFR include:

- Integration with only one party: A company only needs to create one link to one exchange once, rather than several links to several companies that it wants to interact with. This provides an opportunity to save money and to attain more rapid and cheap implementation (Transora, 2001).

- Standardized communication: Electronic marketplaces have the opportunity to impose communication standards, either existing open standards or proprietary standards. Also, marketplaces can offer translation services, i.e. do the necessary translations when two companies needing to communicate use different message formats (Schachtman, 2000).

These advantages, however, need to be weighed against some significant disadvantages:

- Reduced control and power: A company using an electronic marketplace for communicating CPFR information loses control of the information. After the information has been transferred to the electronic marketplace, the company has to trust the marketplace to deliver it to the right recipient, and only to that recipient. Also, there is a significant risk that the development of new features and capabilities will take place according to the needs of the largest companies involved in the marketplace, implicating potential difficulties for the smaller players.

- Problems with scalability: Although the electronic marketplaces support several participants and a significant amount of transactions, scalability may become a problem with CPFR. Since companies are likely to have somewhat different needs when creating collaborative business processes, the electronic marketplaces may have difficulties balancing between tailored and standardized solutions in a way that both customer satisfaction and efficiency remain high (Ferreira & al., 2001). In addition, the issue of keeping information up-to-date becomes aggravated when more complex and rapidly changing CPFR information is transferred.

- Fees: Although the company only needs to pay for investment in one communication link (the one to the electronic marketplace), it still needs to pay transaction fees or service fees to the marketplace.

There are, thus, both advantages and disadvantages with the centralized solution that electronic marketplaces offer. Next, we will examine a decentralized solution and view its strengths and weaknesses as an infrastructure for CPFR.

Peer-to-peer information systems - a decentralized solution

No generally accepted definition exists for peer-to-peer information systems. However, one of the main issues about peer-to-peer is the direct data exchange between systems, instead of making the data pass by servers and centralized databases. In a peer-to-peer architecture, computers that have traditionally been used solely as clients communicate directly among themselves and can act as both client and server, assuming whatever role is most efficient for the task being performed.

Such architectures can significantly reduce set-up times and maintenance efforts of IT systems since databases do no longer need to be created and maintained for temporary storage of data. For instance, in the case of two collaborating companies, there is no reason for the "client" company to locally store information retrieved from the "server" company since the same (or updated) information can be retrieved again any time when it is needed. Therefore, the "client" company does not need to create new databases for storing the information, so the IT department of the "client" company does not need to be involved in setting up the information exchange.

Example implementation

A prototype peer-to-peer system has been developed for improving supply chain management by the exchange of sales forecast information between retailers and suppliers. However, the peer-to-peer solution itself is general enough to support exchange of any kind of information (Främling & Holmström, 2000).

Figure 2 illustrates a small and simplified supply chain set-up. If a supplier wants to get access to forecast data from the three retailers, the supplier first configures the three connections to the retailers and then each retailer configures the connection to the supplier, thereby permitting the supplier access to their forecasting information. A connection is configured by three pieces of information, namely (1) the identifier of the partner, (2) the Internet address of the partner computer to connect to/receive connections from and (3) a public RSA encryption key that uniquely identifies and authenticates the partner.

In our case, the public encryption key is not public to the whole world, it should be known only by the partners of the collaboration network. Encryption keys are needed for authentication of the other party, so that it is not possible for anyone to connect and obtain information just by pretending to have the IP number of a trusted party. Such public key authentication, combined with data encryption for the actual data exchange, makes the communication completely confidential between the two parties (National Institute of Standards and Technology, 2000).

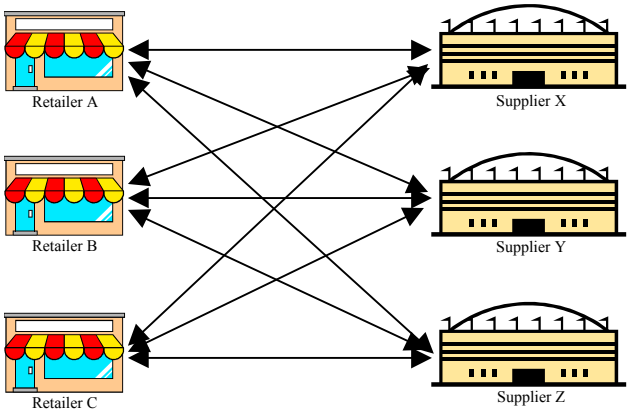

Figure 2. Example of retailer-supplier supply chain setup.

Information sharing connections are set up by mutual agreement and local set-up by the two parties involved. Therefore, every actor of the information-sharing network has absolute control of what information is published to the other actors. There is no need for a "third-party" for setting up or governing the network. Local set-up also means that there is no need for external IT consultants nor extensive negotiations to make the IT systems of the companies understand each other.

Initial set-up of the distributed software is relatively easy. It is sufficient to configure what database to use, tell the program to set up the database tables and eventually add new database users with appropriate access rights. Then supplying the three pieces of information per connection indicated above is enough to configure new connections. Thus, an initial installation should not take more than from about 30 minutes to a few hours at the most.

Advantages and disadvantages

The advantages of choosing a peer-to-peer approach rather than, for example, using electronic marketplaces for CPFR support include:

- Control and power: Each party belonging to the collaborative network can decide for itself what information to share with whom. In addition, all network parties have equal status regardless of their size and can independently choose how to collaborate with the other network parties.

- Scalability: Collaboration networks can be set up dynamically with hardly any limits on the number of parties, products or product groups. The low cost and small effort needed for setting up the software components mean that even a big collaboration network could be rapidly operational. Also, since the collaboration links are easy to set up and because no large IT infrastructure is needed, a peer-to-peer solution makes it economically feasible even for small companies to participate in the network.

- Up-to-date information: Direct availability of information from the source rather than copying and storage of information in several places reduces problems with outdated information. Solutions for automated update notification could also be easily implemented in a peer-to-peer solution since each party of the collaboration network knows what other parties are interested in or have access to specific information. Such automated and asynchronous notification could be difficult to set up with centralized solutions like electronic marketplaces.

- No participation fees: The peer-to-peer solution requires a small investment for each link, but there are no additional transaction or service fees.

The main disadvantage of the peer-to-peer solution is related to standardization:

- Slow standardization: Open information sharing standards are needed for communication. The prototype solution exchanges Java objects, which is not a problem as long as everyone uses the same software. In the future, however, it will be necessary to communicate with software of different companies, which requires the existence of open information sharing standards. Such standards will most probably be XML-based, which can be easily supported. The "advantage" of electronic marketplaces is that they are proprietary, which means that they can impose their own standards without having to wait for common agreed-upon standards to become available for all types of communication.

Conclusions

When looking at basic transactions, such as orders, bidding or requests for information, electronic marketplaces can offer added value. By giving access to a large number of buyers and sellers and enabling, for example, spot trading between parties that do not necessarily know each other from before, the electronic marketplaces can offer similar value to a company as financial exchanges offer to people trading stocks or derivatives.

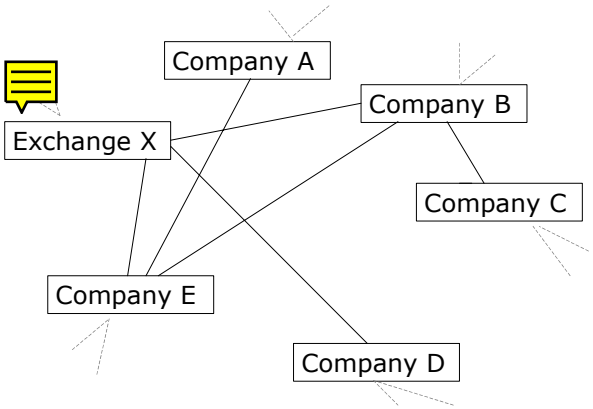

Figure 3. A peer-to-peer solution involving electronic marketplaces as peers rather than central hubs.

However, when examining the requirements presented by CPFR, the situation in somewhat different. When comparing the centralized marketplace model to the decentralized peer-to-peer model, it becomes clear that the marketplaces are not the solution to CPFR they market themselves to be. If the standardization issues can be solved, it appears that companies would be better off choosing a peer-to-peer solution for CPFR rather than relying on electronic marketplaces to provide the necessary support for their collaboration efforts. In this case, the supply network would look something like Figure 3 – a network involving both companies as well as electronic marketplaces as peers, where no party assumes the role of central hub.

References

- Andraski, J. C. (1998), Leadership and the realization of supply chain collaboration, *Journal of Business Logistics*, Vol. 19, Issue 2, pp. 9-11.
- Angeles, R. (2000), Revisiting the role of Internet-EDI in the current electronic commerce scene, *Logistics Information Management*, Vol. 13, Issue 1, pp. 45-57.
- Bowersox, D. J., Closs, D. J. & Stank, T. P. (2000), Ten mega-trends that will revolutionize supply chain logistics", *Journal of Business Logistics*, Vol. 21, Issue 2, pp. 1-16.
- Cross, G. J. (2000), How e-business is transforming supply chain management, *Journal of Business Strategy*, Vol. 21, Issue 2, pp. 36-39.
- Ferreira, J., Schlumpf, E. & Prokopets, L. (2001), Collaborative commerce: Going private to get results, Deloitte Research, available on-line at: http://www.dc.com [last accessed June 25].
- Frantz, M. (1999), CPFR pace picks up, *Consumer Goods Technology*, January/February.
- Frantz, M. (ed.) (2000), Superior B2B Supply/Demand Chain Performance – The 2000 B2B & Supply Chain Management Report, available on-line at: www.consumergoods.com/B2B2K/.
- Främling, K. & Holmström, J. (2000), A distributed software for collaborative sales forecasting, Conference paper, Second Conference on Management and Control of Production and Logistics, 5-8 July 2000, Grenoble, France, available on-line at: http://www.tai.hut.fi/ecomlog/ [last accessed June 25].
- Graham, G. & Hardaker, G. (2000), Supply-chain management across the Internet, International *Journal of Physical Distribution & Logistics Management*, Vol. 30, Issue 3, pp. 286-295.
- Hill, S. (1999), CPFR builds the united partnerships of apparel, *Apparel Industry Magazine*, Vol. 40, Issue 7, pp. 21-28.
- Kaplan, S. & Sawhney, M. (2000), E-hubs: The New B2B Marketplaces, *Harvard Business Review*, Vol. 78, Issue 3, pp. 97-103.
- Morgan Stanley Dean Witter (2000), The B2B Internet Report. Collaborative Commerce.
- National Institute of Standards and Technology (2000), Federal Agency Use of Public Key Technology for Digital Signatures and Authentication, NIST Special Publication 800-25, October, available on-line at: http://csrc.nist.gov/publications/nistpubs/800-25/sp800-25.pdf.
- Quinn, F. J. (1999), Cooperation and collaboration: The keys to supply chain success, *Logistics Management & Distribution Report*, Vol. 38, February 19, p. 35.
- Schachtman, N. (2000), Trading partners collaborate to increase sales, *InformationWeek*, October 9, pp. 182-188.
- Sherman, R. J. (1998), Collaborative planning, forecasting & replenishment (CPFR): Realizing the promise of efficient consumer response through collaborative technology, *Journal of Marketing Theory and Practice*, Vol. 6, Issue 4, pp. 6-9.
- Stank, T., Crum, M. & Arango, M. (1999a), Benefits of interfirm coordination in food industry supply chains, *Journal of Business Logistics*, Vol. 22, Issue 2, pp. 21-41.
- Stank, T. P., Daugherty, P. J. & Autry, C. W. (1999b), Collaborative Planning: Supporting Automatic Replenishment Programs, *Supply Chain Management*, Vol. 4, Issue 2, pp. 75-85.
- Stank, T. P., Keller, S. B. & Daugherty, P. J. (2001), Supply chain collaboration and logistical service performance, *Journal of Business Logistics*, Vol. 22, Issue 1, pp. 29-48.
- Stein, M. & Voehl, F. (1998), *Macrologistics Management*, St. Lucie Press, Boca Raton.
- Transora (2001), CPFR: Reaping the benefits through Transora, available on-line at: www.transora.com/en/pdf/cpfrwhtppr.pdf [last accessed June 25, 2001].
- VICS CPFR Committee (1998), CPFR Voluntary Guidelines, available on-line at: www.cpfr.org [last accessed June 25, 2001].
- VICS CPFR Committee (1999), Roadmap to CPFR: The Case Studies, available on-line at http://www.cpfr.org [last accessed June 25, 2001].