DAMA Model For Collaboration

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1 Executive Summary

The Demand Activated Manufacturing Architecture (DAMA) project during the last five years of work with the U.S. Integrated Textile Complex (retail, apparel, textile, and fiber sectors) has developed an inter-enterprise architecture and collaborative model for supply chains. This model will enable improved collaborative business across any manufacturing based supply chain. The DAMA Model for Supply Chain Collaboration is a high-level model for collaboration to achieve Demand Activated Manufacturing. The industry has determined that collaborative business practices are necessary to provide a significant reduction in time and cost to product pipelines. Potential savings in the U.S. Integrated Textile Complex (ITC) are estimated at $45 Billion per year with a realistically achievable 50% reduction in time.

Collaboration has been recognized as the single biggest opportunity since Quick Response for Industry. "While many companies have redesigned internal processes, the leaders are working collaboratively with trading partners to integrate their processes to eliminate costs and decrease response time to consumer demand. When these best practices are fully implemented in the softgoods supply chain, consumers will save an estimated $48 billion annually" (KSA Report QR From Vision to Reality).

The Collaboration, Planning, Forecasting, and Replenishment (CPFR ®) endeavor, is an initiative to close the business opportunity gap that exists between today's practices (such as Quick Response) and the new best practices of collaboration. Randy Mott, CIO and Senior Vice President, Wal-Mart, made the following comment: "I believe that

CPFR ® is the single largest opportunity to move inventory management forward in the next five years. We plan to implement collaborative relationships with well over 100 suppliers in the next 12 months. We believe that CPFR ® is the driver for moving into the next era of buyer-seller relationships".

"Supply chain collaboration is about companies working together towards a common set of goals. Essential to success is a joint agreement spelling out what success is and how issues are to be resolved. The companies that execute this strategy correctly will recognize significant immediate and long term benefits" (Jim Lovejoy, DAMA Project Director). The architecture and model described in this document provide a roadmap and methodology for executing collaborative business across a Textile Supply Chain.

Collaborative supply chains will not be successfully implemented overnight. It will require changes in business practices, and small-scale proof of concept pilots before they can be implemented successfully in a large-scale manner. This document describes the following components:

- The DAMA Architecture (Figure 1 & 2),
- The Demand Activated Manufacturing Inter-enterprise Model (Figure 4),
- The DAMA Model for Supply Chain Collaboration (Figure 6) and
- The Process for Executing the DAMA Model (Figure 15).

The DAMA Architecture provides a framework for developing business collaboration. The Demand Activated Manufacturing Inter-enterprise model demonstrates the requirements for the new type of organizations required to engage effectively in supply chain collaborative practices. The DAMA Model for Supply Chain Collaboration provides a recommended set of processes that could be implemented in a collaborative manner. Moreover, the Process for Executing the DAMA Model describes a roadmap for establishing a successful collaborative supply chain.

2. DAMA Architecture

The Demand Activated Manufacturing Architecture (DAMA) project has developed an inter-enterprise architecture and Collaboration Model for supply chains that will enable improved collaborative business across the supply chain. The industry has determined that collaborative business practices are necessary to provide a significant reduction in time and cost to product pipelines. The Collaboration, Planning, Forecasting, and Replenishment (CPFR ®) endeavor, in which DAMA played an active role provided the template for this work. DAMA's concern was to include all of the supply chain sectors and all of the textile industry's functions.

One model defined by DAMA was an architecture model. It was designed to assist in understanding important collaboration factors and concepts. This architecture model has five components each with specific definitions. The architecture model, its components, and associated definitions are shown in Figure 1 and Figure 2.

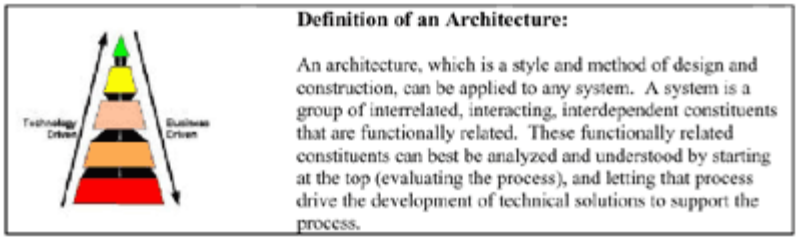


Figure 1. Definition of an Architecture

Component	Architecture	Definition
Process		The activity(s) involved in the accomplishment of a goal.
Information		The derived knowledge from the application of data that supports the process.
Application		The transformation of data into information.
Data		The detailed facts required providing information to support the activity.
Infrastructure		The underlying business, social and technical foundations that support the process. Social foundations include corporate polices, business practices, and trust.

Figure 2. Five Components of the DAMA Architecture

DAMA's Inter-Enterprise Architecture (which spans multiple companies across a supply chain) is shown in Figure 3. Each company (enterprise) in a sector may have their own unique internal architecture for sharing corporate information. The key architecture for collaboration across the supply chain is the support of a common set of information available to all members of the supply chain. The information must be timely, valid, secure and selectively available with client level authentication. The DAMA technologies have demonstrated and piloted this kind of architecture.

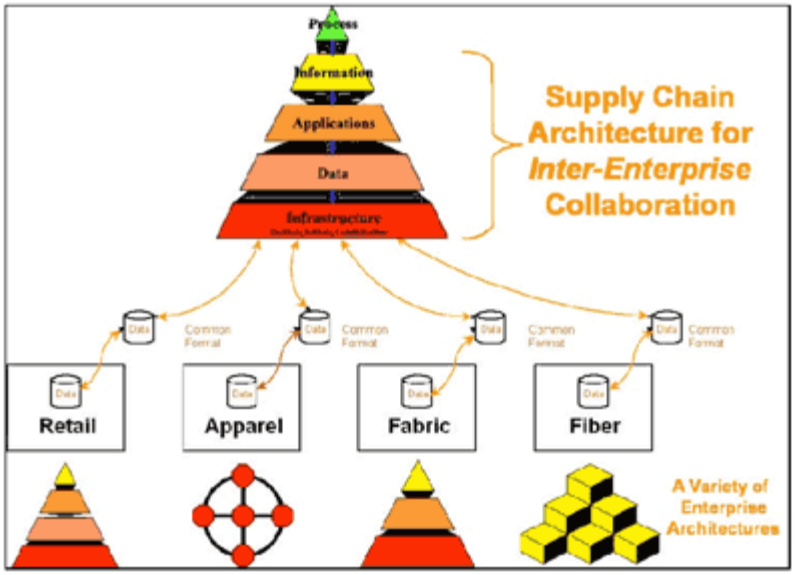
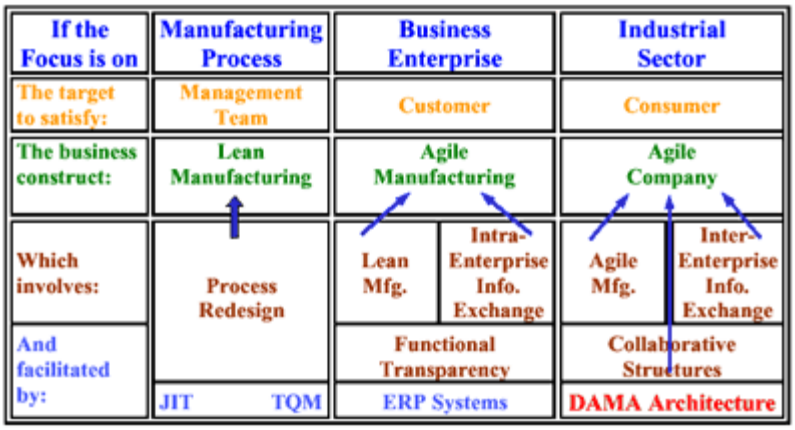


Figure 3. DAMA's Inter-Enterprise Architecture

3 Demand Activated Manufacturing Inter-enterprise Model

Industry is starting to recognize that the new collaborative paradigm provides the right answer. Retail demand needs to be synchronized with manufacturing constraints across multiple companies through collaboration across the supply chain. In DAMA this synchronization is called Demand Activated Manufacturing.

The general literature on supply chain collaboration as well as the information gained from our work directly with the U.S. ITC all point to the emergence of a qualitatively new type of organization as the end point of a shift to supply chain collaborative practices. This new organization is the culmination of a series of changes that begin in the internal workings of a company, and then (and only then) shift focus to inter-company relationships. Internal (to a company) functional transparency and the associated intra-enterprise information exchange structures and processes must be achieved before the cross-company, inter-enterprise exchanges that underlie true collaborative relationships can be maximized. Figure 4 illustrates this movement from left to right, as a company moves from an internal focus to an ultimate focus on the consumer.



Legend: JIT - just-in-time inventory management / TQM - total quality management / ERP - enterprise resource planning

Figure 4. Demand Activated Manufacturing Inter-enterprise Model

The cultural changes required moving a company from lean manufacturing to an agile company can be a multi-year and painful process. The adoption of a series of new business practices and attitudes are required. Our research on the U.S. ITC, supported by the literature review conducted for that research, confirmed that the one necessary piece for the movement to collaboration is industry culture change; changes in the values and attitudes that motivate behavior will facilitate the change. . Once the decision is made to modify corporate value structures and associated activities to support collaborative relationships, a company may employ tools and methodologies to facilitate the changes. These tools and methodologies may include maps of information that flows within the supply chain, collaborative business frameworks, and architecture-based information systems.

4 DAMA Model for Supply Chain Collaboration

4.1 Understanding As-Is in order to proceed to a To-Be Model

In order for DAMA to understand the complete supply chain, it was necessary to understand the "As-Is" information model of the textile industry today. Typically, a textile supply chain consists of several manufacturers, each representing a sector of the industry; i.e. fiber, textile, apparel (sewn products) and retail. A model of the industry was documented that shows the flow of information between these sectors, and is represented in Figure 5.

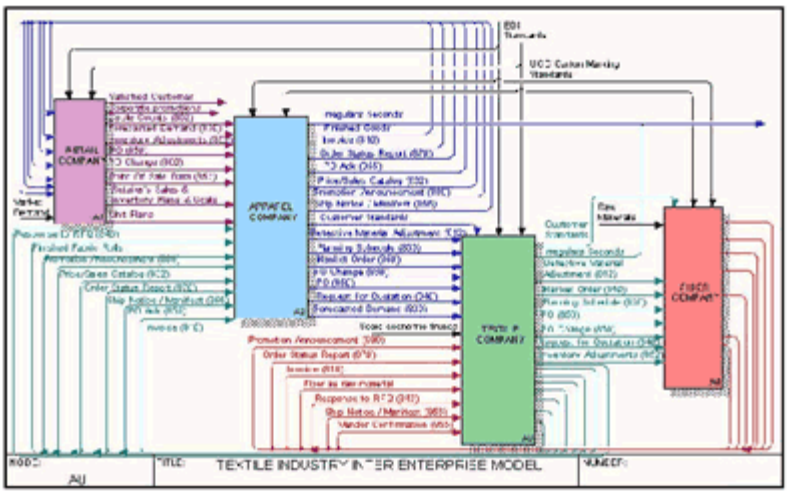


Figure 5. AS-IS Model of U.S. ITC

Information is passed between sectors in the form of Electronic Data Interchange (EDI) transactions, and typically each sector is customer focused (fiber focuses on the textile customer), rather than consumer focused (all sectors focus on consumer demand). Internal to each company there is a number of business processes that occur (forecasting, planning, scheduling, purchasing, etc.). In addition, typically, the customer and supplier in the supply chain have little knowledge of those transactions that are occurring within the other Trading Partner Company(s).

4.2 TO-BE Model for Supply Chain Collaboration

In order for all members of the supply chain to respond to consumer demand, a new collaborative paradigm is required. This new paradigm will provide supply chain visibility of critical information for all members of the supply chain. The DAMA Model for Supply Chain Collaboration has been developed to show how all sectors of the supply chain would participate collaboratively in the major business processes that traditionally have occurred only within the four walls of a particular company. This model suggests that retail, apparel, textile and fiber companies within a particular supply chain share information and collaboratively make decisions about product development, forecasting, planning, scheduling, product delivery and expediting orders. This model is documented in the Integration Definition Function Modeling (IDEF0) format. IDEF0 is a method designed to model the decisions, actions, and activities of an organization or system (http://www.idef.com).

Table 1 can be used to interpret the IDEF0 conventions

Table 1. Interpreting IDEF0 Conventions

Activities	☐
Inputs	☐
Outputs	☐
Controls	
Mechanisms	

4.2.1 Collaborative Process Implementation

The DAMA Model for Supply Chain Collaboration is a high-level model for collaboration to achieve Demand Activated Manufacturing as shown below in Figure 6. There are four possible collaborative activities that may be employed in this model:

- Define Products
- Forecast and Plan Capacity Commitments
- Schedule Product and Product Delivery
- Expedite Production and Delivery Exceptions

Prior to any collaborative activity, the partners must first develop business-planning agreements. Once the agreements are in place, for each of the four collaborative activities, the trading partners must initialize a Supply Chain Utility, the sixth activity in this model. The Supply Chain Utility is a set of applications and/or shared data implemented to support collaborative product definition, forecast visibility, planning, scheduling, and execution.

This model assumes a collaborative supply chain, with multiple trading partners, working collaboratively to meet consumer demand. Trust must exist between all trading partners, and technical data security must be implemented. Working together, the trading partners share information about their products, manufacturing capabilities, allocations of capacity to the partnership, and day-to-day operational status. Each of these collaborative activities will be discussed in detail in the following sections.

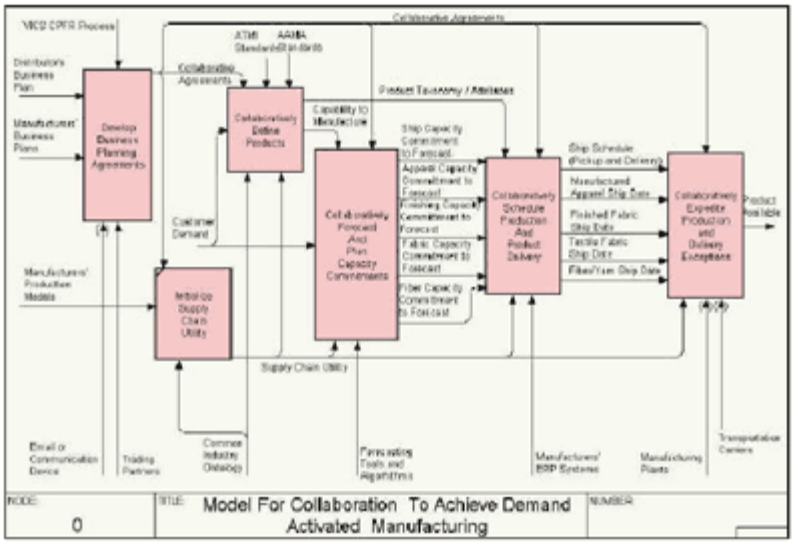


Figure 6. DAMA Model for Supply Chain Collaboration

4.2.1.1 Collaboratively Develop Business Planning Agreements

Successfully implementing this model requires the trading partners first complete the process of Collaboratively Develop Business Planning Agreements. The VICS CPFR ® guidelines thoroughly describe what is required in the business planning agreements. Where the DAMA collaborative supply chain diverges from CPFR ® is in the addition of trading partners from all manufacturing sectors of the supply chain. CPFR ® was developed to support the relationship between the retailer or distributor, and the manufacturer (not the entire manufacturing supply chain for a particular product line). Therefore, the focus of the agreements may shift from product or category roles in the Joint Business Plan overall reduction in inventory throughout the supply chain or shared inventory cost to reduce lead-time for a particular product line. The information gathered and generated to develop business-planning agreements remains very much the same.

The DAMA model, like the CPFR ® model, adheres to management by exception for identifying points of collaboration. The exception criteria is determined jointly by the distributor / retailer and manufacturers, and become the factors used to identify items for collaboration. Figure 7 shows the detailed information that should be included in the collaborative agreements. This same process is also a part of the CPFR ® Model published by VICS (CPFR ® Guidelines, 1998 Voluntary Inter-industry Commerce Standards).

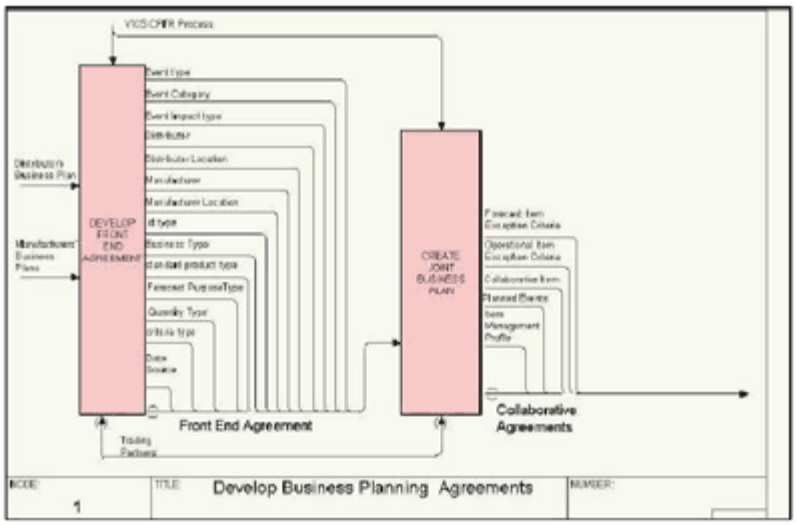


Figure 7. Collaboratively Develop Business Planning Agreements

4.2.1.2 Collaboratively Define Products

The concept of collaboratively defining products in a supply chain requires increased supply chain visibility of all partners to the product lines in each sector. This model (see Figure 8) requires that all partners in the chain provide a

complete definition of products that they manufacture. That definition, which will be shared among the partners, will enable real time product definition. Typically, an order may be “one off” from a previous order (i.e. change the knit gauge, the yarn denier or the fabric finish). If all partners are providing definitions of the products that they manufacture, then the system can determine in real time if the manufacturing capability exists to support a new product.

The process to **Collaboratively Define Products** begins with customer (consumer) demand. The partnership collaborates to develop products to meet demand. Once the product is developed, a product definition is provided to each member in the chain. From that initial product definition, each partner provides an associated set of instructions, bill of materials, and capacity allocation to the partnership to produce the specific product. From this initial information, subsequent new products can then be defined by querying the Supply Chain Utility product data to determine the partnership’s capability to manufacture a new product. As subsequent forecasts are developed and orders are placed, the Supply Chain Utility can determine the partnership’s ability to meet the forecast based on each manufacturer’s capability to manufacture, along with their capacity allocation to the partnership.

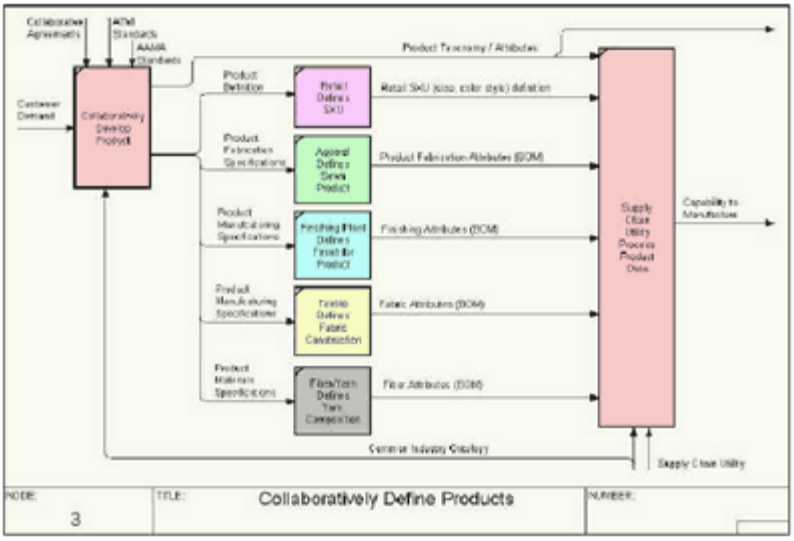


Figure 8. Collaboratively Define Products

4.2.1.3 Collaboratively Forecast and Plan Capacity Commitments

The collaborative forecast was first defined by CPFR ® . In DAMA’s model (see Figure 9), one or several partners in the supply chain may develop the forecast. Once the forecast is developed, it is made visible to all members through the Supply Chain Utility. Each forecast must be reflective of the portion of the order that will be filled by each member in the partnership. The initial loading of the Supply Chain Utility will ensure that the correct proportions for an order are maintained. Based on the forecast received, each manufacturing member of the partnership should then provide a capacity commitment to the forecast for that specific product line.

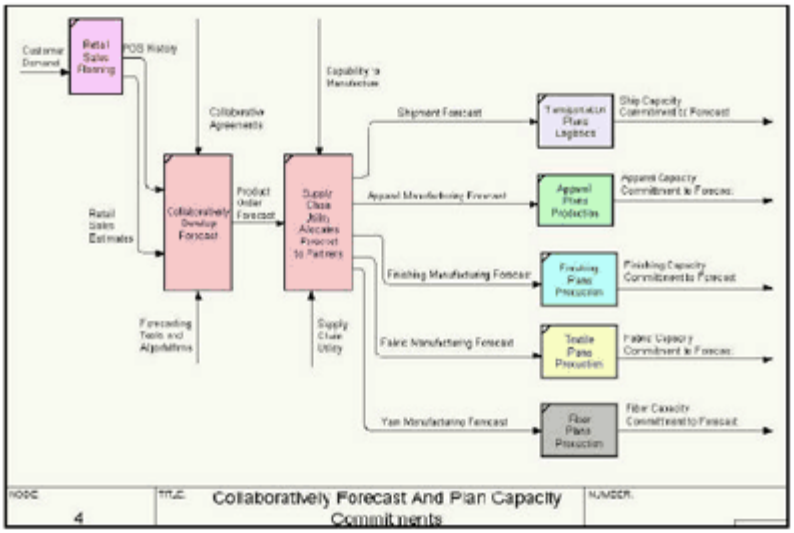


Figure 9. Collaboratively Forecast and Plan Capacity Commitments

4.2.1.4 Collaboratively Schedule Product and Product Delivery

The Supply Chain Utility will balance a final order commitment against initial capacity commitments. Using that information, in addition to manufacturing capability data, the utility will generate work orders for each manufacturer in the supply chain. Each manufacturer then processes these work orders individually. From their internal information, each manufacturer generates a ship date (see Figure 10). A complete timeline for manufacturing the product could be generated from the Supply Chain Utility (see Figure 11.) The timeline here assumes no inventory is available, and the ship date at each stage of the process has been calculated by evaluating the process times provided by each of the manufacturers.

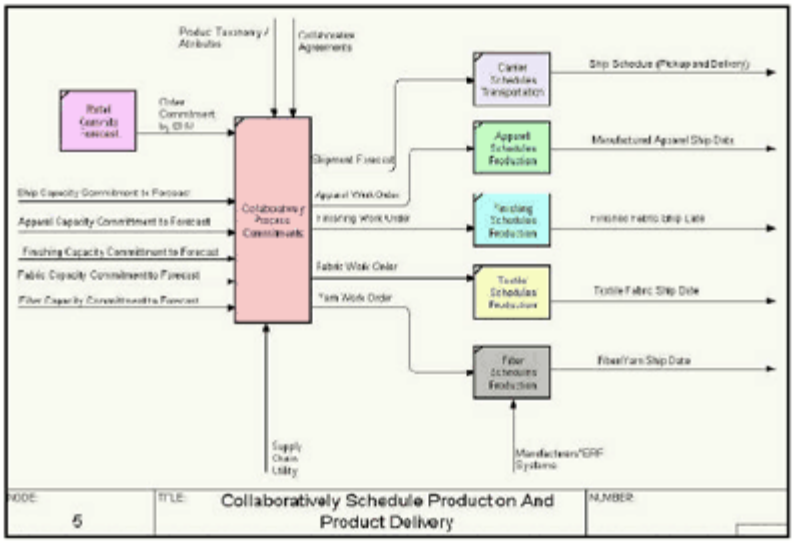


Figure 10. Collaboratively Schedule Production and Product Delivery

4.2.1.5 Collaboratively Expedite Production and Delivery Exceptions

Manufacturers' ship dates generated from the process of collaboratively scheduling production will be compared to delivery status provided by each manufacturer on a regular basis. If ship dates and delivery status for product are not meeting the agreed upon product ship dates, an exception will occur (see Figure 12). Exceptions may be handled in a variety of ways. Most exceptions will only be made available to the trading partner who is initially impacted by the exception. For example, late shipment of greige goods would trigger an exception for the finishing plant. Resolution of that exception would either be expedited or negotiated with the appropriate trading partners. Section 5 provides a description of the process for implementing this model and resolving exceptions.

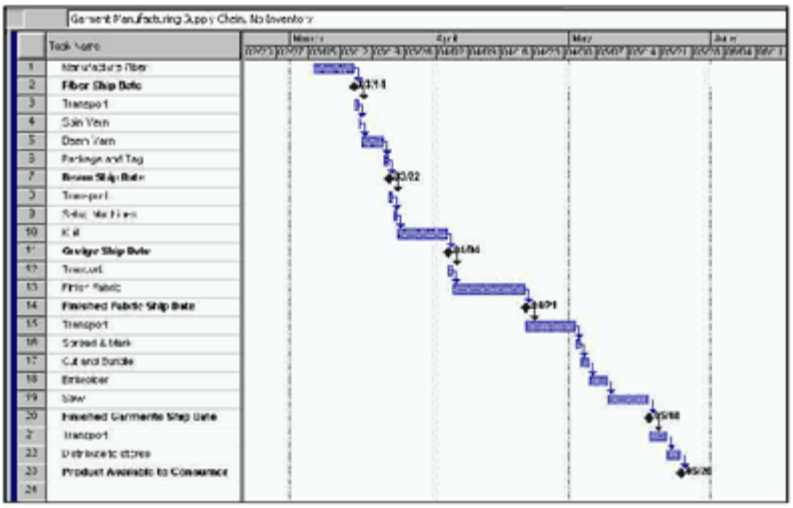


Figure 11. Sample Manufacturing Timeline

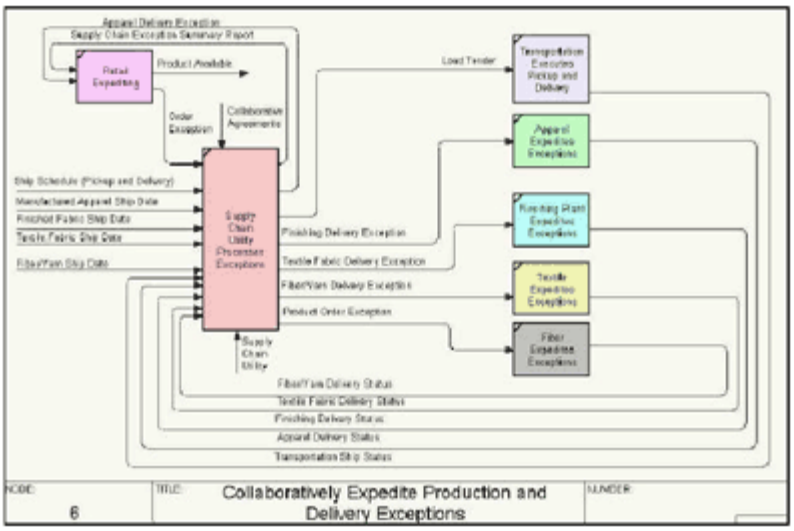


Figure 12. Collaboratively Expedite Production and Delivery Exceptions

4.2.2 Technical Implementation

This Supply Chain Utility is a concept, and the collaboration processes illustrate the activities and information associated with the processes, but they are independent of the architectural implementation of supply chain collaboration. The technical implementation of these collaborative processes may be applied in one of several ways.

Ideally, a supply chain utility will support data sharing through the implementation of software to provide collaborative product definition, supply chain planning, and supply chain visibility. The capability to provide secure data sharing is essential. The technical infrastructure we recommend should follow one of the three infrastructures recommended by CPFR:

- Hub and spoke (Figure 13)
- Peer to peer (Figure 14) or
- Hosted application (Figure 15).

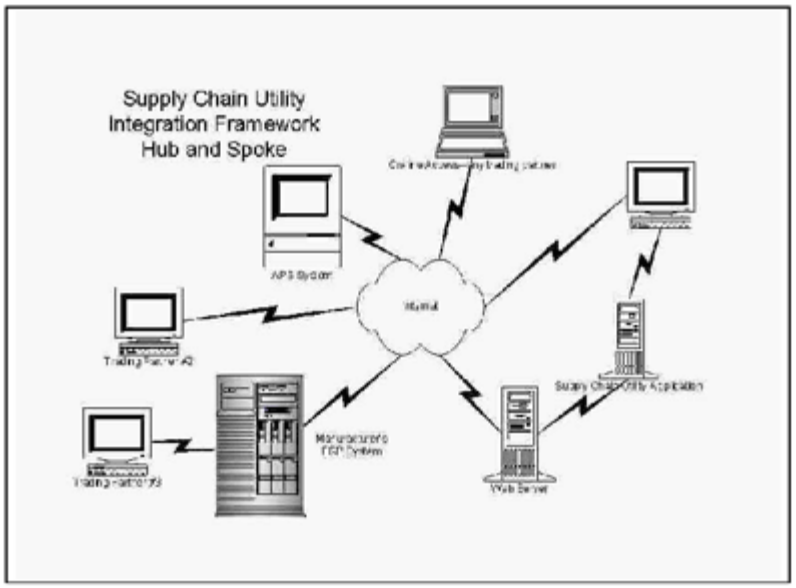


Figure 13. Hub And Spoke

Collaboration data could be managed in a domain shared by the trading partners, or it may exist within one of the partner's domains, giving access to the other supply chain trading partners. A third option would be to employ a third-party service (hosted application). As with the CPFR ® model, the important point about the illustration is the agreement on the types and formats of the data being shared and the nature of the data flows.

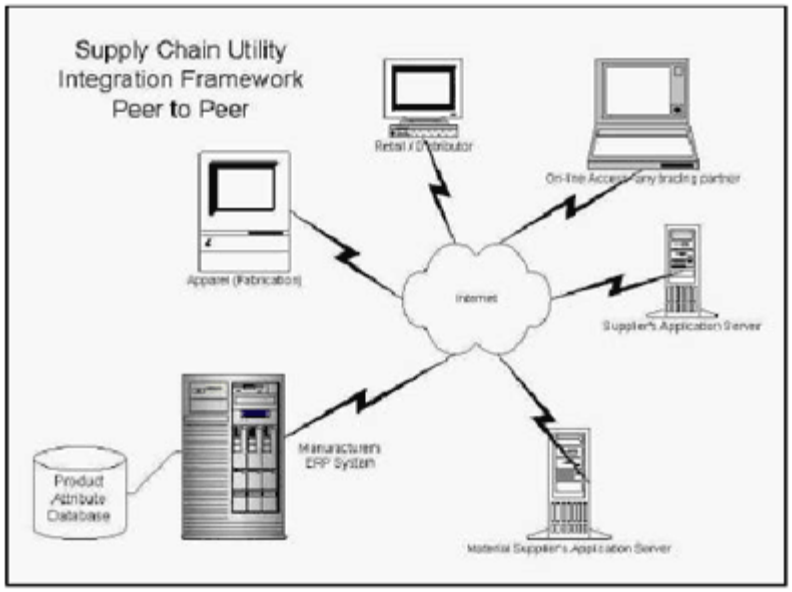


Figure 14. Peer to Peer

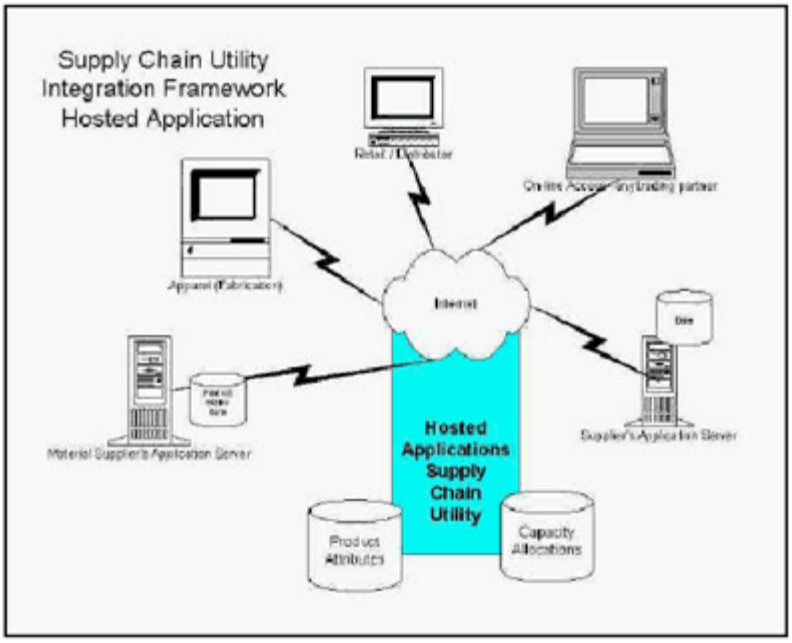


Figure 15. Hosted Application

4.2.3 Initializing the Supply Chain Utility

The DAMA Model for Supply Chain Collaboration includes a process where the trading partners initialize a Supply Chain Utility. The manner in which the Supply Chain Utility is implemented will be determined by the technical infrastructure selected. It may require the implementation of software, or initialization of data. The purpose of the utility will be to support secure data sharing of product definitions, supply chain planning, and supply chain visibility. The Supply Chain Utility (see Figure 16) must provide an integration framework to allow a set of generic, open standards based technology applications to interoperate and provide collaborative product definition, forecast visibility, planning, scheduling, and execution of orders. Each of the trading partners will be required to make information available to the Supply Chain Utility, which will subsequently be made available to the appropriate trading partners in the supply chain. The information to be provided must be defined in the business planning agreements.

Figure 16. Supply Chain Utility

In order for the Supply Chain Utility to be successful, an ontology, or common industry vocabulary, must be established. The ontology is a set of formal definitions of the information being shared. In the textile industry, much of the ontology information can be provided by organizations such as American Textile Manufacturers' Institute (ATMI). The ATMI has published Voluntary Standards Quality Characteristics (FASLINK Voluntary EDI Standards, Version 004, Release 010, Implementation Guide, Quality Characteristics) and Code lists (FASLINK Voluntary EDI Standards, Version 004, Release 010, Implementation Guide, Appendix B). The American Apparel Footwear Association (AAFA) "Guidelines for Purchasing by Specification" will provide good ontology information as well (Guidelines for

Purchasing by Specification, Apparel Quality Committee, American Apparel Manufactures Association). However, some of the ontology will be specific to the partnership, and must be incorporated in the initial business planning agreements.

The information made available through the supply chain utility would require each trading partner provide or make available initial information in the following areas:

• manufacturing (lead times, process times, and transport times),
• capacity allocation to the partnership,
• manufacturing capability (product lines, bill of material for products, product specifications, attributes and boundary constraints), and
• exception criteria.

The information provided to the Supply Chain Utility must be protected in a select, secure manner. Not all partners would necessarily have access to all of the information. The initial business planning agreements must define who has access to what information.

Once the initial information is available to the Supply Chain Utility, the partners must also agree upon the frequency and type of updates required to support the collaborative relationship. This information would include inventory levels available to promise for the partnership, production status, ship status, as well as changes to the initial data (e.g. a new product line is added, or process times are increased or reduced).

The success of understanding exception criteria and metrics measuring the success of the collaborative relationship is highly dependent on the development of the ontology. For example, is “one day late” defined as 8 hours, or 24 hours? Is a day considered a working day? In a textile supply chain, working days vary through the chain—fiber is processed 24 hours a day, apparel manufacturing may only occur 6 days (Monday through Saturday).

The purpose of the Supply Chain Utility is to provide supply chain visibility for all partners to the necessary information they need to meet the goals of the collaborative effort.

5 The Process for Executing the DAMA Model for Supply Chain Collaboration

Figure 17 shows the proposed execution steps for the DAMA Model for Supply Chain Collaboration. (Note change capacity to capacity allocation)

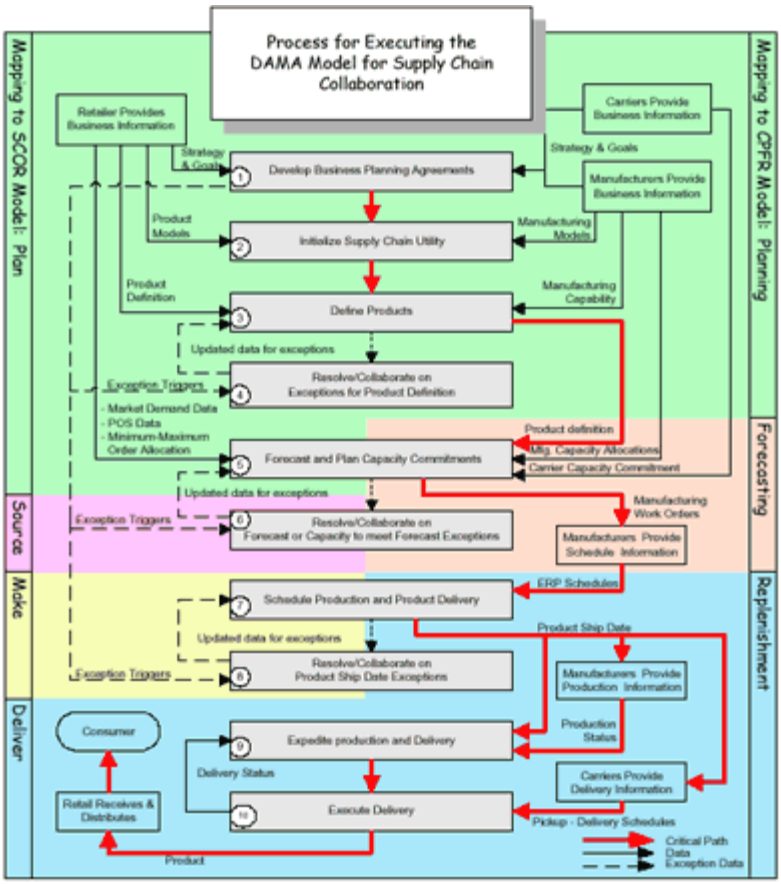


Figure 17. Executing the DAMA Model for Supply Chain Collaboration

The Process for executing the DAMA Model for Supply Chain Collaboration is consumer focused and incorporates all members of the supply chain. This process can be summarized in Table 2.

Table 2. Execution of the DAMA Collaborative Supply Chain Model

Step	Process Name	Description
1.	Develop Business Planning Agreements	All of the information required to execute this step is thoroughly documented in the CPFR ® Guidelines. It is important that each company accesses their own strategy, and goals to ensure that these are incorporated in the partnership agreements. The goal is to arrive at a win-win situation for all players. This requires sharing of some risk and rewards, in addition to sharing common goals.
2.	Initialize Supply Chain Utility	Each company participating in the collaborative relationship provides data to support the area of collaboration defined in the business planning agreements (product definitions, manufacturing capability, capacity allocations to the partnership, etc.). Providing current information to the supply chain is an on-going process. Weekly or daily updates of data might include goods available to promise and reduction in capacity allocation or capabilities, or changes in lead times in a process. The technical infrastructure employed with determine if the data is made available through distributed objects, loaded onto a central server, or implemented through an XML server and application.
3.	Define products	Products for orders are defined using the data that is loaded in the supply chain utility. The utility can determine if the

		product is available; otherwise, the utility will determine the lead-time required to produce the product. From this information, the product definition order is generated.
4.	Resolve/Collaborate on Exceptions for Product Definition	If a particular product attribute is not available, an exception is generated. Resolution and/or collaboration of the exception may involve phone calls, email, or on-line interaction. A company may decide to add a product or manufacturing capability by changing their product mix or outsourcing to a third party supplier who is not a member of this collaborative partnership.
5.	Forecast and Plan Capacity Commitments	As consumer demand and forecasts are generated, all members of the supply chain will have visibility to this information. The supply chain utility must have information about the allocation of a product (for example, the partnership agreement guarantees 50% of a product line to a manufacturer, who in turn guarantees 75% of that same line to their supplier. According to the estimated forecast, each supply chain member will commit a certain capacity allocation to the product line in this collaborative agreement.
6.	Resolve/Collaborate on Forecast or Capacity to Meet Forecast Exceptions	A forecast may exceed original capacity commitments or fall short of the commitments. When this exception occurs, the affected partners must collaborate and either seek third party sources for an increase in demand or share associated risk with a reduction in forecasts. The partnership agreements should provide guidelines for handling these exceptions to facilitate resolution.
7.	Schedule Production and Product Delivery	The supply chain utility, populated with base manufacturing capabilities and capacity allocation commitments and updated with exception updates and firm orders, will generate work orders for each of the manufacturers and a shipment forecast for the carrier(s). Each company will then process the work order into their internal Enterprise Resource Planning (ERP) system generating a ship date for the product order. Ship dates that vary within a specified tolerance of the initial work orders and retail cancel date will generate exceptions.
8.	Resolve/Collaborate on product Ship Date Exceptions	Resolving and/or collaborating on product ship date exceptions leads directly into the expedite production and delivery step. A late ship date on fiber would impact all customers along the supply chain; however, the textile manufacturer might have yarn in inventory that was not previously entered into the supply chain utility (it may have been reserved for a customer outside of this trading partner agreement). The supply chain utility processes the updated data for exceptions.
9.	Expedite production and Delivery	Visibility to the supply chain product ship dates allows each member of the supply chain to expedite production and delivery as it relates to their position in the chain. Each member of the supply chain will be providing status updates for the delivery and production status of the product.
10.	Execute Delivery	The carrier, who provides delivery status information (typically an EDI 214 transaction), handles the execution of delivery. To determine if target ship-dates are being met, the supply chain utility uses these delivery status updates.

6 Future Direction

The DAMA Project has defined an inter-enterprise architecture for demand activated manufacturing. Through several pilots, the project participants have identified benefits of data sharing and collaboration in softgoods supply chains. In order to scale up these supply chain processes with a large number of suppliers and customers, a supply chain utility and industry ontology are required.

There are a number of initiatives that the DAMA project believes will provide the foundation to further develop and complete the DAMA model for collaboration:

- VICS CPFR ® (Collaborative Planning Forecasting and Replenishment),
- VICS CTM (Collaborative Transportation Management),
- ATMI (American Textile Manufacturers' Institute) Voluntary Standards (i.e. Quality Characteristics, Codelists),
- AAFA (American Apparel and Footwear Association, formerly AAMA) Guidelines, and
- GCI (Global Commerce Initiative).

DAMA has taken work from both CPFR ® and CTM and incorporated it into the more extensive DAMA model for collaboration. Industry practitioners will determine the ultimate value of this model. It is the opinion of the DAMA Project that VICS, ATMI, and AAFA would all be excellent places to present the model as a possible standard or guidelines for future collaborative supply chain initiatives.

Collaborative supply chains will not be successfully implemented overnight. They will require changes in business practices, and small-scale proof of concept pilots before they can be implemented successfully in a large-scale manner. The model for collaboration provides a recommended set of processes that could be implemented in a collaborative way. The industry standards groups such as ATMI, AAMA, and VICS provide a forum for developing the industry ontology to support inter-enterprise collaboration.

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