An Overview of
Information Technology Applications in Retail Merchandising

Version 4
August 20, 1998

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A Report to the Harvard-Wharton Project on Retail Merchandising Effectiveness
Project Leaders:
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Dr. Ananth Raman, Harvard Graduate School of Business Administration

The author would like to acknowledge the valuable inputs and feedback provided by Anna Sheen McClelland, Ananth Raman, Marshall Fisher, Tom Armentrout, and access to interview data from participating retailers.

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Introduction

Contemporary IT systems enable retailers and other supply chain intermediaries to answer several interesting questions related to their businesses. However, most retailers remain unaware of the substantial benefits of leveraging IT into their operations. They also lack a suitable roadmap on the types of products and services available in the changing terrain of the IT industry in general, and in the emerging areas of data mining, data warehousing, enterprise commerce, and supply chain management in particular. In this write-up, we briefly explore the evolution of IT systems with potential applications in retailing, and the types of business questions they can possibly answer. Problem areas in application of IT solutions to the retailing industry are identified and discussed, with particular emphasis on merchandising systems. We also provide a description on the state of the industry in the areas of data warehousing, data mining, enterprise software, and back end integration, along with brief summaries of major vendors in each of these categories.

Enterprise IT Solutions - A Historical Evolution

The use of information systems and technologies has gained widespread acceptance in several areas of business. Retailers, in particular, regularly deal with massive amounts of information. Information savvy retailers like Wal-Mart have recognized the value that information can provide to the organization, and have gravitated toward an IT driven model for their businesses. This consists of detailed transactional information collected at the level of the store or the customer, and used to tailor solutions across a range of business functions, including warehousing, supplier management, inventory management, and financial planning. Most of this information can be translated into concrete retailing decisions, if collected, stored and analyzed properly.

A chronological review of IT applications and their relevance to retail merchandising business questions is provided below (Dun and Bradstreet 1995). This clearly shows the growing importance of IT to the retailing business, and more importantly, the increased availability of sophisticated tools and customized solutions to retail problems.

1. 1960-1980: The focus during this period was on developing systems that capture or collect data. The primary enabling technologies included computers, tapes and disks. Major players in the data collection market included IBM and CDC. Products were mainly mainframe based, and enabled static, summary-type applications. Typically, the user could only answer aggregate questions, e.g. "What were the average total revenues over the last five years?"

2. 1980s: Several innovative database applications were developed including relational database management (RDBMS), and structured query language (SQL). The number of players increased significantly, with the likes of Oracle, Sybase, Informix, and Microsoft also entering the market. Product characteristics included retrospective, dynamic data delivery at record level, enabling users to answer questions like, "What were the unit sales in Georgia last April?"
3. **1990s:** During this period, there was a move toward providing more analytical capabilities, at several levels. On-line analytical processing solutions emerged (OLAP), using multidimensional databases and data warehouses. Players like Pilot, IRI, Arbor, Redbrick, and Evolutionary Technologies entered the market, providing retrospective, dynamic data delivery and storage at multiple levels. In addition to record level queries, systems could now handle questions like, "What were unit sales in Georgia last September? Provide breakdowns for Atlanta".

4. **Current:** The move is currently toward systems that not only dynamically retrieve data, but also enable users to forecast future developments in the marketplace, and at the level of consumer. Several advanced algorithms are being used (e.g. neural networks, biological models, etc.) in conjunction with massive databases and customer tracking, to provide predictive power. The marketplace is still in flux, with a number of competitors, who operate in several overlapping solution areas. There is a trend toward detailed prototyping and customization, and integration with back end solutions, e.g. pegging storewide merchandising activity to inventory, warehousing, and supplier functions, for example. Several new players, including HP, Tandem, Lockheed, SGI, KD1, and Retek. The focus is on prospective, proactive information delivery, in conjunction with massive storage capacities and retrieval. Significant industry trends include development of corporate intranets and desktop level delivery of services. The thrust of many of these products is to be able to reveal unknown or unforeseen relationships in the data. Industry analysts predict consolidation among the enterprise players in 1999. Newer versions of OLAP and ORDM (Object Relational Data Mining) are used to investigate questions like, “What is the impact of the seasons on sales of skis in different parts of the country?” or, “What is the relationship between zip codes and total dollars spent in particular market segments?” (Microsoft-Tandem).

### Sources and Potential Uses of Retail Data

Most retailers are faced with a data glut. There is widespread availability of detailed data pertaining to various types of transactions, at various levels in the organization. However, there is considerable variation in how retailers capture, store, and use this data for their business decisions.

Data is typically captured at various interfaces - customer transactions (simple purchase characteristics to detailed behavioral tracking), shipments to the store, inventory and warehousing activities, interactions between the retail outlet and its corporate headquarters, and other interactions with value chain intermediaries are all potential data sources. Several potential applications emerge from these kinds of data capture. At the level of store, these include category management, i.e. category size and growth trends, geographic breakdown of sales and related information, store performance and growth, and the success of new product introductions. Several experimental analyses can also be conducted, e.g. testing the impact of promotions, coupons, shelf space, advertisements, and price elasticity measurement. At the level of customer, they include consumer purchase characteristics and tracking, loyalty measurement, market segmentation, and market basket analysis. Several performance indicators can be tracked and benchmarked, including the effectiveness of supplier plans and programs, retail category plans, and category performance at the level of store, region, and customer (See Figure 1).
Once data is captured, it needs to be stored in a reliable and accessible format. Several powerful database servers are available in the market, which can keep pace with retailer data needs, whether it is in the tens of gigabytes, to multiple terabytes. Further, the costs of storing data are falling rapidly, with advances in semiconductor technology. A study by the META Group in 1997 found that the average data warehousing project budget was around $1.2 m, down from $2.1m in 1996 (for average size of 200-250 GB, not including internal staffing costs). Among the data warehouse managers surveyed by the study, 40% reported using Windows NT as their installed base, followed by 28% for MVS, and 27% for HP-UX.

Given the potential applications of data, and the technological capability to store and retrieve it, one would expect a number of superior decision support systems to be in use in the retailing industry. This is not the case at the present time. A survey carried out by Eric Madden and Associates for Sequent Systems has shown that over 85% of DSS (decision support systems) projects fail, mainly due to a lack of business focus and involvement, and the lack of good delivery methodologies that are specifically designed for decision support. Retailers are also faced with the complex task of evaluating alternative DSS packages, each with its unique bag of features.

Further, we observe that there are several major problems that need to be resolved both at the level of technology and business. Difficulties in data retrieval and manipulation in existing and new systems due to:

- **Category Trends** (size and growth of category, category trends by region and market, new product trends)
- **Consumer Trends** (consumer needs, consumer purchase characteristics, consumer segmentation, market basket characteristics)
- **Causal Factors and Competitive Analysis** (impact of ads and displays on sales and profits, price elasticity, shelf space impacts)
- **Supplier Plans and Programs** (new product introductions, media spending levels, promotion spending plans, missed opportunities by retailer)
- **Retail Category Plans** (target markets, strategy, positioning options, performance measures)
- **Category Performance Benchmarks** (‘fair share’ levels, sales potential, sales opportunity gaps per store, per week, per item, per customer)
1. Multiple Data Sources: Retailers operate with multiple media, with multiple database management systems which are under multiple platforms. Data compatibility is a major resource crunch and challenge, due to scale and complexity of encoding involved.

2. Data Mapping: Mapping data that has different standards (name, meaning, business rules).

3. Data Accuracy: One of the most important sources of errors and problems. Typical reasons for inaccuracy include differences in time bases (e.g., one file reflects daily activity another weekly or monthly activity), and the level of granularity (fine detail can be lost or unseen depending on the storage retrieval system capabilities).

4. Business Level Issues
   a. Lack of business focus and commitment to supporting IT/MIS efforts
   b. Poor appreciation of the VALUE of data for business survival and growth
   c. Time and costs associated with organization-wide learning
   d. Personnel: Lack of skilled personnel at the store/retail level who can use these systems, even if implemented properly

**Competition in Retail/Supply Chain IT**

Initial research shows that the positioning of many of the solutions available in the marketplace is dictated both by company history and evolution, and the expertise gained through internal product development and external alliances. This has led to a profusion of products in the market, and not all of them are either useful or compatible with each other, and the larger enterprise system that they seek to serve. We classify these systems based on their overall scope, as follows:

1. Retail Enterprise Solutions: These firms approach the problem at the enterprise level. Their objective is to provide a **broad-based solution** pertaining to various parts of the value chain impacting the business. Established players proliferate this portion of the market, including and not limited to Microsoft, IBM, HP, Tandem, etc. There is ample scope that many of these players will seek to reinforce their capabilities by acquiring companies that fall into categories 1. and 2. mentioned above, mainly because many enterprise solutions require a good mix of both data warehousing and mining capabilities. Hewlett Packard, for example, provides an umbrella of services for the retail customer (see Appendix III-B) in collaboration with other players. Some other vendors who specifically target retail and merchandising customers include, Comshare (Arthur Enterprise Suite), and Retek.

2. Data Warehousing: Data warehouses and decision support systems (DSS) provide managers with the ability to perform high level analysis and complex modeling capabilities. In very general terms, a data warehouse is used to store large amounts of data and decision support systems are used to analyze the information contained in the data warehouse. Smaller, more focused data warehouses are sometimes referred to as data marts. A data mart might be used to store just the information used by a particular department. A data warehouse converts data from all sources to a common format, and manipulates and presents it in the form most useful to managers and other users. Thus, a company can combine information processed by its legacy mainframe system with external and other data sources to build a large database that can be queried quickly. In other words, the data warehouse consolidates and enriches data to create information unavailable from any single source. It puts vital competitive intelligence...
and improved decision support information at users’ fingertips, across the company. The primary motivation for an organization to implement a data warehouse usually centers around improving the accuracy of information used in the decision-making process. Typically, the data is examined in a longitudinal fashion. The major steps for data warehouse implementation can be characterized as follows (from SAS Institute):

- Creating and populating a data warehouse
- Acquiring the necessary data
- Transforming the data
- Managing the data using meta data
- Loading the warehouse
- Exploiting the data warehouse

As pointed out earlier, some vendors are moving toward building detailed data marts that capture data from a number of sources, and consolidate them into one enterprise-level data warehouse. Using the appropriate decision tools, this warehouse can then be tapped for business insights. Figure 2 shows the structure of a typical retail data store.
3. Data Mining and Decision Support: has been defined as the "process of automatically extracting valid, useful, previously unknown, and ultimately comprehensible information from large databases and using it to make crucial business decisions," OR "You torture the data until they confess" (Renssealer Polytechnic Institute). A number of software vendors offer data mining solutions specific to the retail industry. The idea is to examine data trends and interrelationships in the collected variables, and come up with insights that would have otherwise remain hidden. The leading firms in this area are KD1, Intrepid Systems, and JDA-IBM, which also operate at the level of enterprise as mentioned earlier. Several different algorithms are used, and some remain to be tested for their use. (See Table 1). The market for data mining software in 1997 was estimated to be $4.7 billion, by the META Group of Stamford, CT.

<table>
<thead>
<tr>
<th>Technique</th>
<th>Application</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Association</td>
<td>Market Basket Analysis</td>
<td>Treats purchase of a number of items (basket) as one transaction</td>
</tr>
<tr>
<td>Sequence-Based Analysis</td>
<td>Market-Basket with Time-Series</td>
<td>Combines market basket info. With other time-related purchase info.</td>
</tr>
<tr>
<td>Clustering</td>
<td>Market Segmentation</td>
<td>Collapses records into a few &quot;segments&quot;</td>
</tr>
<tr>
<td>Classification</td>
<td>Classifying Population Info.</td>
<td>Employs decision tree or neural network-based classification algorithms</td>
</tr>
<tr>
<td>Estimation</td>
<td>Scoring</td>
<td>Useful in generating scores as opposed to binary classifications</td>
</tr>
<tr>
<td>Fuzzy Logic</td>
<td>Handling partial truths</td>
<td>Incorporates uncertainty</td>
</tr>
</tbody>
</table>

Other methods: Neural Networks, Fractal-based algorithms, Genetic Algorithms

Table 1: Data Mining Techniques
Source: Renssealer Polytechnic Institute

Decision support systems are often used in conjunction with a data warehouse. Employing user-friendly, business (rather than technical) language, these query based systems let managers quickly and readily interrogate data from numerous sources – enterprise, best-of-breed or legacy systems. DSSs integrate financial and non-financial, as well as internal and external, information. They provide tools to perform powerful modeling, including regression and trend analysis, and they offer unparalleled flexibility to test scenarios and anticipate the effects of various business moves.

DSSs are generally characterized as either managed query tools or on-line analytical processing (OLAP) tools. Often, companies use both. Managed query tools let users query data in relational databases and other legacy systems (without needing any technical knowledge of those databases or systems), and produce reports suitable for distribution to various groups in the business. Leading managed query tools include Impromptu from Cognos and Business Objects from Business Objects Inc. OLAP tools offer more sophisticated analytical capabilities, such as drilling, trend analysis, “snapshots” and “what if” analyses. Leading DSS Agent from MicroStrategy Inc, Decision Suites from Information
Advantage, Express from Oracle, Essbase from Arbor Software and Holos from Holos Systems.

DSSs can extend the life of legacy systems that are adequate for transaction processing. DSS tools let managers explore non-integrated systems, overcoming data inconsistencies, to access real-time business information. Of course, a data warehouse makes this even simpler by consolidating the legacy information into one central location.

Examples of retail questions answered by a data warehouse:
- What is the in-stock position and stock-to-sales ratio of the 15 most profitable items in men’s departments of my Northeastern stores last week?
- Show me the inventory by retailer for all items that have N consecutive days (selected at run time) of no sales in a given week.
- Show me sales and inventory of all discontinued items by region for the first four weeks of the following promotions: Wednesday Promo, Open Sundays and Two-For-One Specials.
- Show me the sales to plan percentage variation for this year and compare it to last year for my Western stores.
- For all shoppers who brought a PC, show me the 5 other items that were most likely to be purchased during the same trip to the store.

4. Supply Chain Management: In addition to storing and managing data, it is imperative to share this information with suppliers and others, so as to achieve an integrated solution to managing the flow of materials through the supply chain. Keeping this in mind, several vendors offer such integrated packages that seek to simplify the complex interactions that traditionally take place in a supply chain.

Overview of Merchandising System Modules

1. Merchandise Planning and Forecasting: Planning and forecasting software facilitate a bottom-up or top-down merchandise planning process. Such systems generally rely on historical sales data to produce detail plan information which is used to forecast sales and optimum inventory requirements at the store/class level. Some software packages, like Forseon, use sophisticated logic to “cleanse” historical data to arrive at more realistic forecasts. They do this using merchandising models that also allow retailers to produce plans for future store locations or for new merchandise classifications that have no historical data. Another feature of most planning and forecasting software is the ability to interactively make “what if” assumptions and immediately see the impact on profitability and inventory.

2. Purchasing: Purchasing systems manage and facilitate the procurement process. Fundamentally this amounts to managing all aspects of vendor relations, which includes controlling price and service agreements, rebates and discount policies, and delivery terms and conditions. Other purchasing related tasks include managing special agreements, for example specification of ticketing, packaging and other services for improved flow-through merchandising. EDI has become an important enabler of streamlined purchasing. Increasingly, retailers are electronically transmitting their purchase orders directly to vendors who in-turn invoice the retailer via EDI.
3. **Open-to-Buy Systems**: Open-to-Buy systems control buyers purchasing options. The systems track purchase and inventory values against a buyer's budget and allow purchasing activities to continue as long as the buyer is within their budgeted range of purchases and inventory.

4. **Merchandise Allocation**: Merchandise allocation systems allow for automated or manual allocation of merchandise to specific stores either through a distribution center or direct to the store from the vendor. Automated allocation systems allow sophisticated distribution of sizes and colors based on store profile information. For example, smaller sizes might be sent to stores that have demographic profiles that consist of predominantly younger people or teens.

5. **Merchandise Receipts/Logistics/Warehouse Control**: Warehouse/logistics software manage the flow of merchandise from the vendor to the store shelf. Categorized as ‘Inbound’ and ‘Outbound’ functions, JDA provides a good summary of typical features found in logistics/warehouse software:
   - **Outbound functions**: Cross-Docking, Inter-Warehouse Transfers, Builder, Picking (RF or Paper), Packing and Shipping, Label Generation and Labor Performance Information. Key enablers of warehouse/logistics software are bar coding and radio frequency technology. Bar coding and automated sorting equipment can virtually eliminate the need for human intervention in the warehouse/distribution center. Radio frequency technology allows for the use of hand held devices that facilitate the management of physical inventory, both goods receipt and periodic inventory counts.

6. **Replenishment**: Sophisticated systems have been developed to automatically replenish basic merchandise items. These systems are well documented and are widely used by grocery, discount, drug and other stores. The foundation for these systems is reliable sales history, which is typically available for basic items like toothpaste and soap, but not fashion apparel. The sales history is combined with in-store inventory levels to determine optimal reorder points. Once reorder information is established, the system uses it to automatically notify the vendor when additional inventory is needed. Some major retailers, like WalMart, rely on their vendors to completely manage the inventory replenishment process using the information automatically communicated by the replenishment system.

7. **Inventory Control and Store Operations**: Since retailer’s inventory is typically located in the retail store, most inventory control capabilities are included in the store operations software. Typical features in such modules include the following: direct to store sales order management; in-store merchandising receiving; inter-store transfers; returns to vendor; physical inventory counts; and physical adjustments.

8. **Promotion Planning**: Promotion planning systems manage all aspects of sales promotions, including price changes, store sign displays, rain checks, advertising development and event scheduling.

9. **Display Systems/Plan-o-grams**: Display systems and plan-o-grams provide large retailers with tools to manage the look and feel of their stores. The systems typically provide detail maps to store personnel to show exactly where merchandise is to be displayed in the store. For example, plan-o-gram software allows drug stores to consistently present their products...
in roughly the same location in every store. Also, plan-o-grams can be used to ensure that certain vendors always maintain the amount shelf space they have been promised.

10. Point of Sale and Store Systems: Point-of-Sale (POS) and Store Systems are primarily concerned with cash register type functions. These systems normally operate on a stand-alone basis and then communicate information to the back office systems on a periodic basis. An example of a POS system configuration would include a main server for storing master data used to calculate prices and discounts. Cash registers would be attached to this server to accumulate daily sales information. The information contained in these sales files is then uploaded to the retailers main computers typically during a polling process that occurs automatically. The polling process might occur many times during the day or may only occur once a night, depending on the management requirements of the business and the need for up-to-the-minute sales information at headquarters. Store Systems are also used to physically manage merchandise moving into or out of the store. Examples would include on-line verification of merchandise received directly from vendors. Tools for simplifying the process of returning damaged or spoiled merchandise to vendors (RTVs).

11. Radio Frequency Panel Displays: This is an emerging area I have been looking at several companies that provide electronic price labeling thru RF (radio frequency) technology. The leaders include Pricer (of Sweden), and Telxon, which markets Pricer products in the US. Symbol Technologies has just made an offer to merge with Texlon. There are other smaller players like ERSI (electronic retail systems intl., based in CT) and Telepanel, based in Canada. All these companies primarily provide price labeling to grocery chains/food retailers. Of late, they have been thinking of integrating back to enterprise level systems, and the big enterprise players have expressed some interest in their products. Examples: 1. The Pricer System can also be linked to InterCept, the Pricer Intactix Space Management software, so that merchandising information can be placed in the label’s secondary register making verification of shelf compliance and reduction of out of stock a simple task. 2. ERSI's ShelfNet system combines patented software, RF technology and intelligent liquid crystal display devices to deliver pricing, merchandising, planogram and replenishment control information to and from the shelf edge quickly and accurately. 3. Telxon has several new products that address point of sale, wireless thin-client computers, and mobile IS. Some pictures of these systems can be found at http://www.telxon.com/news/newproducts.htm

Industry Trends

The boom in Silicon Valley has also fueled the growth of several software ventures, that seek to provide enterprise IT solutions. A good example of such activity is KD1, which received first-round financing of $4 million from Dallas-based CenterPoint Ventures and Palo Alto-based InterWest Partners. Second-round financing added $6 million to bring the total capital investment in KD1 to $10 million. KD1 is now a major player in the data mining area.

A number of analysts predict major consolidation in the industry in the immediate future, as vendors are acquired by more established IT players. A number of alliances are already taking shape, and this trend is expected to continue. We will report on such trends in a future version of this document.
Questionnaire Design

As part of the Harvard-Wharton project, we have designed a questionnaire that would be administered to a select panel of retailers participating in the study (See sample listing in Table I). Through this instrument, we seek to elicit information pertaining to best practices in retail merchandising at the present time. One section of the questionnaire concentrates specifically on the use of information technology in retail settings; themes like IT infrastructure, specific data-collection issues and data-types, and commonly used analytical tools are explored. Feedback from participating retailers will be provided in a future version of this document.

<table>
<thead>
<tr>
<th>QVC</th>
<th>Time-Warner</th>
<th>Circuit City</th>
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<tbody>
<tr>
<td>Sears</td>
<td>Circuit City</td>
<td>Borders</td>
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<tr>
<td>Federated Stores</td>
<td>Radio Shack</td>
<td>Barnes and Noble</td>
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<tr>
<td>Nine West</td>
<td>Staples</td>
<td>Zany Brainy</td>
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Table 1: A Sample of Participating Retailers
Source: Harvard-Wharton Project on Retail Merchandising Effectiveness

Contact Information

Comments, and questions are welcomed. Please address all your inquiries to the author by email at brao@usa.net
### Appendix I-A

## Retail Enterprise Solutions
### Major Vendors

<table>
<thead>
<tr>
<th>Name</th>
<th>Address</th>
<th>Phone</th>
<th>Fax</th>
<th>Web URL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comshare - Arthur Enterprise Suite</td>
<td>555 Briarwood Circle, Ann Arbor MI 48108 USA</td>
<td>1-800-922-7979</td>
<td><a href="http://www.comshare.com">http://www.comshare.com</a></td>
<td></td>
</tr>
<tr>
<td>SAP</td>
<td>701 Lee Road, Wayne, PA 19087</td>
<td>(610) 595-4900</td>
<td>(610) 595-4282</td>
<td><a href="http://www.sap.com">http://www.sap.com</a></td>
</tr>
<tr>
<td>E3 Associates</td>
<td>1800 Parkway Place, Suite 600, Marietta, Georgia 30067-8288</td>
<td>770/424-0100</td>
<td>770/424-0050</td>
<td><a href="http://www.e3corp.com">http://www.e3corp.com</a></td>
</tr>
<tr>
<td>Intrepid Systems</td>
<td>1301 Harbor Bay Parkway, Suite 200, Alameda, CA 94502</td>
<td>(510) 769-4888</td>
<td>(510) 769-4889</td>
<td><a href="http://www.intrepidsys.com">www.intrepidsys.com</a></td>
</tr>
<tr>
<td>JDA</td>
<td>1811 North Tatum Boulevard, Suite 2000, Phoenix, AZ 85028</td>
<td>(602) 404-5500</td>
<td>(602) 404-5520</td>
<td><a href="http://www.jdasoftware.com">www.jdasoftware.com</a></td>
</tr>
</tbody>
</table>
1. **Comshare (Arthur Enterprise Suite)**  
   Objective: Arthur offers a full life-cycle decision support system for step-by-step management of the merchandising cycle. Various Modules within the suite cater to individual applications like enterprise planning, performance analysis, assortment planning, and information management.

2. **Hewlett-Packard**  
   Objectives: At the core of HP's Extended Enterprise Strategy for Retail are HP's five Retail Business Solution Frameworks that specifically address critical retail business requirements for solutions delivery in each key area.

   HP seeks to ensure successful implementation aligning business and application functions with strategic processes. These broad-based frameworks are designed to provide integration methodologies and rapid solutions deployment not only within the enterprise, but across the Extended Enterprise. HP's five Retail Business Solution Frameworks are:
   a. Open Store, for integrated store optimization
   b. Open View, for network and systems management
   c. Open Warehouse, for data warehousing and retail decision support
   d. Open Commerce, for Internet/Intranet and electronic commerce applications, and
   e. Retail Core Systems, for core retail operations

3. **SAP**  
   SAP is the fourth largest software company in the world. SAP R/3 system is a comprehensive business software package that originally focused on all phases of the supply chain up to and including warehousing and distribution. In May of 1997, SAP formally introduced additional functionality that extended their supply chain management capabilities into retailing.

   SAP’s retail solution includes Merchandising, Purchasing, Replenishment, Store Labor Optimization and Retail Information System modules, as well as Business Planning, Controlling, Finance & Accounting, Asset Management, and Human Resources modules. SAP does not offer software for managing Point of Sale (POS) systems (e.g., cash register systems) but does provide links to other third party POS systems.

   Specific features: Merchandise logistics; Inventory management; Stock transfer to stores; Cross-docking; Transportation; Assortment planning; Category management; Purchasing; Replenishment order management; Efficient consumer response (ECR); Integrated human resources; Promotion management; Multidimensional information analysis and data mining; Data interchange with POS systems; Data interchange with suppliers and customers; and, Electronic commerce, including the Internet/intranets.

3. **E3 Associates, Ltd.**  
   E3 provides inventory management tools for managing basic inventory items. They do not offer a product for managing fashion type items.
E3’s software is designed to allow a company to optimize inventory and customer service levels that maximize profit. They claim to be able to reduce inventories 20 to 30 percent, while increasing service levels two to five percentage points, and at the same time significantly boost productivity.

Features of E3’s software include: built-in economic analysis; suggested order frequency; recommended order quantities; automatic lead-time forecasting; automatic safety stock calculation; automatic order building; accurate demand forecasting; sensitive seasonal demand forecasting; and concise reporting. However, it must be emphasized that these features are designed for basic type products and therefore require two to three years of history (actual or like items) to work properly.

Other tools include: deal management/forward buying; alternate sourcing; overstock transfer capabilities; service level analysis/profitability maximization; event management; merchandise planning; vendor order projection and vendor partnering management;

5. Intrepid Systems
Objectives: To offer a powerful business solution for retailers offering greater flexibility and responsiveness, better information access and improved productivity.

Intrepid cites its experience in the retail industry as one of their strong points, and several employees at Intrepid have former merchandising, distribution and financial expertise. Their service areas include: Merchandise Applications, Financial Applications, Warehousing and Store Operations Applications, Decision Support Applications. Has partnered with PeopleSoft, the leading provider of human resources and financial applications. Together, they offer an end-to-end, client/server solution that includes the Evolution Merchandise Management Solution, DecisionMaster Decision Support Solution, and PeopleSoft’s Financial applications.

Evolution, Intrepid’s merchandise management solution, supports a retailer’s core transaction processing requirements. Evolution's base package supports merchandising, invoice matching, sales and store operations. Optional subsystems include warehouse/DC management, accounts payable, retail stock ledger, general ledger and product development.

6. Retek Information Systems, Inc.
Objectives: To provide a scalable, 'open systems' merchandise management solution. Enterprise wide retail solutions for large and mid-sized retailers worldwide.

The Retek Product Suite is centered around the Retek Merchandising System (RMS), which includes key functions such as inventory management, open to buy management, stock ledger, purchasing/receiving, price/promotion management, and allocation/replenishment. It is designed to meet the needs of large retailers with a multi-store, multi-warehouse environment, allowing for both centralized and/or distributed processing. The package can be broadly described in three parts – inventory control, merchandise management, and financial control.

- **Inventory Control** covers the definition and management of the merchandise assortment at item level. This is broken into a number of modules related to the merchandise methods appropriate for specific categories.

- **Merchandise Management** includes the processes by which a Retailer carries out day-to-day buying and selling activities. These functions are tightly integrated with the inventory assortment, and encompass purchasing, receiving, distribution, inter-store transfer, sales
processing, price management, physical inventory, promotion management, distribution, and vendor management.

- **Financial Control** consists of the open to buy and stock ledger modules. The stock ledger is maintained at store/department/day level and provides the point of interface to the general ledger. There is also an Open to Buy module, to manage each buyer's available funds, in relation to the buying plan.

Retek claims that the RMS is a friendly, intuitive GUI environment scaled for the performance required in high volume retail organizations. Available integrated with RMS or stand-alone, the Retek Data Warehouse (RDW) is an enterprise-wide data warehouse, tuned and tailored to the needs of the largest retailers. RDW features a MicroStrategy front end and provides access to difficult retail performance measures via a structured Executive Information System, parameter driven reports, and ad hoc decision support. Retek's Active Retail IntelligenceÔ (ARI) framework closes the retail information loop -- turning knowledge into action by identifying performance exceptions and appropriate corrective action. Retek Demand Forecasting™ (RDF) is also integrated into the RMS and supports superior forecast-based replenishment and allocation functionality. RDF is a statistical and neural network forecasting engine that allows retailers to use their historical data as well as outside factors to forecast requirements at any level of the organization, down to store/sku level. The Retek Product Suite supports full NetPC/Web/Java functionality.

In addition to the Merchandising system, Retek offers the following modules: Data Warehousing, Active Retail Intelligence; and Demand Forecasting. These are described in more detail below.

- **The Retek Data Warehouse (RDW)** comes with more than 500 metrics and 250 reports that are designed specifically for retailers.

- **Active Retail Intelligence (ARI)** automates routine tasks and alerts users to designated situations by linking with the Retek Merchandising System (RMS) and the Retek Data Warehouse (RDW). ARI is used to identify performance exceptions and develop corrective options. Users manage events routed to them by rule and model-based processes. And the system alerts users to events that require attention and further analysis rather than relying on the user to ask the proper questions from the outset. Also, historical data and analysis - or "corporate memory" - is retained for use in future decisions, allowing retailers to learn how particular situations were handled and what outcome transpired.

- **Retek Demand Forecasting (RDF)** employs types of statistical and neural models that learn the retailer’s business, including factors other than sales history that influence product-by-product forecasts, which are used to produce accurate forecasts. It also allows a retailer to use forecasts dynamically to drive merchandise planning, buying programs, promotions, advertising and automated replenishment programs. RDF provides the following capabilities: rolling up to divisional or category levels, or from store to chain; analyze and forecast by individual sku or product family; use "what if" functions to monitor trends; and, set time horizons for forecasts.

Merged with HNC Software to bring state-of-the-art neural network products and modeling skills to Retek's retail customer base.

7. **IBM-JDA Software, Inc.**
Objectives: To provide retailers worldwide with unparalleled integration among software applications and hardware; a commitment to accelerated joint research and application development; and an expanded services organization.
JDA Software, Inc. an international provider of enterprise retail information systems, recently announced plans to expand its global cooperation with IBM Corporation to include development, marketing and support of solutions for the retail industry.

JDA intends to leverage its worldwide professional services team with IBM's Global Services organization. One joint initiative will result in the certification of IBM's North American consulting team to handle implementation of JDA's Open DataBase Merchandising System®. In addition, IBM's store-rollout services will help streamline the installation of JDA's Microsoft Windows based in-store system, Win/DSS®. JDA will also bring in IBM services such as network planning and design, systems management, benchmarking and outsourcing to better serve its clients. JDA is currently evaluating IBM's MAKORO, merchandise planning application to potentially integrate with ODBMS and IBM Lotus Notes software to provide enhanced work flow applications for its retail clients.

JDA and IBM have already collaborated on JDA's In-Store Merchandising System/400, a store-level processing solution for retailers. They are currently involved in cross-training for a team approach to marketing that results in addressing retailers' requirements and resources for an integrated, retail enterprise solution.

JDA provides software for managing all aspects of the retail supply chain. At the corporate level they have merchandising, financial, and data warehouse systems. At the distribution level the offer warehouse management and logistics systems. And at the store level they have point-of-sale and back-office systems.

Specific modules and features within JDA’s merchandising modules include the following:

- **Base Merchandising System**: Inventory Control and Reporting, Purchase Order Management, Merchandise Receiving, Transfer Management, Cycle Count and Physical Inventory, Sales Analysis, Landed Cost, and Program Development and Object Control.
- **Financial Management**: Accounts Payable, General Ledger, Sales Commissions, Open Item A/R.
- **Warehouse/DC**: Base Warehouse/Distribution Center Management, Wholesale Order Entry.
- **Custom Features**: Customer Profile, Big Ticket Order Entry, Merchandise Delivery & Repair, Consumer A/R (Balance Forward), Mail Order Processing, and Style Processing.
- **Open Gateway Systems**: Electronic Data Interchange, Sales Audit/Cash Balancing, Polling and Telecommunication, Advanced Logging, and Store Data Interchange-Extended.
- **Analysis Features**: Graphical Executive Information System, Customer/Market Basket Analysis.
## Data Mining
### Major Vendors

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Contact Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intrepid Systems</td>
<td>Intrepid Systems&lt;br&gt;1301 Harbor Bay Parkway&lt;br&gt;Alameda, CA 94502&lt;br&gt;(510) 769-4888 Telephone&lt;br&gt;(510) 769-4886 FAX&lt;br&gt;(<a href="http://www.intrepidsys.com">www.intrepidsys.com</a>)</td>
</tr>
<tr>
<td>KD1</td>
<td>Knowledge Discovery One, Inc.&lt;br&gt;3636 Executive Center Dr., Suite 201&lt;br&gt;Austin, TX 78731&lt;br&gt;888.ASK4KD1 (888.275.4531) toll-free&lt;br&gt;512.349.5600 voice&lt;br&gt;512.349.5606 fax</td>
</tr>
<tr>
<td>Microsoft-Tandem</td>
<td>Tandem World Headquarters&lt;br&gt;19333 Vallco Parkway&lt;br&gt;Cupertino, CA 95014-2599, USA&lt;br&gt;+1 (408) 285 6000</td>
</tr>
<tr>
<td>JDA-IBM</td>
<td>JDA Public Relations&lt;br&gt;Maureen N. Tuskai&lt;br&gt;Marketing Communications Manager&lt;br&gt;602/308.3233</td>
</tr>
<tr>
<td>ISL Decision Systems, Inc.</td>
<td>USA: ISL Decision Systems Inc.&lt;br&gt;630 Freedom Business Center, Suite 314, King of Prussia PA 19406, USA&lt;br&gt;Tel: +1 610 768 7725&lt;br&gt;Fax: +1 610 768 7774</td>
</tr>
</tbody>
</table>
1. **Intrepid Systems**

Objectives: To offer a powerful business solution for retailers offering greater flexibility and responsiveness, better information access and improved productivity.

Intrepid cites its experience in the retail industry as one of their strong points, and several employees at Intrepid have former merchandising, distribution and financial expertise. Their service areas include: Merchandise Applications, Financial Applications, Warehousing and Store Operations Applications, Decision Support Applications. Has recently partnered with PeopleSoft, the leading provider of human resources and financial applications. Together, they offer an end-to-end, client/server solution that includes the Evolution Merchandise Management Solution, DecisionMaster Decision Support Solution, and PeopleSoft’s Financial applications. Intrepid provides an enterprise wide retail software solution.

Evolution, Intrepid’s merchandise management solution, supports a retailer's core transaction processing requirements. Evolution's base package supports merchandising, invoice matching, sales and store operations. Optional subsystems include warehouse/DC management, accounts payable, retail stock ledger, general ledger and product development. Their merchandise management components support the planning, selection, acquisition and control of merchandise. Their store operations applications allow stores to perform transactions on-line to the host system to maintain real time information access by management. The warehouse/DC management system provides end to end control of merchandise as it moves through the warehouse or distribution center.

2. **Knowledge Discovery One, Inc.**

Objectives: (KD1) was founded in January 1996 to build complete, sophisticated, yet easy-to-use applications that allow retailers to better understand and predict their customers' buying habits. Employing advanced knowledge discovery & data-mining techniques, KD1's Retail Discovery Suite allows the retailer to operate a more profitable organization by providing a complete and detailed understanding of their advertising, merchandising, assortment, inventory, promotions, and vendor performance issues.

KD1 is based in Austin, TX, and markets its applications through a direct sales and consulting force to medium and large-scale companies in the food, drug, convenience, department, specialty, and discount retail industries. KD1 also operates a complete 7x24 data center to allow customers to run proof-of-concept studies using their own data & KD1 applications.

KD1's Retail Discovery Suite consists of application modules that share a common architecture and intuitive user interface. Customers may start with any of KD1's modules and add any of the other modules at any time. KD1's application architecture is designed to support thousands of users and very large volumes of data through its parallel, scalable structure. The application modules are: a. BASKETDynamics, a full-function transaction analysis system for measuring performance at the store/transaction level and above. Market basket profit, revenue, margin, and product affinities are among the more than 170 different measurements displayed.
Basic and advanced decision support functionality is organized by major reporting categories such as advertising effectiveness, inventory, basket performance, vendor performance, assortment profiling, and so forth. Custom categories, measurements, and reports can be easily added. BEHAVIORdynamics, a complete customer profiling and target marketing application. Where the customer identity is known, this application provides very accurate profiling, loyalty, and segmentation models and measurements. (Commercially available in Q2 1998.)

3. Microsoft-Tandem
Tandem’s data mining solutions take advantage of Object Relational Data Mining technology, enabling users to consider the entire database instead of a limited extract. When retailers add new stores, they can improve merchandise planning and allocation by examining patterns for stores with similar demographic characteristics.

Store Clustering: For planning purposes, stores are often grouped by size, sales, market, or geography. However, in many cases, these groupings tend to force individual stores into average-store models, which don’t accurately portray the characteristics that actually drive their performance. Object Relational Data Mining technology enables merchants to group like stores based on characteristics that more accurately reflect each store’s merchandising requirements for optimizing sales and profit.

Space and assortment optimization: With historical sales statistics and store demographics, retailers can use data mining to determine the ideal layout of a particular store. The analysis generates new layouts that maximize turnover during each season.

Retail decision-support customers of Tandem include Victoria’s Secret, Woolworths United Kingdom, Elder-Beerman, Target, Fegro-Selgros, and others.

4. JDA
See description above

5. ISL Decision Systems, Inc.
This UK/US based company created the Clementine system. Clementine provides enterprise-wide data mining and is fully scaleable for multiple users on any size of database or data warehouse. Clementine has a strong Unix user base with companies such as Daimler Benz, Reuters, Caterpillar, Halfords, Unilever, Du Pont, and ICL Retail. Clementine predicts that as the battle for the departmental server intensifies, many clients, especially in banking, insurance and retail, will backing Windows NT. In the retail area, this package mainly helps in siting superstores (retail). The company reports that most clients report payback on their data mining investment within a month.
# Data Warehousing
## Major Vendors

<table>
<thead>
<tr>
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<th>Address</th>
<th>Phone</th>
<th>Fax</th>
<th>Web</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAS Institute</td>
<td>SAS Institute Inc.</td>
<td>(919) 677-8000</td>
<td>(919) 677-4444</td>
<td><a href="http://www.sas.com">www.sas.com</a></td>
</tr>
<tr>
<td></td>
<td>SAS Campus Drive</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cary, NC 27513-2414</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Information Advantage</td>
<td>7905 Golden Triangle Drive</td>
<td>(612) 833-3700</td>
<td>(612) 833-3701</td>
<td><a href="http://www.infoadvan.com">www.infoadvan.com</a></td>
</tr>
<tr>
<td></td>
<td>Eden Prairie, MN 55344</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MicroStrategy</td>
<td>8000 Towers Crescent Drive, Suite 1400</td>
<td>(703) 714-1206</td>
<td>(703) 848-8670</td>
<td><a href="http://www.strategy.com">www.strategy.com</a></td>
</tr>
<tr>
<td></td>
<td>Vienna, VA 22182</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8000 Towers Crescent Drive, Suite 1400</td>
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</tbody>
</table>
1. SAS Institute
SAS provides three major industry solutions:
- SAS Enterprise Miner Software: to conduct comprehensive analyses of customer data
- Customer Relationship Management: to manage, acquire and build customer loyalty
- Geographic Reporting: to exploit geographic elements of business data

They also provide a SAS Data Warehousing Solution, which includes advanced statistical analysis, and the creation and management of meta data.

2. Information Advantage, Inc.
Information Advantage Inc., is a leading provider of enterprise on-line analytical processing (OLAP) software. Recently chosen by EDS, to be the provider DecisionSuite and its codeless desktop for the Web, WebOLAP(tm), to support implementation of the EDS knowledge management strategy. Information Advantage believes that the data warehousing initiative will deliver mission-critical information to thousands of users in North America, Europe, Asia and Latin America. EDS is rolling out DecisionSuite to several hundred users performing on-line analyses on a 50GB database. 1998 deployment could scale up to 9000 knowledge worker desktops. Future phases would include incremental deployments throughout the company.

MicroStrategy provides of high-end decision support systems that allow access to and manipulation of vast amounts of data stored in the data warehouses of large corporations worldwide.

MicroStrategy pioneered Relational On-line Analytical Processing (ROLAP) by being the first vendor to deliver high-performance, multidimensional OLAP analysis directly from relational databases without requiring any proprietary multidimensional databases. In addition, MicroStrategy has engineered many data warehousing breakthroughs: intelligent agents; VLDB drivers for terabyte-range scalability; a dynamic, multi-pass SQL generation engine; DSS metadata CASE tools; a VLDB-savvy OLAP report writer; a mission-critical ROLAP server; and OLAP over the World Wide Web. MicroStrategy claims that its powerful ROLAP architecture is capable of calculating the most complex analytics required by retailers and is designed to handle any type of schema and scale to handle terabytes of data; and gives buyers and merchandise managers the ability to analyze detailed data and dramatically improve the efficiency and profitability of their retail business.

Some of their customers include Dairyworld, Hallmark, Shopko, Victoria's Secret, Hannaford Brothers Co., and Woolworths plc.
## Appendix IV-A

### Supply Chain Management Software

#### Major Vendors

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Address</th>
<th>Phone Numbers</th>
<th>Website</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agile Software</td>
<td>Agile Software Corporation One Almaden Boulevard San Jose, CA 95113-2215 Tel: 408-975-3900 Fax: 408-271-4862 <a href="http://www.agilesoftware.com">http://www.agilesoftware.com</a></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAPS Logistics, Inc.</td>
<td>2700 Cumberland Parkway Suite 150 Atlanta, GA 30339 Voice: (770) 432-9955 Fax: (770) 438-9630 <a href="http://www.caps.com">http://www.caps.com</a></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I2 Technologies, Inc. (merged with InterTrans Logistics Solutions, Ltd.)</td>
<td>909 E. Las Colinas Blvd. 16th Floor Irving, Texas 75039 (800) 800-3288 (214) 860-6000 (214) 860-6060 fax <a href="http://www.i2.com">http://www.i2.com</a></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manugistics</td>
<td>Manugistics, Inc. 2115 East Jefferson Street Rockville, MD 20852-4999 Tel: 301-984-5000 Fax: 301-984-5370 <a href="http://www.manugistics.com">www.manugistics.com</a></td>
<td></td>
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</tr>
</tbody>
</table>
Supply Chain Management Software
Select Vendor Summaries

1. **Agile Software**
   Agile Workplace is a complete suite of Windows-based product change management software solutions that totally automate the management of product information and engineering change orders (ECOs). Like most product data management (PDM) software, Agile Workplace manages all product information, as well as the entire life cycle of the product. Unlike other PDM solutions, Agile Workplace is not a "customized toolkit" -- it’s an affordable, full-featured, off-the-shelf application that can be implemented immediately.

2. **CAPS Logistics, Inc.**
   CAPS offers solutions that address routing and scheduling, transportation and supply chain optimization and modeling through its RoutePro™, TransPro™, and Supply Chain Designer™ Packages. The Supply Chain Designer™ offers modeling and optimizations on a Windows 95/NT interface, and includes an integer/linear programming solver, model setup wizards and a scenario manager which allows the user to quickly and easily define, analyze, and compare the effects of different business practices. With the Supply Chain Designer, the user can visualize how materials flow through a distribution network. Users can define various cost components and assign them to related objects, and model a variety of costs such as facility costs, delivery costs, fixed and variable costs. Supply Chain Designer also allows the modeling of inventory costs. Detailed business graphics and reports aid in strategic decision making and implementation of changes. In addition to the standard reports included with Supply Chain Designer, the user can create their own custom reports, graphics, charts, etc through Excel, Access and Crystal Reports.

3. **I2 Technologies** (recently merged with InterTrans Logistics Solutions, Ltd.)
   Recognizing that the typical supply chain spans multiple enterprises that use multiple ERP systems, i2’s RHYTHM was designed to support a heterogeneous planning enviroment. RHYTHM’s is designed to work with a multitude of supply chain applications including ERP systems, other advanced planning engines and complementary systems like shopfloor control systems and POS data collection systems. Using an open integration technology called RhythmLink, this architecture offers the security, speed, and scalability needed for multi-enterprise supply chain planning.

4. **Manugistics**
   Supply Chain Navigator uses an advanced planning engine to synchronize and optimize the flow of materials through your supply chain - from suppliers to customers. It allows you to create feasible plans for material acquisition, production, inventory, and transportation in response to rapidly changing demand and supply conditions. Supply Chain Navigator is part of a fully integrated, total supply chain management solution. It is tied into Manugistics Demand Planning, Supply Planning, Manufacturing Scheduling, and Transportation Management for end-to-end connectivity of business processes.
The Navigator makes decisions based on time-phased demands, customer service objectives, resource constraints, resource availability, and resource costs. It simultaneously:

- optimizes material, semi-finished, and finished goods sourcing
- develops time-phased inventory pre-builds for any seasonal products
- determines supplier and transportation mode preferences
- quantifies cost tradeoffs for changes in demand and/or resource mix
- identifies cost reduction opportunities
Integrated Merchandising Systems/Enterprise Systems

Apropos Retail Management Systems
Auto-Star Compusystems, Inc.
BACG, Inc.
Churchill Systems, Inc.
Comshare Retail/Arthur

E3 Associates
E3 Associates, Ltd.
Foreson Corp.
GERS Retail Systems

Hewlett Packard

Intrepid Systems
Intrepid Systems, Inc.
Island Pacific Systems Corp.
IT Resources

JDA
JDA Software, Inc.
Merchandise Management Systems, Inc. (MMS) - owned by STS

Merchant Industrial Software
Mitech Computer Systems, Inc.
PeopleSoft Inc.
Radiant Systems
Radius Retail, Inc.

Retek Information Systems
RETEX-The Retail Technology Buying Consortium
Richter Systems, Inc.
SalePoint, Inc.

SAP
SAP America
Smyth Systems, Inc.
Sterling Software/Creative Data Systems
STS Systems
Technologies for Growth - T4G

Supply Chain Management Systems
Agile Software
American Software (tieup with HP)
CAPS Logistics, Inc.
Equinox/Computer Sciences Group
Hewlett Packard
I2 Technologies
InterTrans Logistics Solutions, Ltd.
Manugistics
Oracle
PSC Inc.
Rockport Trade Systems, Inc.
The Kewill Group

**Consulting/IT Service Companies**
BSG Alliance/IT
CFT Consulting, Inc.
Coopers and Lybrand
Deloitte & Touche Consulting Group/GARR
KPMG Peat Marwick
Kurt Salmon Associates
LakeWest Group
IBM
Ernst & Young
Sequent

**Data Warehousing**
Cirrus Recognition Systems, Inc.
HP - Red Brick
**Information Advantage**
Informix Software, Inc.
Intrepid-Decision Master
**MicroStrategy, Inc.**
NeoVista Software, Inc.
Oracle
Pilot Software
Red Brick
Rodin
**SAS Institute**
Show Case Group
Tandem Computers, Inc.
Teradata

**Data Mining/Decision Support Systems**
Clementine
Cogit-Digital
**Intrepid Systems - PeopleSoft**
ISL Decision Systems, Inc.
**JDA-IBM**
Knowledge Discovery One KD1
Microsoft-Tandem
Sequent
References

Madden Group
META Group
Dun and Bradstreet
Rensselaer Polytechnic Institute
Vendor Web Sites