In-Transit Visibility at Federal Express and UPS: An Approach to Reengineering Processes

by

Harshal Shah

Submitted to the Department of Electrical Engineering and Computer Science

in Partial Fulfillment of the Requirements for the Degree of

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Thesis Supervisor : Dr. Amar Gupta, MIT Sloan School of Management

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1. Introduction

In-Transit Visibility can be defined as the view of a shipment's progress through the transit route, from the shipper to the receiver, as a function of distance and time. Typically, it is provided to the shipper and the receiver of the good/s, to aid in logistics planning for manufacturing, to help value-added resellers provide definite time-frames to their customers, and/or to aid in re-routing of the goods as the need may arise.

Transportation companies are the primary providers of this kind of information. In-transit visibility of goods serves them two purposes: increased levels of customer satisfaction, and better tracking of goods internally. Federal Express has been the pioneer in providing this kind of information to its clients - and this has done wonders for its business. It has grown manifold over the last twenty or so years [37], and is still providing the leading-edge visibility of goods to its clients. This growth has been at the cost of other competitors in the package delivery market, especially, UPS. Not until 1986 did UPS wake up to the fact that Federal Express was earning about four times as much per package as UPS on only about an eighth of UPS' daily volume, and with far fewer workers - roughly a third the number UPS employed [15]. The key to this fact was that Federal Express used some of the best information systems in the industry, while UPS was trying to compete by delivering the packages cheaply, and had not employed state-of-the-art information technologies.

The customers' desire to have more information-based, value-added services supplementing the business has been the primary driver behind Federal Express' competitive edge over UPS [34]. In-transit visibility is the primary information-based, value-added service that has been provided by Federal Express while UPS is just beginning to provide in-transit visibility to its customers. The benefits associated with providing such services must be staggering - they are evident from the fact that between 1986, when UPS began planning the transformation from a low-tech to a high-tech delivery company, and the end of 1991, when most of the new systems were up and running, the company spent $1.5 billion. And UPS has allocated an additional $3.2 billion to continue the job for the next five years [15].

This massive revamping of information systems to increase service levels and productivity, can alter the nature of the competition. The threat of receding competitive advantages for Federal Express, or the opportunity to leap-frog the competition for UPS, both present the opportunities to examine the new paradigm of reengineering. By reengineering the processes at the respective companies - and that means radically changing the structure of the processes - either company can reduce costs, improve customer service levels, and increase productivity per employee. As was mentioned by Dr. Michael Hammer, one of the key-note speakers at Enterprise '93 Conference in Boston, information technology is the key enabler in reengineering the processes.

This thesis examines the in-transit visibility processes at Federal Express and UPS. Specifically, the next two chapters examine the information systems - hardware, software, and network configurations - being used at both companies, and describe, in detail, the system workflow during the internal transit of a shipment from a shipper to a receiver. They describe how the view of the shipments is provided to the customer, and internally within the companies, and when a trace is initiated by a shipper to track the movement of a shipment.

The fourth chapter discusses the information technology concepts behind the information systems in use at Federal Express and UPS. It describes the implementation issues and developments in concepts such as electronic data interchange, and barcodes and scanners. The chapter also examines how these technologies can provide benefits to the companies as the technologies develop and are further integrated within the industry.

The fifth chapter discusses the concepts underlying the reengineering paradigm. It justifies the reengineering of the in-transit visibility process, discusses how the process can be reengineered, and finally, presents a model for reengineering the in-transit visibility process. Most of the concepts and ideas related to reengineering have been adopted from Michael T. Hammer's book, "Reengineering the Corporation" and articles in the Fortune Special Edition on "Reengineering".

State-of-the-art information technologies are the enablers behind the reengineered in-transit visibility process model. The sixth chapter discusses, in detail, the information technologies and concepts in the reengineered in-transit visibility process. It also proposes some products that may be used in the process to lay the network of sophisticated information management and processing systems.

The last chapter concludes this thesis by discussing the benefits that would actually accrue by way of implementing the proposed reengineered in-transit visibility process model. It also details the advantages of implementing such a model as it addresses the factors affecting in-transit visibility and fully exploits any advances in the information technologies being used within it.

2. Federal Express Corporation

2.1 Organization Structure

2.1.1 Organizational Background

In April 1973, Frederick Smith started Federal Express Corporation. Federal Express (or FedEx) soon became a premier carrier of high priority goods in the marketplace. Federal Express pioneered the "hub-and-spokes" system of distribution and developed information systems that gave, and continue to give, it a significant competitive advantage over its competitors.

Today, Federal Express is the world's largest express transportation company. It delivers over 1.4 million items in 178 countries each working day, while providing international time-definite services for important documents, packages and freight [27].

FedEx flies into more than 365 airports, using a transport fleet of 455 Boeing, McDonnell Douglas, Fokker and Cessna aircraft. Approximately, 31,000 computer and radio-equipped vehicles are in service to support its operations around the world. Federal Express also maintains, what it calls, a "convenience network" of approximately 1,400 staffed facilities and more than 29,500 drop-off locations [24].

To provide real-time package tracking for each shipment, Federal Express utilizes one of the world's largest computer and telecommunications networks. These networks form the backbone of the COSMOS (Customer Operations Master On-Line System) information system that allows Federal Express customers to access information concerning a shipment's status around the clock, around the world.

The company received the Malcolm Baldrige National Quality Award in 1990, the first company to have won this award in the Service category. Federal Express employs more than 90,000 people and daily handles, on an average, 1,470,520 express packages with an average weight per package of 5.5 lbs. Company revenues for its latest fiscal year ending May 31, 1993 were $8.35 billion [27].

2.1.2 Organizational Mission

The organizational mission of Federal Express is stated as follows: "Federal Express is committed to People-Service-Profit philosophy. We will produce outstanding financial returns by providing totally reliable, competitively superior, global air and ground transportation of high priority goods and documents that require rapid, time-certain delivery. Equally important, positive control of each package will be maintained utilizing real time electronic tracking and tracing systems. A complete record of each shipment and delivery will be presented with our request for payment. We will be helpful, courteous, and professional to each other and the public. We will strive to have a completely satisfied customer at the end of each transaction" [1, 5].

Also, internally, Federal Express take care of all its employees, for, as they are responsible for providing the service, they would also affect the bottomline - profits.

2.1.3 Internal Structure

Federal Express has been more appropriately organized, along regional division lines, to decentralize and put executives closer to the field. The reporting structure calls for the regional executives to report to the executive committee in the headquarters in Memphis, Tennessee.

Some of the managers were pushed into advanced projects group to explore innovative ideas for the future. Strategic planning and related functions have now taken a more active role in setting the company's direction. More than ever before, information technology is at the forefront of the strategic planning models, and as a powerful aid to better customer service (and therefore, retention) and as an effective barrier to entry for other competitors [50].

2.1.4 Operations

Federal Express is headquartered in Memphis, Tennessee from where most of its primary operations are rallied as well as monitored. The major operational requirement for the overnight business, the primary business of Federal Express, is that it has to be in operation 100% of the time. The "hub-and-spokes" system has cultivated a certain amount of decentralization and most of the operations there are managed by local managers. The local managers are, in general, responsible for ensuring in-transit visibility during the internal transit of a shipment from its place of origin to the destination via the sorting hub.

To aid the local managers, Federal Express first put computerization to use to help derive solutions to scheduling and logistics issues. Now, these areas have not only defined growth opportunities for Federal Express, but have also raised effective barriers to entry to competitors. Overall, the operations at Federal Express are planned and organized, and its technical infrastructure can be deemed as not only the best in the industry, but also as one of the best systems overall. The infrastructure aids in providing the "system-based" high service levels to the customers and is complemented by the initiative of its employees [55]. The next section details the hardware, software and network configurations of the technical infrastructure.

2.2 Technical Infrastructure

The computerized tracking systems developed by Federal Express, COSMOS, and now, COSMOS IIB, were designed to tell the company and the customer where any package or document was at any time from pick-up through delivery. The COSMOS IIB information system uses a combination of SuperTrackers, digitally-assisted dispatch systems (DADS), and PowerShip terminals to provide in-transit visibility to the customers.

The pick-up and delivery personnel at Federal Express use SuperTrackers, which are hand-held computers, to transmit locational information to the mainframes housing the information systems.

Federal Express also uses digitally-assisted dispatch systems (DADS) to communicate to couriers through computers in their vans. DADS provide quick courier response to dispatches and allows them to manage their time and routes with extreme efficiency and accuracy. Information pertaining to pick-up/delivery routing is sent to the DADS by dispatchers via a radio dispatch system. The dispatchers use COMPU.MAP and the McIDAS weather processing system to decide the optimal routes for the vans.

Also, Federal Express recently introduced the Federal Express PowerShip systems, on-premise computers, which now process approximately one-third of FedEx shipments. The PowerShip terminals provide automated billing, allow customers direct access to their package information, and give international shippers directions for their particular needs.

Finally, Federal Express established the Business Logistics Services division to provide full range of logistics services for customers. This division utilizes its access to the information systems and provides inventory management and distribution solutions, including warehousing services, customer service, transportation, credit and collections or technical support, and, tracking services customized to the company's (the customer's) needs. By way of these systems and services, Federal Express provides in-transit visibility of the shipments to the respective customers [25].

The technical infrastructure supporting the primary information system - the COSMOS IIB system - is discussed below in detail (figure 1).

2.2.1 System Hardware

Federal Express uses the SuperTrackers to track its shipments internally, provides the option of in-transit visibility to the customers via the PowerShips, and provides the customer service agents with terminals attached to the databases to assist the customers with their tracking requests.

The 60,000 SuperTrackers are hand-held computers that the couriers use to scan the airbill number, and to store the destination zip code, routing instructions and type of service requested by the shipper. The SuperTracker is the size of an HP calculator, has 1 MB of RAM, and is driven by a clone 386-AMD 25SLC microprocessor. It has an LCD display that shows the specific routing code for the shipment (figure 2). It was developed by Mobile Data International, the same company that developed the DADS, into which the SuperTrackers are meant to fit [18].

The DADS, or Digitally Assisted Dispatch System, are the on-board computers fitted in the courier vans. They acts as intermediate information "buffers" in that they is used by the dispatchers to communicate with the couriers and by the couriers to communicate with the

Figure 1 - Technical Infrastructure at Federal Express

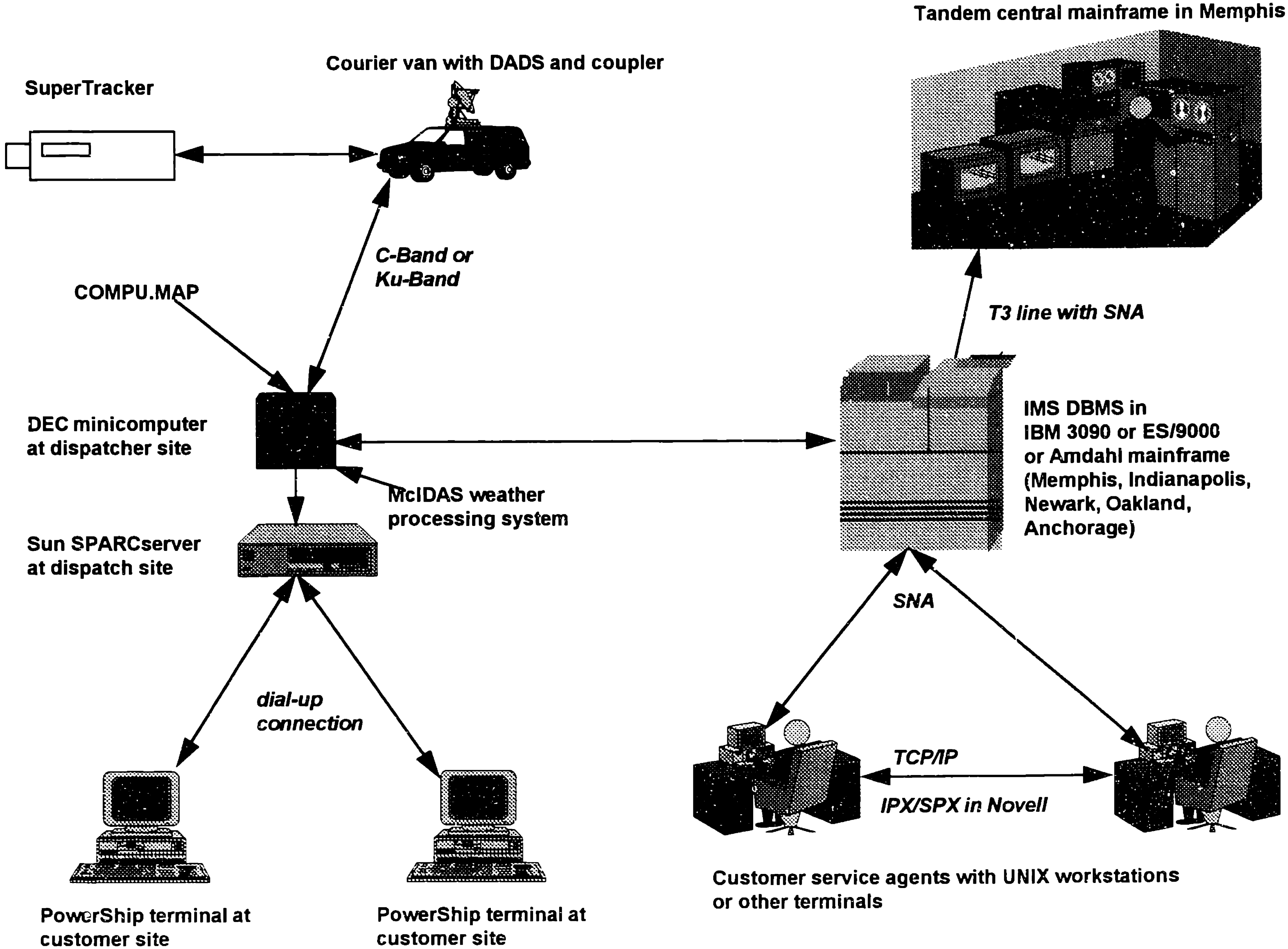


Figure 2 - Federal Express' SuperTracker

dispatcher's computer. When the customer service agents insert the details of the customer request for pick-up into the database, the details pertaining to the shipper's name and address are sent to the dispatcher's computer. The dispatcher, in turn, passes the same information to the DADS in the form of short bursts of data sent via satellite. The DADS are interfaced with the receivers on top of the vans, to receive and display the data [24]. The DADS are considerably more powerful than the SuperTrackers, in that, they are driven by a 386-AMD 33DX microprocessor and have 4MB of RAM and 20MB hard disk memory.

The DADS communicate with the dispatcher computers via a coupler on each of the DADS. The dispatcher computers are Digital Equipment Corp. minicomputers that access the COSMOS mainframes. The mainframes consist of IBM 3090s and ES/9000s, and some from Amdahl Corp. These mainframes, which are located in the five primary sorting areas (Memphis, Indianapolis, Newark, Oakland, Anchorage), communicate with a Tandem Computers Inc. system in the company headquarters in Memphis, Tennessee [63].

The PowerShips are dedicated systems provided to some high-volume shippers to provide them access to information regarding their shipments. The PowerShips are menu-driven IBM-PC compatibles that are used to interface with COSMOS, as well as to print thermal shipping labels, and to generate invoices for the customer (figure 3). The PowerShip is linked via a dial-up line to a Sun Microsystems, Inc. SPARCserver located at one of the local dispatch sites [25, 63].

The customer service agents are being upgraded to UNIX workstations to offload some of the processing done by the mainframes at present. The addition of the UNIX workstations will allow the peer-to-peer distributed computing environment that Federal Express believes will allow it to interface with third-party software [63].

POWERSHIP Plus® Automated Shipping System

- Custom-designed for those who ship a heavy daily volume within the U.S.
- Our automation advisors work with your own programmers, on your computer, to integrate Federal Express shipping information systems with your other systems
- Fast, efficient flow of information is especially useful for companies with short windows for package processing
- Offers self-invoicing, convenient package tracking, and other timesaving features

POWERSHIP PassPort® Automated Shipping System

- Combines benefits of POWERSHIP 2 with the power of POWERSHIP Plus
- May be connected directly to your PC, mini or mainframe, or used as a stand-alone device
- Ensures more accurate inventory control and accounting
- Enhances your customer service
- Automatically updates rates, routing codes, and new software releases from Federal Express
- Allows you to operate in both interactive and diskette-fed modes for shipments within the U.S.
- Provides a manual process for international shipments

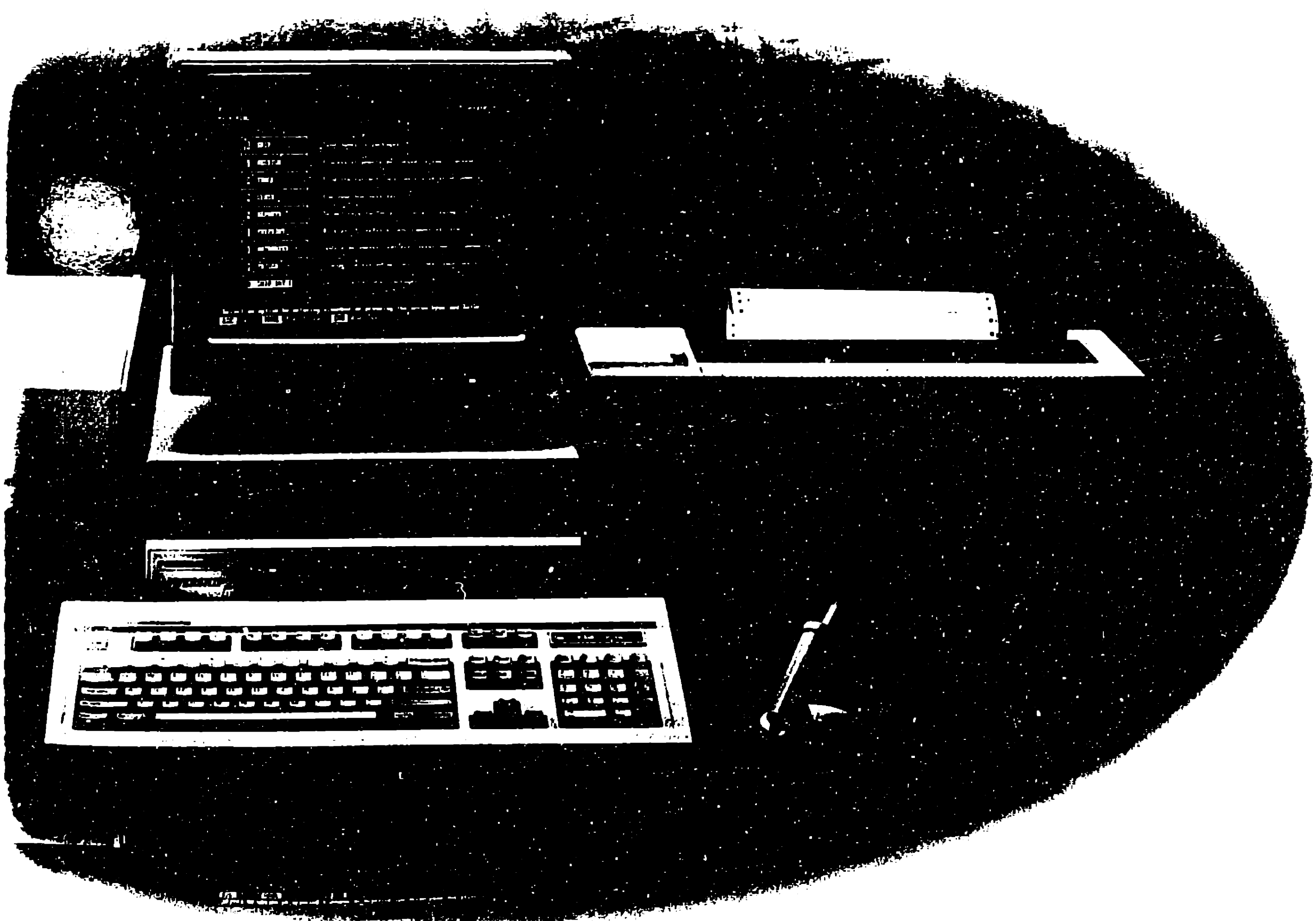


Figure 3 - FedEx's PowerShip

2.2.2 System Software

The COSMOS mainframes are used to house all the information pertaining to the shipments, starting from the shipper/receiver information received by the customer service agent and ending with the time of receipt acknowledgment from the receiver of the shipment. The information is stored in the IBM mainframes using IBM's IMS database management system.

The mainframe processes the information and communicates with the customer service agent terminals, the PowerShips, and the dispatcher minicomputers on-line. The hierarchical format of the data allows fast access and storage of the data but the storage of the data requires large amounts of memory due to data redundancy. This issue is managed somewhat by the disbursement of the data among the five primary sorting areas where the mainframes are housed. Each primary sorting area has a data center, and the data center is responsible for providing the information to the local customers. In case of tracking requests by customers outside the area of the mainframe's domain, the data is replicated using mirroring techniques. The data is stored on magnetic media and is modifiable in case of the need for re-routing. The load on the mainframes is being reduced by the introduction of the UNIX workstations that allow distributed peer-to-peer computing. The software will soon be made to interact with relational databases to eliminate redundancy and to manage the data more efficiently, though, maybe, at the cost of speed due to the relational nature of the databases [63].

2.2.3 System Network

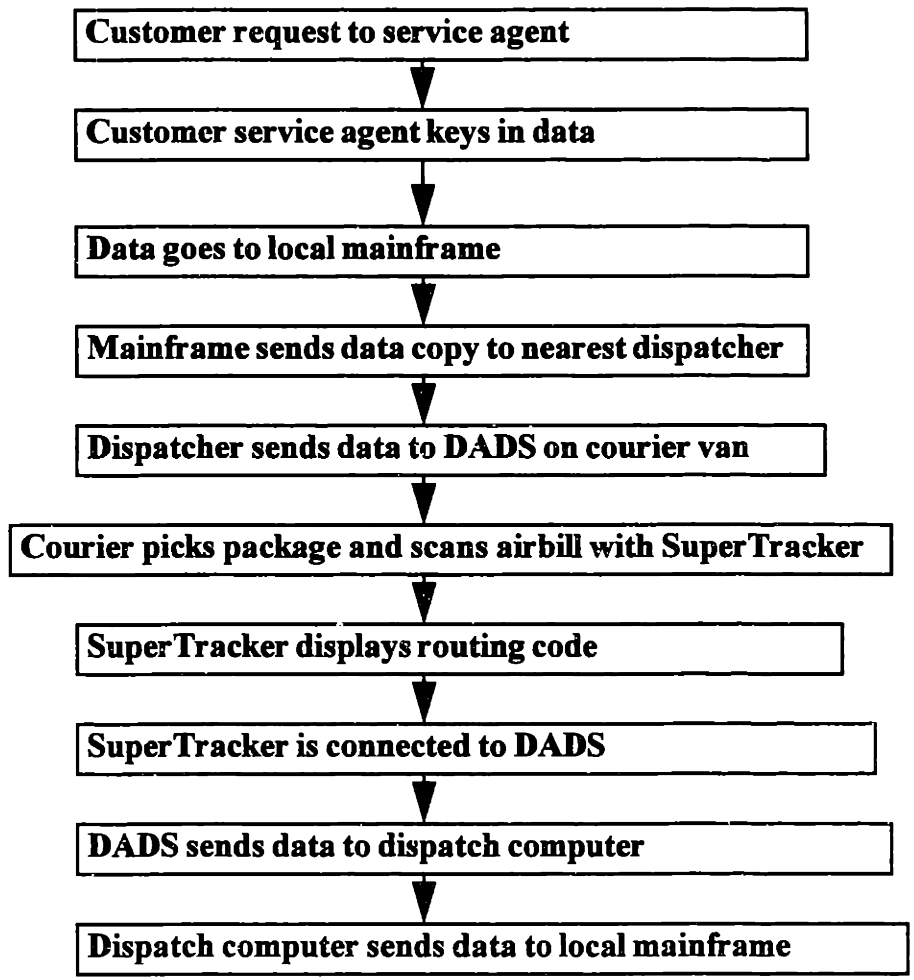
The SuperTrackers communicate with the DEC minicomputers at the dispatcher locations via a coupler on each of the DADS. The communication takes place via C-band and Ku-band satellite transponders. The UNIX workstations are connected to each other as well as with the mainframes in the data centers via TCP/IP protocols. The other terminals that have not been upgraded are interconnected via Novell network operating systems using IPX/SPX communications protocols. These terminals are connected to the mainframes via gateways and routers using IBM's SNA hierarchical environment. The mainframes in each of the five sorting areas are connected to the Tandem Computers Inc. [63]. system in the company headquarters via five leased T3 lines using IBM's Systems Network Architecture. Thus, the terminals can talk only to one of the five data center mainframes, while the central mainframe in the headquarters is used to dictate the policies and demand the requisite data from the other mainframes and the minicomputers - similar, to the hierarchical format of data stored in the databases.

2.3 System Workflow

COSMOS IIB has been designed to monitor every phase of the delivery cycle. Information is constantly fed into the system by the employees through a number of other systems and devices. There are, essentially, three phases in the transit of a shipment through Federal Express - pick-up from shipper, internal transit through Federal Express' multi-hub system, and delivery to the destination.

In the first phase (figure 4) of the delivery cycle, as each customer gives the customer service agent the details of the pick-up request, COSMOS automatically notifies a dispatcher about the customer pick-up. A customer service agent enters shipping information through COSMOS that

Figure 4 - Federal Express - Phase I of System Workflow



alerts the dispatcher nearest the pick-up location of a shipper's request. The dispatcher then relays that pick-up information to the DADS in the courier's vans.

At the point of pick-up, the courier uses the SuperTracker that retains and then transmits package information such as destination zip code, routing instructions and type of service to COSMOS via the DADS. The SuperTracker scans the airbill number on each package. As the SuperTracker reads a computerized barcode on the airbill (figure 5) using the scanner, it stores the information in its memory. After the information has been recorded, the SuperTracker tries to match the characteristics of the package to hard-coded information stored within itself about the routing paths to be taken for the kinds of packages. After the match has been made, SuperTracker identifies the typical route the package should take through the Federal Express system and displays a specific routing code. When the courier returns to the van, SuperTracker is connected to the dispatch computer from where information is uploaded to COSMOS. The package now travels through the internal transit system - the multi-hub system - of Federal Express [18, 24].

The internal transit of the package through the multiple "hub-and-spokes" system of Federal Express is the second phase (figure 6) of the transit of every shipment. At the end of the courier's day, the van is brought to the city station. The packages are consolidated into containers at the stations, loaded on the Federal Express aircraft and flown into one of five major sorting facilities in the US - Memphis, Indianapolis, Newark, Oakland, and Anchorage. The packages are unloaded directly from the container onto automated belts. Meanwhile, employees key the zip code of every package into a Superhub computer. The freight moves down the belt to the first sorting area called the Primary Matrix. The zip code on the package alerts an electric eye as it moves down one of the 84 automated belts in the matrix. The computer instructs the correct diverting arm to

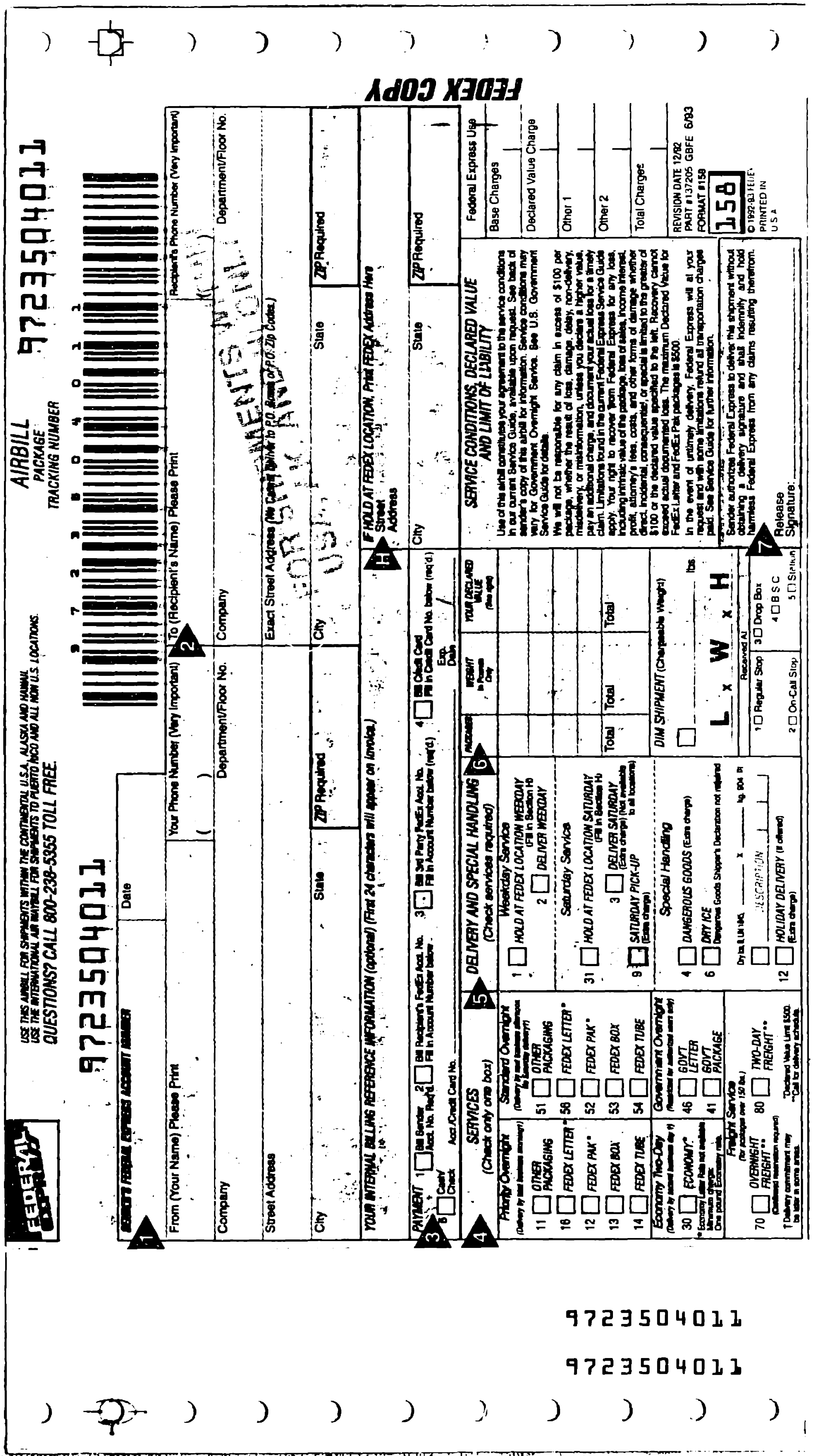
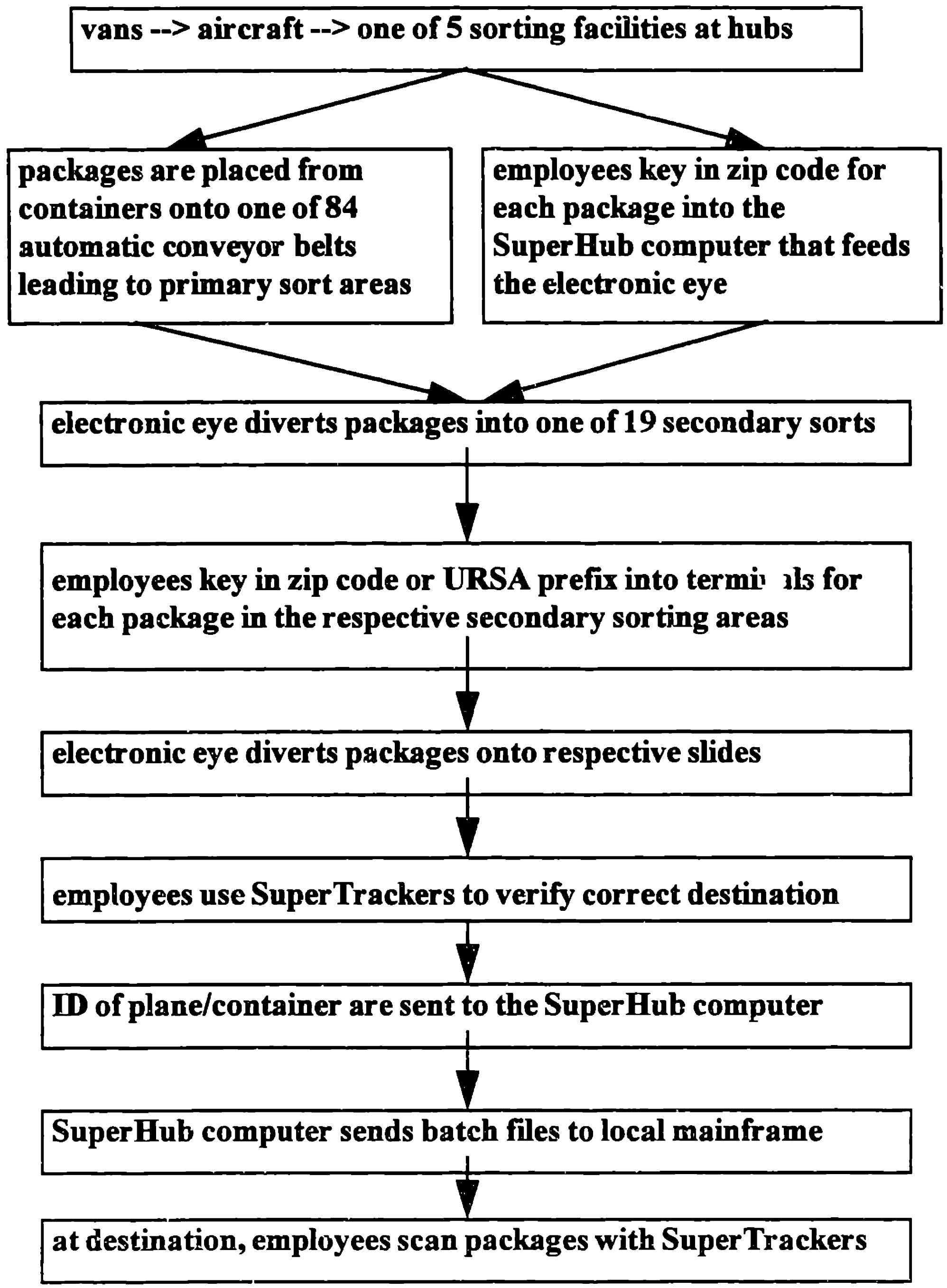


Figure 5 - Federal Express Airbill

Figure 6 - Federal Express - Phase II of System Workflow



push the package onto another conveyor belt, which takes the package to one of 19 secondary sort areas.

In the secondary areas, employees again key in the five-digit zip code into a terminal for each package that comes down the belt. This rekeying allows rerouting of packages. If a request for rerouting is placed by the shipper to a destination other than the original destination, this rekeying allows FedEx to send the package towards the appropriate container and flight for the new destination, and to track which new destination the shipment is sent to. This number allows the Superhub computer to again signal a diverter to push the package down the appropriate slide where it is placed in a container for shipment. Before the package is locked into the container, it is checked by the city, state and zip code and scanned with a SuperTracker to verify that it is in the right container. A similar sorting process is also carried out for documents. As the information is recorded by the SuperTracker, it is constantly fed into one of the Superhub computers. Once the recording of information by the SuperTracker is completed within each respective area, the containers are locked and loaded onto the planes. As the plane takes off for its destination, the identification number of the respective airplane and the respective container is added to the information collected by SuperTracker from the packages and documents, already existing on the Superhub computer. This information is then sent as a batch file to the COSMOS mainframes. Batch files of this nature are sent to the COSMOS mainframes as each airplane leaves with the respective containers [24].

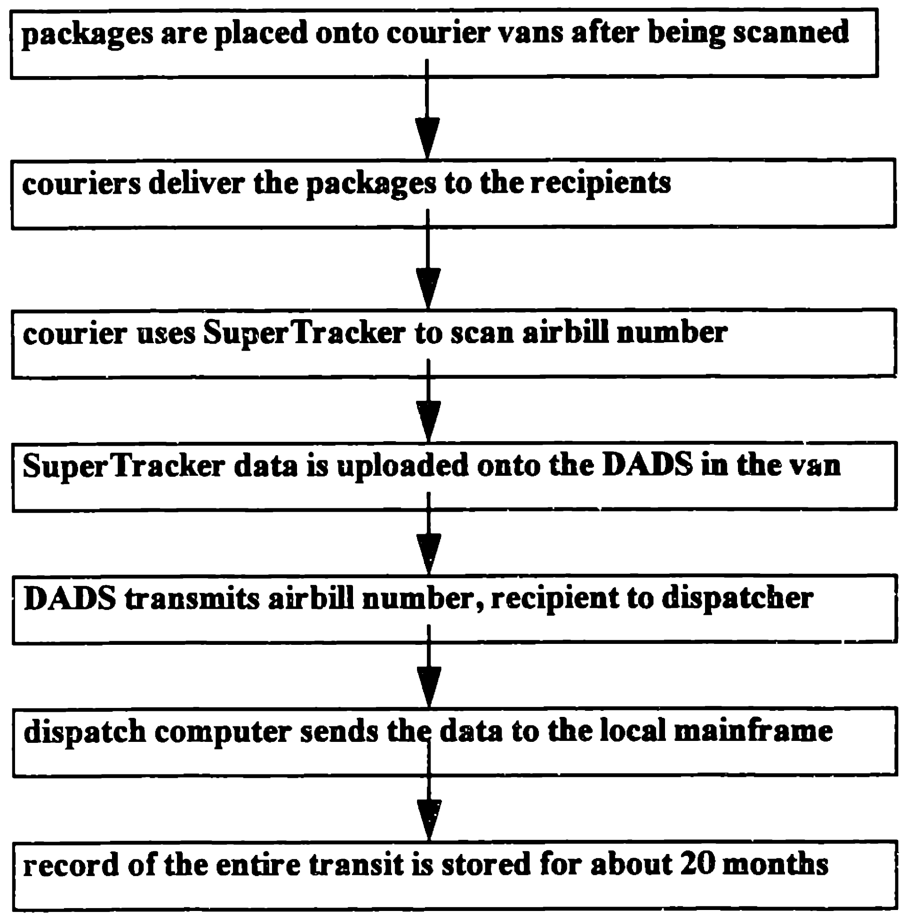
In the destination cities, Federal Express crews sort the packages again, from the containers into courier vans. The SuperTracker is used to record the information from the packages and the collected information from the packages is uploaded to the COSMOS mainframes after the sorting has been completed and the vans are en route to deliver them.

The third and final phase of the transit cycle (figure 7) of the package is the delivery of the package to the destination indicated by the shipper. The van carries the package to the party, who, upon receipt of the package, acknowledges receipt by signing on a voucher. The courier scans the barcode on the package using the SuperTracker and, once again, sends the information to the COSMOS via the DADS on the van. The delivery of the package is considered successful and a complete record of the transit is stored in the COSMOS system for a specific period of time that is determined by the time of the year and the load on the system during that period. Typically, the data is stored for a period of twenty months after the completion of the delivery [24, 48].

2.4 Bottlenecks

Federal Express has created a mainframe-based information system that is quite centralized. The data from shippers is captured at the source and transmitted back to one of the five mainframes which, in turn, send the data to one of the dispatcher minicomputers. The dispatcher minicomputers are allowed to communicate only with the mainframes in the sorting areas and are incapable of communicating with other dispatcher minicomputers. The mainframes in the five sorting areas, in turn, receive all policy details from the central mainframe in the headquarters in Memphis. While this structure prevents the redundancy of data, there are bottlenecks associated with it. Further, there are bottlenecks associated with the system workflow.

Figure 7 - Federal Express - Phase III of System Workflow



1. data accessibility - customers can either call the customer service agents who direct their queries to one of the five mainframes, or the customers can place a query via a dial-up connection to the dispatcher minicomputer which, in turn, accesses the data from one of the five mainframes. In case of a breakdown in the connection with the dispatcher minicomputer, or if the minicomputer is temporarily incapacitated form accessing the mainframe, a secondary source cannot be accessed by the customers as their data is accessible via only one route (ie. via the hook-up to the local minicomputer). The only alternative is to call a service agent, who, in the case of multiple shipments, may not be able to respond quickly.
2. modes of communication - customers can only call in their requests or send data via the proprietary PowerShip terminals. Smaller customers also have to subscribe to the proprietary terminals [25].
3. internal accountability - when the shipments are sent via the hub to the destination, there are chances that the shipment may be lost. With the present system, once the shipment has been sent, from, say, the primary sorting matrix to the secondary sorting matrix, there is no way of finding where the package may have been lost if it does not reach the secondary matrix. This is because the zip codes manually keyed-in at the primary sorting matrix are not verified with the zip codes keyed-in at the secondary matrix. For the employee entering the zip codes at the primary matrix, the job is considered complete, and the employee has no responsibility for the package anymore.

4. customer service agents - the queries entered by the customer service agents, as well as the requests for pick-ups are subject to human error as the information is manually keyed in.

5. manual keying-in of data - workers at the sorting matrices manually key-in the data to allow re-routing of the shipments. However, failure rate because of human error could be high when the data is manually keyed-in.

3. United Parcel Services

3.1 Organizational Structure

3.1.1 Organizational Background

UPS was started in 1907, when Jim Casey, then 19 years old, founded the then American Messenger Company with the help of his brother. In 1919 the company changed its name to United Parcel Services. UPS prided itself on being responsive to customer needs in shaping its package delivery system. These included: simplified documentation, automatic insurance, using the same zone system as the Post Office for determining rates, serving all addresses within the served regions, automatic daily call pick-ups, multiple delivery attempts, returns of undeliverable packages at no extra charge, and so on [5, 50].

Due to significant pressure from competitors who were entering the market with low-cost, better service package delivery, UPS made the decision to enter the overnight market, competing directly with Federal Express [5]. The service provided by UPS competed on the basis of price, its existing ground network, and its emphasis on cost-effectiveness. Since 1986, UPS has moved to close the technology gap that existed between itself and its competitors as the existence of superior information systems were giving the likes of Federal Express better customer ratings. It bought Roadnet Technologies and II Morrow to help develop the kind of technology Federal Express uses in its vans. UPS computer hardware went up from one IBM mainframe and 600 terminals in 1985, to five IBM 3090s and 17,000 terminals by the early nineties. Services are provided to over 50 countries and the information technology infrastructure seems to have caught up to the best there is in the industry [29].

3.1.2 Organizational Mission

The company's objectives can be summed up from the UPS Policy Book: "To fulfill a useful economic purpose - satisfying the need for prompt, dependable delivery of small packages, serving all shippers and receivers wherever they may be located within our service areas - with the best possible service at the lowest possible cost to the public". The book goes on to state the objectives "to develop additional profitable businesses which complement our efforts to maintain a financially strong company;" and "to be alert to changing conditions and ready at all times to adjust our viewpoints and operations to meet them". The policy book goes on to define the main business of the company as 'consolidated parcel delivery' [5].

3.1.3 Internal Structure

UPS' corporate structure seems to have remained fairly consistent over a long period of time. Changes that have occurred appear to be concentrated in marketing and sales, strategic planning and technology. The customer service group, which covered sales, was expanded to include a marketing group, and today comprises a group referred to as Business Development. This is illustrative of the fact that some time ago, UPS relied solely on direct sales and some trade press advertising to sell its services.

When the air service was added to the range of operations, in 1982, it became another region in the operations part of the company, parallel to the geographic regions that make up the ground operations. In about 1985, the information services group finally moved from being a back-office operational group to a front-end operations group when the manager of the information services group finally began reporting directly to the Chief Financial Officer. In 1986, a strategic planning group was added for the first time. One of the group's functions was to spearhead the thrust into using advanced technology to meet or, even, surpass the present state-of-the-art at Federal Express [5, 60].

3.1.4 Operations

UPS operations have developed over 80 years, in many cases operations today are carried out the same way they were 20 years ago. Almost all its operations are approached from an engineering perspective, with the company's industrial engineering group involved in every aspect of the operation from developing the hub and spoke system, to the hubs, to designing the trucks used for deliveries. Much like Federal Express, the company seems to deal with the shipping process as an entire system.

A description of UPS' operations highlighted that: "[among] the main reasons for UPS' strength is its emphasis on building route density [number of packages per stop per customer per mile], standardizing the job of the route driver to allow comparison and control, and designing its sorting facilities and transport equipment to handle packages of no more than 108 inches in combined length, width, and height and 70 pounds in weight. This single-minded approach to a service concept allows UPS to realize substantial profits while charging its customers as little as half that of its competition" [28].

The basic organization of UPS' Air Operations, is much the same as Federal Express'. The principal differences lie in the ground service, and the lack of technology in most of UPS' operations. The ground service has a more complicated hub and spoke structure than the air operations since the trucks can cover only about 400-500 miles overnight and requiring multiple hubs to cover the entire US.

3.2 Technical Infrastructure

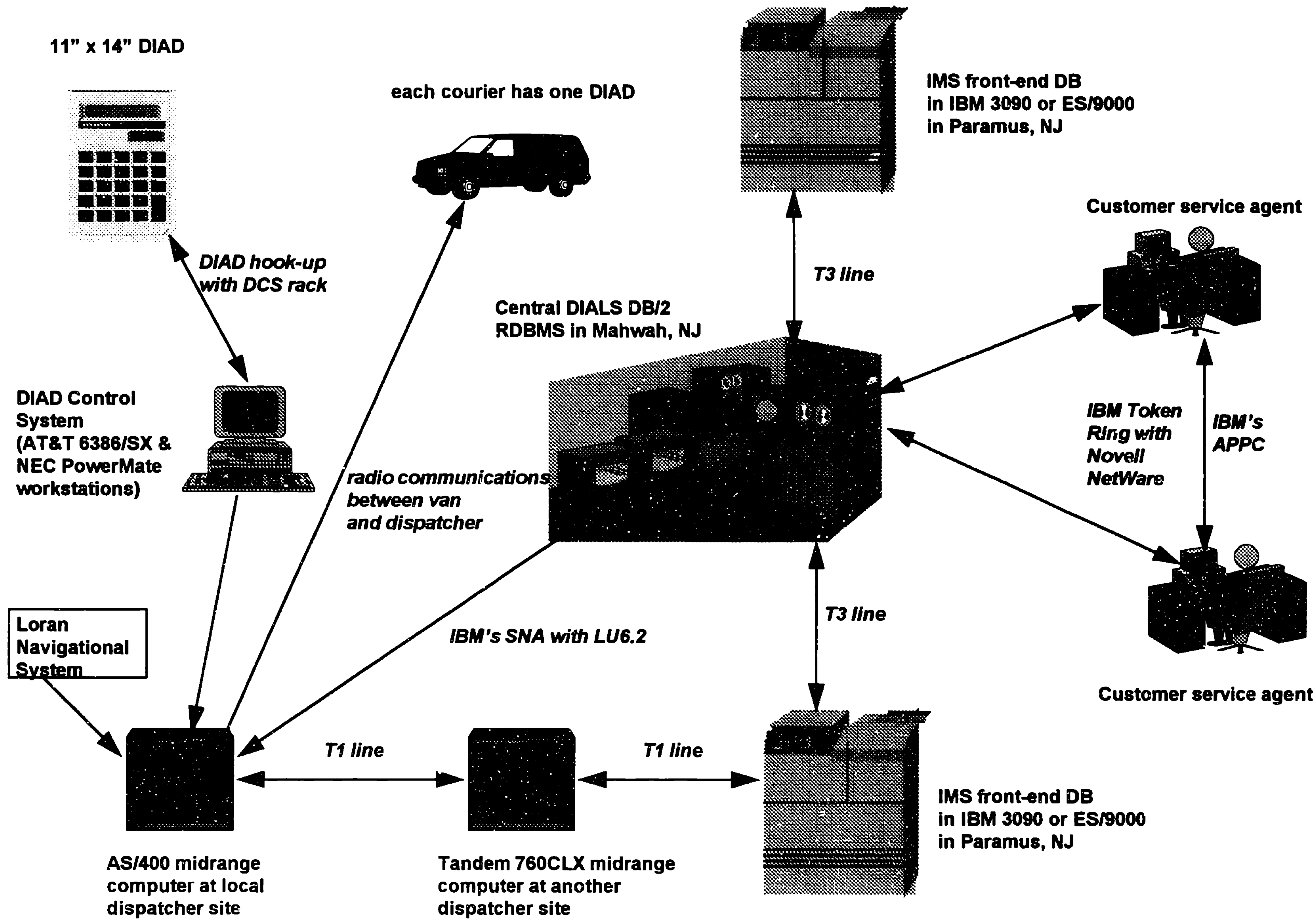
UPS' approach to technology, until about 1988, was strictly on the basis of weighing the operational benefits of adding technology against the cost of implementing it. In effect, the company only added new technology when it made its operations more efficient, and offered a measurable pay-off. Today, as a result of intense pressure from competitors and demanding customers, it is introducing new technology to win business and to ensure the best possible customer service. This section describes the technical infrastructure in existence within UPS and the latest additions of features and services to the service backbone (figure 8).

UPS delivers information to about 60,000 customers who call in daily inquiring if their package arrived on time at its proper destination. The system that aids the customer service representatives to respond to these inquiries has evolved over the past few years from a manual system for tracking packages to an on-line interactive electronic system. The in-house systems integration team manages a newly-evolved package-delivery project, including cellular and wireless technology, which improves service and driver productivity.

3.2.1 System Hardware

The core technology that begins the information "process" is the Delivery Information Acquisition Device (DIAD) (figure 9). UPS defines DIAD as an 11-inch-by-14-inch hand-held

Figure 8 - Technical Infrastructure at UPS



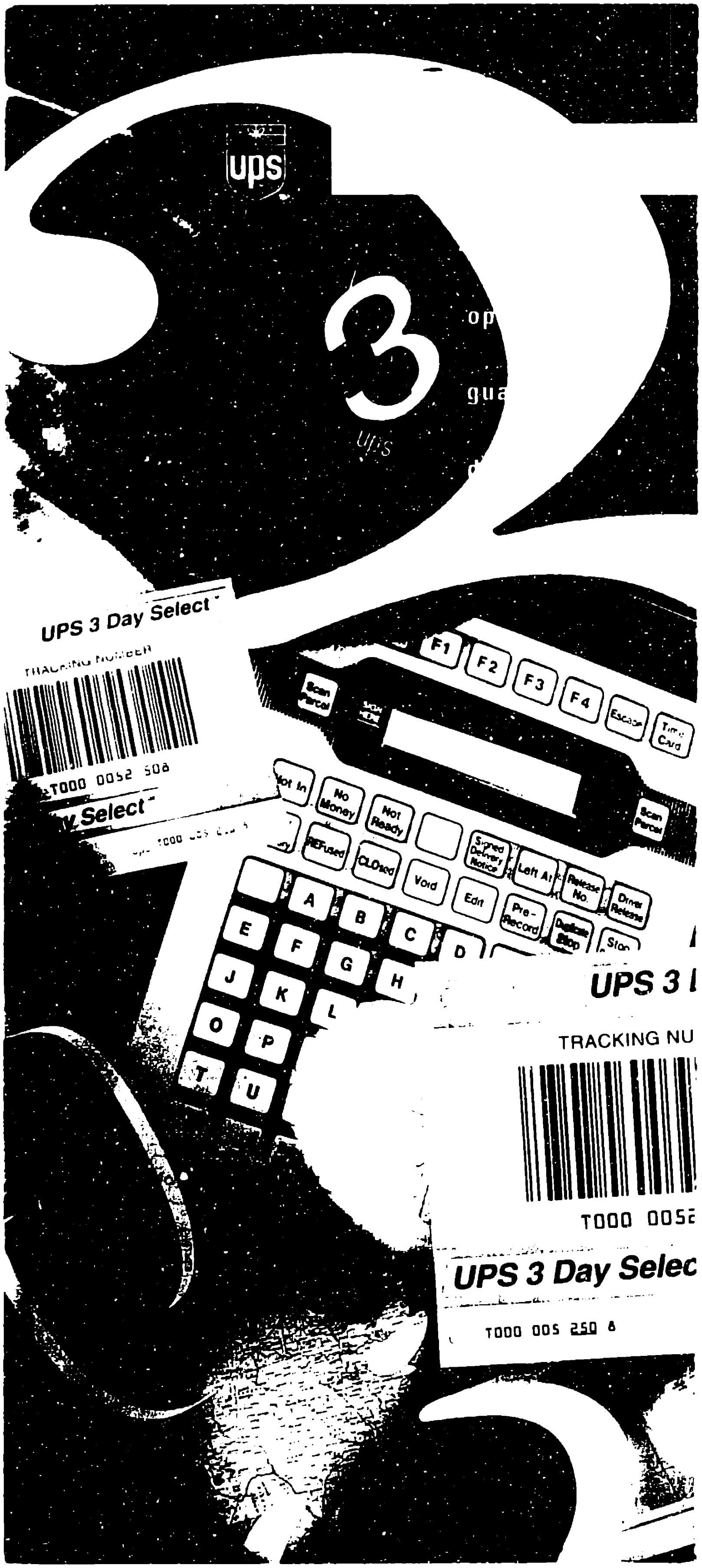


Figure 9 - UPS' Delivery Information Acquisition Device (DIAD)

computer that drivers use to record delivery, pickup, time-card and customer-signature information that previously had been kept on paper forms. The DIAD is, in effect, an electronic clipboard designed to cope with severe weather conditions. Drivers enter information on a color-coded, pressure-sensitive keypad. Toppan Moore Co. of Japan, a forms-development supplier, custom manufactures DIADs for UPS. Inforite Corp., a subsidiary of Toppan Moore, provides the keypads and also markets commercial versions of the device (information derived from telephonic interview with Dennis Livingston of Cahners Publishing - 617-964-3030).

UPS subsidiaries, Roadnet Technologies Inc. and II Morrow Inc., are responsible for DIAD software and manufacturing specifications, respectively. UPS also worked with Symbol Technologies Inc. to develop a bar code scanner that is incorporated into the DIAD to improve package tracking (figure 10). Tekneron Communication Systems Inc. was involved in an earlier pilot version of the delivery system.

DIADs work with other hardware at UPS offices and data-processing centers. This includes AT&T 6386/SX and NEC America Inc. PowerMate Sx workstations, IBM Corp. AS/400 midrange computers, IBM 3090 and ES/9000 mainframes and Tandem Computers Inc. 760 CLX minicomputers [54].

3.2.2 System Software

The Delivery Information Automated Lookup System (DIALS) is the central database for all package location information from pickup to delivery. DIALS information is stored on an IBM mainframe using both Information Management System (IMS), a hierarchical database, and Database 2 (DB2), a relational database.

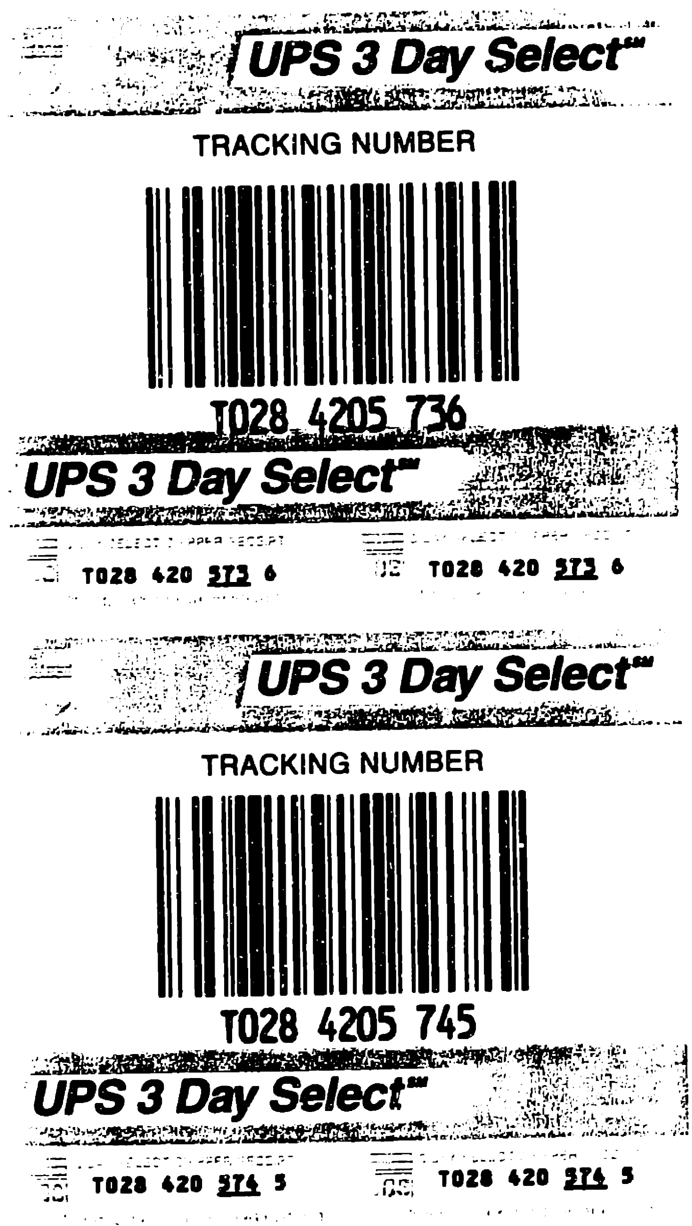


Figure 10 - UPS' barcode label

The reason for using two different databases is because IMS is deemed better for loading high-volume data, while DB2 is useful for accessing information in tables and also to eliminate redundancy of storage. It would not be possible to efficiently load straight onto DB2 with the data volume (approximately 4.91 gigabytes daily) generated within UPS for the system [34].

Database loading speed is crucial for UPS, because UPS wants by 8 a.m. each day, the information on the 12 million packages it delivered the day before. IMS serves as a transient holding pen for this data. As IMS fills up, information is sent to DB2 for indexing and sorting.

Tariff regulations require UPS to retain information on deliverables for up to 19 months. That translates into a potential 2.8 terrabytes of data. Approximately, four-and-half months of DIAD information is stored on DIALS magnetic media. The remaining data goes to write-once, read-many (WORM) disk drives. Backups of the data are saved on magnetic tape reels [54].

3.2.3 System Networks

UPS transmits package delivery data, electronic data interchange (EDI) documents and data for coordinating its airline fleet over its $14 million UPSnet. Components of UPSnet include:

- T1 leased lines connecting regional nodes;
- Two T3 lines that link UPS data centers in Paramus and Mahwah, NJ;
- DPN-100 packet-switches from Northern Telecom Inc.;
- Network Equipment Technologies Inc.'s IDNX multiplexers, which help the system quickly reroute traffic around failed nodes.

UPS benefits from transmission economies of scale by aggregating bandwidth. It is possible to fit 24 56K-bit circuits into a T1 line for the same price as seven or eight 56K-bit circuits. UPS has installed more than 300 local area networks (LANs) in more than 200 sites worldwide. A LAN typically uses IBM Token-Ring hardware and Novell Inc.'s NetWare operating system. Microcom Inc. bridges connect most LANs to UPSnet regional switching sites over 56K-bit lines.

UPSnet uses IBM's Systems Network Architecture (SNA) running over X.25 packet-switching protocols. X.25 provides the peer-to-peer communications that UPS needs as minicomputers and PCs become more prevalent in its offices. X.25, which covers the lower three layers of the SNA protocol stack, is complemented by Logical Unit 6.2 (LU 6.2) in UPSnet. LU 6.2 implements IBM's Advanced Program-to-Program Communications (APPC). Traditional hierarchical SNA environments would have allowed only one AS/400 to talk to another AS/400 by going through the mainframe. With UPSnet, one AS/400 can talk to the mainframe, to another AS/400 and to PCs compatible with APPC, over one physical link [22, 34].

3.3 System Workflow

UPS integrators expect to improve the productivity of drivers by speeding up data entry, eliminating most paper forms and reducing human error. Most drivers, for example, currently handwrite delivery information on paper documents.

The manual package tracking process leaves something to be desired. All customer inquiries are transmitted to a mainframe in the UPS data center. They are then routed to a Delivery

Information (DI) office in the area where the package was supposed to have arrived, according to the destination zip code [15].

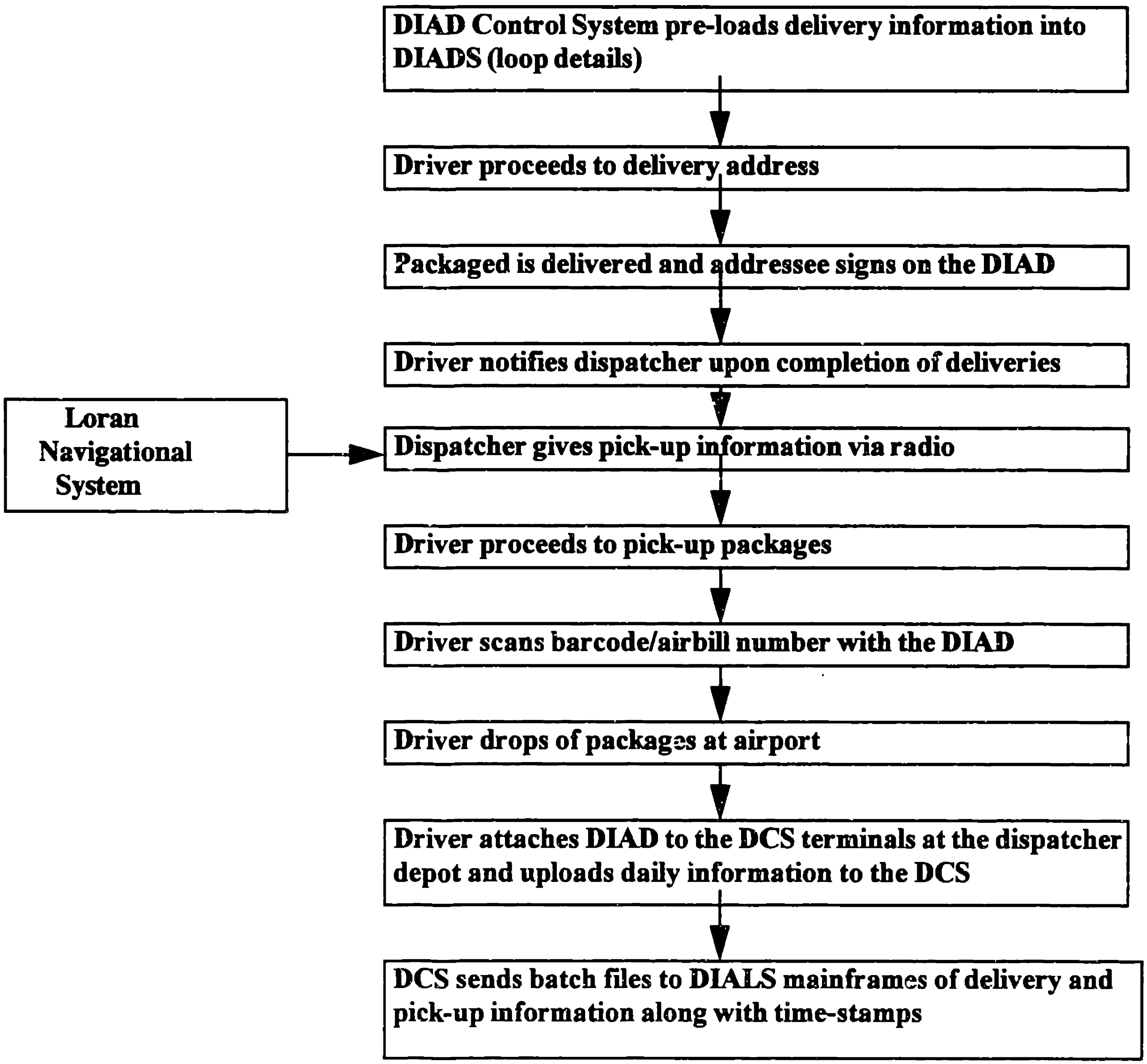
Systems manager Antonio Solana mentioned in a BusinessWeek article: " A customer service representative in the DI office is surrounded by data sheets with 18 months worth of information. If a customer wants to know who received a package, and, perhaps, receive a copy of the signature, the customer service representative has to locate the right documents. We need a fast, accurate response technology, as well as one that saves space and dollars. We have to pay a claim if we can't find the paper proving a package was delivered". These needs are addressed by the newly upgraded technology infrastructure and the information workflow [15].

Drivers begin the day at a distribution center by pulling out their DIADs from a communications rack called a DIAD Control System (DCS) (figure 11). Every driver is assigned his own DIAD. Information on each driver's route for the day, known as a "loop detail", is downloaded from workstations via the DCS into the DIADs.

About 80% of a driver's daily deliveries are to the same addresses. So the information is pre-loaded into the DIADs with the streets the driver normally goes to. A driver just keys in a street number when he makes the delivery. The street name, city, state and zip code are already recorded, saving the driver time at each stop [53].

Drivers can call up their time cards and truck odometer readings on the DIAD's liquid crystal display (LCD) screens. A driver sees the street name of each stop, and the direction that the street turns, by pressing the "delivery" button on the keypad. Packages are loaded into the van in the order in which they are to be delivered.

Figure 11 - United Parcel Services - Phase I of System Workflow

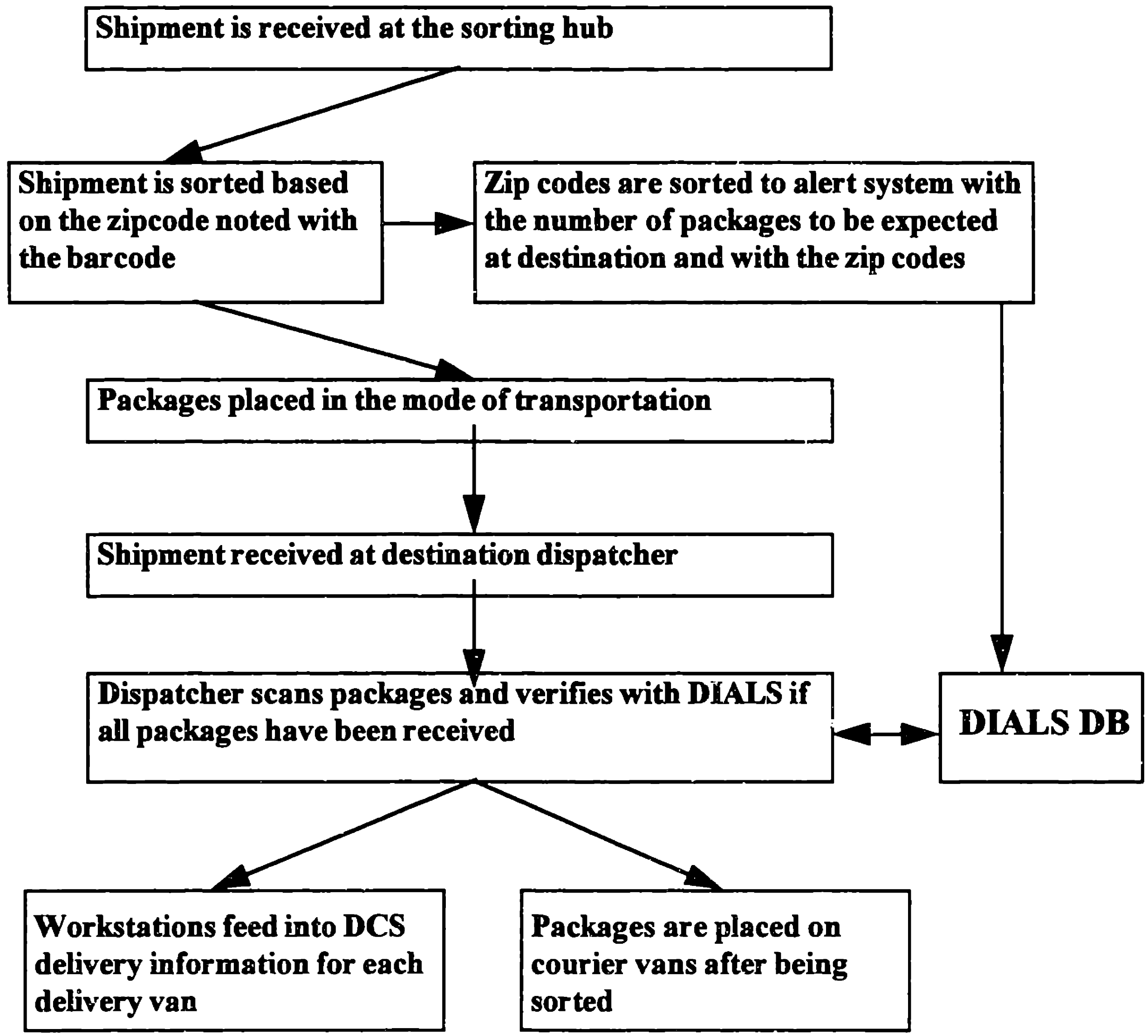


The addressee signs for delivery of a package on an electronic signature pad - located on the DIAD - using a stylus provided by the driver. The signature is displayed on the DIAD's screen as it is written on the pad, much as with an Etch-A-Sketch pad, and digitally stored by way of a compression algorithm. If the signature is illegible the driver can type in the name of the recipient. After the deliveries are completed, the driver proceeds to receive pick-up instructions from the dispatcher. This occurs via narrowband receivers placed on each truck. A pickup truck can be located within 50 feet, depending on the direction and strength of the signal. The dispatcher views on a computerized map the location of the respective drivers using the Loran navigational system and assigns the nearest driver to pick-up the package. The driver then proceeds to pick-up the packages [49].

The driver enters into the DIAD all the data required to complete his time cards, including stops, time spent in the buildings and cash-on-delivery (C.O.D.) payments. At the end of the day, drivers place their DIADs back into the DCS, which automatically uploads delivery as well as pick-up information to workstations. Information travels from the workstations through UPSnet into the DIALS database in the form of batch files. DIADs are recharged while sitting in the DCS. Paper delivery records can be printed by the DCS, if desired.

The other segment of the transit (figure 12) of the package occurs through the hubs of UPS spread out across the country. Once the shipments are received at the hubs, they are sorted based on the zipcodes printed on the labels. The zip codes are also, in the meanwhile, fed into the hub computers. This information, at the end of the day, is uploaded into DIALS database, where information about how many packages are sent to the dispatch from the hub, as well as to which

Figure 12 - United Parcel Services - Phase II of System Workflow



zip codes, is processed. It remains in the DIALS database and also aids later if a trace is needed on a package [28].

Once the packages are received by the destination dispatcher, the dispatcher verifies with the DIALS database that all packages have been received. This does not happen on-line but is done using a print-out of the file, downloaded from the DIALS database, containing the number of packages (and their respective zip codes) with the zip codes scanned off the packages actually received. The information received from the DIALS database is stored in the DCS. The DCS workstations feed the information into the respective DIADs based on the "local loop" of the drivers.

DIALS automates the tracking-information processing system. A customer-service representative only has to access the on-line DIALS database to perform the search process previously done manually. The system looks for the closest match between candidate document and information on the tracking inquiry. DIALS can display the recipient's signature on the screen.

Database keys and indexes enable the customer-service representatives to refine document searching to yield more accurate candidates. DIALS also provides daily reports of DIADs needing repairs, any paper delivery records used and all DIAD activity for specified amounts of time [33, 58].

The newly upgraded system now uses technology that has been used in air delivery shipments for all its deliveries. For example, a nationwide Loran navigational broadcast system enables dispatchers in many areas to track and communicate with special trucks that pick up "on call" air packages. The pickup trucks have a narrowband receiver that uses the Loran C system. A dispatcher views pickup truck locations on a computerized map of the area and assigns the nearest driver to the pickup site. He then sends a radio message with the relevant information to the driver. UPS plans to outfit all the pickup trucks with a radio system that would communicate with the DIADs. A driver could then notify the distribution center immediately upon delivery of the package, instead of waiting to unload the information at the day's end [49]. UPS uses the DIAD bar-code scanner for inputting shipping information on air delivery labels when packages are picked up from large customers. UPS intends to use DIADs to read bar-codes on other pickups as well.

Case - "UPS to deploy wireless network" *[Computerworld, May 18, 1992]*

"United Parcel Services, Inc. will invest $150 million to deploy a nationwide, data-over-cellular system for its vehicles by mid-1993, the shipping company said last week.

The addition of a wireless capability, UPS said, will enable it to track deliveries for all air and ground parcels throughout the day. This information is collected nightly and uploaded into a mainframe in New Jersey and is available to customers the following morning.

Analysts said UPS' sizable investment is sure to raise the profile of data-over-cellular technology. According to Arthur D. Little, Inc. (Cambridge, MA) estimates, within five years there will be 5 million to 7 million users of mobile data services of all types, including those based on public cellular networks. Last month, nine leading cellular carriers announced the summer trial of CelluPlan II, an IBM technology used for sending packet data in circuit-switched cellular voice networks. But UPS could not wait for commercial availability of CelluPlan II-type systems. UPS had evaluated other wireless options, but the thing that gave the edge was its extensive geographic coverage.

The remaining problem was that each cellular company had a different approach for transmitting data over its own network. To overcome this and to provide nationwide consistency, UPS developed its own nationwide communications protocols. UPS will use cellular networks from McCaw Cellular Communications, GTE Mobile Communications, PacTel Cellular and Southwestern Bell Mobile Systems. The four carriers have also formed an alliance to provide UPS with unified billing and network management.

The cellular networks will tie the UPS trucks into UPS net, a 40-node private X.25 data network UPS completed last year. Because the cellular switches will be directly linked to the UPS net nodes, call completions will be in the 15-second range, and UPS will not be billed by the carriers on a per-minute basis.

In the vehicles, UPS will deploy cellular radio communications controllers from Motorola, Inc. The controllers will read information from the electronic order-entry clipboards already carried by UPS delivery personnel. Transactions will be sent over local cellular networks and patched into UPSnet.

3.4 Bottlenecks

The system in place at UPS is centrally decentralized in that the local midrange computers are capable of communicating with other midrange computers, as well as with the central DIALS DB2 database residing in the IBM ES/9000 mainframe in the Mahwah, NJ data center, as well as with the front-end IMS database in the IBM 3090s in the Paramus, NJ data center. In the case of data accessibility this system is quite capable of obtaining data from the primary data source

(DIALS DB2 database in Mahwah, NJ) or also collecting the data from secondary sources (local midrange computers and front-end IMS databases in Paramus, NJ). However, there are significant bottlenecks that ought to be addressed:

1. modes of communication - customers are capable of obtaining information about their shipments only via customer service agents. While UPS is moving towards integrating non-proprietary systems with its own, it leaves a lot to be desired in the case of increasing communicability with the customer via other media.
2. tracking time - once the data is collected at the local dispatcher site, it is uploaded to the IMS hierarchical database in Paramus, NJ. This data is sent overnight to the DB2 relational database in Mahwah, NJ via batch files. The information pertaining to the shipments is available to the customers only the next day.
3. internal accountability - the system encourages the postponement of error-detection. This is evident from the fact that when the shipments are received at the sorting hub, the zip codes are sent overnight to the DIALS database via batch files to alert the system with the number of packages to be expected at the destination. While this allows the system to verify if the packages have arrived at the destination, it does so only after the batch files arrive overnight from the sorting hubs and the destination computers.
4. customer service agents - when the customer service agents receive requests for pick-ups they manually key in the information. This makes the system prone to human errors.
5. re-routing - the data pertaining to the shipments arrives at the central database the day after the shipment is sent. As a result of this long time period, the package may already be

on its way to the original destination while the customer may have desired to redirect the package to another destination.

6. status messages - as a result of the long time period after which the data is received by the central mainframe, status messages are provided only in the case of shipments that are not being sent overnight.

4. Implementation of Technology

4.1 Electronic Data Interchange

For the companies that move bills of lading, tracking information, delivery receipts, and other information electronically, EDI has drastically changed the way of doing business. UPS has done a specifically good job of gaining competitive edge over Federal Express in terms of developing non-proprietary solutions to integration of external databases with its own systems. While Federal Express has pushed ahead with the development and implementation of the PowerShip, UPS has supported most forms of systems integration and has aided in the development of standards. This has benefitted Federal Express, though the effect of this move will be beneficial only in the short term.

Besides customer acceptance of non-proprietary EDI products, EDI adds speed and a high degree of accuracy to the exchange of information. As many as 30,000 companies in the US. will be using EDI by the end of 1993, creating a $2 billion industry in EDI products [23]. Further growth will come from smaller companies that are suppliers and customers of the larger corporations.

4.1.1 Uses and Benefits of EDI

Many kinds of information are exchanged electronically via EDI. These include purchase orders, bills of lading, freight bills, shipment status, proof of delivery, and payments. Federal Express found it useful that many of its huge customers were already using the EDI systems to move such information around. To exploit the benefits of EDI even further, Federal Express has begun a pilot project to integrate COSMOS with the US Customs' systems to transact arrival notifications, entry summaries, payments, protests, and invoices. In general, this shift to EDI is because of the benefits arising from cost savings, accuracy in conveying information, and speed and timeliness of data transmissions [34].

4.1.2 Obstacles to Implementation

Despite the advantages, many companies have failed to adopt EDI. Lack of financial resources, primitive internal computer systems, resistance to shift to proprietary EDI systems are some common reasons. Additional issues include lack of single information transmission standards and lack of trust.

Companies today use standards like ANSI (American National Standards Institute) and EDIFACT (the international standard) to communicate business information. Each of the nearly 200 transportation-related messages used to electronically transmit shipping documents is in a different ANSI format, or transaction set.

The advanced state of EDI technology and transmission standards has largely removed technical barriers to its adoption. An additional incentive is that costs are lower than a few years ago. Relatively low-cost PC-based EDI is also available. However, lack of trust remains an issue in some cases. Some of UPS customers have remained steadfast in maintaining the "paper backups" [28].

Some of the other problems that Federal Express complains of (and, also uses to justify its adoption of non-proprietary solutions to EDI) are related to the transmission of invalid or missing data elements received from customers. Reconciliation of such errors sometimes carry overheads that are way more than the benefits realized by way of adopting EDI. Another problem arises as a result of communications. Analog, voice-grade lines on the public network carry a great deal of the EDI message volume. Yet, some of the vendors of EDI information do not incorporate communications error-checking. As a result, many transactions that are received by UPS receiving host-system are rejected - thereby, forcing one or more re-transmissions. In extreme cases, the sending party even had to revert to pre-EDI communications methods [28].

4.1.3 New EDI developments

Some of the newer uses of EDI has been reflected in the widespread use by customers of integrating technologies such as bar code and image processing into EDI systems to enhance the performance of central distribution centers and terminal operations [3].

Electronic links of this sort between customers and carriers like Federal Express and UPS allow retail inventory replenishment, in which point-of-sale information collected at the cash registers is used to replenish retail stock. Federal Express' Business Logistics Services have been especially created in providing third-party logistics and warehousing services to aid this form of inventory replenishment [25, 26].

As satellite communications cost decrease with economies of scale, EDI information will be transmitted in real-time via satellites to allow multi-modal access to the in-transit information.

4.2 Image Processing and Bar Code Technologies

Image processing and barcode technologies are figuring prominently in the operations of numerous shippers and receivers. Image processing is relatively newer, with very high start-up costs, and while Federal Express has been rather slow in adopting it, UPS uses it to store customer signatures on its delivery information acquisitions devices (DIADs) [58]. Bar codes have been used by Federal Express for some time, and UPS is developing a high-density code capable of storing up to 100 characters of data - much more than traditional bar codes - in a stamp-size space. UPSCODE, as it is called, is considered, even by Federal Express, as the most advanced code available in the industry [33].

4.2.1 Benefits and Drawbacks of Image Processing

Image processing enables streamlining of paper handling and storage by converting documents to unalterable electronic images that are easily accessible in a computerized filing system. UPS invested in it for a number of reasons, among them customer service benefits (such as providing a copy of the signed acceptance acknowledgment by the receiver to the shipper), faster response to requests for copies of documents, reduced physical storage needs, labor hours, and administrative costs [23].

Image processing has also redefined business procedures by relocating data entry work to one central site. Normally, each origin terminal (shippers and other customers) has its own set of billing clerks. Through image processing, bills of lading are scanned remotely and transmitted to a central site, where a billing clerk uses an image of the bill for data entry into an electronic freight bill file and to place orders to carriers. This reduces personnel and training costs, and improves data accuracy when the same image is used to track in-transit visibility of the shipment with the carrier [3].

The major drawbacks of the technology result from its high hardware and software costs, and extensive systems integration requirements. It is also difficult to find expertise to develop and manage such a system. Customers realize the potentiality of the system but are waiting for the "critical mass" achievement of capabilities and costs, to start using this technology. Other issues include the communications costs which may be substantial and the costs of indexing documents at the time the images are captured. The development of better compression technologies will allow faster transmission of the documents and will make storage costs within acceptable range.

A significant advantage of image processing is that it does not depend on two trading partners to make it work. UPS can send printouts of the acknowledgment receipt signed by the receiver to the shipper who may not be having an image processing system capable of receiving images.

4.2.2 Bar Code Uses and Benefits

Bar coding has been around for some time within Federal Express. As mentioned earlier, however, UPS has done a very good job of developing UPSCODE - a high-density code capable of storing up to 100 characters within itself.

Bar codes are encoded labels that store shipping and product identification information on a series of lines that can be scanned electronically. The advantage is rapid, error-free data entry. Untrained workers can scan bar coded information much faster that trained data entry personnel can key in the information. The information can be used for shipment tracking, billing, customer service, sorting, inventory management, and assembling, as has been done by COSMOS during the transit of the goods from the shipper to the receiver via the hub-and-spokes system [18].

The customized UPSCODE from UPS is being heralded by officials from the company as the enabler of competitive advantage over Federal Express. The barcode will allow better in-transit visibility, by packing more information within the 100 characters bar code, and will also facilitate UPS' "automated hub of the future" at Grand Rapids, Michigan [49]. The facility already has diverters, readers, keying stations, and other elements of an automated system in place.

4.2.3 Cost of Scanning Technology

Federal Express uses low-cost hand-held scanners called SuperTrackers. A hand-held scanner used in 1987 cost $4,000 and is now available, in 1993, for about $400 [39]. Typically, during the eighteen hours that air freight shipments are with Federal Express, the shipment will likely be scanned seven times [63]. Scanning equipment has improved in its ability to read different bar code symbologies. Many symbologies exist, and most new scanners can read ten or more different symbologies. Yet, both Federal Express and UPS provide pre-printed bar code labels to the customers, as they do not wish to deal with the possibility of errors from reading different symbologies, as well as the extra time and processing required by the battery-operated hand-held scanners. The SuperTracker and the DIAD are both powered by Ni-Cd batteries and are charged by the respective delivery vehicle's engine batteries (mentioned by FedEx and UPS delivery personnel).

4.2.4 New Bar Code Developments

Bar codes are being used for more internal functions by many shippers, brokers, and carriers. They have begun sending via EDI to US. Customs officials a copy of the bill of lading containing a bar coded entry number before the carrier arrives at the port. This can be used by Federal Express and UPS in inter-modal transportation, as well as international freight and goods shipments. Information such as the destination zip code and carton identification number, help speed shipments and improve accuracy [34].

A common transportation label used by many Federal Express customers contains the standard components including unique carton numbers, shipper identification, and destination zip codes. By having its own proprietary system, the PowerShip, Federal Express, prevents the existence of multiple barcodes by providing printing facilities on the PowerShip for barcode labels.

This approach is now being viewed as counter-productive, in light of trends toward Just-In-Time distribution and QuickResponse retail replenishment, both calling for accurate communication among shippers, carriers, and receivers [4]. The existence of proprietary has the long-term effect of not facilitating this level of communications. One of the results has been to move towards standardized bar codes, unlike the ones being used by Federal Express, and that proposed by UPS (UPSCODE).

The newest bar code symbologies are two-dimensional or 2-D car codes, which stack information, one line upon another, rather than stringing it out in a single line as the many present bar codes do. One of these codes, PDF 417, stores up to 1,850 characters of information; one-dimensional codes, like the Universal Product Code found on grocery items, hold about 20 characters, and other two-dimensional codes hold no more than 250 characters [47].

5. Reengineering In-Transit Visibility : A Model

The in-transit visibility processes at Federal Express and UPS are the primary enablers of improved customer service levels and better tracking of goods. The new business environment demands from both companies that they provide more of such information-based, value-added services with a higher degree of efficiency and quality. At the same time, other transportation companies and shippers/receivers are integrating disparate "islands" of information. As a result, Federal Express and UPS should, both, fully exploit this opportunity to integrate their systems with those of their clients.

The model in this chapter uses concepts borrowed from the reengineering paradigm as well as some sub-processes and systems already in existence at Federal Express and UPS. Overall, it represents an abstract system that will substitute the processes that make up the pick-up/delivery life-cycle at either of the two companies.

5.1 Why Reengineering?

Reengineering has become a powerful "watchword" in the corporate world and information technology is one of the most potent enablers of reengineering. As the new business environments shape the corporate nature of transportation, particularly that of package/document delivery, the new equations created present an unprecedented opportunity to change the nature of the competition. The new business environments are now dictated by:

- <u>Customers:</u> Increasingly expecting low-price, dynamic customer service, and high-quality products on time, along with the desire for information-based, value-added services,

- Competition: Increasing rapidly due to falling trade barriers, and
- Change: Becoming constant in the marketplace, and product life declining.

5.2 Reengineering In-Transit Visibility: The Methodology

Reengineering in-transit visibility (ITV) involves identifying and annihilating assumptions about the process of ITV. The reason why ITV happens to be the ideal candidate for reengineering is because ITV is the process that has the greatest customer impact, and is the process for which reengineering (by way of advances in enablers such as information technology) is most feasible. The model incorporates the characteristics of the reengineered process:

- Organization of the process - Creation of cross-department teams or "case teams" that ensure that the responsibility of a certain case is entirely their own. This encourages increased decision-making at lower levels, while improving accountability, thus, flattening the hierarchy.
- Job Design - Combining several jobs eliminates the unnecessary monitoring of employees and rather, focuses on the delivery of the product and monitoring the ITV information.
- Work Flow - Performing work where it makes sense and where it is necessary ensures that the product and the ITV information are delivered to the designated shipper, consignee or third-party.

5.3 Federal Express vs. UPS

In terms of in-transit visibility, the attributes of the ITV process stand out as follows, respectively:

Attributes	Federal Express	UPS
communication media used to initiate trace	telephone, PowerShip terminals at customer site	telephone only; moving towards computers, too
response time to trace	almost instantaneous	next day; moving towards instantaneous response
data availability (including integration with clients' information systems)	from dispatcher minicomputers to client computers, or central mainframe to service agents	from central mainframe to customer service agents only; moving towards multiple access media
reports	complete record provided without signatures	name of receiver provided with signatures
status update	when van sends data via satellite to dispatch computer	when DIAD is put into DIAD Control System at end of day
routing of shipment internally	based on McIDAS weather processing system and COMPU.MAP, both feeding the SuperTracker - dynamic	internal routing based on fixed "loop details" downloaded daily into each DIAD - static
re-routing of shipments	possible, provided package has not been through the sorting hub	not possible for express packages as locational information of shipment is received only the next day

5.4 The Model for Reengineering ITV

The accompanying work-flow diagrams (figures 13, 14, 15) represent the three reengineered phases of the pickup/delivery life-cycle. The work-sub-processes improve the quality of the in-transit visibility provided to the customer/s as well as to the host package company. The information technology enablers of these reengineered phases are highlighted in the diagrams and their technical characteristics will be discussed in detail in the next chapter. For the purpose of this model, all packages are assumed to be delivered within the US. However, the model can be expanded to include international package delivery.

5.4.1 Phase I

Phase I of the reengineered model (figure 13) involves three sub-processes:

- request for pick-up,
- package pick-up, and
- package transit to hub.

Request for pick-up - Information Acquisition

The request for a pick-up (RFP) can be initiated via any mode as deemed convenient by the customer. Information about the pick-up can be received via an interactive dialog with the customer's computer, a fax reception from the customer's fax medium, or a voice dialog with the customer. Remote or distant customers (such as ships, customers on an airplane), can also initiate a RFP by way of a voice dialog via cellular phone or data/fax transmission via a direct satellite link with the computer.

The information typically needed of a customer will consist of:

shipper information (the items in parentheses are data field names for the database):

i) account number (ACCT_NUM, if YES, then GOTO (vi),

if NO, then GOTO next),

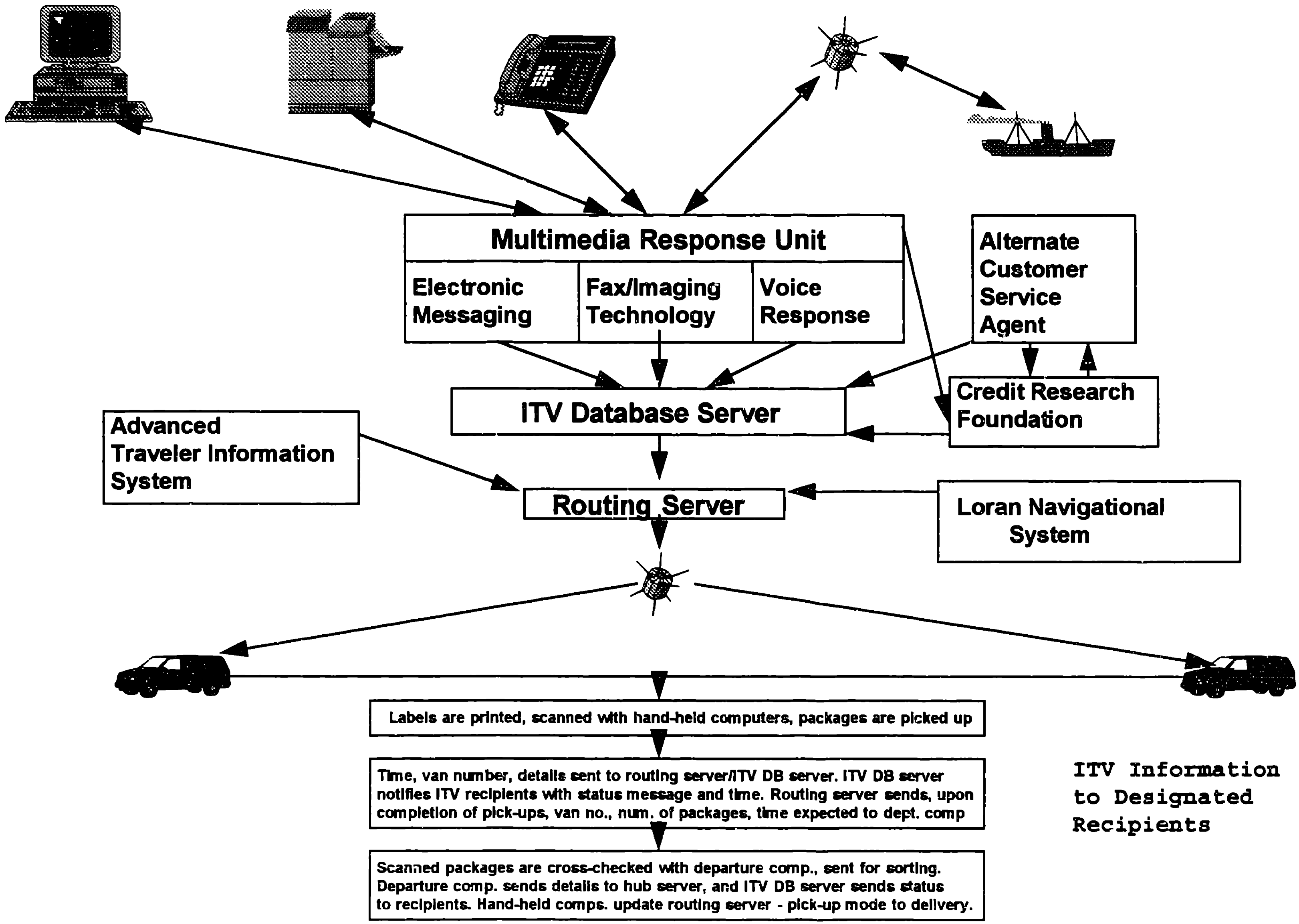
ii) name (SH_NAME),

iii) address (SH_ADDR),

iv) telephone number (SH_TEL),

v) billing reference information (GOTO (xii)),

Figure 13 - Phase I of Reengineered ITV Process



vi) type of service requested (SER_TYPE),

vii) request/no request for constant tracking (CONS_TRAC, if YES, then GOTO next,

if NO, then GOTO recipient info),

viii) mode of tracking information receipt desired (MODE_TRAC),

ix) details of recipient mode (if MODE_TRAC = COMP, then NODE_ADDR;

else if MODE_TRAC = FAX, then FAX_NUM;

else if MODE_TRAC = VOICE, then TEL_NUM),

x) any other recipients (MORE_REC),

xi) start from (viii) (if MORE_REC = YES, or SKIP next), and

xii) billing information - credit card number and expiration date (CRED_NUM,

EXP_DATE,

then GOTO (vi))

<u>recipient information</u>:

i) recipient reference number (REC_REF, if YES, then END,

if NO, then GOTO next),

ii) recipient name (REC_NAME),

iii) recipient address (REC_ADDR),

iv) recipient telephone number (REC_TEL).

Once the information receipt is complete and the data is processed, a confirmation message is sent to the recipient via the medium of RFP. This confirmation message also includes a tracking number which is tagged to the received data. As mentioned previously in Chapter 3, UPS handles 12 million packages a day and so, initiates as many transactions within the system (on an average, 140 transactions per second). It is assumed that the model being presented also encounters the same number of transactions. Each transaction generates about 400 bytes of data (4.91 GB / 12 million packages - section 3.2.2). Assuming this load rate of 400 bytes of data per transaction, each second generates 56KB of data. The time taken to respond by the system with a confirmation message would be dependent upon the processing speed of the Multimedia Response Unit. If it is assumed that the data is uncompressed and is received and transmitted at 9600 bps (common speed for a data/fax modem), it can be assumed that for transactions initiated via fax or electronic messaging, the response time of the system, once the data is sent by the shipper, would be the sum of the time to receive the data, the time to process the data, and the time to respond with the tracking number. (The response time for a interactive voice session between the customer and the MRU will depend upon the customer response time upon query, processing speed of the voice recognition unit of the system, and the database performance of the processing server unit.) Receiving the data will take approximately 40 seconds (400 bytes / 9600 bps). To process the data, it is assumed that the MRU is comprised of the Sun SPARCserver 1000. A Sun SPARCserver 1000 has a database performance of 400.8 TPC-A running IBM's IMS database management system. It has a maximum I/O data rate of 1.4 MB per second [62]. On an average, it can handle a total peak load of about 3400 incoming (400 bytes per transaction) and outgoing (12 bytes for each tracking number) transactions per second (1.4 MB / 412 bytes per each completed RFP). Also, the time to send the12 byte tracking number (similar to the one being used by UPS, and as shown in figure 10) would be about 1.5 seconds (12 bytes / 9600 bps).

The data, tracking number and time of RFP initiation are logged into the ITV database server. The shipper and recipient information and tracking number are sent to the routing server.

Package pick-up

In this model, the routing server is interfaced with ATIS (Advanced Traveler Information System - part of the Intelligent Vehicle Highway System), and the Loran Navigational System. These locally integrated information systems communicate with the transponders on the courier vans to determine their location, and estimated time to reach shipper. Based on optimizing algorithms, these information systems transmit the information to the computer in the van that can optimally reach the shipper. The information systems also relate the optimal route to reach the shipper. The display in the vans shows the shipper information (items (i) through (v), and (xii)) and the optimal route. Meanwhile, the laser printer on the van prints out the labels containing the shipper information and the recipient information, the tracking number and the routing code as fed in by the information systems. At the point of pick-up, the courier receives the package, applies the label on the package, and scans the barcode with a hand-held computer with a built-in scanner. The courier also requests the sender to provide a release signature on the hand-held computer. In the case of large businesses, systems such as the PowerShip could be used to generate the barcodes, print the labels, and send the barcode data directly to the carrier. In this case, the courier only scans the packages to verify that the packages corresponds to the barcode data sent by the shipper, obtains a release signature from the shipper, and picks up the packages. Once the package has been picked up from the shipper, the hand-held computer uploads the barcode information to the van's computer which transmits the data along with a time-stamp and the van identification number to the ITV database server and the routing server. The barcode number corresponds to the tracking number issued during RFP. Upon reception of this information from the van's computers, the ITV database server transmits to the designated ITV information recipients, a status message and the time of pick-up. The routing server, in the meanwhile, sends the information received from the van, upon completion of all pick-ups, to the departure server at the port of dispatch to the hubs in the form of a batch file. This batch file tells the departure server the number of packages to expect, the delivery van identification number, time when the packages can be expected at the port of dispatch.

Package transit to hub

The vans deliver the packages to the port of dispatch from where the packages are to be sent to the hubs for sorting. As the packages are off-loaded, their barcodes are scanned. The information received from the routing server, and now in the departure server, is cross-checked with the barcodes scanned to ensure that all packages have been received for dispatch to the hubs in the designated vans. As the packages are placed aboard the planes or mode of transport to the designated hub, based on the kind of service requested (SER_TYPE), the barcodes on the packages are scanned, while container and flight number are entered into the departure server during the loading of the packages. Also, the departure server is interfaced with the Ramp Management Advisory System which sends it notifications when the flights leave.The departure server sends a batch file consisting of the barcodes (keys), container number (CONT_NUM), flight number (FLT_NUM), number of packages, departure port and the time of departure to the hub server. The departure server sends another batch file consisting of barcodes (keys), container number (CONT_NUM), flight number (FLT_NUM), and time of departure to the ITV database server and the routing server. The ITV database server, sends an update to the designated ITV information recipients consisting of the status message and the time of departure.

The vans, upon completion of the off-loading process of the packages at the port of dispatch, log their hand-held computers to the departure server which also updates the routing server. The status of the van is reset from pick-up to delivery. Also, the release signatures from the shippers are uploaded to the ITV database server via the departure server.

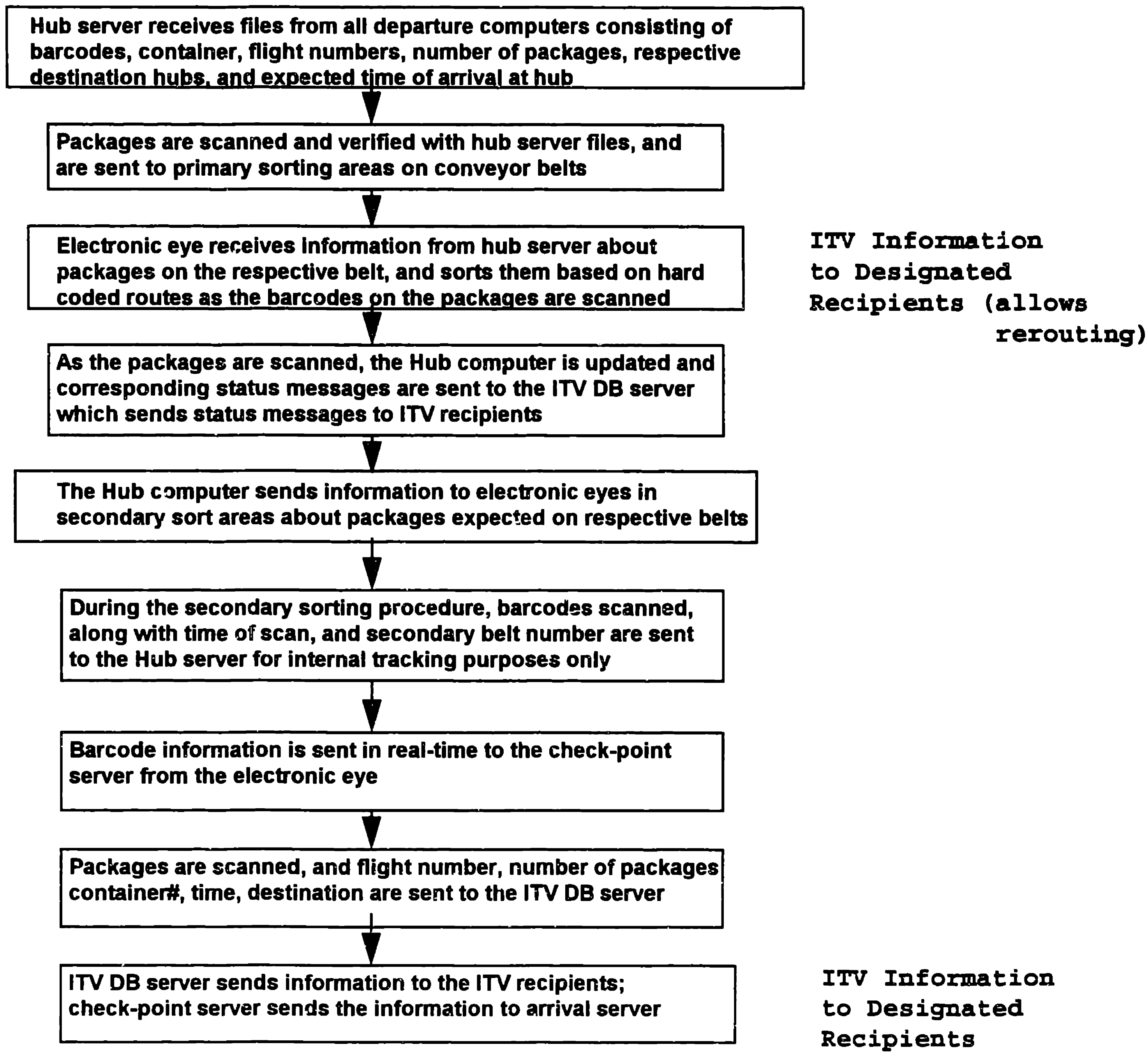
5.4.2 Phase II

Figure 14 represents the work-flow diagram of phase II.

The hub server is fed with batch files containing the aforementioned information from all the ports of dispatch. As the packages are received and off-loaded, the packages are scanned as they move to the primary sort area and a verification routine is performed with the file containing the information about the expected packages. The status, time of arrival and hub name are sent to the departure server and the ITV database server. If the verification routine is error-free, then the status message received by the departure hub completes the hand-shake and the departure server's duty is complete. If not, then the route on which the package was misplaced is already traced and the tracing procedure can be initiated on the respective fronts (i.e.. the employees who loaded the airplane in the port of dispatch and the off-loaders at the hub form the "virtual team" to solve the case event). The ITV database server sends the status message, and time of receipt to the designated ITV information recipients. The scanned barcodes are also fed directly from the hub server to an electronic eye so that it knows which packages to expect on the automated belts.

The electronic eye is programmed to activate the sorting arm based on the routing information as scanned from the barcode, and the hard-coded information relating the routes and the corresponding belt. The sorting arm directs the package on to one of the conveyor belts that leads

Figure 14 - Phase II of Reengineered ITV Process



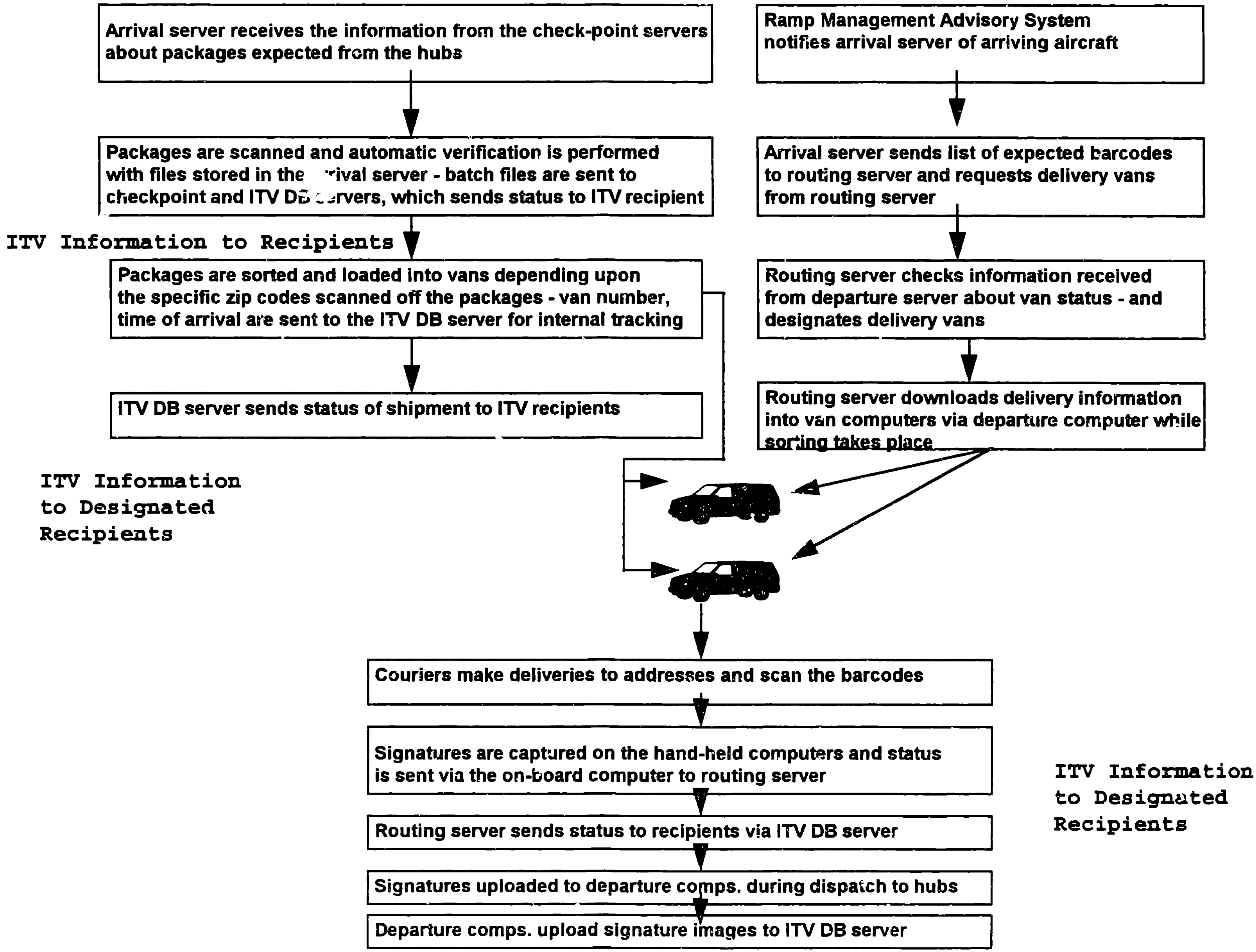
to one of the secondary sorting areas. As the electronic eye scans the packages as each one comes along the conveyor belt, it marks the corresponding expected barcode as received from the hub server, and sends the status and the conveyor belt number to the hub server in real-time. The barcode information is also sent to the electronic eye at the respective secondary sort area so that the secondary electronic eye knows which packages to expect. Once again, if a package is unaccounted for, a trace can be set up between the off-loaders and the area where the electric eye scans the packages.

As the packages move along the conveyor belt to the secondary sort area, the same routine is performed by the electronic eye in the respective secondary sorting area. The electronic eye directs the package to the container area. The status and the secondary conveyor belt number are sent to the hub server . The electronic eye also sends, in real-time, the barcode information to the check-point server. The packages, in the meanwhile, are scanned and loaded onto the containers. The container number, the flight number, destination, barcode information are scanned and loaded into the check-point server which verifies that all packages have been received and loaded. The check-point server sends the status message to the hub server, and also sends the flight number, number of packages, container number, barcode information, time stamp, and destination to the ITV database server via the hub server, and the arrival server at the port of arrival. The ITV database server notifies the designated ITV information recipients with a status message and a time stamp.

5.4.3 Phase III

Phase III of the reengineered model (please refer to figure 15) consists of two sub-processes:

Figure 15 - Phase III of Reengineered ITV Process



- package receipt from hub, and
- package delivery.

Package receipt from Hub

The arrival server receives from the check-point server the information related to the packages to be expected at the port of arrival. As the packages are scanned and off-loaded status messages and time stamps are stored into the arrival server. An automatic verification routine like the one performed at the port of dispatch is performed and the batch file is sent to the ITV database server, which, in turn, sends a status message and a time stamp to the designated recipients.

In the meanwhile, as a plane arrives at the port with the packages, the Ramp Management Advisory System (already in existence at Federal Express to manage flight logistics) notifies the arrival server [30]. The arrival server sends list of expected barcodes to the routing server which checks and designates available vans to deliver the packages as they are off-loaded. Multiple vans are loaded depending upon the routes, and the computers in the vans are updated with the destination addresses, optimal route to follow (as received from the routing server via the arrival server) and the corresponding barcode information on the packages.

Package delivery

As the vans reach the recipient address, they scan the barcode and receive a signature from the designated recipient which is loaded onto the computer in the van. The barcode information, along with a time-stamp and name of the recipient is transmitted to the arrival server which designates the process that it had initiated as "complete" for that package, and sends a status message with a time stamp and the name of the recipient to the ITV database server. The ITV database server does the necessary to update the designated ITV information recipients. As the packages are delivered, the van automatically sends a status message to the routing server that its deliveries have been completed and is now available to perform pick-ups. The signature of the recipients are uploaded via the departure server to the ITV database server.

Finally, when the signature is received, the package delivery is designated as complete and a final report containing the signatures of the shipper and the recipient, along with the time logs and corresponding status messages is sent to the shipper and the designated ITV information recipients.

6. Information Technologies in the Reengineered ITV Process

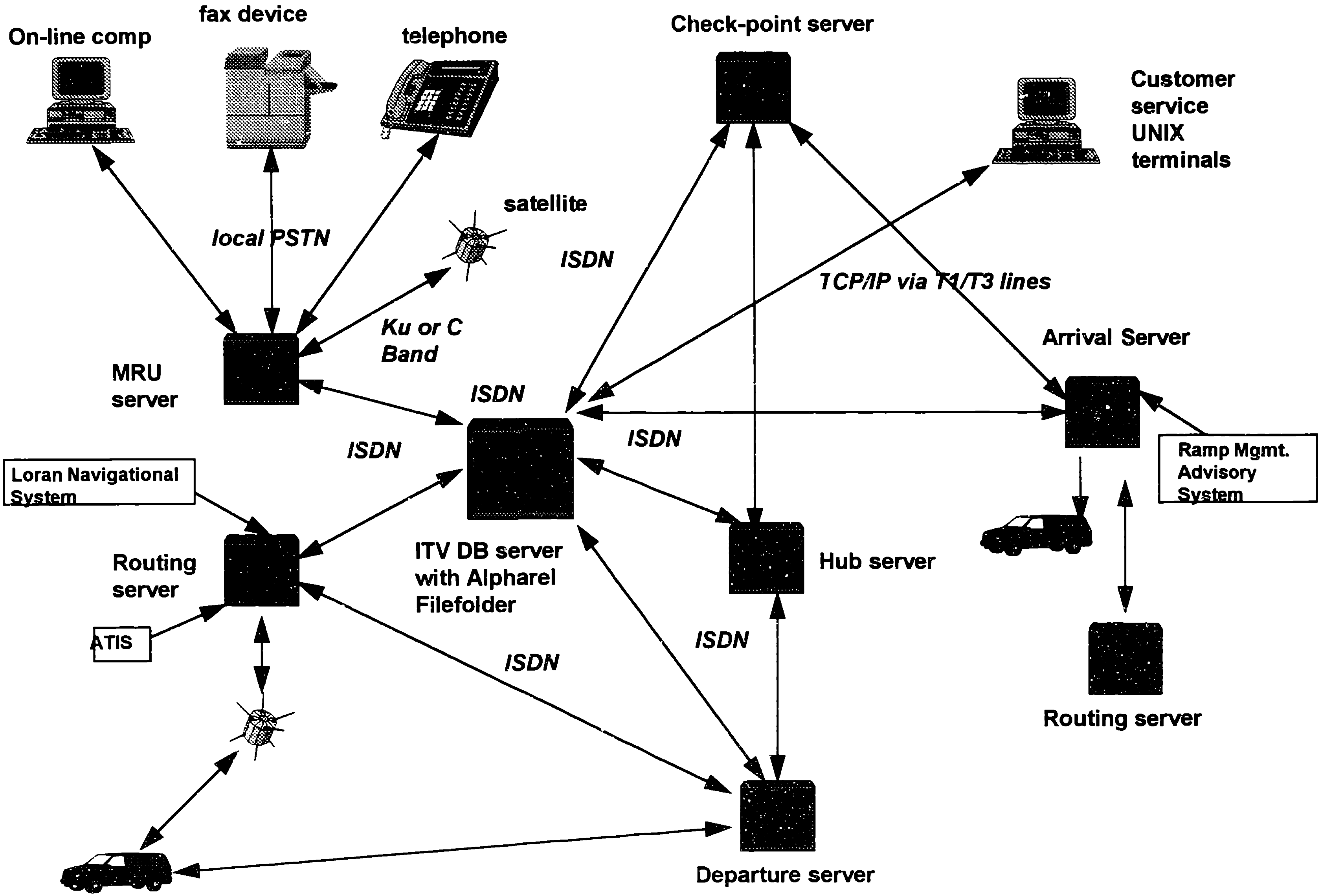
This chapter details the information technologies used in the reengineered in-transit visibility process. The concepts discussed in chapter 4 are further discussed in this chapter in their context to the reengineered ITV process.

To quote Dr. Michael Hammer at the Enterprise '93 Conference in Boston, to be able to successfully reengineer a company's processes "one must imagine all the possibilities of information technology, what it can be pushed to achieve". The reengineered process must be expected to bring about major results - in this case, dramatic improvements in the in-transit visibility process and therefore in customer satisfaction . The information technologies being discussed in this chapter will lay a network of sophisticated information management and processing systems (figure 16). These systems, in turn, will be placed so that they can fully exploit any advances in the information technologies.

6.1 Multimedia Response Unit (MRU)

When the customer wishes to initiate a request for pick-up (RFP) or to initiate a trace of a package that has already been dispatched, the customer can chose to respond via any medium desired. The response can also be received by the customer in any communication medium of choice. This is done via the Multimedia Response Unit which acts as an interface between three technical enablers and the customer. The Multimedia Response Unit consists of three

Figure 16 - Technical Infrastructure for Reengineered ITV Process



sub-interfaces which connect to the three technical enablers. The enablers connecting to the MRU function via electronic messaging, an image processing system and a voice response unit, respectively. The MRU is also interfaced with the Satellite Communications Controller which allows the customer to proceed with the RFP or to receive a trace in the same way as is done via a ground-based communications medium (electronic messaging, fax transmission, or voice). The entire network will be based on the CCITT X.400 Recommendation which will allow for the inclusion of elements crucial for electronic data interchange - the acceptance/delivery vehicle for messages between the company and the customer.

6.1.1 Electronic Messaging

The Consultative Committee on International Telephony and Telegraphy (CCITT) Recommendation X.400 has a set of standards for electronic messaging. These messages will be used to update the customer's computer with status messages regarding the in-transit visibility of the package. The X.400 Recommendation is the first application layer in the 7-layer model used by the industry to conform to the ISO/OSI model (see figure 17). The standards will also conform with the X.435 which offers standards for electronic data interchange.

The use of these standards will allow the creation of an electronic messaging vehicle that will enable customers to link their computers to the company's MRU in spite of the disparate nature of the computer systems, operating systems, or communication networks. The set of standards released by the CCITT X.400 committee has already created a slew of products and interfaces in the industry capable of integrating existing proprietary systems, thus, allowing global compatibility for electronic-mail and other electronic-messaging systems [3]. The X.411 Message

The Structure of the OSI Model

The OSI model has a layered architecture. Each of the seven layers performs a different function, and is at a different stage of standardization.

Layer 7: Application Layer allows the application to access the OSI environment.

Layer 6: Presentation Layer translates and transforms information, providing workstation standards and display rules.

Layer 5: Session Layer coordinates communication dialogues among cooperating applications.

Layer 4: Transport Layer is responsible for end-to-end data integrity. It is defined and supported by more organizations than any other layer.

Layer 3: Network Layer moves data through a network.

Layer 2: Data Link Layer provides the procedures and functions to establish, maintain, and release connections between two communicating nodes.

Layer 1: Physical Layer transports data on the transmission medium.

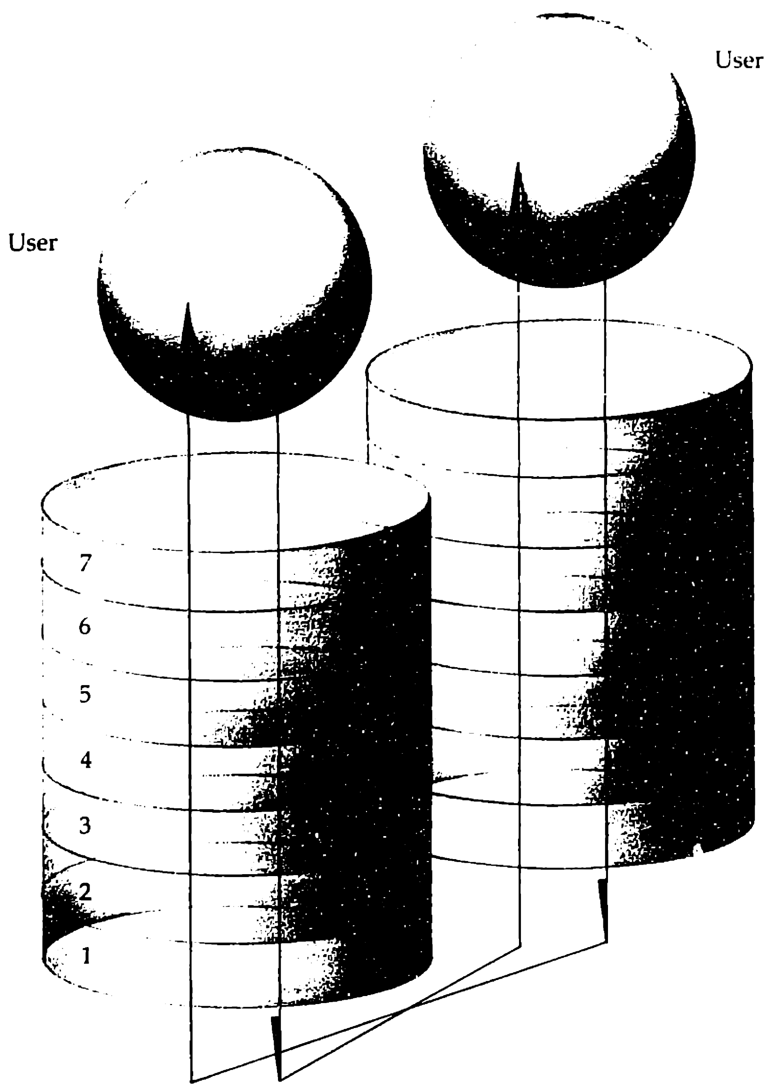


Figure 17 - The 7 layers of the Open Systems Interconnection (OSI) Model

Transfer Layer provides general, application-independent message transfer. The Message Handling System (MHS) user can, thus, be a computer or a person. The MHS consists of User Agents (UAs) and Message Transfer Agents (MTAs). A customer prepares the message consisting of the shipper and recipient information and with the assistance of the local UA - on the customer's system, structures the information for delivery to the Message Transfer Agents. The UAs interact with the MTAs of the customer's system and, in turn, send the message to the company (Federal Express or UPS) MTAs which in turn send the message to the MRU.

The UA performs various functions such as creating, filing, presenting messages as well as managing incoming or outgoing messages. The customer interacts with the UA via traditional input/output devices, including keyboards, video displays, printers, or facsimile equipment. A UA is implemented as a set of processes in the computer system or intelligent system. An MTA is also, likewise, a set of processes which reside as standalones or in a computer system [16].

Messages originated or received by the UA are handled in the form of an "envelope" plus content structure. The interactions are analogous to the ways individuals use public and private services to distribute mail and parcels. The basic MT service provides the UAs with two-way access to MTS and assigns each message a unique reference (tracking) identification code. When a message is undeliverable, the MTS informs the originating UA. The UA can specify the encoded types of information within a message, such as original encoded types (text, data, image); times of submission and delivery; and content conversion instructions, such as encryption.

Once, the message is received, it is sent via the protocols to the database servers where the client verification is performed (i.e.. credit verification, account verification) and upon receipt of the "ok" status, a confirmation message is sent out to the customer. The message is sent out via the same protocols as used during the message receipt from the customer.

The same procedure is performed when the customer is notified of the status of a shipment.

6.1.2 Facsimile/Imaging Technology

The facsimile technology, at a level of processes, works in a similar fashion as that in electronic messaging. However, facsimile technology has an added component that greatly differentiates it from regular electronic messaging. While electronic messaging takes place via direct data communications between computers, facsimile technology uses image processing to convert hard copies of images into digital signals when they are being sent, and vice-versa when they are being received.

The component parts of the facsimile system include the transmitter (or document scanner), which sends the data; the receiver (recorder or printer), which accepts and reproduces the data; and the transmission facility, the connection between the sending and receiving stations. The customer either handwrites or types the shipper and recipient information and feeds it to the facsimile device [39].

The transmission of the output signal is accomplished through modems that act as modulators (at the transmitter) and demodulators (at the receiver). Modems are classified according to the capacity to handle the number of bits per second (bps): 2400, 4800, 9600, 12800, 14400. The signals, in the case of the MRU, are sent via local PSTN or Public Switched Telephone Network which integrate into the digital network (ISDN) connecting the local PSTNs. At the MRUs, the analog signals received via the local PSTN are converted into equivalent digital signals via a analog-to-digital converter [39].

The facsimile receiver is typically an Intel-based PC running MS-DOS, MS-Windows, or UNIX, or a RISC-based computer running UNIX. Considering the high volume of calls received per day to track packages now, it can be reasonably assumed that a RISC-based UNIX computer will be used for the scanners. Also, the UNIX computer has the added advantage of following the ISO/OSI platform. As the facsimile receiver will be a part of a distributed system, the storage servers (ITV database server) will be fed by the capture workstation (UNIX workstation) via the network.

At the point of capture, image compression is done under CCITT Group 4 compression standards, yielding 10:1 compression. A de facto standard called Tagged Image File Format (TIFF) can also be used to specify the header, a text portion of the file containing information about the graphics contained within, such as the size of the image, the number of bits per pixel, and the resolution. TIFF can be used with the CCITT Group 4 standards. Another compression format, Computer Aided Logistics (CALS) file format, used by the U.S. military and its contractors, can also work with the CCITT Group 4 format, thus giving the MRU the advantage of working with civilian as well as with military customers.

Once the image is received by the facsimile receiver, indexing of the electronic image of the document can be avoided by tagging the tracking number to the image. The tracking number can be used as a function of the database index. The imaging system used by the MRU will consist of the Alpharel Filefolder. The characteristics of this product are described in the table below.

Vendor	**Alpharel, Inc.**
Product	**Filefolder (Host and C/S)**
Features/Functions	
View Functions	Pan; reverse; rotate; scale; scroll; windowing; zoom
Image Retrieval via	Color monitor/printers; digitizing microfilm readers; high-res monitor; high-speed/laser printers; plotters
Facsimile support	Receive/transmit
Document Annotation/Markup	Yes/yes
Storage Media Supported	12-inch WORM optical disk; 5.25-inch WORM optical disk; 9-track cartridge; CD-ROM; aperture cards; magnetic disk; optical jukebox; magnetic tape; rewritable optical disk
Compression/Decompression Standards	CCITT G3; CCITT G4; JPEG
Import/Export Document Formats	ASCII; CALS 1; CCITT G3; CCITT G4; CGM; DXF; HPGL; PCX; TIFF; TRIF
COLD/COM/OCR	yes/yes/yes
Image Enhancement/ICR	yes/yes
Quality Control on Scanner Input	Data field validation checks; rejecting document batches; rejecting individual document; rescan; reentry; replace; scanned data confidence checks
Image Index Database	DB2; DEC-VMS/RDB; Oracle; any existing index database
Workflow Processing Features	Automatic time checks; document rendezvous; electronic paperclip; programmable routing; suspense files; user-override of programmable routing; user-scheduled work assignments; work prioritization
Configuration Architecture	IBM mainframe; multiserver/client workstations; single-server/client workstations; standalone
Workstation (Standalone) Model	Apollo; Digital VAX; IBM 370; IBM PC and compatibles; IBM PS/2; IBM RS/6000; Macintosh; Sun Microsystems

Workstation Operating System	AIX; MS-DOS; MVS; Macintosh; OS/2; UNIX; VM; VMS
Server (Host) Model	DG AViiON, DEC; IBM 370; IBM PC and compatibles; Macintosh, Sun Microsystems
Server (Host) Operating Systems	AIX; MS-DOS; MVS; Macintosh; OS/2; UNIX; VMS; VM
Local Area Network Support	DECnet; FTP; IPX; NETBIOS; NFS; Named pipes; TCP/IP 3270
Terminal Emulation	VT-100; VT-200; VT-320
Application Development Tools	APIs from existing applications; APIs to existing applications; calls to object libraries for imaging services; image management utilities; menu-driven programming interface; programmable device drivers
Graphical User Interface Support	Intuition; Macintosh; Motif; PM; Windows; X-Windows
Interfaces to Existing Databases	DB2; Oracle; any existing IBM, DEC, and UNIX database
Price (Base System) ($)	100,000 to 2,000,000
Proprietary Hardware Required	**None**

The Alpharel Filefolder will be interfaced with the ITV database server (IBM's IMS hierarchical database server) to support quick storage of the data received. The images will be stored on 12 inch WORM (write once read many) optical disks. These optical disks will hold about 2 GB of data or about 50,000 images of standard business letters. The WORMs will be stored, in turn, in optical jukeboxes, which can hold as many as 200 optical disks, and can automatically retrieve disks from racks and load them into drives.

6.1.3 Voice Response System

Voice response systems essentially enable people to communicate with computers. They are usually menu-driven based on voice-processing principles, where the voice of the caller is translated into digital format that the computer processes and stores. The voice response system is supplemented by the customer service agents who intercept the system in case of trouble or in the case of the caller requesting a customer service agent.

The voice response system prompts the caller (the shipper) to find out if the shipper is already a account-holder with the company. If so, the account number and password are entered by the shipper and the shipper can bypass the routine of entering by voice all the shipper information otherwise required by the system. This also saves processing and time required for the usual voice response session and keeps the menu-options to a minimum.

The VRS accepts the voice (if the shipper has an account, then the digital tone signals), as input. The VRS translates the voice into computer digits, which it sends to the storage receptacle. If the voice recognition process is not sufficient to process the voice of the caller, the customer service agent can interject to continue the conversation, or the caller can request another medium to initiate the RFP or the trace.

Each time a voice is processes, the digitized voice is played back using a digital-to-analog converter to confirm correct entry. The VRS stores voices in the same way as is stored in the databases, as the voices are recognized and converted into binary digits. The VRS used in the MRU will be a transactional voice response system, that performs the functions of interacting with the host computer database (ITV database server) to selectively retrieve data, converting the digital data to analog voice and transmitting it through the telephone, and also allows the caller to input the data to the host computer.

This application is expected to develop significantly in the near future, and the existence of such as unit will serve the company as a prototype to evaluate customer response to the technology and the company's improvement in the in-transit visibility process. This will also allow the company to reduce the overheads attached to the customer service agents. A product that has been used by Sea-Land Service, Inc., a unit of CSX Corporation, allows the user to interact with the system. The product, InfoPlus from Periphonics Corp., allows customers to receive information about their shipments as their speech is processed by Periphonics VPS 9000 voice-response systems. These systems are typically configured with 10 hours of vocabulary storage on disk and 3000 seconds of RAM [17].

6.1.4 Satellite Communications

The Satellite Communications Controller interfaces with the multimedia technical enablers with information received in the form of electronic messages, facsimile, or voice, via satellite transmission. This will facilitate the initiation of RFPs or tracing requests from customers who do not have access to ground-based communication media - for example, customers on a ship who wish to have the company pick up a package from the port upon arrival of the ship. The satellite communications also allow the transmission of the in-transit visibility information to the designated recipients via any medium of choice. The use of the satellite communications medium also has its benefits internal to the company. The fixed satellite communications technology also allows the real-time tracking of the pickup/delivery vans via the routing server which is interfaced to the Advanced Traveler Information System (ATIS) and the Loran Navigational System. This medium facilitates the sending and receiving of information (for example, shipper information to a pickup van, and recipient information to the ITV database server) between the vans and the database servers. The cost of having such a communications setup is quite reasonable and also allows the interface to grow as new applications such as global mobile communications increase in the near future (for example, Motorola's Project Iridium which will put 77 geo-stationary satellites in low-orbit around the Earth, facilitating the communications between anyone in the world with anyone else).

The information to be transmitted either to the vans or to the designated ITV information recipients is sent via the Satellite Communications Controller. The technique used to transmit the information to the satellite is time-division multiplexing (TDM). Since the information being sent is voice as well as other data services, the TDM is especially useful in efficiently transmitting the data. Because the TDM transmissions permit only one signal to occupy the available full channel bandwidth at any moment, unwanted crosstalk between signals occupying the same frequency spectrum is not created.

The information received by the Satellite Communications Controller is done via a technique called cross-strapping which involves uplinks to the C-band and downlinks from the Ku-band, to take advantage of both frequencies. The band used to transmit the messages to the vans is done via the C-band as the C-band has a smaller "footprint" (the area of the earth where the signal can be received) while the messages received from the customer is quite possibly via the Ku-band, as it has a bigger footprint and thus, reaches a larger area [43]. The best protocol for satellite transmission is the bit-serial protocol - the CCITT's HDLC. In this protocol, the unit of transmission is a frame of variable, but usually large, length. For the case of the interface, this provides the capability of transmitting multiple media (using TDM at the Satellite communications Controller) and is quite useful as it provides the company the ability to transmit and receive large amounts of data.

The Satellite Communications Controller has two regions of control. One is the control region dedicated to the communications with the pickup/delivery vans and the other control region is dedicated to communications with the customer. As was mentioned previously, the information is exchanged between the band and the Controller using the C-band while the other region uses the Ku-band. Each region needs a special kind of earth station. The corporate network, as it interfaces with the multimedia customer communications, uses a "mesh" network which allows it to be connected to any other station in the network. As each earth station covers about one million square miles, ten of these stations can span the entire country. The cost of each of these stations is about $500,000 [40].

The other region involves communication in a local area of about one hundred thousand square miles. This can be done via a VSAT (very small aperture terminal) network which consists of one master earth station (MES) and up to two thousand VSAT terminals sharing the same MES. As efficiency dictates, the routing of vans is multiple (and nearby) areas ca be performed by one MES/MRU. These networks are generally limited to data transmission and image reception.

The advantages of the satellite communications system within the information system are:

- stable costs - the cost of transmission by satellite is the same regardless of the distance between the sending and receiving stations. Additionally, all satellite signals are broadcast. The cost of a satellite transmissions, therefore, remains the same regardless of the number of stations receiving that transmission - especially useful in broadcasting ITV information to multiple recipients, simultaneously, and in real-time.
- high bandwidth - satellite signals are at a very high bandwidth, and thus capable of supporting the multimedia communications between the MRU and the customers.

- low error rates - bit errors in a digital satellite signal occur almost completely at random. Therefore, statistical systems for error detection and correction can be applied efficiently and reliably. The random bit error rate is very negligible to the human error rate in manual keying in of the data by customer service agents.

6.1.5 ISDN and Satellites

An all-digital communications network benefits the network's users and the network. As was mentioned earlier, ISDN is being brought into local networks with the purpose of making the entire communications network within terrestrial US all-digital. ISDN is intended to be a global communications system and satellite communications being still the only way to reach some customers must be a part of the network.

ISDN users have several advantages: universal ports, dynamic allocation of bandwidth, multiple phone lines, advanced digital signaling, improved network efficiency, and very low error rates. Yet, some of the Regional Bell Operating Companies only accept analog signals in their PSTNs. The use of analog to digital converters facilitate the interconnection to the ISDN in these areas. The services provided by the satellites are ISDN-type but they cannot be considered ISDN because they do not follow the recommendations of the CCITT. However, a new CCITT-International Radio Consultative Committee is expected to release the standards allowing complete compatibility of ISDN with satellites. By the time, the project is developed and systems are ready to be implemented at the company to reengineer ITV, compatibility issues will be resolved.

Some of the recommendations have already been released. Recommendation T.90 addresses group 4 facsimile characteristics and protocols over ISDN. Circuit-mode speech is addressed in recommendation I.231. Both of these recommendations take care of the problems that may accrue out of the ISO/OSI model that has its own procedures in place. As the procedures take place sequentially, the time taken to clear the seven-layered protocol stack can be several seconds, regardless of the transmission speed. This can be a potential bottleneck when high volume data is being sent via the satellites/ISDN network [7, 43]. The Q.922 addresses the ISDN data link layer specifications for frame mode (the data transmission window which was discussed earlier). It discusses dynamic window size to control congestion and describes the congestion control algorithm.CCITT SG VIII is addressing these and other issues and has introduced changes that alleviate the problems and provide an increased degree of satellite compatibility [40].

6.2 Intelligent Vehicle Highway Systems (IVHS) Technologies

The Intelligent Vehicle Highway System will offer benefits specifically to operators of delivery vans and other commercial vehicles. In the reengineered model, the commercial vehicle operations and the Advanced Traveler Information System will represent the some of the ideas behind IVHS.

Although commercial vehicles will benefit from these other applications, Federal Express and UPS have special needs related to fleet management, and efficiency. The advancement of technologies such as satellite communications and tracking systems, on-board computers, and automatic vehicle identification with electronic transponders, promise to allow far superior tracking capabilities than the ones currently in existence at Federal Express and UPS.

Satellite systems are one of the most heavily used tracking systems. They are used in fleet management operations by specialized truckload carriers, transit buses, and police vehicles. One of the primary functions of the satellite systems is to determine vehicle location. This function is called Automatic Vehicle Location (AVL). While GPS (Global Positioning Systems) and other satellite-based systems are the most widely used AVL technologies, alternative, terrestrial vehicle tracking technologies are proliferating. These include adding special equipment to cellular telephones to determine their location and various methods using radio signals.

Another primary function of most tracking systems is to enable real-time communication between the driver and central dispatch office. Typically, satellite systems consist of a communications control center, a vehicle tracking unit, and a communications interface. The control center serves as a monitoring station for each vehicle equipped with a tracking unit, communicating with the vehicles by two-way radio, cellular telephone, and communications satellite. The tracking unit has a multi-channel receiver. These systems allow dispatchers to view the fleet and track movements on computerized maps allowing superior in-transit visibility of goods to the carriers as well as customers who tap into the network.

Communications and tracking systems are integrated with computer-aided dispatch (CAD) systems and related fleet management systems. By way of CVO, a vehicle routing and scheduling system, for example, may use current vehicle location to update a route with stops added since dispatch. An on-board computer or trip recorder (like the "black box" on airplanes) is used to automatically log engine RPM/temperature, vehicle speed, cargo temperature, and other information as functions of time, to predict the time-to-arrival, and to anticipate problems [23].

The benefits of tracking technology and real-time communications technology are summed up in an advertisement placed by Coded Communications, Carlsbad, CA, for its GPS vehicle tracking system. "Knowing exactly where your fleet is at all times improves response time, in-transit visibility of goods to your customers, efficiency, and profits".

The use of these technologies make possible faster dispatching, fuel-efficient routing, more timely pick-ups and deliveries, real-time information to shippers, more reliable passenger service by transit providers, and improved incident response by public service vehicles.

The package carriers, such as, Federal Express and UPS, are viewed as a "huge market" by satellite communications companies. These companies hope to satisfy the ever-increasing levels of service requirements with technology that makes real-time communication and tracking readily available. In fact, many observers feel that the competitive pressures may force all companies in the specialized and truckload carrier sectors of the industry to acquire the technology [36].

If not satellite technology, then a terrestrial system with similar benefits will provide the essential communications between the drivers of the vans and the dispatchers.

Satellite/land-based tracking will be used in Advanced Traveler Information Systems, which includes navigation systems requiring accurate location information. Satellite positioning, electronic reference beacons, or "dead-reckoning" will be used to determine vehicle locations[2].

6.3 Standards for Electronic Data Interchange

As was discussed in previous chapters, there are numerous problems associated with the implementation of EDI in Federal Express and UPS. Though Federal Express has its own proprietary network that takes care of addressing issues arising from differences in data formats, the advantages accruing out of it, as pointed out, will be only short-lived. UPS has proceeded to support the development of standards that will allow the compatibility of multiple systems, thus, giving UPS access to a bigger customer base. Electronic data interchange is being supported by entire industries and there are already some standards that address protocols related to shipper information, bills of lading and other documents. The model that is being described uses the defined standards as the superficial layer above the MRU to provide connectivity to the customers.

6.3.1 EDI Standards

The Transportation Data Coordinating Committee system focuses on how to format the message content rather than how to transmit the message (the aforementioned chapters have already addressed that issue) [19]. It uses a transaction-set structure for defining different message types. Transaction sets correspond conceptually to business forms designed for particular transaction types and are composed of structured data segments used to present specific types of information (for example, ship-to-address). Data segments are composed of a defined sequence of data elements, such as unit price or carrier code. Specific data elements are designated by their position within each data segment. A data element dictionary defined the composition and interpretation of data elements. For example, standards define the interpretation of the date 910403 as April 3, 1991 rather than March 4, 1991.

The standards developed by the TDCC are practically relevant to the model being described. This is because virtually any industry can use the TDCC architecture to structure and define the message types and transaction types. The MRU will provide the calling party with the data necessary to generate and interpret the basic procedures. The common data element dictionary will be used in the systems software within the model with some additional data elements to accommodate a particular industry's requirements to simplify the creation and interpretation of transaction sets.

Also, the system is capable of communicating with credit agencies to verify the information provided by the initiator of the RFP. A separate group consisting of the TDCC, the Credit Research Foundation (National Association of Credit management), and interested corporations was organized for more general EDI between buyers and sellers of durable goods. These participants formed an ANSI working group, now called the Accredited Standards Committee (ASC) X12 on EDI. With few exceptions, the ANSI X12 standards (industry-wide EDI standards highlighted in figure) use this architecture to structure messages.

The fundamental concept of EDI is the electronic transmission of a message generated by a sending firm's computer to a recipient's computer for subsequent processing and action. Instant interactive response is not required in all cases when the ITV information is received within the system (such as the primary sorting area belt number, which is used only for internal tracking); the recipient can accumulate this kind of electronic messages and can add them to the server when convenient. The sender can transmit messages and deposit the messages through an electronic-computer-based mailbox and therefore need not schedule and synchronize message generation and message response operations. Several mailboxes are available via companies such as McDonnell Douglas EDI-Net Service, Sterling Software, CDC's Service Bureau Corp., and General Electric Information Services Co. (GEISCO) [31, 35].

In our case, the information is received in the IMS hierarchical database which interfaces with the MRU, and is subsequently distributed to the other database servers supporting DB2 relational database tables (departure server, arrival server). The interchange of data is between the vans and the MRU, the database and the MRU, is achieved by way of a hybrid network of ISDN and satellites, along with terrestrial leased T1/T3 lines, respectively [16].

6.4 Database Servers

While the communications network incorporating the interfaces with the ISDN and the satellites form the essential backbone of the information system being discussed in this model, the technology that actually contains the information to be "delivered to your fingertips" is that of the database servers.

While servers conjure up notions of high-end PCs with lots of RAM and hard disk space, the database server refers to a more formal, abstract definition - of the server as being a "process". A process is basically a memory-resident program or program module [52]. In the database server arena, then, the model refers to the "server", the reference is to the software that fulfills the server function.

When the model referred to the ITV database server, the reference was to essentially two components of the server - the hierarchical database management system and the relational DBMS. Both the servers consist of four functional parts that make up the architectural paradigm of DBMSs [62]:

- user interface - what the customer service agent sees when he/she interjects the conversation between the automated MRU and the customer, in case of error or customer request. This is made up of UNIX terminals which support the ISO/OSI reference model.
- presentation/internal database logic - the hierarchy of screens and menus plus the logic governing the relationship between them (for example, screen (or computer) prompts for shipper information before requesting recipient information).
- transaction and data integrity logic - this determines whether the request made by the caller to the system is valid by testing the parameters against business rules or policy (such as, the same shipper cannot send and receive the package at the same address).
- data access - this is the process of retrieving, updating and adding data.

The network protocol supporting the interconnection between the terminals and the database servers is made up of the TCP/IP protocol stack. The Alpharel Filefolder product that has been adopted as one of the MRU server unit, is compatible with the UNIX protocol stack and will allow the storage/access from optical jukeboxes of faxes and other images such as signatures.

The IBM IMS hierarchical database is used to manage the storage of all the ITV information and to guarantee fast performance - that is, fast storage of the data received from the couriers, customers (via the Alpharel Filefolder and other MRU server units) and the relational servers. The DB2 servers, in the meanwhile, act to provide the final/intermediate reports to the ITV information recipients by way of tables and to allow easy replication and navigation of the data as the data is divided into tables that are easy to manipulate and use. The replication of the data is necessary to ensure that data is received by the arrival/departure and other relevant servers, as the case may be. Data in some of the regions may be stored in one central data repository within one of the regions, thus, eliminating the need of many massive storage areas [45].

The nature of the database servers represent a centrally decentralized approach where data repositories (physical storage of data) are centralized in the region to hold the customer information as well as the ITV information, and the data managers (abstract DBMS software) are decentralized to provide efficient management of the ITV information to track the shipments [11].

7. Conclusion

The in-transit visibility processes at Federal Express and UPS are the primary enablers of improved customer service levels and better tracking of goods. As the nature of the new business environment dictates customers' demands for improved quality and information-based, value-added services, increasing pressures from global competition, and constant change in the markets, the new solution prevalent in the markets is to reengineer the processes to sustain or gain competitive advantages. Simultaneously, as other transportation companies and shipper/receivers integrate their disparate "islands" of information systems [13, 19, 20, 21], the reengineered processes must stand to fully exploit the opportunity to integrate their systems with those of their clients. This provides the reengineering companies with an opportunity to define new business areas based on a solid understanding of the clients' needs (a very good example of this is the Business Logistics Services of Federal Express, where Federal Express takes care of logistics processes of their customers by integrating their customers' needs with Federal Express' global product visibility) [25, 27].

The model proposed in the previous chapters integrates the concepts of state-of-the-art information technologies in a way so as to not only improve service levels and productivity per employee by reducing costs, but also by positioning the company to identify and exploit any new business opportunities. The advantages of the reengineered model elucidated below eliminate bottlenecks associated with the existing in-transit visibility processes at Federal Express and UPS:

A) Organization of the process -

As a result of the organization of the process, the proof of transit is the most visible product that proves the completion of pick-up/delivery life-cycle. By making the data accessible even in the case of breakdown and by way of constant automatic verification performed by the various servers, the employees work in "case teams" on each tracing request. Customer service agents, employees in the sorting hubs, workers at the destination port are all working towards monitoring the ITV information and in ensuring the successful completion of internal verification routines between the servers for each package. If a routine is incomplete for a certain package, the employees at the respective sites work toegther to isolate the area of possible error, and locate the package. Further, service agents can access the entire record of that package's transit and provide the employees working on the case with the details necessary to trace it.

1. <u>data accessibility</u> - better availability of data from secondary sources in case of breakdown of primary sources feeding the customer - for example, the report being presented to the customer can be as re-created by requesting the copies of the status messages with time-stamps and line-item details from the secondary database servers such as departure server, arrival server in case of accessibility problems with the ITV DB server,
2. <u>proof of transit</u> - complete report of goods' transit presented to customers including copies of the shipper's and receiver's signature,
3. <u>internal accountability</u> - improved internal tracking of the goods thereby improving accountability, and increasing empowerment and decision-making at lower levels,

4. estimation of business needs - improved estimation of customer needs, and typical lead times expected, thus, presenting an opportunity to provide third-party logistics and other business services.

B) Job Design -

Unnecessary monitoring of employees is eliminated as tedious jobs of manual keying-in of data and dispatching of vans are avoided by automating the jobs. The focus of each employee is to ensure that the package is received by the designated internal recipient and so, is constantly monitoring the verification routines being performed by each of the servers with each other.

1. customer service agents - fewer customer agents as the multimedia response unit communicates directly with the customers and verifies each segment of information, thus reducing errors associated with rekeying of information,
2. dispatching - fewer dispatchers and improved optimization of pickup and delivery schedules with computer-based optimizing algorithms being used for route scheduling based on anticipation (not reaction) to weather/traffic patterns,
3. vehicle utility - improved utilization of delivery/pickup vehicles as the need to go to a "data control center" to download data is eliminated,
4. keying-in of data - fewer workers needed to rekey zip codes at sorting hubs thus reducing chance of human errors and failure rate associated with rekeying of information.

C) Work Flow -

Work is performed where it "makes sense" and procrastination of the error-detection is avoided. This happens by way of multiple status messages which ensure that the package is constantly tracked internally. The speed of communication between the internal servers because of the residence of data nearest to the shipper as well as at the servers involved during the internal transit of the package ensures that verification routines are performed efficiently and problems are isolated as quickly as possible.

1. modes of communications - dramatically improved communications with customers via computer links, facsimile technologies, voice response - to and from anywhere in the world,
2. number of status messages - increased in-transit visibility of the goods to the customers and other designated information recipients (status messages received six times),
3. speed of communication - faster communications with the shipper because of the residence of information in data centers nearest to the shipper,
4. tracking time - in-transit visibility of the goods (location and time) provided in real-time via status messages and time-stamps,
5. re-routing flexibility - increased flexibility to customers in case of re-routing shipments as communication is possible via the ITV DB server to the departure server, hub server and check-point server,
6. recipients of information - multiple departments can view the in-transit visibility of the shipments as the systems allow as many recipients to receive information as the shipper designates,
7. data addition capability - information can be added to the system to facilitate export/import of goods (hazmat and export/import data).

Some other factors are also addressed in the reengineered process:

1. data integrity - data transmission errors associated with analog/digital communications with the shipper are reduced by way of the statistical error correcting algorithms as communication errors occur almost in random,
2. sorting capacity - increased time available for sorting goods at the hubs as the time needed to manually key in the zip code for each package is eliminated - increased capacity to handle packages,
3. standards - codes printed on labels by laser printers in vans, based on standards that allow identifications of destination/hub sites and thus, lower failure rates as a result of misinterpreted location codes,
4. logistics - better estimation of lead times for raw materials,
5. carrier performance - improved evaluation of carrier performance.

The reengineered in-transit visibility process will position the company to take advantage of development in promising information technologies such as:

1. intelligent voice processing systems,
2. improved compression and storage technologies for imaging systems,
3. clear (fewer data transmission errors) communication links via digital communication media,
4. open systems internetworking with customers' systems which were previously considered as "islands" of information containing disparate databases,
5. third-party electronic data interchange products,
6. advanced database servers (perhaps, object-oriented DBMS),

7. intelligent traveler based information systems, part of the Intelligent Vehicle Highway Systems project, and
8. improved quality of scanners and hand-writing recognition software/hardware.

The reengineered process will dramatically improve customer satisfaction levels, drastically cut costs and reduce chance of human errors in the extremely time-sensitive package/document delivery market. For the company, it will also raise the barriers to entry for potential entrants, decrease the threat of substitutes, and reduce the bargaining power of customers - the essential attributes of a powerful competitive strategy [46].

Last, but surely not the least, in the name of conceptual selling and at the risk of appearing nonchalant, I might add that like the whispering cornfields in the movie "The Field of Dreams", if they reengineer the process, the customers will come....

BIBLIOGRAPHY

1. American Management Association Management Briefing. *"Blueprint for Service Quality: The Federal Express Approach"*. American Management Association.

2. American Shipper. *"Truckers sign up for tracking systems"*. May 1993.

3. Andersen Consulting. *"Trends in Information Technology: The Challenge of Business Integration"*. Arthur Andersen & Co., S.C.

4. Ballou, Ronald H. *"Basic Business Logistics"*. Prentice-Hall.

5. Banks, Alan Drew. *"Deriving Competitive Advantage through a Sophisticated Information Technology Infrastructure (A Look at Federal Express and UPS)"*. SM Thesis - MIT.

6. Bonney, Joseph. *"Shipper-controlled cargo tracking"*. American Shipper, February 1992.

7. Bonney, Joseph. *"Unified air cargo booking system"*. American Shipper, May 1991.

8. Booker, Ellis. *"UPS to deploy wireless network"*. Computerworld, May 18, 1992.

9. Brown, Bob. *"Rivals Fedex, UPS bring battle to high-tech arena"*. Network World, June 7, 1993.

10. Canna, Elizabeth. *"Carriers ready to share global systems"*. American Shipper, August 1991.

11. Cash et al. *"Corporate Information Systems: Text and Cases"*. Irvin Publishing.

12. Christian Science Monitor. *"UPS facility sorts 30,000 parcels an hour"*. August 28, 1991.

13. Christie, Rick. *"JAL, Lufthansa, Nissho seek DHL stake, raise ante in express-delivery market"*. Wall Street Journal, May 10, 1990.

14. Consumer Reports. *"United Parcel Services"*. November, 1987.

15. Coy, Peter. *"UPS: up from the stone age"*. Business Week, June 15, 1992.

16. Davidson, Robert P. *"Hybrid Networks"*. Information Management, 1990.

17. Diamond, Sam. *"Voice-response system allows fast cargo tracking"*. Telecommunications, October 1990.

18. Dietzel, David C. *"Federal Express: COSMOS package and document tracking system"*. International Forum for Air Cargo - Conference Proceedings, 1990.

19. Distribution. *"Cargo data link linked between major carriers"*. August 1990.

20. Distribution. *"Carrier consortium jump starts cargo automation system"*. February 1992.

21. Distribution. *"Integrators go for global contracts - outsourcing distribution operations"*. October 1992.

22. Duffy, Caroline A. *"UPS toes the lone with its package-tracking technologies"*. PC Week, June 28, 1993.

23. Erickson, Cathy L. *"Current Trends in the Use of Information and Communications Technology in the Transportation Industry"*. Truck and Economic Studies Section, Minnesota Department of Transportation, 1992.

24. Federal Express. *"COSMOS: How the System Works"*. Federal Express.

25. Federal Express. *"Federal Express Service Guide"*. Federal Express.

26. Federal Express. *"Making Every Minute Count - Federal Express Service Guide, Volume 2"*. Federal Express.

27. Federal Express. *"Form 10Q - Federal Express"*. Securities and Exchange Commission.

28. Flynn, James M. *"United Parcel Services - A Presentation"*. November 9, 1988.

29. Fost, Dan. *"Roadnet and high-tech home delivery"*. American Demographics, February 1991.

30. Gray, Robert Gordon. *"A model for optimizing the Federal Express overnight delivery aircraft network"*. Thesis - Arizona State University, 1990.

31. Graziani, Joseph M. *"Electronic Data Interchange issues in the transportation industry"*. Remarks at the Center for Transportation Studies, MIT, November 11, 1988.

32. Hannon, Kerry. *"Shifting gears: Roadway Package System"*. Forbes, December 11, 1989.

33. Kindel, Sharen. *"When Elephants Dance"*. Financial World, June 9, 1992.

34. Knee, Richard. *"Next 3 steps in Customs Automation"*. American Shipper, November 1992.

35. Lyon, Mark. *"Filling the void: automation of air cargo service"*. Airline Business, January 1992.

36. MacDonald, Mitchell E. *"Satellite tracking has trucking industry beaming"*. Traffic Management, July 1989.

37. Maglitta, Joseph. *"Being the best in business: Fedex CEO Smith"*. Computerworld, February 2, 1991.

38. Malkin, Richard. *"A portrait of air cargo's future: views of UPS exec T. Keating"*. Distribution, March 1991.

39. May, Thornton A. *"Imaging Technology"*. Information Management.

40. Mitchell, Gerald A. *"The Coexistence of ISDN and Satellites"*. Data Communications Management.

41. New York Times. *"UPS to track packages with cellular system"*. February 9, 1993.

42. New York Times. *"United Parcel Services of America, Inc."* June 25, 1993.

43. Norris, Richard. *"Communications Standards for Industrywide Electronic Data Interchange"*. Information Management, 1990.

44. Parker, Rachel. *"UPS pioneers a cellular data network"*. InfoWorld, June 8, 1992.

45. Port Authority of New York and New Jersey, Transportation Information Action Panel. *"Strategies for the dissemination of transportation information"*. Port Authority of NY and NJ, 1988.

46. Porter, Michael E. *"Competitive Advantage"*. Free Press.

47. Purchasing. *"UPS softens rate hike with new service, fast tracking"*. February 18, 1993.

48. Rouse, Kimberley. *"Federal Express Corporation: A Case Study"*. Crown Publishers, 1991.

49. Schulz, John D. *"A glimpse of UPS in 21st century: innovative, international, automated"*. Traffic World, May 4, 1992.

50. Seward, David L'Estrange. *"The Response of Established Firms to Radical Innovation in Service Industries: UPS vs. Federal Express"*. SM Thesis - MIT.

51. Sigafoos, Robert. *"Absolutely, Positively, Overnight! - Federal Express"*. St.Luke's Press, Memphis.

52. Swedish Transport Research Board. *"Information databases in the field of transportation and traffic"*. Swedish Transport Research Board, 1989.

53. Traffic Management. *"UPS Unveils Tracking System"*. May 1993.

54. Traffic World. *"UPS opens information center; moves towards global network"*. September 16, 1991.

55. Trimble, Vance H. *"Federal Express and Frederick Smith, its renegade creator"*. Crown Publishers, 1993.

56. United Parcel Services. *"Form 10Q - United Parcel Services"*. Securities and Exchange Commission.

57. United Parcel Services. *"UPS 3 Day Select".* UPS.

58. United Parcel Services. *"UPS GroundTrac".* UPS.

59. United Parcel Services. *"UPS Service Guide".* UPS.

60. Vogel, Todd. *"Hello, I must be going: On the road with UPS".* Business Week, June 4, 1990.

61. Wall Street Journal. *"UPS plans tracking service".* April 16, 1992.

62. Watterson, Karen. *"Database Servers: Overview".* Datapro, April 1993.

63. Wexler, Joanie M. *"COSMOS2: Fedex's Next Generation".* Computerworld, February 11, 1991.

64. Wigan, M. R. *"How do we tie the transport information we need together and deliver it?"* Australasian Transport Research Forum, 1990.