Managing The Real-Time Supply Chain

Dr. Sandor Boyson (sboyson@rhsmith.umd.edu)
Dr. Thomas Corsi (tcorsi@rhsmith.umd.edu)
Directors, Supply Chain Management Center
Robert H. Smith School of Business,
University of Maryland, College Park
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The great divide separating industries and companies within an industry is between those who are up shifting to real time supply chains and those who are not. Until today, very few organizations have succeeded in seamlessly integrating all levels of supply chain activities to achieve a quantum leap in business process. The ones that have succeeded are reaping big competitive rewards and offer us a window into netcentric business processes across the supply chain. This paper discusses some of these vanguard organizations and the important insights they provide us into the future. An earlier version of this paper appeared in the Supply Chain Management Review, January/February 2001.

1. Introduction: The Real Time Supply Chain In Motion

The following two cases represent the power of the real-time supply chain.

Case 1

A customer service representative in Atlanta turns to the computer to review an incoming order over the Web. Is the product available to promise the customer? The representative clicks the “search inventory” icon. Immediately, a software agent interrogates the global inventory database, which includes not only its own corporate inventories in warehouses across the U.S., but those of its supply chain partners in Europe and Asia. The software agent:

- locates the necessary products and components the customer has requested.
- calculates the guaranteed lead time to source and assemble these items.
- calculates the most optimal transport route to the customer’s site.

All of these transactions occur within 3 seconds.

Case 2

An importer or an exporter in Singapore has to get necessary approvals from 18 agencies that handle customs/trade approvals. How long does it take for a shipper or freight forwarder to get those 18 different approvals?

A trader can accomplish this by logging on to the island’s TradeNet, a 24 by 7 Internet-based system, making the request, and filling out the necessary on-line forms. The forms are then routed through eighteen different agencies simultaneously. The whole permitting process is accomplished online within fifteen minutes.

2. Driving Forces of the Real-Time Supply Chain

The great divide separating industries and companies within an industry is between those who are up shifting to real time supply chains and those who are not. The real time supply chain business model is being formed, fundamentally shaped by the following three major technology trends:

- Accelerating Connectivity and Broadband Networks Converging Voice and Data
- The Transition To Smart Networks
- Real-Time Total Asset Visibility

These three major technology trends are now described.

30 Accelerating Connectivity and Broadband Networks Converging Voice and Data

Massive investments in fiber and satellite infrastructure capacities are leading to the doubling of speed of communications every three to six months (a forecasting rule known as Metcalfe’s Law). In addition to increases in speed of communication, sheer volume of bandwidth is increasing exponentially. For example, transatlantic fiber capacity expanded ten times between 1998 and 2000. Currently, we are verging on a bandwidth glut in key economic corridors. 360networks expects to have laid 56,000 miles of fiber on three continents within the year. Global Crossing is installing 97,000 miles of fiber on five continents; and Qwest is building a fiber optic network of 48,000 miles. It is estimated that only 6.5% of installed fiber in the U.S. is presently even “lit” and used; the rest is dark fiber awaiting higher demand.1 This burgeoning availability of bandwidth is reflected in long distance telecommunications charges to corporate customers. The price of a call minute from the U.S. to Israel dropped from 32 cents to 8 cents over past three years.

The emerging technological environment will be marked by massive bandwidth availability across the entire globe. In addition to fiber networks traversing the

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major economic corridors, **low orbiting satellites**, provided by companies like Teledesic, will offer wireless internet access anytime and anywhere at speeds up to one thousand times present day modems. Core engineering obstacles to high speed Internet satellite delivery are rapidly being removed. Recently, a Microsoft/Gilead Inc. partnership announced a technology for uploading data digitally via satellite, significantly bolstering the transfer rates and freeing users from the need to be tethered to land phone lines.

Despite this emerging global massive bandwidth availability, **constraints to fully exploit the bandwidth resource** will probably not be completely eliminated. These constraints will likely include:

- Nation-state and bureaucratic interference with the user-community, with gateway access to bandwidth still subject to control and excessive rents by totalitarian or corrupt state telecommunications authorities. The idealistic notion of the early 1990s that information wants to run free will remain just that- an idealistic notion- well into the future.

- Persistent last mile problems, with the firehose of bandwidth meeting a needle-size lumen of connector devices. The United States military today, with massive global bandwidth availability under mega-outsourcing contracts with telecommunications giants like AT&T, still has to strip away graphics from Power Point presentations when relaying data files to submarines at sea because of antennae limitations. Imagine the situation if the military truly ‘informatizes” itself and total situation awareness infiltrates every aspect of operations. If present trends continue, the likelihood of crippling data jams or-worse- dangerous stripping away of crucial data to achieve some modicum of network throughput will be omni-present.

4. **The Transition To Smart Networks**

We are witnessing the following transition of software applications. Software applications are moving from separate packaged software bought and installed on local machines and internal corporate networks to integrated suites of applications, managed remotely by 3rd party applications service providers.

Application Service Providers (ASP), such as Digex, US Internetworking, Corio, and Exodus are leading the conversion of software to hosted applications. These ASPs replace the customer’s IT infrastructure with the transfer of any applications and data onto the ASP servers. All that is left on the customer’s site are the desktop PCs or terminals, connected onto a phone line or Internet connection. Typically, the ASP provides 24X7 customer support and ongoing system/ software upgrades, with charges based on the number of concurrent users and the amount of use by each user. For example, Corio will charge a daily user between $595 and $895 a month to access hosted applications over a wide area network; whereas an occasional user accessing applications over the Internet would cost only about $20 month.

Software providers, such as SAP, PeopleSoft, and Oracle are already hosting ERP modules remotely via ASPs. For example, USI’s suite of Internet managed applications include: financial management and human resources management software, powered by PeopleSoft; customer relationship management powered by Siebel Systems; and electronic Commerce, powered by BroadVision and Microsoft.

The telecommunications providers whose bandwidth carries the data and supports the ASP networks and user-communities are positioning themselves to be part of this revolution in computing and Internet-based services. Qwest signed a $500 million deal with Hewlett Packard to equip Qwest’s CyberCenters with hardware and software to support the carrier’s forthcoming SAP/ERP outsourced service. On June 28, 1999, Qwest launched CyberSolutions, a joint venture with KPMG to develop application service provider hosting and management services for software such as ERP and Microsoft BackOffice Applications.

GTE has collaborated with the Sun-Netscape Alliance to create its Network Commerce Platform. GTE bills the Network Commerce Platform as a “web-based application rental platform for any hosted application.” This system is an operating system and is application neutral with security features including digital certificates and user authentication.

Currently, we see other major telecommunications players, such as MCI and AT&T directly entering into alliances with application service providers such as Digex and USInternetworking. These telecom players are attempting to absorb software hosting services right into their networks, a transitional phase on the way to smart networks with on-demand intelligence and functionality. Other companies, such as Lucent, envision networks becoming “application switches” that enable users to source and use specific software functionalities from different ASPs on an as-needed basis. Thus, the smart network will sense when one ASP’s application servers are reaching overload and will automatically roll users over to another ASP’s application servers that have available capacity.

A variant on this vision is extending the operation system and applications of one server via real-time global satellite linkage to other servers in the same corporate network on the other side of the globe and snatching the remote server capacity. This overall transition will continue so that there will soon be **smart global networks with so much bandwidth availability that instant point to point connections can be established anywhere on the network and the delivery of as needed, customized data/applications can be sped to users**. The direction and phasing of this software transition are shown in Charts 1 and 2 found at the end of this paper.

There are enormous challenges to reaching this vision of smart networks. Domain support, sustaining 200 millisecond transactions from a network
perspective, remains a significant hurdle; as does tracking and reporting different levels of licensed software services usage. But a concerted effort is underway to solve these issues.

For example, Cisco has pulled together an ASP “ecosystem” of some 127 technology companies, ranging from companies that provide web hosting services, such as MSIA, to companies, such as Xevo, that have developed intelligent agents that migrate to desktops and monitor use of rented software over the net.

In addition, Cisco is even reengineering its core product, IP routers, for the future smart networks. Cisco is now embedding Tibco, Inc.’s middleware and real-time messaging and publish-and-subscribe technology into its new generation of intelligent routers. Eventually, these routers will become business message traffic cops, extracting real-time data from heterogeneous databases and dynamically addressing vital business data and messages to corporate users across the network.

Such innovations can extend computing power and can offload complexity from in-house corporate managers and management systems to outsourcing specialists. Nevertheless, the most significant danger of these innovations is the possible subversion of mission critical hosted servers by hackers intent on mischief or terrorism. One can envision a scenario where hosted systems become slave systems under the control of intruders for short or extended periods.

5. Real-Time Total Asset Visibility

The ability to link and to effectively monitor, in real or near real-time, disparate remote assets and devices of all kinds, from inventory in-transit to sensor devices out on remote grids, is on the horizon and achievable in the short-run. This ability will flow from the following developments:

- **Spread of protocols for pervasive device intercommunication and networking**, such as Sun Microsystems’s Jini and Intel’s Bluetooth, enable a device to register itself on a network and update its location and systems status in real time
- **Spread of standards for industry-wide transactions processing**, such as RosettaNet’s XML consortium for the electronics industry or the Data Interchange Standards Association’s XML consortium for the financial industry.
- **Rise of new, integrated operating platforms for electronic processes**, such as proposed in IBM’s Supply Chain Development Initiative.
- **Rise of more reliable and cheaper radio frequency tags, Internet (I)-buttons and other field sensors**. For example, Dallas Semiconductor produces thermocron I-button devices today that attach to shipments of fresh produce and seafood. These devices take constant temperature readings to assess shipment safety and can be scanned and read by handheld devices.

Taken together, these spreading protocols, standards, new operating platforms, and sensor technology will enable an organization to track and monitor highly distributed assets in real time. This functionality will allow firms to rapidly reconfigure and deploy joint assets with extended enterprise partners and to conduct global transactions with less “friction,” e.g., less cost and time delays.

Yet, it would be wrong to imagine this type of visibility as a process that will unfold in some automated or semi-automated fashion or as the result of one dominant standard or platform that will ultimately prevail. Visibility will more likely flow from a series of highly labor intensive efforts to tag and inventory assets in the field and to connect them together with whatever evolving technologies seem most reliable at the time.

6. Year 2001 Supply Chain Business Practices

Regardless of the IT architectures that are employed; or the application-level transport protocols (such as HTTP, FTP, etc.); or the basic message constructs (such as XML headers and MIME types), the need for underlying business process integration and system documentation of the rules governing that process integration will remain constant. The underlying business processes themselves will likely be transformed and will be radically different from those that dominate industries today.

As massive bandwidth and the multi-media Internet transform the way whole industries conduct business, a fundamentally new set of business/transaction processes and embedded system process-descriptions/electronic business rules to support those processes will have to be developed. RosettaNet calls these process descriptions “choreographies”. As Rick Drummond writes:

A simple choreography might be where a message is sent to a server and a response is received. These two messages together form the choreography of the transaction. The complexity rapidly increases as the choreographies that must be supported increase. The choreographies are often business sector-or application-specific so that only the people who know them well are the business process experts in that application and industry. We see choreographies all the time in information gathering on the Web. More sophisticated transaction choreographies need to be supported, such as those used in Internet credit card purchase transactions, including, for example, issuing the request to buy, verifying the credit card, and confirming the purchase. The shipping facilities are contacted and the product shipped. However, the transaction is not completed until all of the

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above steps have been completed, perhaps over an extended period of time. One of the most complex choreographies comes from the travel industry, where a single transaction may be composed of airline, car rental, hotel, and other bookings that occur across multiple industries and organizations.

Yet, when we try to visualize such real time supply chain business processes and transaction choreographies, we mostly imagine a patchwork quilt of technology pieces and programs. This is demonstrated in Chart 3 (found at the end of this paper). Chart 3 portrays how companies are cobbling together self-service customer-order portals; ERP systems across internal processes; middleware links to disparate trading partner systems; collaborative planning/forecasting systems to aggregate supply chain community inventory/materials positions and requirements; and purchasing/auction portals to meet those aggregate requirements.

Until today, very few organizations have succeeded in seamlessly integrating all these technology pieces for quantum leaps in business process. The ones that have succeeded are reaping big competitive rewards and offer us a window into netcentric business processes across the supply chain. We shall discuss some of these vanguard organizations and the important insights they provide us into the future. As shown in the FedEx case, this will overturn our highly linear paradigm of supply chain operations and lead to a new webbed mode.

6.1 Federal Express: Simultaneous Processing Across An Extended Supply Chain

Situational Analysis at Federal Express:

- Army of portable bar code scanners feeding a centralized database
- 400,000 customer service calls, 2.5 million packages daily
- Business model dedicated to increasing speed of information and logistics flow
- The FedEx-Proflowers Alliance
- Massive available bandwidth can enable simultaneous, rather than serial processing, e.g., a single event will trigger multiple real-time actions throughout the chain.

Today, FedEx is a leading model of simultaneous processing across an extended supply chain. Federal Express employs real-time data transmission to assist in routing and tracking packages. Information recorded by portable bar-code scanners is transmitted to a central database and can be made available to all employees and customers, not just managers in traditional decision-making roles. The FedEx corporate communications network is one of the world’s most sophisticated and most reliable, each day processing nearly 400,000 customer-service calls and tracking the location, pickup time, and delivery time of 2.5 million packages.

Federal Express is as much an information firm as a transportation company. Federal Express’s business model is now dedicated to:

- increase transaction speed (single transaction triggers multiple enterprise actions)
- connect systems and customers, globally
- reduce costs (shifting processing burden to customers)
- improve information control (available to employees, customers, and between customers)
- provide solutions beyond the immediate business case (through re-engineering the supply chain, and alliance strategies)

The best example of how this is playing out today is the example of FedEx’s alliance with Proflowers.com, an internet company that runs a portal for ordering fresh flowers. When Proflowers receives a web order, the Proflower webservice simultaneously records the transaction and messages FEDEX. Based on this message, FEDEX generates both a shipping label (that is returned to the Proflower webservice and downloaded to the grower) and a request to its fleet to pick up the order at the grower’s site. When the pickup occurs, the FedEx shipping label with all the requisite customer information is already on the carton of flowers to be shipped.

In essence, FedEx and Proflowers.com are using a single shared trigger event, a customer order on the web, to generate multiple supply chain transactions. This is a completely new paradigm of supply chain, a webbed model (rather than a sequential model based on serial handoffs) to attain quantum leaps in time savings and administrative processing costs.

FedEx wants to develop global information systems for use by customers. The systems will be integrated with customers’ systems so that customers will not know where their systems end and FedEx’s systems begin... FedEx would like to develop a “real time information superhub”. This information superhub will allow FedEx to use the information it collects and warehouses in an intelligent manner to foresee industry trends and to provide its customers with useful intelligence.

6.2 Cisco: End-to-End Internet Supply Chain Integration

Situational Analysis:

- Customer self-help. Customers submit support requests on web site. They also can download software updates and diagnostics tools
- Electronic Commerce. Customers use web-based apps to price configure, validate, and order products.
- Software Distribution via downloads from web site
Cisco Systems has a profound mastery of supply chain and e-business processes utilizing the Internet. Cisco has employed the Internet to reengineer processes across its whole span of operations and has become a global networked organization. Every step of its supply chain, from customer order self-service/product configuration to supplier management employs Internet-based processes. This has worked so well that Cisco’s per employee revenue is almost three times that of competitors such as Lucent.

Cisco has reaped huge benefits from successfully and seamlessly integrating the fundamental technologies and components of the Internet on an enterprise-wide basis. Further integration will occur as customer-order self-service portals; web-enabled “demand-driven” production and inventory replenishment processes; distributor/supplier collaborative planning/forecasting efforts, and online purchasing/marketplace exchanges, all come together into more seamlessly inter-woven supply chains.

Today we are seeing only the very beginnings of such integration. Take Cisco Systems as an example of early success in supply chain integration. Cisco has used the Internet to lower its cost of doing business more than $560 million per year.

It now receives more than 50% of its product orders via the Internet. Its customers use 24-hour web based applications to price, configure, validate, and order products. By automatically trapping errors at the configuration stage, Cisco has reduced orders that require reworking from 15% to 2%. On the supply side, Cisco’s e-commerce applications automatically notify a group of suppliers when incoming orders deviate from forecasts. By increasing responsiveness to customers, Cisco has been able to improve revenue capture by $100 million annually. By integrating suppliers earlier in the ordering process, the company has reduced lead times from an average of 40 days to 7-21 days.3

Cisco has had to cobble together functionality and best of breed technology applications from providers such as Ariba and Extensity in order to attain their pipeline flow. Soon more integrated application sets will be available. Oracle recently unveiled its web-rewritten integrated ERP system 11 I which is a first attempt to put a whole intermeshed suite of supply chain applications on the web.

But integrated web-based supply chains are not only internally managed, as in the case of Cisco. Hosted application suites, such as the Pandesic suite hosted by Digex, represent early attempts to migrate supply chain management to the web as an outsourced service.

6.3 SUN Microsystems : The Network is the Supply Chain

Situational Analysis:

- Sun Peak network links 50,000 employees, suppliers, and distributors
- Sun Peak is supporting $250 M supply chain BPR designed to cut 5 weeks out of 14 week product cycle time and 25% of the costs
- The goal is a Virtual Merge. Jini-enabled supply chains that automatically adjust assets, machines and inventories to real demand.

Sun is a multi-billion dollar company that is an industry leader in scalable servers to power PC Networks and Web sites. Of its $9.7 billion in revenue, 88% is server hardware sales. Sun Peak, a Web-centric infrastructure (servers and Java workstations) links 50,000 employees, suppliers, and distributors. Sun’s last mainframe was unplugged in January, 1999. The Sun Peak provides the foundation for future growth and flexibility to compete and serves as a demonstration of Sun’s role in networking. It will help Sun transform itself to a net-centric way of doing business. The new type of networking will allow Sun to reduce its planning and testing times and costs and move to a collaborative product innovation system based on rapid experimentation and correction off real market/customer data.

There are many management challenges currently facing Sun. First, it must master better surge management techniques to cope with volatility in the marketplace. They encounter 480% spikes in demand for a product from one year to the next. Sun cannot simply be better at forecasting; the Sun supply chain must be better at adapting to real time demands on a chain-wide basis. One way that Sun has accomplished this is via a shared extended enterprise-wide data network and more collaborative relationships across the chain that exploit this available real time data.

Thus, Sun Peak infrastructure is being used to support a $250 million supply chain BPR project designed to cut 5 weeks out of 14 week product cycle times and 25% of cost. This reengineering of the supply chain is vital, given the speed and volatility of the high tech marketplace.

Also underway is a plan to implement Jini-enabled supply chains that automatically adjust networked assets, machines and inventories to real demand. Once plugged into a network, a Jini-enabled device, with an address, can broadcast its capabilities to other devices in the network. Internally, Sun is attempting to use Jini to implement a “Virtual Merge” functionality in the supply chain, or a real time synchronization of all components to arrive at the same time into production/distribution staging areas.

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Other current Sun management challenges include implementing horizontal process owners/incentives and spiral promotion policies so that workforce development and deployment can keep pace with the netcentric technology infrastructure being developed.

6.4 The Automotive Network Exchange: Industry-Wide Process Design and Effectiveness

Situational Analysis:
- VPN/Industry Wide real-time management infrastructure among automotive trading partners
- Led by Ford, Chrysler, and GM and 3 dozen trading partners
- Certified ISPs used to guarantee reliable connection

The Automotive Network Exchange (ANX) highlights how real time networks are changing the way companies interact with each other not only across supply chains, but across whole industries. As an industry-wide real-time management infrastructure, this virtual private network provides the medium for e-commerce and data transfer among authorized automotive trading partners. ANX provides a common transaction infrastructure to handle computer-aided design (CAD) files, purchase orders, and payments in North America.

ANX is the product of an industry-sponsored initiative led by Ford, Chrysler, and General Motors, working in concert with the AIAG (Auto Industry Association Group) and nearly 3 dozen automotive trading partners. Participants in the ANX project identified four criteria that they felt were essential for their communications: These criteria are: performance, reliability, security, and management. As is well known, the issues of reliability (servers that are down) -- and performance (fluctuating transfer rates) are current serious concerns for users of the public Internet.

ANX was designed to be as secure as a Virtual Private Network (VPN); have an organization responsible for the management of the transport of the electronic data, the ANX Overseer; and have a reliable infrastructure and a steady performance.

7.0 ANX Design Issues And Solutions

7.1 ANX Performance

A stable level of performance is a key advantage of ANX over the public Internet today, because transmission rates fluctuate in the public Internet. Highly synchronized production facilities require real-time data transmission and real-time data transmission can only be achieved with a network that offers a predictable performance. Organizations are asking for performance guarantees, like those that the telephone companies routinely provide. The issue of data transmission performance is crucial for manufacturing companies that work in a Just-in-Time environment, where electronic data runs parallel to the physical transport of goods. A company that connects to the ANX service may choose between different performance or bandwidth levels, starting from a 52 KBPS dial-up line up to a 3 MBPS dedicated line.

7.2 ANX Reliability

Common problems for users of the public Internet are data loss or servers that are not accessible. Within the ANX community, “certified’ Internet Service Providers – the CSPs – are committed to guarantee a very high level of availability of their infrastructure and, thus, a high reliability. They take the full responsibility for the data transport from one trading partner through the ANX “cloud” over to the other trading partner. Thus, trading partners do not need to worry about losing data as is happening on the public Internet.

7.3 ANX Security

ANX has addressed this problem with the adoption of the Internet Protocol Security (IPS) standard. Within the ANX operating sphere, CSPs are allowed to exchange data only with other certified CSPs. This ensures that no data is sent “unattended” over the public infrastructure.

7.4 ANX Management

Whereas there is no central management of the public Internet, the management of VPNs (Virtual Private Networks) is limited to a service provider’s customers. This means that there is no single organization responsible for the management of data that runs across the secure VPNs.

Within the ANX community, the ANX Overseer (ANXO) is the entity responsible for managing data that runs among the certified Internet Service Providers. The ANXO additionally provides information to the trading partners about the performance and availability of ANX services. According to Forrester Research, “corporate extranets need a single-point management solution for all security options.” This issue has been addressed by ANX through the ANXO function. Additionally to these advantages, members argue that the service quality of the CSPs will be improved over time due to competition for the acquisition of trading partners.

8. Anticipated Impacts of ANX Between Business Partners

Direct savings of having ANX between business partners include: cost reductions through elimination of contract, billing, network management, equipment maintenance, and floor space overhead, through elimination of transaction-based charges for connectivity, through elimination of private lines; and
complexity reduction through reduced need for multiple providers to reach trading partners globally, and through increased compatibility.

9. Summary Of Major Business Process Themes For The Real Time Supply Chain

The review of the pioneering organizations described above give us insights into the direction and character of the real time supply chain. The major interrelated themes that emerge are the following:

- Real time supply chain business processes capitalize on massive available bandwidth through simultaneous, rather than serial processing, e.g., a single event will trigger multiple real time actions throughout the chain. As shown in the Fedex case, this overturns our highly linear paradigm of supply chain operations and lead to a new webbed model.
- More seamless technology integration across supply chain activities enable the “straight through processing” of customer orders. Customer self service portals are increasingly setting the pace for the whole supply chain and providing clear real time market feedback and strongly signal inventory requirements directly to the supply base. This has tremendous implications in cutting the costs generated by chain-wide buffer-stocking as hedges against unknown demand patterns, a syndrome known as the bullwhip effect. This is the implication of the Cisco case.
- Real time extended enterprise architectures will not only permit new transaction efficiencies between trading partners, but also new strategy and product planning efficiencies, as the case of Sun implied. This is a very important distinction—not only the process but the product itself, it’s very design and evolving menu of features—will align with customer requirements more in real time.
- Increasingly, the emphasis in business process design and performance effectiveness will move from an emphasis on the individual organization and its supply chain, to industry-wide process design and effectiveness. This is the implication of the ANX case.

10. Conclusions

While the power of the real-time supply chain will revolutionize business processes in the coming years, there are some important overall conclusions about the path that we will take in realizing these gains.

- Second, an enterprise should be seeking to portal supply chain applications and services in a far more comprehensive manner than hitherto attempted. It needs to migrate to an architecture of centrally managed servers and much thinner, more pervasive clients to gain greater situational awareness and distributed real time computing. This means senior supply chain managers need to establish a shared supply chain application service provider capability to support business units in a leveraged and efficient manner; to distribute new supply chain technology upgrades instantly across the network; and to maintain a single enterprise-wide supply chain deployment visibility.
- Enterprises should be expanding discussions with global telecom providers and application service providers to ensure the availability of suites of hosted supply chain applications needed for its own distributed transactions.
- While pursuing centralized portaling and hosting strategies, an enterprise must simultaneously focus on a massive diffusion strategy to the services that will enable the easing of the last mile constraints. Two way digital satellite-based internet connectivity is one tool that can be employed in this strategy.
- Enterprises should be expanding discussions with global telecom providers and application service providers to ensure the availability of suites of hosted supply chain applications needed for its own distributed transactions.
- While actively pursuing extended enterprise activities and linking to a range of industry or commodity-specific procurement portals to benefit from scale efficiencies in purchasing, an enterprise must nevertheless monitor the negative impacts of such activities on core suppliers to avoid endangering the critical supply base in pursuit of short term operational gains.
## CHART 1: EVOLUTION OF SUPPLY CHAIN MANAGEMENT SOFTWARE

### Evolution of Supply Chain Management Software

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<td>Bulky applications designed to run on corporate networks</td>
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<td>Internal Data Center-Managed applications</td>
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<td>Virtual Supply Chains, reconfigurable on the fly</td>
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**Note:** This chart highlights the evolution of supply chain management software from 1995 to 2010, focusing on three main phases. Each phase introduces new models and characteristics that reflect changes in technology and business needs.
Transition to Smart Networks

- Discrete Supply Chain Management Applications Installed on internally run networks
- More integrated suites of Supply Chain Applications Installed on Externally-run 3rd party Application Service Provider Networks
- Instant Point-to-point Supply Chain Mgmt Applications Installed and Delivered via Broad Band Networks Run by Telco Service Providers

- Leased line costs
- Purchase costs of software
- Separate network access charges to ISP or Telco Service Provider plus software licensing fees
- Single corporate customer billing for network access, rented applications, and data storage

Source: S. Boyson
Supply Chain Management Center
March 24, 2000
An order placed through the Customer Order Portal activates a series of order fulfillment activities. Real time inventory fluctuations across the Supply Chain are recorded in the collaborative planning layer, and reorders of necessary supplies, parts, and components are automatically submitted to multiple possible suppliers through the Supplier Exchange.