Global Supply Chain Management in the Telecommunications Industry: The Role of Information Technology in Integration of Supply Chain Entities

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ABSTRACT

In just the past few years, options have been examined for determining optimal operations and logistics strategies for competing in the global market. In terms of advances in technology and globalization of markets, organizations have had to improve their internal processes just to stay competitive. However, as a result of these changes, organizations are determining that these internal improvements were not enough. Where once information technologies allowed businesses to reengineer and streamline their internal business processes – streamlining the global supply chain will require the internal information systems extended beyond a firm's enterprise and include electronic connections between each of the global supply chain partners. An in-depth case study is used to illustrate a broad view of an entire supply chain to reveal full product and component life cycle that not only reveals opportunities for cost reduction but also stimulates revenue growth. It makes the point that organizations must get more involved in the management of their global supply chain network of all upstream firms that provide inputs as well as the network of all downstream firms that provide outputs of the product to the final customer.

KEYWORDS

E-Business Implementation, Globalization, Supply Chain Management, Advanced Planning and Scheduling, Enterprise Integration

INTRODUCTION

During the last few years, several options have been examined for determining optimal operations and logistics strategies for competing in the global marketplace. Due to advances in technology and globalization of markets, organizations have had to improve their internal processes in order to stay competitive. Not only is the speed of business getting faster, the scope is getting wider. As a result of these evolving changes, organizations are now discovering that improvements to internal processes are not enough. Organizations must therefore get more involved in the management of their supply chain network of all upstream firms that provide the inputs as well as the

network of all downstream firms that provide the outputs of the product to the final end customer. Thus, the concept of supply chain, supply chain management (SCM), and now global supply chain management (GSCM) can no longer be defined at a local level and must be defined in terms of a global network of information systems integrated to include both upstream supplier networks and downstream distribution channels.

The objective of the paper is to highlight, using a case study, the importance of inter and intra supply chain management through, not only integrating the internal systems, but also collaborating with supply chain partners and entities on both upstream and downstream. The case study describes a specific supply chain synchronization problem faced by a telecommunications Original Equipment Manufacturer (OEM) and the implementation of an Advanced Planning and Scheduling (APS) system that extended beyond its four walls, to address this problem. The OEM implemented APS to integrate it's internal demand flow system with electronic (e)-business software that helped in real time collaboration with trading partners resulting in specific business benefits that encompassed the whole supply chain.

Fundamentally, GSCM can be defined as the synchronization of demand and supply across all the nodes of supply chain by reducing the uncertainty in demand or supply and trying to maintain a permanent and optimal balance between them. For most firms, this is managing the activities that transform raw material into intermediate goods and final products, and ultimately delivered to a final customer using the three fundamental flows of material, funds, and information, with information being the most critical piece. In the past, companies have implemented many transactional systems to integrate various functional entities within the organization so as to translate the end item demand to individual components and then determining the optimal utilization of material and capacity to match the demand and supply. However, these transactional systems only integrated the functions within the organization and did not take into account the capacity/material constraints as well as variations in the supply. This resulted in optimization of a sub-system whereas the overall system (the global supply chain) still remained disjointed and un-optimized.

With the flow of information focused on integrating business and production management processes, manufacturing management systems have evolved from early introduction of materials requirement planning (MRP) batch data processing to manufacturing resource planning (MRP II) employed as a useful tool to address the mid- to long-range planning at independent locations. The users develop production plans that are based on sales orders and some kind of static forecast. However, as competition increases, this type of static information becomes less adequate to meet the customer's expectation of quick response; leading to the changes in planning and control systems. In order to balance the customer's expectation of quick response, enterprise professionals needed more real-time information.

The next generation change is enterprise resource planning (ERP) systems, which focuses on business and production management processes. ERP systems evolved

from MRP-II systems linking the firm's multiple divisions into one enterprise database. The search is for improvements in the GSCM activities by streamlining forecasting, distribution management, production planning, and transportation planning. Additionally, ERP adds the ability to interface with all processes within the firm, with respect to the overall multiple manufacturing system requirements. Communication between the suppliers, enterprise, and its customer-base is key for getting demand and supply information into balance.

The general push in industry is to increase integration throughout the entire supply chain with consistent and timely information, and visibility to all participating stakeholders (i.e., suppliers, distributors, customers), with the goal of reducing inventories and ultimately a better investment on working capital. Theoretically, relevant material and information flow from all of the business units are structured and shared with all of its suppliers, manufacturers, and customers. However in practice, extending ERP to suppliers is generally impossible. Most of the time integration is achieved through data warehouses, extensible markup language (XML) and to lesser extent electronic data interchange (EDI) (being displaced by XML).

Next, we take a closer look at GSCM systems and fundamentally rethink the roles played by suppliers, customers, and partners of the linkages between the various steps in the process.

Globalization of supply chain management systems

Among the drivers for GSCM are lower prices of material, products, and labor; availability of products that are unavailable domestically; the firm's global attitude; advanced technology available in other countries; high quality of products available; intensification of global competition which drives companies to cut costs; the need to develop a foreign presence; and fulfillment of counter-trade. In the forefront of enabling technology, re-shaping the GSCM integration is the extranet that is now being used as a vehicle allowing customers direct access (as an interface) to the suppliers' ERP system to check order status, inquire on availability, and verify pricing. Many ERP systems are integrated with SCM software, providing an integrated solution.

There are two trends that are distinctly visible in today's manufacturing world – one, offloading some of the generic manufacturing operations to contract manufacturers and second, wide geographic distribution of these contract manufacturers, primarily to the locations where the cost of manufacturing is relatively low. Both these trends are driven by the need for the companies to reduce the cost of manufacturing, but they add tremendous complexity to the global supply chain. The complexity lies in the materials flow as well as information exchange. However, the challenge lies in overcoming this complexity in such a cost effective manner that the benefits accrued from this globalization far outweigh the complexity of globalization as well as the cost of doing it in-house.

One way to overcome these challenges is to implement a solution that allows the trading partners to be aware of the demand signal, and take immediate corrective action based on real time information of the variation in demand and supply. The case study presented in this article highlights some of the means by which the OEM achieved both these objectives of sharing planning and execution data and also notified its trading partners of variations in demand/supply and other business exceptions.

The real time exchange of information between these global trading partners requires tight integration between the planning and execution systems of OEMs and contract manufacturers. The concept methodology is that as firms evolve, so do GSCM operations with mutual access to both the customer's and supplier's planning system as extensions of the enterprise. The nature of this information relationship is a close linkage between the partners, forcing the extended ERP systems to become more flexible to accommodate these types of inputs (Shore, 2002).

This paper is structured as follows. Following this introduction, we review and synthesize the literature that is pertinent to the study objectives. Next, we outline the research methodology used, followed by a detailed description of the case study. The final section discusses the lessons learned from the global supply chain for e-business implementation described in the case study, followed by the conclusion.

LITERATURE REVIEW AND SYNTHESIS

Swaminathan et. al. (1998) define the supply chain as a "network of autonomous or semiautonomous business entities collectively responsible for procurement, manufacturing and distribution activities associated with one or more families of related products" [p. 607]. Whereas, Lawrence (1999) emphasizes that the ultimate goal of SCM is to focus the supply chain on the final customer and avoid local optimization. The focus on supply chain instead of local optimization results in buyer-supplier relationships becoming more dependent on factors such as quality, delivery performance, flexibility, and commitment to work together, as opposed to the traditional cost-based relationships (Ballou, 1998; Braithewaite, 1991; Fawcett 1992). Today the concept of SCM refers to a total systems approach to managing the entire supply chain and it includes the organizations and processes that create and deliver products, information, and services to the end customers.

Lummus and Vokurka (1999) describe the supply chain as a network of entities where companies must capture 'moments of information,' so that the linked members can better respond to changes. A 'moment of information' is described as "any episode in which the company can gain information from the customer, however remote, and thereby have an opportunity to form a response to the customer demand." Stressed is the need to continuously re-examine the solutions reached today as the technology and business evolves. SCM includes many tasks such as purchasing, payment flow,

materials handling, production planning and control, logistics and warehousing inventory control, and distribution and delivery.

Akkermans et. al. (1999) and Walker and Alber (1998) advise to build a competitive infrastructure, leverage the worldwide logistics network, synchronize supply to demand and measure performance globally. While there are various variations on how, there should be caution to the supply chain infrastructure performance, which is determined by the least common denominator of the hardware technology and the applications software. Aligning partners' performance measures for the supply chain is critical to smooth functioning of the supply chain.

A close analysis of the supply chain's cost structure and its various components reveals that coordination among several activities, internal units, and business partners is a major part of the problem. Integration of information systems could potentially eliminate the delays caused by these coordination issues by streamlining business processes in a seamless manner with the human interfaces. Inventory flow information should be accurately captured and made available at all points of the supply chain. Use of automated data-entry (barcodes, radio frequency tags, etc.) can reduce the data entry errors and personnel required for data input. Evans et al. (1993) showed a 73% reduction in on-going costs (due to 50% reduction in manufacturing lead-time and EDI) on implementation of information in a simulation study. Furthermore, proactively feeding forward the actual customer demand to all players in the chain to address the "bull-whip" effect problem presented by Lee et. al. (1997) also reduces costs.

The next section presents the case study on a telecommunications company that is engaged in GSCM and builds a conceptual framework to guide the inquiry.

THE TELECOMMUNICATIONS COMPANY CASE STUDY

A global Internet and communications leader (referred to as the "Telecommunications Company" (TC) in this case to disguise its identity) has capabilities spanning optical and wireless products and services for the Internet and intranet infrastructure and e-Business in 150 countries and territories. The TC had U.S. General Accounting and Administrative Practices (GAAP) revenues of US$22 billion in 2000. It is focused on building the infrastructure service enabling solutions and applications for the new, high-performance Internet. TC's business consists of the designing, developing, assembling, manufacturing, marketing, sales, financing, installing, servicing and supporting networking solutions and services for Internet Service Provider, Carrier and Enterprise customers. Today, this TC is creating a high-performance Internet that is more reliable and faster than ever before. It is redefining the economics and quality of networking and the Internet, promising a new era of collaboration, communications and commerce.

This TC operates in two main segments, i.e., Enterprise/E-business Solutions and Service Carrier. Enterprise Solutions provides world-class IP-based data communications solutions and industry-leading solutions that enable interpersonal electronic communications for businesses of all types and sizes. The combination of Enterprise Solutions' local area networking and wide area routing, and it's wide area asynchronous transfer mode (ATM) and Frame Relay technology, results in a new dimension of network power and efficiency. TC serves as an OEM in the Service Carrier segment.

Research Methodology

A qualitative research methodology of a case study was employed to take a closer look at global SCM. A case study was considered most appropriate since it allows for the adoption of multiple case data collection methods (Yin, 1984), which was thought to be important in order to develop the rich case description needed to build theoretical understanding. Methods of data collection for this case study included on-site observation and documentation, and semi-structured face-to-face interviews. Documents, such as press releases, media articles, minutes, reports and intranet sites were used to further enhance the richness of the material collected. Stake (1995) suggests that adopting multiple methods is important not only to enhance the richness of findings but also to ensure validity and consistency through the process of triangulation across the different sources of primary and archival case material. Case research has the advantage of allowing the researcher/s to study the concepts in a realistic setting and place the research in the context of the environment in which it naturally occurs. The ability to focus on the dynamic interaction of the GSCM and the ability to probe a situation in depth and study the aspects of a situation were considered important for this study. The disadvantage is that it is difficult to replicate, due to the variety of extrinsic factors that are present in any real setting. While there were no prior hypotheses at the outset of the inquiry, patterns emerged from the data that suggested the key issues and theoretical linkages.

The Industry and it's Challenges

As with any industry, the telecommunication industry has it's own unique structure viewed from a supply chain perspective considering the multitude of players and unique challenges as a result of different factors such as demand and supply variations. Figure 1 shows the high-level supply chain structure of a telecommunications industry.

The two prime players in this industry are the Equipment Providers (including contract manufacturers), and Hardware OEMs. The TC in this case study is a major Hardware OEM. These equipment manufacturers focus on technology development and creating value added services. The Service providers are primarily focused on Marketing and Customer acquisition.

Some of the typical challenges faced by this industry are that equipment provides are constantly looking for sources for new supply and increasing the width of channels of new demand. This is primarily motivated by a need to reduce cost and increase market-share. Network integrators and manufacturers are migrating to services by seeking to define and provide new and innovative services to consumers. The life cycle of typical telecom product particularly wireless equipments has reduced from

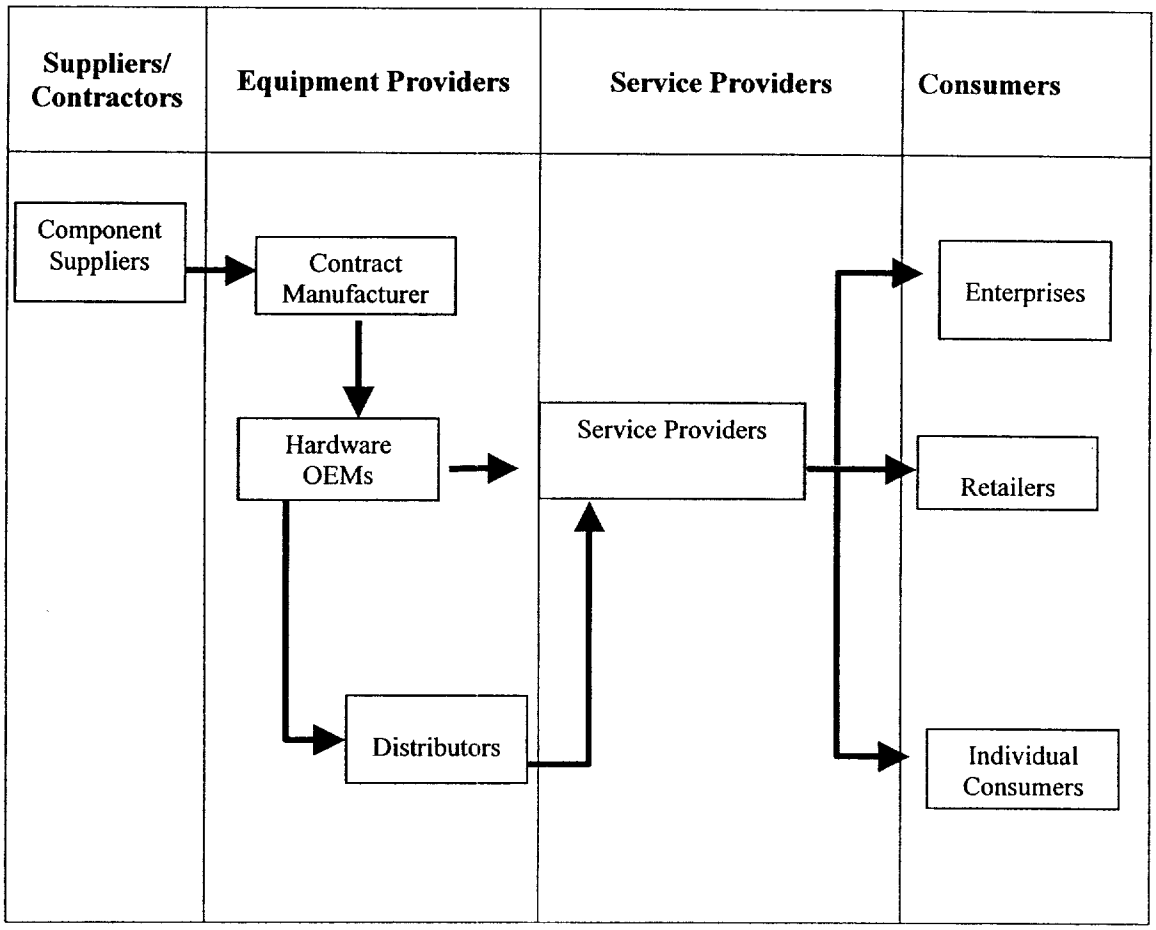

Figure 1: High Level Supply Chain Model of the Telecommunications Industry

years to months. This has put tremendous pressure on all the players in the supply chain in general, and equipment providers in particular, to co-ordinate design, production, procurement, and logistics to bring new and innovative products to the market and make as much profit as possible in the short product life cycle. Given all the above challenges, it is imperative for the players to work in synchronization to reduce the lead-time of production, information sharing, transaction, material movement, and so forth to bring new and innovative products to the market in the shortest possible time. Given the pressure to reduce cost and improve the efficiency and effectiveness of adding value to the product, more and more equipment providers

are outsourcing the manufacturing to contract manufacturers. This necessitates the improved management of relationships with a diverse and dynamic supply base.

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A Plethora of Problems

The TC, which is a large equipment provider, was facing the following specific problems as part of its supply chain:

Multiple business views across multiple regions: Since this TC had disparate ERP systems across different business units/geographic locations, common customers and suppliers across these different business units were looking at inconsistent views of the demand and supply situation.

Reactive responses to order input: In the zeal to fulfill the ever-changing demand picture, primarily because of incorrect demand planning, order fulfillment was handled in a reactive mode. This led to a large build-up of inventory of unnecessary parts and stock-out at the same time of the needed parts. Also, to improve the customer service, a lot of inventory buffers were being created at various points of the supply chain, leading to redundancy and an increase in cost.

Standard lead times used to promise delivery of solutions to customer: Salespeople were promising the delivery date and quantity to customers based on standard lead times, which in fact were never achieved due to variation in supply and manufacturing problems. There was no way for the salespeople to know the missed deadlines in terms of dates and quantities, until it was too late to react.

Silo scheduling – individual components: Despite the proper bill of material documentation being present in the system, the scheduling of individual components was done more or less in absolute silo, primarily because, there was no communication between product managers of different products that may share the same components. This lack of communication arose primarily due to the lack of a standard platform to see the effect of demand and supply of individual product components on each other.

Local inventory management: As there was no global visibility of demand and supply of products at the various level of the supply chain, both, horizontally (i.e., one product was dependent on another) and vertically, it resulted in the maintenance of buffers at various stocking points in the supply chain to meet the uncertainty in supply and demand.

Extending Information Systems beyond the Four Walls

This TC had some of the biggest deployment of ERP systems within the organization. It had an ERP system from different vendors such as SAP and Baan for different sites/factories. The TC had achieved significant improvements in it's internal efficiency by deploying a GSCM software on top of these ERP systems, but it realized it had to overcome the challenges put forward by changing channels, shortened product life cycles, shortened lead times, and need to outsource. It had to change and extend the boundaries of its information system applications beyond the four walls of the TC and involved partners at both ends of the supply chain (upstream and downstream). More specifically, in order to succeed in the future, its supply chain was required to provide an ability to fulfill orders that are sourced from multiple sources in the supply chain, to add/subtract business units quickly and easily, assess global demand and global supply, optimize use of supply chain resources to achieve high service at low inventory, and achieve performance levels that allows daily schedule commitments, weekly forecast updates and real-time order processing (i.e., by collaborating online with suppliers and contract manufacturers).

The TC undertook the tasks of implementing a complete suite of products under the umbrella of APS that started with on-line collaboration with customers/service providers; continued with aggregate master planning and detailed factory scheduling; and finally ended with on-line real-time collaboration with suppliers and contract manufacturers. More specifically the solutions that were implemented as part of the APS solution were to allocate available-to-promise capability across the supply chain; generate constraint-driven plans that accounted for demand, material and capacity; update the plan continuously based on the changing dynamics of supply chain; and collaborate with customers and multi-tier suppliers/contract manufacturers using e-business software as an aid in carrying out a real time exchange of information and exception of business rules. Figure 2 indicates a high level view of the scope of APS Solution implemented by the TC.

Some of the specific improvements that took place after the implementation of complete APS system and the e-Business software are an overall view of demand

from all customers, proactive and flexible delivery of customer solutions that was promised based on actual capability, customer order scheduling, and global inventory management.

The next section discusses the architecture of the APS solution and the key performance indicators that the TC used as a guide to measuring its value.

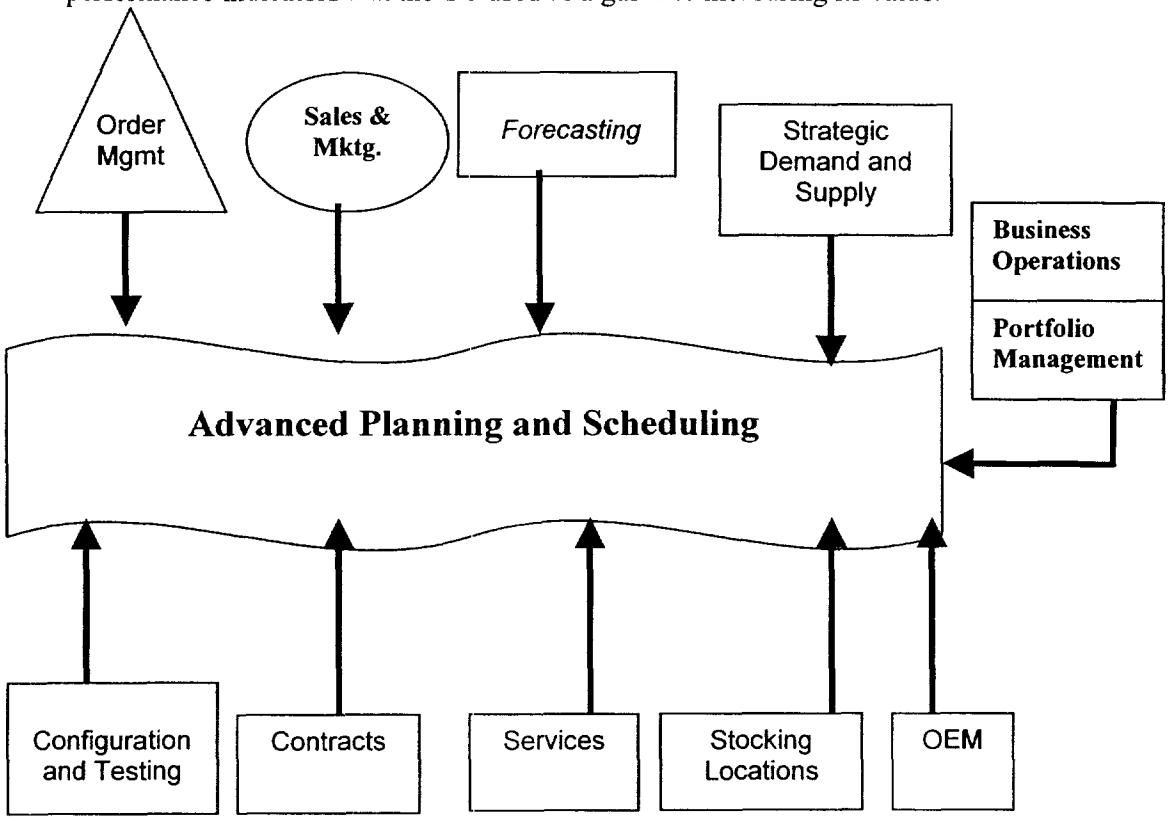

Figure 2: High level view of the scope of APS solution implemented by the TC

APS for E-Business Implementation Framework

The APS for e-Business system was implemented to deliver a complete integrated solution, covering end-to-end business process, starting with the customer and ending with the customer; complete synergy of process, people and technology; dramatic improvements in cost and delivery intervals; and radical improvements in customer service. Figure 3 illustrates the complete architecture of the solution designed and implemented at this TC.

Some of the key performance indicators that the TC used as a guide to measuring the value of these abilities were customer-centric focus, improved forecast accuracy by

collaborating with customers and suppliers; improved supplier performance in terms of delivery and cost; improved commitments to customers and hence, improvement in customer satisfaction; agility in addressing some of the variations in demand and supply across the supply chain; and last but not the least, reduction of cost over-runs by reducing inventory at various nodes in the supply chain. The improvements in agility resulted due to changing monthly forecasting to weekly forecasting, product and location specific demand/supply management to global supply and demand matching, and weekly production scheduling to daily production and ATP based scheduling.

The main focus of the implementation was the APS system. Traditionally, when APS is discussed and/or implemented, it is done only in the context of intra-company implementation. However, in this case, this implementation took this concept beyond the four walls of the company and extended it to its suppliers on upstream and customers on downstream. This extension of APS solution to partners in the supply chain was a big step forward and it achieved the following two important benefits:

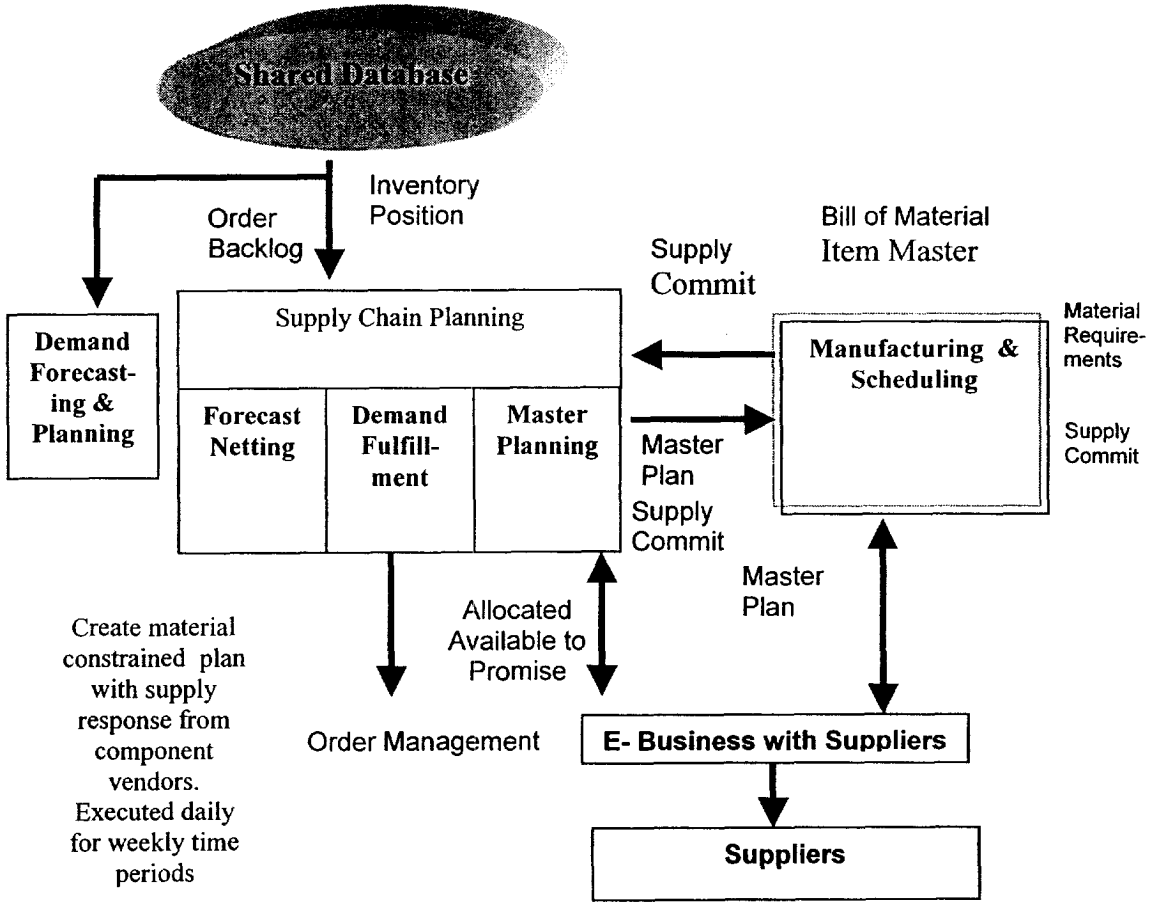

Figure 3 : Overall Architecture of the APS for E-Business System

1. Real time and accurate data from partners - True benefit of APS can be derived only if the data, which goes into it is as accurate and real time as possible. This would not be possible if there is no real time exchange of data with partners.
2. Inter-company modeling of APS solution - Carrying out the planning just within the four walls of the company can only result in local optimized solution for the supply chain. For the global optimization, it is important to link to the APS solution of the partners. This can be achieved by modeling the APS solution at partners and manufacturers in such a way that they do not just consider the other company as merely a black box and focus only on input from that black box, but, they also consider the dependency between two APS solutions by modeling the parameters of each other and exchanging the value of these parameters on a real time basis.

E-Business with Suppliers

The movement of the TC to carry out e-Business with its suppliers was the final step towards providing complete end-to-end visibility in the supply chain. The TC went from being an ERP establishment, to implementing APS system, to finally carrying out short-term and long-term collaboration with their suppliers using e-Business tools. For long-term collaboration, they started sharing "Capacity Level" information with their suppliers. The requirement from the TC got translated into capacity requirements from suppliers and suppliers committed back at the capacity level. This helped in identification, and resolution of long-term capacity problems with suppliers. This greatly improved the ability of the TC to plan their production in advance and hence, provide an accurate commitment to their customers.

For the short-term collaboration, it was primarily focused towards demand and pull signals. Many of the suppliers were just-in-time (JIT) suppliers based on the "Vendor Managed Inventory" principle. As soon as demand data from "manufacturing scheduling" software came to e-Business software, it was communicated to suppliers, which in turn provided the replenishment from their hubs. The key to this piece of collaboration, were accuracy and speed, both of which were provided by the e-business software.

The TC has primarily 10 different locations worldwide for the manufacturing of different telecommunications components. All these different sites have different ERP/legacy systems. As part of the e-business initiative, a single business model was applied to all these different sites. The data from all these disparate ERP systems were brought to a common database repository, from where data was processed and sent across the web to all the respective suppliers. There were some business rule exceptions defined in the model, based on the business needs, for example a mismatch between buyer requests and supplier commitment. Wherever these exceptions were flagged based on the transactions, alert messages were sent to the respective buyer and supplier based on the severity of exception. This greatly helped both buyers and suppliers to manage the procurement based on exceptions thereby saving a lot of time.

E-Business with Customers

The on-line collaboration with customers was primarily implemented by either collaborating with the service providers or the distributors. The results of both of these collaborations were fed into the Demand Forecasting tool to capture both the actual customer orders (from Service Providers) as well as Demand Forecast (from Distributors).

In case of collaboration with Service Providers, service providers log into the collaboration tool and upload the actual as well as forecasted customer demand. The equipment provider and service provider then could go into a collaborative mode to come to a common understanding and consensus on the forecasted customer demand.

In case of collaboration with Distributors, distributors feed both their own version of the customer demand as well as inventory status into the collaboration tools. This collaboration was a three-way collaboration in which customer forecast was the primary concern of the equipment provider, whereas inventory status was the main concern of the service provider. Distributors were required to maintain a certain level of inventory decided by service providers. Whenever, the actual inventory fell below the minimum inventory level, or climbed above the maximum level, it triggered alerts to the service provider, who then collaborated with distributors to resolve exceptions.

Prior to this system being in place, most of the communication was carried out either via email or fax. There was hardly any accountability and much confusion. With this tool, not only the short-term and long-term forecast could be shared, but also, a history of forecast numbers could be maintained, and hence, one could be made accountable for any forecasted quantity.

Often a side effect of establishing a new channel is the ability to reach alternative customers that a firm is not currently serving effectively. Can a firm reach other geographies or other customer types through B2B/extended SCM technologies? For example, if you extend EDI systems to XML or interactive Web sites, will it gain new desirable customers not currently being serviced? When extending a process, opportunities exist to supplement the parties involved with new services. A firm can think about what other value-added services make sense in its industry such as dispute resolution, financial settlement, logistics, or authentication? By having a better and deeper relationship with customers, a firm can have happier and more loyal customers who spend more money and return more often. If the firm represents the easiest and simplest channel to buy from and offers rich customer value (more variety, best information on availability, highest quality, and so forth), then it has a competitive advantage over the rivals.

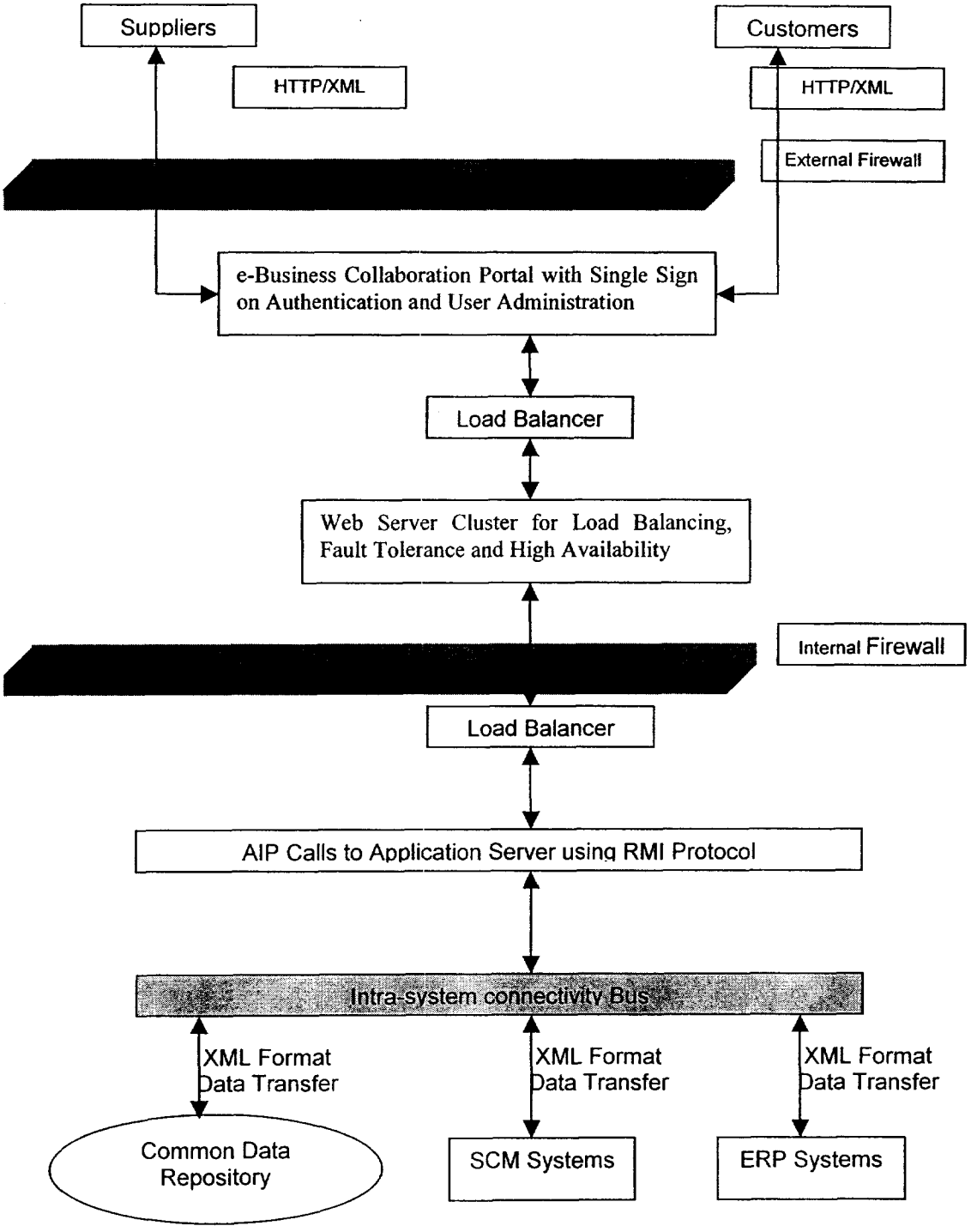

Figure 4 :Technical Architecture of the E-Business Portal

Technical Architecture for e-Business with Customers And Suppliers

The technical architecture illustrated in figure 4 is a 3-tier architecture, where the top-most layer is a presentation layer, designed specifically to address web based presentation to users as well as ensure a single authentication using single-sign on tool. The middle layer is an application layer, which provides multiple services based on certain business rules. These services include authorization service, security services, alert and email notification service, business rules, etc. The lowermost layer, which is the database layer, has the schema that holds the data in a relational database management system.

The major challenges that needed to be addressed by this architecture were as follows:

1. Design of a single portal through a single sign on system for the suppliers and customers to login and carry out their business with TC - this single portal not only served as the single point of entry for all the internal and external users (suppliers and Customers) of TC, but also, carried out the authentication of the users using built in User administration.
2. Performance and Scalability - Performance and scalability is one of the most important elements of an e-Business implementation. At no point, the portal should become the choking point in the communication between TC and it's external users. There are primarily two types performance considerations that need to be made, one, that is related to interaction of users on to the web user interface, and second, related to the batch processing, like upload and download of files. There are various approaches to ensure that both these performance considerations are met, like, using cluster environment for Web Servers as well as Application servers. This ensures that any single machine does not become a bottleneck.
3. Security and Reliability – this being a web based system, where users would login from web and carry out collaboration, hence, security and reliability of the system was of prime concern. Most of the configurations done for security were done at the web server and single-sign system level. SSL was enabled to allow only https connection between web server and external world. Also, two firewalls were implemented in order to protect the application server and database from any external access.
4. Seamless integration with the existing internal systems such as ERP – this was one of the biggest challenges in the implementation phase. Traditionally, ERP systems are pull-based or batch oriented systems when it comes to exporting data out of these systems. This was one of the biggest shortcomings in the system that was preventing any real time exchange of data with partners. This was changed to a push based real time exchange of data through an implementation of a bus architecture, and the event driven mechanism of Application server. All the back end applications including existing SCM application were required to subscribe or post their data to service bus, which in turn identified these pre-defined post

events understood by application server. These events in turn triggered the sending or receiving data from or to the bus.

LESSONS LEARNED FROM THE TC CASE

Significant technological advances in web-based tools are considered by many organizations to be a primary facilitator for streamlining the global supply chains for products and services. In the effective and efficient management of marketing and operations activities related to a global supply chain, information technologies play a critical role in providing a broad view of an entire supply chain to reveal full product and component life cycle. By integrating supplier, manufacturing and product data, it not only reveals opportunities for cost reduction, but also stimulates revenue growth. A dynamic chain links and optimizes the cross-operations and logistics flows of all parties involved as each coordinates its needs and demands.

The e-business phenomenon seems very fundamental, since it creates an immediate and intimate connection with customers, vendors and suppliers. It is very difficult to develop an appropriate e-business information system if the senior management has not formulated an e-business strategy or if it has been articulated in such fuzzy terms that no one understand. And it is very difficult to deliver a successful e-business information system if the associated business processes have not been re-engineered. Information Technology (IT) managers typically do not have the political clout to make dramatic changes in the business processes of an end-user department. This was also witnessed when IT managers embarked upon business process re-engineering projects during the client/server era.

To summarize, the key lessons learned from this case study are to focus on business results; adopt a common business model across the global supply chain; focus on process, people and technology; deliver value at regular intervals; and move fast. Moreover, strong leadership is paramount to the success of e-business system implementation, stretched goals can lead to stretched results, and customizing the software adds to complexity and cost.

Industry consortia initiatives are likely to become essential in developing industry standards around common capabilities. However, at best they can only enable competitive parity. Companies seeking a competitive advantage are currently establishing "private" collaborative commerce networks with their own trading partners. The business benefits of a strong supply chain for suppliers facilitated by the APS for e-business system described in the case study are that it allows suppliers to forecast their inventory needs eliminating the need for them to acquire product from alternative sources, transforms customer relationships into supply chain partnerships, and allows suppliers to differentiate themselves from competitors on their value-added service offerings thus increasing revenue from existing accounts and obtaining new customer revenue streams. The business benefits of a strong supply chain for customers facilitated by the APS for e-business system described in the case study are

that it allows them to share inventory management functions, reduce on-site and in-transit inventory stocks to lower working capital costs, and reduce the need for emergency shipments, thereby lowering transportation and administrative costs.

Among the barriers to achieving Web-based, real-time data visibility through supply chains are trust issues, the complexity of existing procurement processes and the lack of scalable technology to handle the huge volumes of data involved. The biggest bottleneck to enabling this real-time data visibility is that there are no common data standards or systems across the supply chain. More standards are needed so global firms can transact business more efficiently. The cost of complete visibility can also be prohibitive in time and money and only those companies whose business demands such flexibility are going to pay the price for end-to-end visibility.

Not only that, there are other obstacles, such as the suppliers themselves. Although Dell, Cisco or Ford can have their suppliers change the way they do business with relative ease because of their purchasing power, small and medium sized enterprises (SMEs) have a harder time in devising a synchronized supply chain that shares data through every link in real time. This will not be easy and will require a significant investment of time and money. Many companies are looking to pilot extended supply-chain management with selected trading partners.

Finally, a key success factor in the successful implementation of a GSCM systems is ensuring that one does not overlook either the buy-side or the sell-side of the value chain – by considering the benefits and opportunities from operational efficiency and new revenue potential. Recent examples abound in the industry literature on the successes of alternative technologies that have increased operating supply chain efficiency. For example, real-time auction mechanisms are leading to reductions in procurement costs; switching costs are becoming a smaller consideration for the consumer since search engines have automated the time-consuming search process; and vast amounts of consumer information can be collected and analyzed quickly to realign supply chain operations in real time.

CONCLUSION

Many manufacturing operations have implemented ERP–type systems in efforts to optimize their operations. However they focus on optimizing the "local" function of production or financial reporting. Similarly, other functional departments within the firm and/or the firm's suppliers and distributors optimize their workflows. Unfortunately most of the time this set of local optimization does not result in an end-to-end (global) optimization of the value-addition process from raw material to the final customer. The lack of accurate information flow across supply chain partners' results in inefficient supply chains where inventory buffers and customer service are the tradeoff variables. The problems are emphasized even more in global supply chains due to the increased transportation time and uncertainties associated with crossing national boundaries.

The global perspective basically centers on the need to integrate the various information systems (ERP or otherwise) across the global supply chain to enable quick flow of information between the trading partners. Within the company, ERP systems can achieve the desired integration of the information. Inter-company systems can be then linked using EDI/Internet to facilitate the information exchange between companies. Information infrastructure of ERP systems interconnected with the EDI/Internet enable optimal global supply chain strategies. Forecasts can quickly incorporate retail POS data, marketing's promotional plans as well as the historical data. The forecasts, and the plans derived, are then continually updated based on the latest POS demand information. POS data can be batches from the prior day via data warehouse or updated real-time data on demand. Supply orders can be automatically updated if deviations from previously agreed upon plans are detected, which reduces distorted information in the network. Supply chain experts from the partners can resolve situations where deviations from preset plans are substantial. Although information technologies allow businesses to reengineer and streamline their internal business processes, streamlining the global supply chain will require the internal information systems to be extended beyond a firm's enterprise and include electronic connections between each of the global supply chain partners. As manufacturers look for any leverage that can help them achieve critical velocity to raise performance above a plateau to satisfy the ever-demanding consumer, the ideas presented in this article will help extend the enterprise resource planning system and enable effective GSCM.

Finally, as in any research, our analysis has some limitations, which should be addressed in future research. For instance, the dynamic interaction of the GSCM and the ability to probe a situation for our study was difficult to replicate due to the variety of extrinsic factors that are present in a real setting. Future research should also include improvements in agility by moving to daily forecasts and therefore triggering more real-time alerts, which would further reduce variations in demand and supply for improved GSCM.

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