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Assessment of Computer Dispatch Technology in the Paratransit Industry

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Executive Summary

Intelligent Vehicle-Highway Systems (IVHS) technologies include a range of communications and control technologies.The U.S. Department of Transportation has applied IVHS technologies, such as electronic payment media, automatic vehicle locator systems, and intelligent databases, to highways and roadways. The Federal Transit Administration (FTA), recognizing the importance of this technology and its potential applications to public transit, has now made IVHS technologies a priority research and development program through their Advanced Public Transportation Systems (APTS) Program. Central to the APTS program is the "mobility management" approach to service delivery. The Mobility Manager is a mechanism for achieving the integration and coordination of transportation services offered by multiple providers (public, private for-profit, and private non-profit) involving a variety of travel modes (bus, taxi, van pool, fail, etc.).

This report contains the results of an investigation into one area of technological advancement--computer dispatching and scheduling technology. The central research question is whether computer dispatch technology is, or will be, capable of effectively improving the efficiency of dispatching shared-ride vehicles on a real-time basis. The research objectives follow:

- Determine the current operating capabilities of computer dispatch systems,
- Assess the costs and economic benefits of'these systems,
- Determine the suitability of computer dispatch technology for transit applications, including user interface and information and the Mobility Manager concept, and
- Recommend future technological directions for computer dispatch.

This study examines current computerized dispatching capabilities of taxicab companies and computerized scheduling capabilities of paratransit operations. Data were obtained through telephone interviews and site visits.

The selected taxicab companies range in size and are scattered geographically throughout the United States. All taxicab companies selected have fully computerized dispatching in place. The purpose of interviewing them was to learn about the reliability of specific computerized dispatching software and hardware, to identify the advantages and disadvantages of implementing such systems, and to understand how computerized dispatching impacts staffing and overall operations. From the interviews, it can be concluded that taxicab companies that transitioned from voice dispatch or computer-assisted dispatch to fully computerized dispatch have experienced a reduction in personnel costs, greater customer satisfaction, increased ridership, faster response times, and an overall more efficient operation.

Computer dispatch systems are not inexpensive. They average about $1 million for a company with 300 taxis; however, the investment can be recouped by fleet expansion. On a national scale about 30 taxi companies have invested upwards of $30.million over seven years. The current estimated savings in travel time to passengers, however, is approximately $44 million annually, a savings resulting entirely from private investment. Proportional savings to the public are likely as computer dispatch technology expands to meet the needs for transportation under the Americans with Disabilities Act (ADA). In the Los Angeles area alone, over 400 operators could benefit from computer dispatch technology.

Other large cities promise similar' markets for computer dispatch. Industry estimates place computer dispatch, scheduling, and information management systems sales at $200 million per year over 10 years--all as a result of ADA.

Although this research focuses on the computer dispatch of taxi trips, paratransit operators and managementcompanies were also interviewed. The purpose of these interviews was to gather information regarding the progress toward automated, real-time scheduling for shared-ride para transi t services. Since fully computerized scheduling is relatively new to the paratransit industry, most of the paratransit companies interviewed utilize specialized software for limited purposes, such as automating recordkeeping and generating "day-in-advance" route schedules for shared rides. Strengths and weaknesses of current computer-assisted and fully automated. scheduling software were reviewed and future technology needs were defined. From these interviews, it can be concluded that all of the operators benefited from implementing automated scheduling and dispatch systems. Automation facilitated the generation of reports, reduced costs (personnel, fuel), allowed for more accurate recordkeeping, and increased overall productivity.

In addition to the telephone interviews and site visits with taxi and paratransit companies, another component of the study involves developing a comparative list of taxicab dispatching software and paratransit scheduling software. Telephone interviews with software vendors, vendor brochures, and a survey by ATE Management and Service Company provided data for comparisons. The results of this investigation show that the paratransit software packages claim similar features. However, the technology for paratransit scheduling and dispatching is rapidly advancing in order to meet the requirements of the ADA, and prospective software and hardware purchasers should evaluate competitive system demonstrations before investing in a system.

The pace of technological change in the taxi and paratransit industry is rapid. Such change is exciting--new products, and concepts for service delivery literally appear every month. Such rapid change also generates concern about the longevity of innovations and their integration.

Currently the focus of the industry is on technology, and many hardware and software improvements are occurring. These include smart cards, automatic vehicle location, real-time dispatch and scheduling for shared rides, integrated reporting and billing, minimum time and distance routing for pickup and delivery of passengers, guaranteed and confirmed service, 911 passenger identification and validation, geographic information system database maintenance, and graphic displays of service areas with relative passenger and vehicle locations. Such "micro-level" improvements are vitally important; however, they will not in themselves improve public mobility appreciably. Innovative thinking is needed about the service delivery system and its affect on area mobility. Creative concepts like the Mobility Manager are needed to impact the way people think about their transportation choices.

Computer dispatch taxi service (especially when effective shared-ride service is available) and real-time dispatch of shared-ride paratransit service are precursors of new service delivery concepts like the Mobility Manager. Already operators have improved their response times, vehicle utilization, and operating costs. They provide wider service options to passengers. And they have simplified fare, billing, and reporting procedures. Real-time computer dispatch has demonstrated its effectiveness in the relatively simple case of exclusive-ride taxi. Now technical and financial resources must be applied to the problem of extending computer dispatch to shared-ride services and accommodating public transit Section 15 reporting requirements.

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1. Introduction

1.1 The Promise of IVHS in Public Transit

Perhaps not since the start of the Interstate highway system in 1956 has the transportation,. sector experienced as dramatic a change as is now occurring with the implementation of Intelligent Vehicle-Highway Systems (IVHS) technologies. including a wide range of communications and control technologies, IVHS is likely to producedramatic changes in how vehicles operate and how travelers learn about transportation alternatives. IVHS offers the promise of increased capacity of existing roadways, safer vehicle movement, more efficient management of freeways, and more accessible and abundant information for travelers both before and after they enter their vehicles. Congress has acknowledged the potential of IVHS by authorizing $660 million for IVHS development in the Intermodal Surface Transportation Efficiency Act of 1991 (U.S. Congress 1991; Deen 1992).

Nowhere is the promise of NHS more tantalizing than in public transit, particularly in non-rail transit. Transit patronage has long suffered from three factors, both perceived and real. First is the difficulty of knowing when and where to board the correct vehicle. Second is the difficulty of knowing the correct fare and producing the exact fare necessary to board a transit vehicle. This problem is particularly acute in metropolitan areas with two or more transit operators using different fare structures. Third is the user's perception of personal risk while on board or waiting for a transit vehicle. Together, these factors act as impediments to transit usage, especially for-occasional or new transit users.

IVHS offers hope for alleviating these problems in fixed-route bus service, demand-responsive general public service, taxicab service, and specialized services for elderly and disabled persons. IVHS technologies are expected to make vehicles safer for passengers and less prone to service delays due to vehicle failure or schedulenon-adherence. NHS is also expected to change completely the manner in which would-be passengers learn about transit alternatives, check on actual vehicle arrival times, and reserve space on vehicles. IVHS will likely change how transit managers monitor the level and quality of service provided and how passengers pay for their rides. Furthermore, these potential benefits are near-term and are likely to occur before many of the highway IVHS applications are fully developed.

The promise of IVHS in the transit sector is so appealing that both the Federal Transit Administration (FTA) and IVHS America, a non-profit organization, have placed a special emphasis on its development. Advanced Public. Transportation Systems (APTS) is one of five program areas within IVHS America. It is also a priority research and development program within FTA.

The advent of APTS is also very timely for the transit sector. in both urban and rural areas the transit industry continues to be pressured to achieve critical societal goals, such as cleaner air, more efficient use of energy, and mobility for elderly and disabled citizens. The Americans with Disabilities Act of 1990 (ADA 1990), for example, requires fixed-route transit systems to provide complementary paratransit services for persons within a three-quarter-mile radius of a transit route and unable to board conventional transit vehicles. ADA also requires systems to respond to previous-day reservations and to strive for real-time response. It stipulates that passengers can be on board no longer than one hour.

Similar pressures exist outside of ADA within the human service agency transportation realm. Here, agencies fund and sometimes provide transportation services for clients with a wide range of disabilities. Because the transportation of agency clients is billed to specific agencies, providers of human service transportation must contend with enormous recordkeeping. IVHS offers hope for efficiencies in handling these recordkeeping chores. And, the 1990 Clean Air Act amendments place particular requirements on transit operators to decrease pollutants. All of these pressures add to the already difficult challenges that public transit operators face in retaining existing patronage and in attracting new riders. APTS applications promise transit operators help in meeting these challenges while assisting transit users in accessing and paying for transit use.

By improving how vehicles are scheduled and dispatched-particularly on a shared-ride, real-time basis-three benefits will result. One is that operators will be able to improve their current services. lmproved dispatching and scheduling mean improved efficiency, which translates into quicker response times and more efficient vehicle utilization. Coupled with on-board data capture, it means less billing and recordkeeping expenses for human service transportation providers and their transportation providers needing to meet Section 15 requirements. As a result, agencies and employers wishing to subsidize certain trips for their clients or employees can do so and can even vary their subsidy rates by person, day of the week, time of the day, or trip purpose.

Second, and perhaps more importantly, improvements in vehicle dispatching will enable operators to offer new, higher quality services. One example is the elimination of advanced reservations requirements for specialized transportation, which is particularly important given the new ADA requirements. Another example is dynamically dispatched, route-deviation transit services. Simply put, better scheduling and dispatching of vehicles allow transit operators to reconsider the range of services that they find feasible to offer.

Third, improved vehicle dispatching dramatically changes the relationship between the passenger and the operator. Traditionally, transit passengers must depend on printed schedules for fixed-route information or telephone calls to transit operators for demand-responsive trips. The ability to make a trip reservation has been necessarily reserved to the transportation operator. For example, a human service client must call an agency to request a pickup, and a taxi passenger must call a taxi company to order a taxi. In the former case, the process of vehicle scheduling and dispatching is so complex that passengers usually are required to call a day or more in advance and often are not given confirmed reservations when they first call.

Improved dispatching, however, will allow the'passenger or the passenger's agent to access the reservation system directly, thereby eliminating the need to call the transportation provider. This change is analogous to the advances in airline reservations. One no longer needs to call each airline to learn of available seats on flights to desired destinations. Instead, travel agents long ago developed this capability, and more recently individuals with personal computers have gained access to flight availability information. Comparable changes in the public transit sector have been slower to occur, but they are no less feasible.

The process of rethinking transit service in light of improved scheduling and dispatching is evident in FTA's Mobility Manager concept (Fisher 1990). Both an organizational and communications innovation, the Mobility Manager is a central agent who not only can provide one-stop shopping for transportation information, such as schedules and fares, but also can make real-time reservations for a person while on the phone. Further, the Mobility Manager can even handle the fare collection for the passenger and process payments to the operators and billings to agencies or companies which subsidize the trips. Figure 1.1 shows how the Mobility Manager concept might work, and Figure 1.2 illustrates the flow of funds under this concept.

1.2 Problem Statement

Central to the ability of IVHS to improve public transit services is the effectiveness of IVHS in improving the process of dispatching and scheduling demand-responsive transportation. How vehicles and trips are matched directly affects passenger service levels and svstem productivity

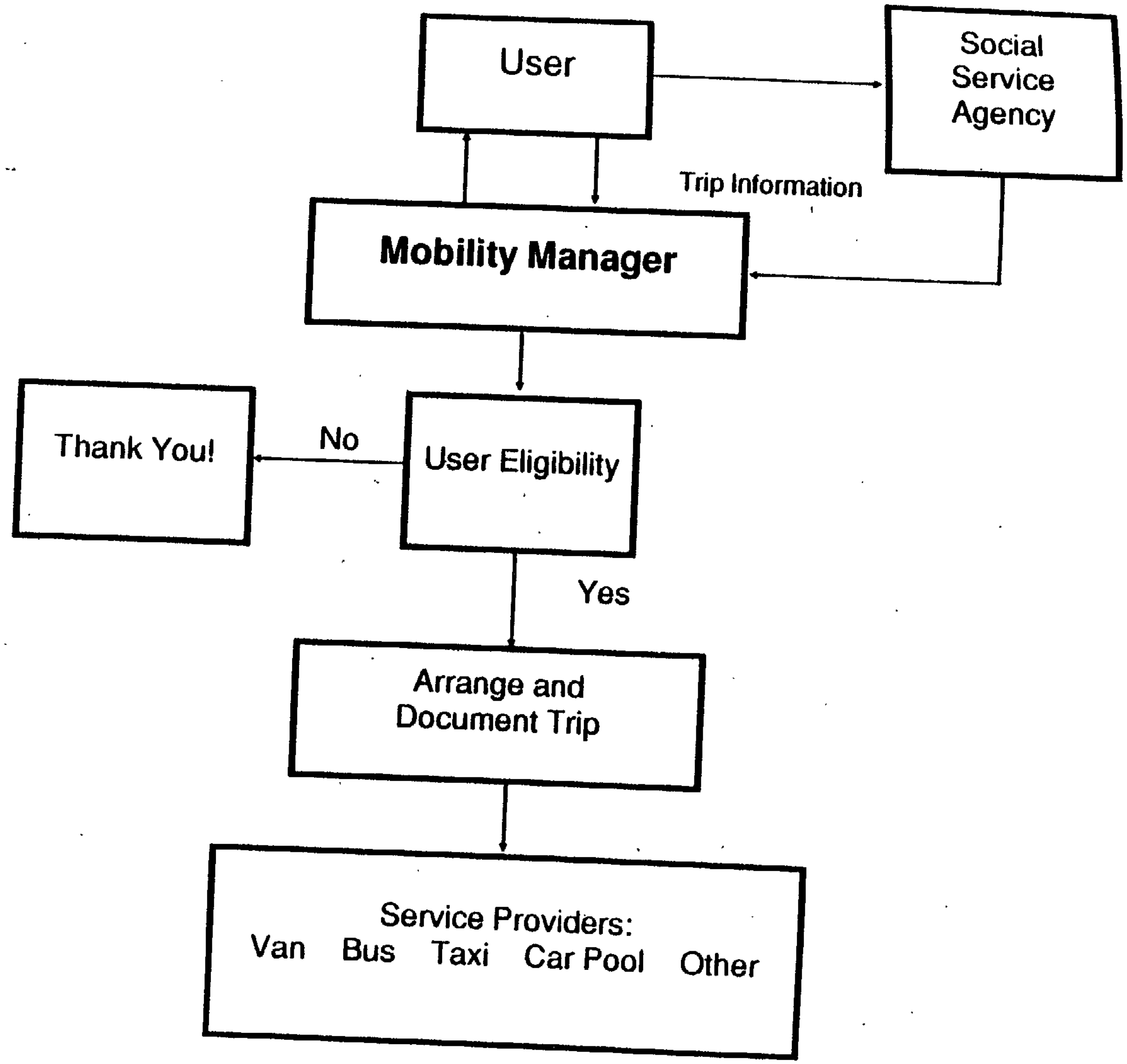

Figure 1.1
Mobility Manager Concept

ce: Jeffrey Parker & Associates. 1991

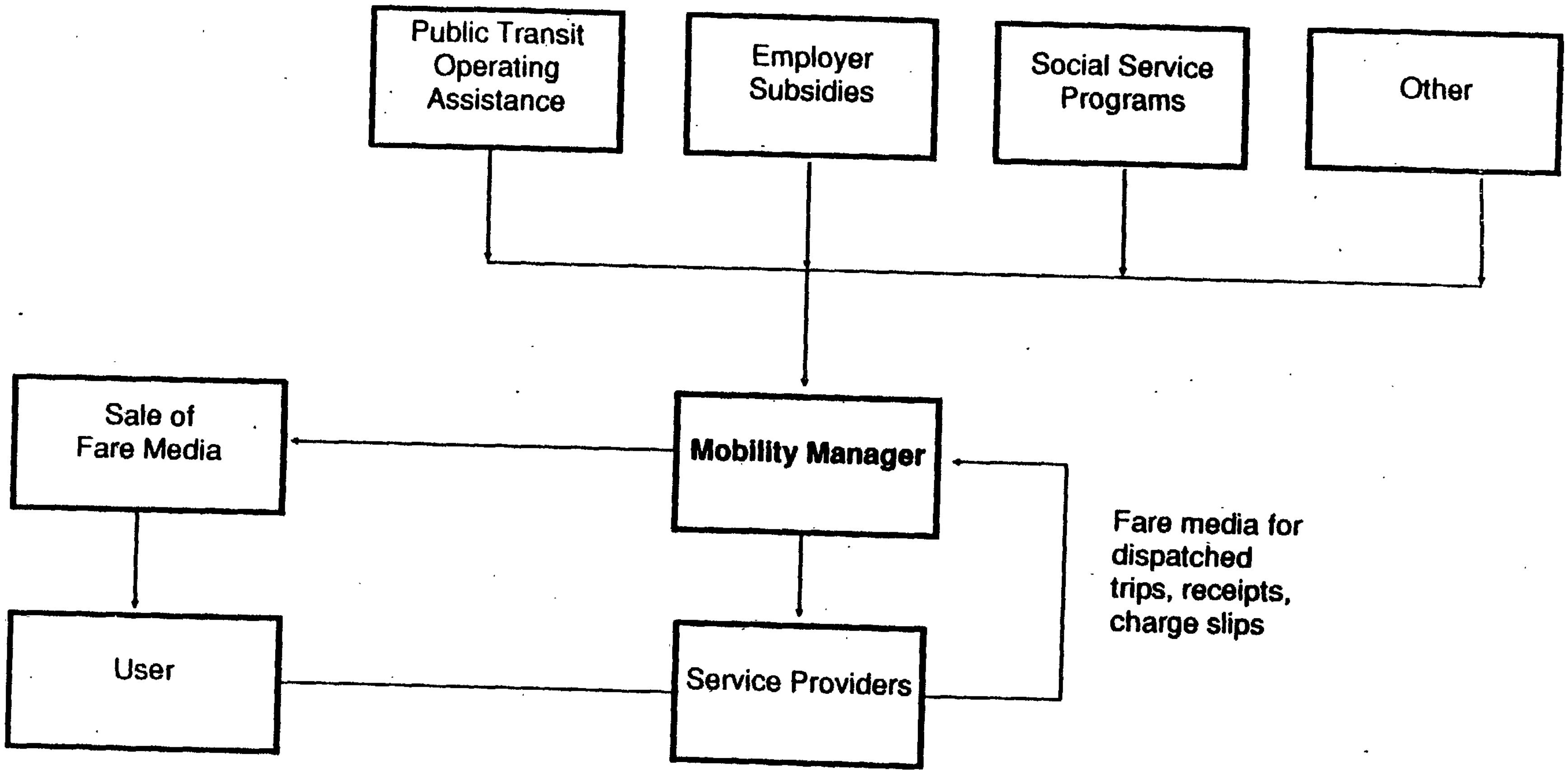

Figure 1.2
Flow of Funds Through Mobility Manager

Source: Jeffrey Parker & Associates. 1991

Matching vehicles and trips is a formidable operations problem. It requires the operations staff to perform three functions: accept requests for trips, assign those trips in a logical manner to specific vehicles, and follow up to document the trip completion. Each of these functions i.s challenging. Accepting trip requests requires the operations staff to take trip data accurately, efficientIy, and pleasantly. Documenting trips is challenging because much recordkeeping may be required by agencies and companies that subsidize trips. But, it is the second function--assigning trips to vehicles -- whichis the most intellectually formidable and which most severely affects system performance.

For conventional taxicab services the dispatching problem is made less complex by two facts. First, conventional taxi services operate on an exclusive-ride basis, meaning that one passenger (or group) is matched with one available vehicle. Second, most conventional taxi passengers have no special vehicle requirements,such as wheelchair lifts.- Taxi passengers do sometimes ask for a specific driver, but this complication is minor. In addition, most taxi trips are paid by cash, so the recordkeeping requirements for sponsored and charged trips are modest.

For general public paratransit the dispatch problem is commonly referred to as "scheduling." General public paratransit includes public dial-a-rides, shared-ride taxis, and airport van services. For these services, the scheduling problem is more complex than taxi-dispatching because of their shared-ride nature. This complication affects the order-taking function because it requires one crucial additional bit of trip information: trip destinations for all trip requests. More importantly, it requires a much more complex scheduling algorithm since multiple trips must be scheduled in a logical sequence for specific vehicles.

For special *paratransit services* the scheduling problem is even more complex owing to the special needs of the passengers. Trips must be combined, as with general public paratransit, but ail trip requests are not the same. Some passengers need on-board, wheelchair space, and some do not. Some have limits on how long they can be onboard; some do not. Some require drivers with special training; some do not. It is this scheduling problem which is the most complex,

The dispatch (or scheduling) problem for each of these three types of services is illustrated in Figure 1.3. Traditional exclusiw-ride taxi service poses the least complex dispatch problem. Consequently, taxi services do not require advance trip reservations, although they do accept such reservations. On the other hand, pickups for special paratransit services typically require prior-day reservations in order to allow the operations staff sufficient time to do the scheduling.

The entries in the upper right cell in Figure 1.3 require special mention. These are services that face the most demanding dispatch problem: real-time, shared-ride service. Both general public paratransit and shared-ride taxi are listed here, but not all such services are able to or need to achieve this level of service. Thus, these services are also listed in the upper left cell. Special paratransit services do face this dispatch situation for some return trips, such as clients returning home from a doctor's office. The return trip times are often not predictable for such trips, and the

1.3 Research Questions

If the promise of APTS is to be fully realized, computer dispatch technology must be effective in improving the efficiency of dispatching shared-ride vehicles on a real-time basis. The research question is, therefore, whether dispatch technology is, or will be, capable of efficiently handling this dispatch problem. If so, a second problem arises: how best can this technology be utilized? And accordingly, what are the implications of computer dispatch on the Mobility Manager?

In considering both the challenges facing transit and the potential benefits of lVHS technologies, it is clear that the term transit requires definition. Transit has been defined by FTA to includeall forms of passengersurface transportation excluding thesingle-passenger automobile. It is this same definition which is used in this report, although as noted earlier, the APTS technologies apply particularly to the non-rail transit services. Thus, bus services, general public paratransit services, taxicabs, elderly and handicapped services, ADA-required services, and ride-sharing services are the focus of this report.

Chapter 2 presents the research approach used in this study, including the data collection steps. Chapter 3 discusses how computer dispatching and scheduling work in the taxicab and paratransit industries. The results of the study are presented in two chapters: Chapter 4 presents the findings from the surveys and site visits, and Chapter 5 discusses future prospects for computer dispatch including applications to the Mobility Manager. Chapter 6 presents conclusions, a summary of findings, and recommendations for future service tests and research.

Mode of Trip Requests

Mode of Vehicle Sharing	Reservations	**Real** Time
Shared Ride	Special Paratransit (Pick-ups Only) General Public Paratransit Shared-rid.e Taxi	Special Paratransit (Return Trips Only) General Public Paratransit Shared-ride Taxi
Exclusive Ride	Limousine	Exclusive-ride Taxi

Figure 1.3
Categories of Dispatch Complexity

2. Research Approach and Methodology

2.1 Research Approach

We designed this study to address the problem as outlined in Section 1.3. The main research objectives are to

1. Determine the current operating capabilities of computer dispatch systems,

2. Assess the costs and economic benefits of these systems,

3. Determine the suitability of computer dispatch technology for transit applications, including user interface and information and the Mobility Manager concept, and

4. Recommend future technological directions for computer dispatch.

Before moving into a more detailed discussion of methodology, several points need to be emphasized relating to the research approach. First, any assessment of a quickly changing tehnology such ascomputerdispatching, risks becoming obsolete before the research iscomplete. We have responded to this reality by completing the research as soon as possible after the data collection was completed.

Second, claims about the capabilities of software and hardware are sometimes far different from reality. Therefore, we queried both software vendors and actual users of the software to assess current capabilities.

Third, it is necessary to define computer dispatch technology for the purposes of this assessment. Within the taxicab and paratransit industries there are two categories of computer dispatch technology: computer-assisted dispatch and fully computerized dispatch. In fully computerized dispatch, the computer actually determines which vehicle is assigned or offered a particular trip, whereas in computer-assisted dispatch the computer assists a human dispatcher who makes the selection of vehicles. Since computer-assisted dispatch is a precursor to fully computerized dispatch, we excluded it from our assessment of the taxicab companies.

In the realm of specialized paratransit services the technology is mostly limited to computer-assisted advance scheduling with limited real-time dispatching. Therefore, when providing information about current computerized dispatching or scheduling capabilities within the paratransit industry, we will be generally referring to computer-assisted technologies.

2.2 Research Methodology

The methodology developed for this study is heavily empirical and relies on three major research components: (1) telephone surveys of selected taxicab companies and paratransit operations, (2) site visits of selected taxicab and paratransit operations, and (3) review of software vendor literature, and telephone contacts and visits with software vendors.

The telephone surveys and site visits provided information on the range of operational systems in use by both taxi and paratransit services, their system performance, and the operational strengths and weaknesses of the technology.

A total of 16 taxicab companies and 10 paratransit operations were included in the site visits and telephone surveys. The taxicab companies were selected from lists provided by the International Taxi and Livery Association (ITLA), Gandalf Mobile Systems, and Motorola Mobile Data Systems. The main criterion for selection was that all have automated computer dispatch technology in place. The companies surveyed vary in size and represent various geographic regions.

The paratransit operations were selected from lists provided by software vendors. The major criterion for selection was that they have some form of computer-aided scheduling system in their operation.

The telephone contacts and visits with software vendors, and the review of the literature on their software, yielded information on the capabilities of the computer dispatch software, including strengths and weaknesses of computer dispatch and scheduling software systems. In addition, ATE Management and Service' Company provided the results of a special paratransit scheduling survey. The following features were assessed: client registration, geodata file, vehicle file, standing orders, order taking, scheduling, dispatching, billing, reporting, and costs. Thev were compared on the basis of current operating capabilities in order to determine their suitability for Advanced Public Transportation Systems (APTS), including the Mobility Manager concept.

3. Review of Computer Dispatch and Scheduling

3.1 Development of Taxi Computer Dispatch

Computer dispatch has its origins in the taxicab industry, beginning in the mid-1970s and even earlier in the dial-a-ride industry. The taxicab industry is an appropriate incubator for dispatching technology since it operates 24 hours per day, seven days per week. It is also a surprisingly large industry with approximately 6,300 operators and about 170,000 vehicles (Gilbert 1991), It carries about the same number of passengers as do all the bus transit systems in the United States. Entirely within the private sector, it is also highly unconcentrated with only a few multi-city firms. These last two facts, in particular, are important when one considers the spread of technological innovations such as computer dispatch. In the taxicab industry, technological changes spread only through the Independent decisions of many operators, each assessing the perceived benefits of the innovation and each finding the necessary private capital to invest in the innovation. Consequently, technological changes within the taxicab industry occur at a cautious pace, with larger operators usually the first to adopt capital-intensive innovations.

For decades before taxi companies acquired computers, taxi dispatching was performed manually using slips of paper, voice radios, and a variety of devices such as peg boards, conveyer belts, and magnetic boards. Each trip request was written on a small slip of paper, which was transported (by hand or conveyer belt) to a dispatcher. The dispatcher would select a driver and communicate the trip pickup information by voice radio to the driver. To keep track of the location and status of taxicabs at any point in time, the dispatcher would often use a magnetic board, a peg board, or some other visual aid. Needless to say, dispatchers were required to have extensive geographic knowledge of the service area and an ability to work under pressure.

Among the problems of manual dispatching are accuracy and speed. Accuracy was limited by the ability of the staff to avoid losing call slips before they were dispatched. Speed was related to volume. . During busy periods a manual dispatch operation could not keep up with the calls because of too few dispatchers and too few radio channels. Thus call slips would pile up in a dispatch office for 30 minutes or more before they could be dispatched to drivers. Service quality was directly a function of the speed and accuracy of the dispatch operation:

The early attempts to computerize taxi dispatching *were* crude; they amounted to using computers to assist in the recordkeeping associated with taking trip request information and storing this information in a convenient manner so that a human dispatcher could decide which taxicab vehicles should get which calls. These computer applications represent an intermediate stage of computerization. In recent years, however, these early efforts have been supplanted by more sophisticated systems that actually make the dispatch decisions and communicate the information for a given trip to the selected taxicab. It is this latest generation of systems that at last warrants the label computer dispatch.

3.2 Taxi Computer Dispatch Operation

Computer dispatch typically operates using data communications to link vehicles with a central dispatch computer. The incoming call is taken and input into the computer, which determines which vehicle is to be offered the call. Digital call information is transmitted to the selected vehicle ahd appears on an in-vehicle terminal screen. If the driver accepts the call, the computer transmits the entire information on the call, and the driver proceeds to pick up the passenger.

Figure 3.1 illustrates how a typical computer dispatch works. A redundant host computer message switch, and network call processor operate in parallel on "hot standby" to ensure reliability. The system includes the following:

1. Call-taker terminals in the dispatch office for call data entry,

2. Host and backup computers with dispatching functions,

3. Message switch that routes digital messages between dispatcher and drivers,

4. Network call processor (NCP) to store and prioritize all messages between the host computer and in-vehicle mobile data terminals (MDTs),

5. Radio site controller to code and decode digital and radio frequency information,

6. One or more base radio stations for data transmission,

7. In-vehicle mobile data terminal to communicate with the driver, and

8. In-vehicle taximeters linked to the MDTs to track mileage and fares

This system is similar to those in operation ,in Los Angeles, California; San Francisco, California; Fort Lauderdale, Florida; Miami, Florida; and Arlington, Virginia; In Los Angeles, for example, the system dispatches four taxi fleets totalling 530 vehicles. The system has 11 base stations to cover 30 jurisdictions in the 700-square-mile Los Angeles area.

The host computer contains an address database (geo-file) with the address ranges for all streets in the service area. The address ranges are keyed to three-digit zone numbers. The zones are defined by the taxi company and are usually about four square miles in size. However, major traffic generators, such as a large hotel or anairport, are often designated as separate zones, whereas the zones are larger where taxi demand is low. The geo-file is structured so that when a specific address is entered, the computer finds the appropriate zone number for that address.

Also in the software is a database of vehicles and drivers. Each vehicle is described by a three-digit number, with specificranges of numbers associated with separate fleets. Information for each vehicle describes whether the vehicle is a sedan or a wagon as well as other information. Driver information includes the municipalities for which the driver possesses a valid taxi driver license, foreign languages spoken by thedriver, whether the driver allows smoking in the'cab, and whether or not thedriveraccepts personal checks. Most taxi drivers are lease drivers, which means that they are free to make these decisions independently of the company.

The taxi dispatch system operation can best be described by following the process involved in handling a single call from a passenger desiring taxi service. This process must be considered from two perspectives: that of the taxi driver and that of the dispatch personnel.

After logging onto the system, a driver queries the computer dispatch system through the MDT. One screen available to the driver shows the current status of each zone: how many calls are waiting in that zone and how many other taxicabs have posted into that zone to await calls, After searching this screen, the driver decides where he or she wishes to do business and "posts" into a particular zone. The driver then awaits a call to be automatically dispatched to him or her

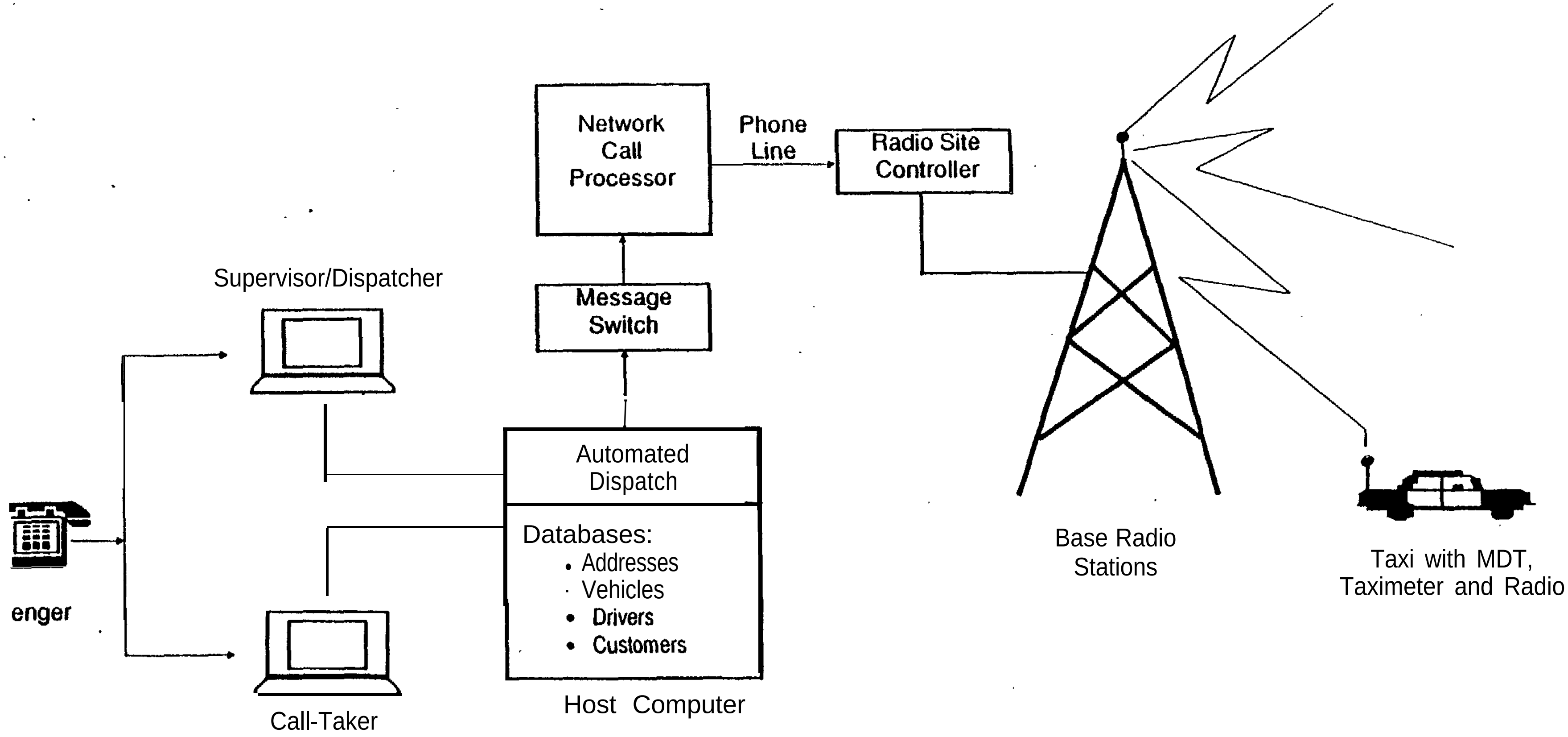

Figure 3.1
Computerized Taxi Dispatching System

In the meantime, in the dispatch room, call-takers answer telephone calls from persons requesting service. The call-taker inputs the caller's trip information beginning with the street address and the city of pickup. In large urban areas, taxi companies may serve many municipalities and street names and address ranges vary from jurisdiction to jurisdiction, so it is essential to obtain the name of the city. As soon as theaddress and city are input, the host computer uses the geo-file to locate the proper zone for that pickup address and inserts the zone number on the call-taker's screen. The call-taker completes the input process by asking for the caller's first name, telephone number, and specific pickup instructions, such as where the person will be waiting and what type of building is at the pickup address. The call-taker then hits the "send" key, which clears the call-taker's screen to accept the next incoming call and sends the previous call to the computer.

The trip request is now in the computer, which scans the taxicabs that are posted in the requested zone. Taxis are considered on a first-in-first-out basis determined by when each taxi posted into the zone. The computer finds the first vehicle that meets the customer's order, That is a customer might have requested a station wagon, in which case the computer would scan the available taxis posted into the zone to find the first one which is a station wagon. Absent a special request, the computer will select the first taxi. If no taxi is posted, or if no taxi meeting the special request is posted in the zone, the computer will begin searching nearby zones for available taxis. The algorithm used to scan other zones is subject to control by the dispatch manager and varies from zone to zone.

Once a taxi is selected, the computer offers the trip to the taxi driver in abbreviated form. The driver hears a beep from the MDT and reads abbreviated trip information consisting of the pickup zone. The driver is allowed a set time-usually one minute-to accept or reject the trip. If the driver hits the "reject" key, the driver is kept in queue for the next available trip, and the trip is offered to the next available driver. If the driver hits the "accept" key, all the trip information is displayed on the MDT, and the driver is obligated to serve the trip. Included in this information are map coordinates and a page number for the local metropolitan map book. If 60 seconds elapse without the driver responding, the computer offers the trip to the next driver and boots the first driver from the queue.

In servicing the trip, the driver continues to add to the computer vital information about the thp. When the driver accepts the trip, his or her action in hitting the "accept" key also tells the computer when this action occurs. When thedriver picks up the passenger, the taximeter is turned on, and the time is stored in the computer. When the passenger is dropped off, turning off the taximeter also signals the computer that the trip is ended. In addition, the computer notes and stores the time that the trip request was originally entered by the call-taker as well as any other transactions regarding the trip, such as the passenger calling back to find out where the taxi is or the driver asking for directions. Thus for each trip thecomputer retains a complete history of every event from the original request to the trip conclusion.

The communication flow is illustrated in Figure 3.1. The host computer sends a signal via telephone line to the network call processor (NCP), which recognizes the fleet and the single vehicle to which the message is intended. The NCP directs the message by telephone line to the network of base stations, then the message is sent by radio frequency to a particular taxi. Unlike voice dispatch, no other taxis hear the communication. The first taxi to receive the message is the one which is first in the queue of calls "posted" to the zone (or zone closest to) the call's address. When the driver responds, the procedure is reversed. The base station receives the message and relays it to the NCP. The NCP recognizes the address of the sending taxi and routes the message to the host computer.

The computer dispatch system used by taxicab operators has several salient features. The first is that it normally handles exclusive-ride trips and does so without an automatic vehicle locator (AVL) capability. It relies on drivers to tell where they are or wish to do business, and it includes safeguards to detect drivers who incorrectly report where they are. This approach works fine for the typical exclusive-ride taxi trip, for which the computer needs to be concerned only with the pickup location and time.

The system also provides an expedited data entry capability. Many taxi customers are repeat customers, and they understandably become annoyed if asked each time they call to provide their address, name, phone number, and pickup instructions. The system allows this information to be pre-entered and accessed by a code that is unique to each caller. Thus, a caller needs only to tell the call-taker a short number; the call-taker enters this number and instantaneously sees the complete pickup information displayed on the screen. The call-taker merely verifies this information and then sends it to the computer. Without this feature the average call takes 30 to 60 seconds; with it the talk time is about 10 seconds.

The system provides a mechanism for monitoring, the level of service provided to customers. The dispatch personnel continuously watch screens that show the zones that have calls waiting and the, calls that have not been serviced within a specified time period. In the latter instance, for example, the calls show up on the screen as "late meter" exceptions. Dispatch personnel then contact the drivers to find out why they are late and when they will be at the pickup locations. Similar actions occur when the passenger calls back to find out where the taxi is.

Typical systems also include radids for occasional voice dispatching instructions to drivers and to allow voice communication during emergencies.

3.3 Paratransit Computer Scheduling

In general public and special paratransit systems, the matching of vehicles and trip requests is called *scheduling.* As noted in Section 1.2, the scheduling of paratransit trips is more complex than taxi dispatching because of the shared-ride nature of these trips, however, the shared-ride scheduling problem is facilitated by preparing the routes and passenger pickup sequence in advance, typically the night before trips are needed.

The non-scheduling functions of paratransit operations were the first functions to be computerized. Client certification, records, and agency billing are the primary functions that have been computerized. A variety of software vendors offer systems to handle these functions as well as scheduling. Some of these are briefly mentioned later in this report.

Scheduling, however, is less easily automated. Most paratransit operators, particularly smaller systems, use manual scheduling procedures. These vary considerably. Some operators prepare two tripcards for each trip request; one for the pickup address and a second for thedrop-off address. These cards are then arranged in order on a desk or attached to a wall. They are lined up in a column representing the itinerary of a single vehicle. Some operators do the scheduling by writing the trip information on sheets of paper. Regardless, the last step is the same--giving each driver a list of pickups and drop-offs. This information is often referred to as a schedule for the driver.

An interesting example of manual scheduling is that used by some general public dial-a-rides which use magnets and a metal-backed map board. Each trip is represented by two color-coded magnets, one for the pickup and one for the drop-off. These magnets are mounted at the appropriate places on the map. The mapboard also has different maps designating each vehicle in service. At any time the dispatcher can look at the mapboard and tell where the vehicles are and where the trip requests are located. Using this visual aid, the dispatcher assigns a new trip to a vehicle.

Theuseofacomputer toautomate thisoperationissimilar to the early attempts to automate taxi dispatching. Computer systems have been developed to assist the paratransit scheduler. Thus, instead of manipulating cards or magnets, the scheduler can form the schedules on a computer screen. The resulting schedules are printed out and given to the drivers. Many systems use this approach to develop a base schedule of repeat riders for each day and then insert new trips into their base or master schedules.

More recently, several have developed software which will automatically assign trips to vehicles rather than just assist the scheduler. Para transit scheduling is much more complex than taxi dispatching because of the shared-ride nature of paratransit trips and because of the special needs of the passengers- They may require vehicles with wheelchair lifts, for example, or drivers with special training. Furthermore, care must be taken in grouping the passengers.

Figure 3.2 schematically displays the paratransit scheduling function which includes grouping, sequencing, and optimization (Young 1992). Incoming trip requests, which are answered by the call-taker, may be reservations for the next day, week, or month, or they may be real-time taxi-like calls. The call-taker enters the caller information into the host computer, and the caller's eligibility to use paratransit is verified. Next the scheduling function takes over. Passengers, vehicles, and drivers are grouped according to special passenger characteristics and transportation services offered. General sequences of vehicle trips are identified depending on time of day, day of the week, and location for which the transportation is needed. The vehicle path is optimized for minimum time or distance with respect to such schedule constraints as vehicle capacity and the ADA limit of one hour on the vehicle for any passenger. As additional requests come into the system, the path is re-optimized until a schedule of pickups and destinations is built.

At the beginning of a typical paratransit tour, a pre-arranged schedule is given to each driver. It lists the sequence, pickup times, addresses, and destinations of the passengers. It also gives directions for the minimum time or distance path to follow. To this point, the scheduling process parallels traditional manual or computer-assisted paratransit scheduling. However, since the computer "remembers" the exact schedule and can predict the approximate location of the vehicle at any time during the schedule, it can accommodate real-time trip requests as Figure 3.2 indicates. Any new real-time request is inserted into the pre-arranged schedule at an appropriate point depending on the results of the grouping, sequencing, and optimizing functions. The new schedule is transmitted to the driver who deviates from the scheduled tour and picks up the new passenger.

Depending on the degree to which real-time and advanced reservations are mixed, paratransit may be called subscription service (all advanced reservations), route deviation (mix of reservations and real-time dispatch), or *did-u-ride* (all real-time dispatch). It should be noted, however, that real-time, shared-ride scheduling remains a goal to be achieved in high-volume, everyday service. It is not yet a practical reality.

3.4 Other Automated Functions

While dispatching is the major automated function of a taxi company, and scheduling is the primary computer function of paratransit services, there are other important computer functions as summarized in Figure 3.3.

Order taking,dispatching, and scheduling have already been discussed. Reporting is required in both taxi and paratransit operations in order for management to track overall system productivity, individual call-taker and driver performance, and customer trip information. in taxi operations, for example, it is important to know if the flow of incoming calls exceeds call-taker capabilities, or if call-takers are not performing up to standards. Daily reports include total Calls, directly answered calls, and calls which are delayed or lost. Driver reports, which compare the dispatch log to the driver MDT log, allow the company to monitor driver performance to ensure Consistently quick response., Typical driver data include vehicle number, driver name, average response time, and number of fares dispatched, accepted, rejected, and picked up. In order to guard against drivers "beating the system," the frequencies of fast meters, no shows, and slow meters are observed.

In paratransit operations similar data are kept to monitor overall performance of the system. The emphasis, however, is on passenger records for billing purposes, not on call-taker and driver performance. In order to meet Section 15 reporting and billing requirements, the following data are required for each passenger: identification number, pickup and drop-off points, vehicle odometer readings to determine distance traveled, time of arrival and departure, and method of payment or sponsoring agency (Federal Transit Act Amendments 1991)). At present that information is usually handwritten by drivers on trip sheets which are later transferred to the records and billing software by computer operators. With trip information, the passengers' fares can be determined and the appropriate agencies billed.

Other computer functions of automated taxi services control the redundant backup system which was discussed previously, the archive files for long-term storage of service information, the correction and maintenance of address files, and training which can operate from the backup system. These functions may or may not be part of current computer-assisted paratransit systems, but they will have to be present for automated scheduling/dispatching.

3.5 Computer Hardware, Software, and Costs

For simplicity the major elements of a computerized dispatch or scheduling system may be classified as computer hardware, software, mobile radio equipment, and mobile data terminals.

These elements may be provided as turnkey systems by single suppliers, or the elements may be installed as a customized system using the services of several suppliers, The turnkey approach includes computer software and hardware and a mobile data communications system. Typically, the turnkey system will rely on radios which already exist in the vehicles and possibly on existing host computers at the company. Customized systems usually combine software, computers, and mobile data terminals from different vendors. Table 3.4 summarizes some of the major hardware and software vendors, and Table 3.5 gives typical costs for computerized taxi dispatch systems.

Typical costs for computerized paratransit scheduling software and hardware are presented in Section 4.5. Paratransit software costs average about $25,000 depending on available functions. Hardware typically ranges from $5,000 to $40,000 depending on the number of computer terminals and the processing capabilities required by the operation. Compared to taxi dispatch systems, paratransit scheduling systems cost about one-sixth as much, however, para transi t systems usually have fewer vehicles than taxi companies and carry fewer passengers. Furthermore, paratransit hardware and software do not have to accommodate real-time service requests.

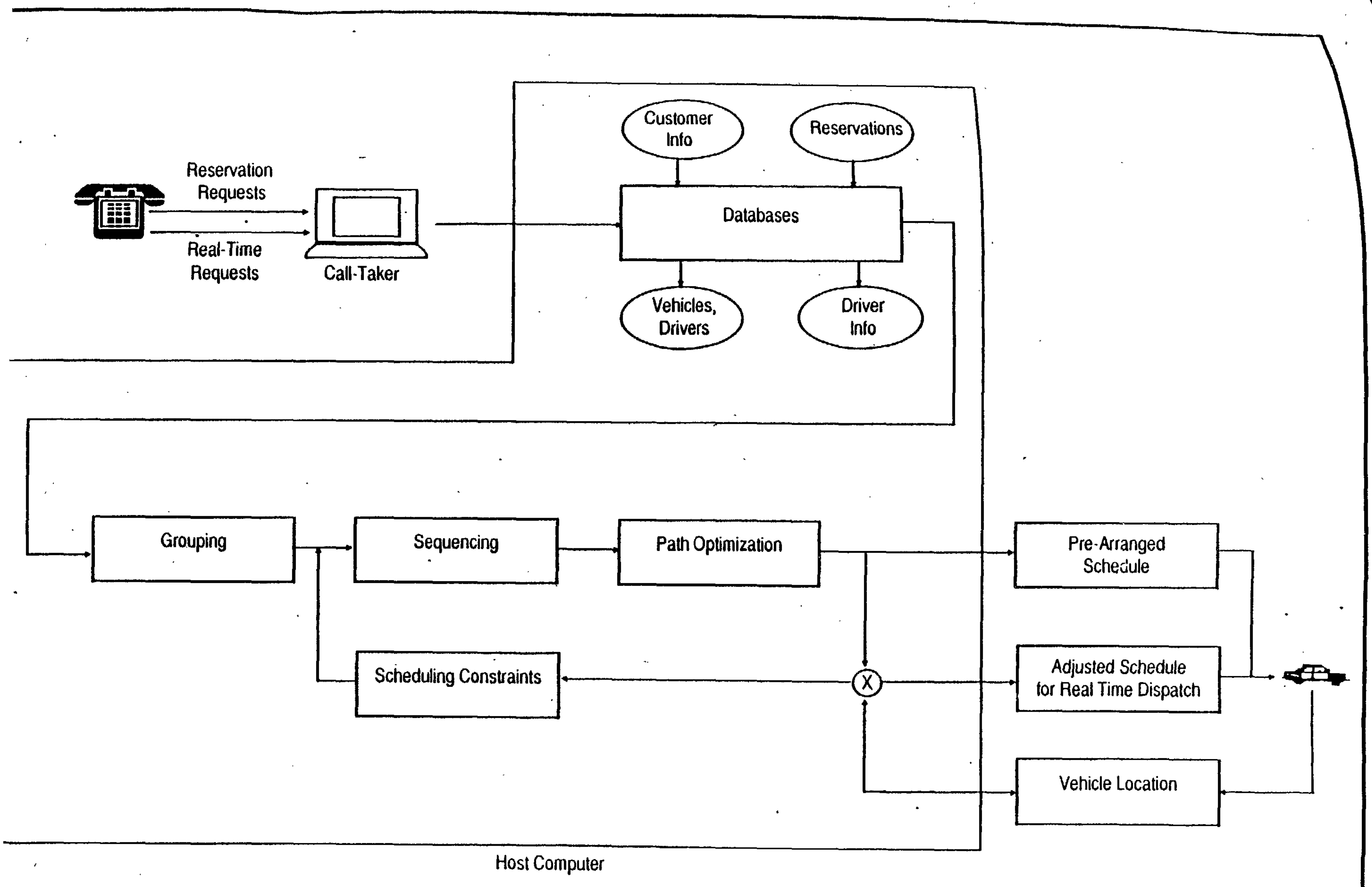

Figure 3.2
Paratransit Computer Scheduling

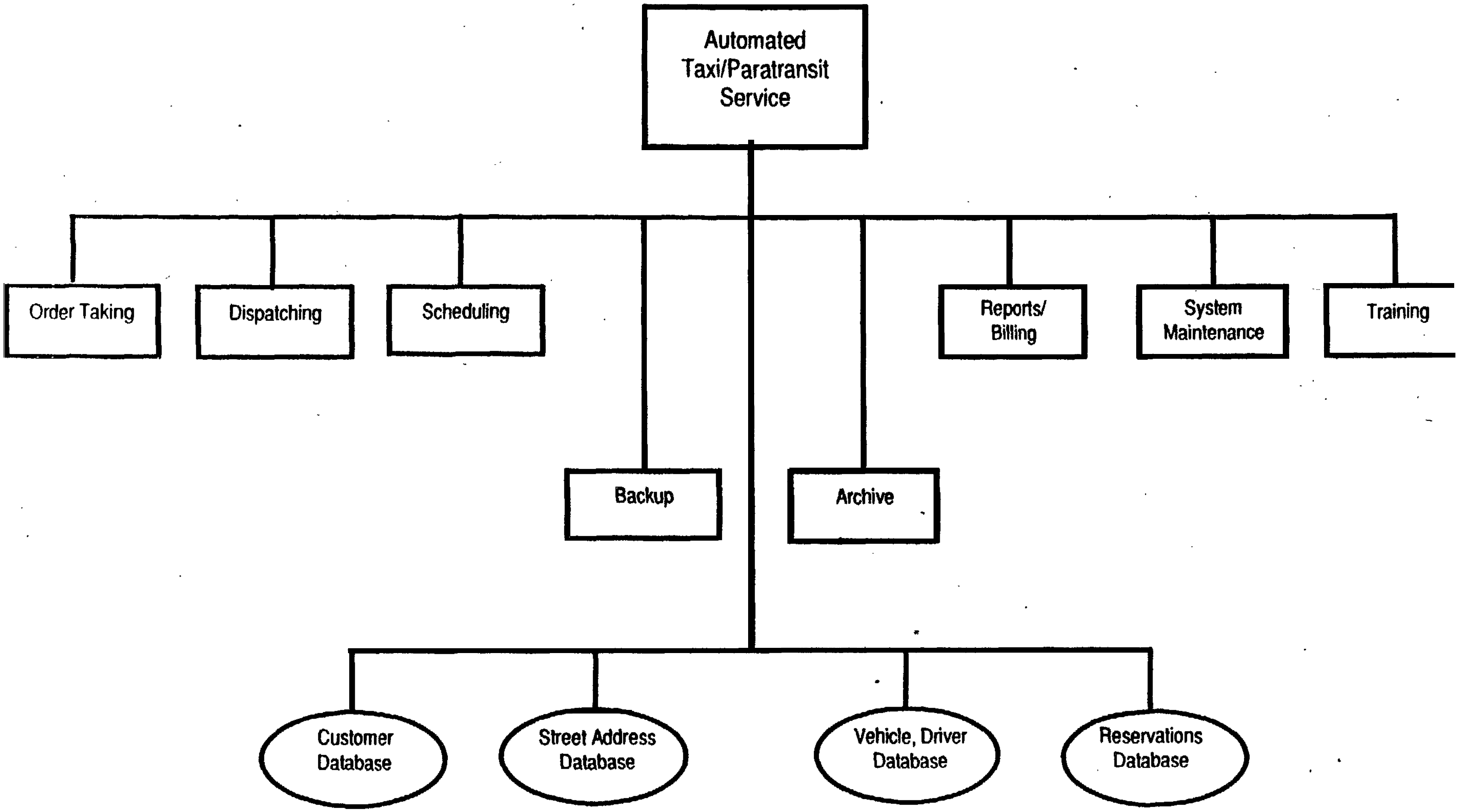

Figure 3.3
Computerized Functions

Table 3.4
Major Equipment and Software Vendors

Product	Vendors for Taxi Products		Vendors for Paratransit Products	
Computer Hardware	Compaq Dec VAX IBM (and compatibles) McDonnell Douglas	Motorola NCR Stratus UNISYS	AT&T (UNIX) Alpha Altos	Compaq IBM (and compatibles)
Computer Software	Aleph CODAPRO	Gandalf Mobile Systems Motorola (Mobile Data)	Aleph ATE-Ryder Automated Business Solutions (PtMS) Comsis (CTPS) Easy Street (EasyTrips) Ketron (PARMIS) Micro Dynamics Corp. (CADMOS PRO+)	Mobile Computer Systems (PC Dispatch) Modeling systems (Scooter) Multisystems (Dispatch-A Ride and GIRO/ACCES On-Line Data Products. Inc (PASS) Paratransit Software (PARRAS) Paratransit Systems Int'l (Rides Unlimited) Scandia Transport System, Inc (Planet)
Mobile Radio Equipment	E.F. Johnson General Electric Glenayre	Midland Motorola	E.F. Johnson General Electric Glenayre	Midland Motorola
Mobile Data Terminals	Dinet Distributed Networks Gandalf Mobile Systems	Kustom Electronics Mobile Computer Systems	Halda, Inc. (Trancometer) (MDTs not widely used)	
Turnkey Systems	Gandalf Mobile Systems Kustom Electronics and Digital Dispatching systems	Micro Dynamics Mobile Computer Systems Motorola	Comsis Micro Dynamics	We Computer Systems

Table 3.5
Taxi Computer Dispatch Systems Costs

System Size	Major System Components	Features and Limitations	Approximate Cost
100-200 Vehicles (No Growth)	Fully Automated Dispatch Software Single 386 Central Processing Unit (CPU) - 100 Vehicles Single 486 CPU - 200 Vehicles 16 Channel Multiplexer Voice Backup Single Call-taker Terminal per 50 Vehicles Single Data Channel 6 Month Warranty	No Training System No Graphics Address Manager Customer Responsible for MDT Installation	$350,000 (Based on 150 Vehicles)
100-200 Vehicles **(Possible Growth to 400)**	Fully Automated Dispatch Software Dual 486 CPUs Single Access Server Dual Data Channel Graphic Address Manager 1 Year Warranty	No Training System Second Data Channel Included at 225 Vehicles	$415,000 (Based on 200 Vehicles)
200-800 Vehicles	Fully Automated Dispatch Software Dual 486 CPUs Fully Redundant Multiple Data Channels Graphics Address Manager 1 Year Warranty Training System	Spare Base Station Unit Included Second Data Channel Included at 225 Vehicles	$860,000 (Based on 350 Vehicles)

Prices include $1,200 MOT per vehicle and one call-taker terminal per 50 vehicles.

Source Gandalf

4. Operational Applications of Computer Dispatch and Scheduling

4.1 National Market for Computer Dispatch

Candalf and Motorola, which are two major vendors of taxi computer dispatch software, agreed to supply the research team with lists of their clients who use computer dispatch. Other vendors are in the market, but their client lists are unavailable. Additional sources for the study were provided by paratransit scheduling software vendors and operators of paratransit services.

Tables 4.1 and 4.2 contain names of taxi companies with fully computerized dispatch. Together, Gandalf and Motorola have installed computer dispatch systems in more than 40 taxi companies representing about 13,000 vehicles in the United States and Canada. Approximately eight percent of the 170,000 taxi vehrcles carry either Gandalf or Motorola fully automated dispatch equipment. Perhaps another five percent use other systems. Applying the system costs of Table 3.5, computer dispatch represents a private investment in North America approaching $40 million, assuming $1 million per system.

The market for computer dispatch will increase significantly as a result of transportation requirements in the Americans with Disabilities Act. More than 300 fixed-route transit systems must contract with auxiliary paratransit or taxi systems to carry ADA eligible passengers to fixed routes or to their destinations. In Los Angeles alone, there are 400 paratransit operators who could potentially purchase computer dispatch systems. This one city represents a ten-fold increase compared to the current total number of operators with computer dispatch in the United States and Canada (tables 4.1, 4.2). Other large cities and counties promise similar markets for computer dispatch. One vendor estimates the market at about $200 million per year over the next 10 years for automated paratransit dispatch, scheduling, and information systems,

4.2 Taxi Company Interviews and Site Visits

Forward-looking leaders in the taxi industry have used computer dispatch to improve: service, increase productivity, and better their competitive positions. However, service and other improvements have not been won without difficulties. As part of the research involved in assessing the costs and benefits of computer dispatch, the research team gathered telephone interview and site visit data from a number of taxicab companies.

The telephone survey contained questions about the company, types of services provided, type and cost of the computer dispatch system, dispatch statistics, and general remarks about the impact of the system (Appendix A). The site visits collected similar, more in-depth data (Appendix B). The following paragraphs expand on the responses for these categories, and Table 4.3 summarizes the responses.

The telephone interviewers contacted nine taxi companies, and ITRE staff visited another seven companies, Fleet size varied from 100 to 670 vehicles. The companies are in cities across the United States, and an attempt was made to contact representative companies for various hardware and software configurations.

The company characteristics tell what number and mix of exclusive-ride and shared-ride taxi service is offered. All of the companies contacted provided exclusive-ride taxi service, and six offered shared-ride service, at least on a limited basis. A few also deliver packages.

Dispatch system characteristics include type, year installed, cost, hardware, software, and system reliability. Eight of the companies use Gandalf equipment, seven Motorola, and one Aleph Of the systems surveyed, several were among the first to be installed in the United States, While U.S. systems began to make their appearance in 1985, Canadian systems were in use as early as 1981 (Table 4.1). Installations increased dramatically in 1989 and 1990 as some of the early hardware and software problems were rectified. Company representatives said that system costs generally vary according to the size of the fleet and the amount of vendor customization. Most persons contacted, however, were reluctant to provide specific system costs.

Automated dispatch can be accomplished with fast personal computers or minicomputers, depending on fleet size and dispatching volume. For example, as shown' by Table 3.5, a medium-sized taxi fleet with 100 vehicles can be accommodated by a personal computer system, However, several company representatives indicated that minimum fleet size for automated dispatch is more practically about 200 taxicabs or about 2000 daily dispatches. As more and better systems are designed, the fleet size threshold of 100-200 will decrease. At present the reliability of computer dispatch systems is very good; however, early systems suffered from a variety of hardware, software, and MDT problems.

Dispatch statistics are important measures of the impacts of computer dispatch. The information in Table 4.3 displays before/after values of common statistics. Fleet size, for example, needs to be assessed carefully. If fleet size increases dramatically after computer dispatch, it typically means that the company expanded or absorbed other operators who could not compete. Note that the expansion typically occurs with the same number of call-takers and dispatchers. which is an indication of increased productivity as well as competitiveness. In the case where the fleet decreased by 40 percent, dispatches increased by 25 percent-an indication of increased productivity. Taken together, virtually all of the statistics show increased productivity and competitiveness.

The most dramatic indicators of increased productivity are call time and response time. Typically call-takers are on the phone with passengers about 30-60 seconds with computer dispatch. Call time can be reduced to 10 seconds or less if special locator identification numbers are used. Response time measures the time between the completion of the call and the driver's arrival at the passenger's location. Typical response times may now average 10 minutes or less, whereas before computer dispatch average response times approached 20-25 minutes. The reduction has occurred as a result of automated digital dispatch, which can occur in fractions of a second rather than seconds required by voice transmission. In addition only a single, queued taxi receives the dispatch: Candalf estimates that compared to voice radio, the same digital message can be sent in one-tenth the time.

Given the savings in response time for the passengers carried by the taxi companies contacted, an approximate dollar savings may be estimated. Table 4.3 yields a response time savings of 7,675 passenger-hours per day for the 16 companies studied. Assuming an average value of time of $8 per hour, this translates to a savings of $22 million annually. Based on fleet size the companies in this study represent 52 percent of the U.S. taxi companies with automated computer dispatch (tables 4.1 and 4.2). By extrapolation, therefore, computer dispatch represents a total savings of approximately $44 million annually for an estimated original total investment of $30 million, assuming an average system cost of $1 million. , It is noteworthy that this savings accrues to the public at no expense to them. Entirely private investments paid for the computer dispatch systems, and passenger fares typically remained unchanged.

Several operators indicated anecdotaily that the daily number of "exceptions" approximately equalled the number of dispatches. Exceptions are calls For which the dispatch? must get involved. While this seems extreme, it is understandable. Critical exceptions are short

Table 4.1
Taxi Companies with Automated Computer Dispatch
(Gandalf Mobile Systems)

Company	Location	Number of Cars	Year Installed
Abraham Transportation	Tampa FL	200	1988
Alberta Co-op	Edmunton ALB	450	1981
Bell Radio	New York NY	350	1985
Blue Bird Cab	Hyattsville, MD	220	1992
Blue Line Taxi	Ottawa ON	700	1979
Cab Co-op	Toronto ON	420	1988
Checker	Detroit MI	475	1990
Checker and Yellow	Chicago IL	700	1988
City Cab	Orlando FL	350	1986
Communicar	Corona, NY	335	1991
DiamondTaxi	Toronto ON	600	1986
Farwest Service	Seattle WA	150	1991
Jacksonville Trans	Jacksonville FL	200	1988
San Francisco Yellow	San Francisco CA	275	1988
Unicity Taxi	Winnipeg AB	250	1981
United	Philadelphia PA	725	1990
UTOG Two-Way Radio	New York NY	350	1988
Yellow Cab	Anaheim CA	100	1985
Yellow Cab	Columbus OH	150	1988
Yellow Cab	Hamilton ON	100	1982
Yellow Cab	Hartford CT	150	1988
Yellow Cab	Indianapolis IN	360	1985
		Total 7,610	

Table 4.2
Taxi Companies with Automated Computer Dispatch
(Motorola Mobile Data Systems)

Company	Location	Number of Cars	Year Installed
American Cab	Austin TX	157	1986
B&L Services	Ft. Lauderdale FL	517	1990
Baker & Drake	Sparks NV	121	1987
Barwood Cabs	Kensington MD	50	1989
Blue Eagle	Detroit MI	N/A	1989
Broadway Cab	Portland OR	132	1987
Checker Cab	Calgary AB	246	1984
Greater Houston Trans	Houston TX	1450	1989
Metro Taxi	Denver CO	200	1989
Miami Metro (Eights)	Miami FL	330	1989
Richmond Taxi	Vancouver BC	127	1989
Royal City	New Westminster BC	41	1985
Skyline Credit Ride	Long Island NY	440	1986
Taxi Systems (LA Taxi)	Los Angles CA	530	1990
Transponation General	Arlington VA	664	1989
United Cabs	Saskatoon SK	105	1984
Vital Two-Way	New York NY	350	1987
Yellow Cabs	Vancouver BC,	150	1986
	Total	5,411	

Table 4.3
Taxi Interviews and Site Visits

Company Characteristics				Computer Dispatch Systems						Dispatch Statistics				
Company	Location	Types of Service*	# in Fleet B/ A**	Host Computer	Software	Software Vendors	Year Software Installed	Estimated System Cost (Total)	Reliability of System	# of Call Takers B/ A	# of Dispatchers B/ A	Calls Taken (Daily) B/ A	Call Time (sec) B/ A	Average Pickup Time (mm) B/ A
TAXI INTERVIEWS														
Atlanta Metro Leasing. Inc.	Atlanta GA	ER	200 / 200	DEC/Gandalf	Cabmate 4.4	Gandalf	1989	$800,000	Good	2 / 2	2/ 1	1400/ 180	45/ 45	15 / /
Chicago AutoWerks	Chicago IL	ER	500 / 670	INTEL 486	Cabmate 4.4	Gandalf	1988	Confidential	Good	6/ 10	2/ 1	Unk./ 4000	Unk 150	5 20 / 5 20
Grtr. Jacksonville Trans. Co.	Jacksonville FL	ER/PD	170 / 170	DEC	Cabmate 4.4	Gandalf	1988	Confidential	Good	6/ 3	5/ 2	2000/ 2000	30/ 30	25 / 10
Yellow Cab/United Trans.	Colombus OH	ER/SR	Unk. / 175	DEC	Cabmate 4	Gandalf	1988	Confidential	Fair	5/ 5	2/ 1	2000/ 2000	20/ 20	15 / 10
Indianapolis Yellow Cab, Inc.	Indianapolis IN	ER/SR	300 / 221	INTEL	Cabmate	Gandalf	1986	Confidential	Excellent	7/ 7	3/ 1	Unk. / 4500	15-20/ 15-20	15 20 / 10 15
Yellow Cab of N. Orange Co.	Anaheim CA	ER/SR	55 / 118	INTEL 486	Cabmate 4.2	Gandalf	1985	$400,000	Excellent	2/ 3	2/ 1	800/ 1600	30/ 10	20 / 10
Checker cab co.	Detroit MI	ER/PD	460 / 460	Micro VAX 330	Cabmate	Gandalf	1999	$1,300,000	Good	9/ 6	9/ 0	6500/ 7000	20/ 20	20 / 5
Baker and Drake, Inc.	Sparks NV	ER	100 / 100	PDP-1173	MDI 2.0A	Motorola	1988	$485,000	Excellent	2 / 2	1/ 1	Unk./ 1500	30/ 15	Unk. / /
Broadway Cab, Inc.	Portland OR	ER/PD/SR	115 / 152	PDP-1173	Taxipac 3.5	Motorola	1987	$650,000	Excellent	4 / 7	2 / 1	2000/ 2100	15/ 25	15/ 5
TAXI SITE VISITS														
Barwood cabs	Kensington MD	ER	330 / 350	Aleph Micro	Aleph	Aleph	1989	$750.000	Excellent	6/ 6	2/ 1	3700/ 4700	27/ 42	25/ 15
Yellow cab Corp.	San Francisc CA	ER	315 / 315	Aleph	Aleph	Aleph	1989	$1,200,000	Excellent	4/ 4	2/ 1	5000/ 5000	30/ 30	8/ 8
Mears Transportation	Orlando FL	ER/PD	170 / 335	DEC	Cabmate 4.1	Gandalf	1986	$250,000	Good	6/ 5	1/ 1	950/ 2800	25/ 30	Unk./ 10
B&L Service, Inc.	Fort L'dale - FL	ER/SR	440 / 510	Motorola 8000	MADS 2.0	Motorola	1988	Confidential	Excellent	10/ 7	2/ 2	Unk. / 5600	60/ 35	1251 8
LA Taxi	Los Angeles CA	ER/SR	500 / 550	Motorola 8000	MADS 5.0	Motorola	1990	Unk.	Good	10/ 11	3/ 2	5500/ 6000	Unk./ 60	15/ 10
Miami Metro (8's)	Miami FL	ER	340 / 204	Motorola 8000	MADS 5.0	Motorola	1989	$1,500,000	Good	10/ 13	3/ 1	2400/ 3000	45/ 45	111 9
Transportation General (Red Top	Arlington VA	ER	229 / 664	Motorola	MADS 5.0	Motorola	1989	$1,000,000	Very Good	8/ a	3/ 2	4200/ 5000	50/ 35	10/ 6

* ER = Exclusive Ride
PD = Package Delivery
SR = Shared Ride

** B/A = Before/After Computerized Dispatch

Unk. = Unknown

or late meters, response times greater than 15 minutes, driver rejections, driver time outs, and calls which stay in the system longer than 10 minutes. Other exceptions may include unzoned addresses no shows, driver requests to talk, messages to drivers, system errors, power off before the MDT is off, and other situations. Multiple exceptions may be generated by one trip request, and correcting one exception corrects several for a particular call.

The information On exceptions illustrates the new role taken on by dispatchers in an automated system. Before computer dispatch, dispatchers received the call information from the call-taker andradioed. instructions to the driver. Now the computer does that automatically, and the dispatcher' s role is more one of customer service representative. The dispatcher mediates problems with customers, maintain service levels, and sometimes monitors and sanctions driver performance.

4.3 Impacts of Computer Dispatch

Besides receiving data and statistics on computer dispatch systems, the research team obtained many comments about the impacts of the system on dispatchers, call-takers, drivers, management, and passengers. problems and needed innovations were also identified, This important information is summarized below.

The impacts on dispatchers, call-takers, and drivers affect favoritism, productivity and workload, and training.. Specific comments include the following:

- Computer dispatch essentially eliminates dispatcher favoritism and driver payoffs. Indeed, some dispatchers and drivers quit when computer dispatch is implemented and kickbacks cease.
- Productivity increases for call-takers and dispatchers after they learn to type and enter data on the system terminals. Some productivity gains measured in time per call may be lost, however, if additional information is taken about the fare, as some drivers prefer.
- Less skill is involved for both dispatchers and call-takers. They do not have to memorize street locations and other complex, abbreviated dispatch information. With less skill needed to be productive, less skilled, lower paid call-takers can be recruited and trained. Thus, on-the-job training programs have to be established. There tends to be more turnover among the less skilled workers.
- Generally the same number of call-takers is maintained after computer dispatch is implemented, but a dispatcher may be eliminated or shifted to supervisory work. The system is less dependent on the dispatcher, whose workload and stress decrease.
- More calls can be processed per hour, and, previously missed calls that went to competitors can be answered.
- If the system does fail, traditional voice dispatch can be used. Unfortunately, there are fewer personnel who know how to manually dispatch. Fortunately, system reliability is high because of redundant computers, and total failures of more than a few minutes are rare.

Drivers prefer fhe computer dispatch system for reasons of fairness, productivity, personal profit, and the quality of information provided. Driver skill and training are important factors, however, in their acceptance of the system. Better drivers are attracted to computer dispatch because their fares increase. Additional driver impacts follow:

- Calls are distributed more evenly to drivers, and there is less chance of fare stealing and resulting driver fights. Driver/dispatcher friction is reduced, and drivers learn to trust the computer.

- Drivers are more independent with computer dispatch. When they learn to use the system, they can determine where the high-demand areas are, where other drivers arc posted, and consequently increase their fares. Or, they may choose to work at their own, slower pace.

- The quality of the transmitted digital data is much better than voicedispatch. More data than just the address can be transmitted in a shorter time, and the driver does not have to memorize it or write it down. Indeed, drivers are starting to request more information about the fare, a situation which increases call-taker time.

- The reduced verbal communication means that immigrants with poor English skills can make money as drivers.

- Better educated drivers are required by the computer system. The system attracts the best drivers from other companies, and they tend to stay longer with computer dispatch.

- Training programs for the computer dispatch system, mobile data terminals, and taximeters must be established to ensure consistent skill levels in what is usually a transient profession.

- With no radio chatter, the taxi is quieter, and drivers may listen to music instead of a dispatcher. There is less stress on drivers and passengers.

As the management of one company said, "We will never go back to radio and voice dispatch." Management is convinced that the systems will improve their competitive position for drivers and passengers, reduce personnel costs relative to the volume of calls, and solve the recordkeeping problem. Additional comments are as follows:

- Computer dispatch receives good public relations coverage when it is implemented, and the public learns to expect better, more prompt service. The major advantage is expedited, more efficient service.

- Several companies have installed computer dispatch and literally taken over their competition.

- There is more overhead from the capital cost and operating expenses of the compute' system, but there is more revenue (at least to the drivers) from the increased volume of calls and cab coverage. To increase company revenue additional cabs have to be leased to the drivers, i.e., the company has to increase its share of the local market.

- Computer dispatch can lead to consolidated operations in one building. This can save significant operating expenses. Similarly, several fleets can consolidate or share one computing system for cost savings.

- Less skilled, lower paid dispatchers can operate' the system. Often one dispatcher position can be eliminated. This saves a major salary expense. However, personnel costs may increase as additional staff are added to serve more calls and maintain dispatch hardware and software.

- better real-time information is available on the number of cabs available.

- Records on just about anything can be printed out. Indeed, some companies are swamped by data and would prefer simplified, executive summaries of the data so management can respond promptly to productivity problems.

- Internal records are better for charge account fares. It is easier to settle disputes. Nearly 90 percent of the problems can be cleared up satisfactorily.

A11 but one' of the companies contacted are very satisfied with computer dispatch technology. The one disatisfied company is currently negotiating with their vendor for a more effective system to meet their needs. The financial investment is considerable, and the payback period may be lengthy for companies which do not grow. Recall that many taxi companies lease taxis to drivers, and more taws mean more company revenue. While some increased profits result when increased computer productivity allows reductions in staff, real revenue gains occur through fleet growth.

To the passenger the advantages of computer dispatch are improved services as well as the following:

- Response is faster. Indeed, some callers who are inexperienced with computer dispatch are not ready when the taxi arrives.

- Regular customers can use identifier numbers to reduce call time to less than 10 seconds.

- The cab interior is quieter without radio communications.

- Fares tend to call the company with computer dispatch instead of the voice dispatch competition.

- Overall, the systems are "transparent" to the passenger, i.e., the passenger experiences better service without having to learn about the "hi-tech" computer system.

The positive impacts of computer dispatch have not come without problems. While many system problems have been resolved, early systems suffered software bugs and hardware failures. Fortunately, companies report that system failures have been no more frequent than with radio dispatch. The next section of the report reviews features of the more prominent software products for computer dispatch and enumerates improvements to the software as suggested by taxi company managers.

4.4 Taxi Computer Dispatch Software Review

There are two major automated computer dispatch software packages for taxi operations (Table 4.4). CabMate is manufactured in Ncpean, Ontario, Canada, and Taxi Pak is offered by Motoroia Mobile Data Systems in Schaumburg, Illinois. These two systems are fully automated and include mobile data terminals and related subsystems. Other systems typically lack full automation and are usually integrated with Candalf or Motorola systems.

Candalf and Motorola were the choices of all but one of the companies which were interviewed in this study. Gandalf and Motorola offer complete turnkey systems including design, installation, training, and support, as well as software and hardware.

A number of features should be considered when choosing an automated computer dispatch system. These include standard provisions for passenger identification and location, geodata, vehicle data, order taking, scheduling, dispatching, billing, and reporting (ATE 1991): It is fair to say that all four of the dispatch systems include these standard features at least to some degree according to product iiterature and discussions with operators. A complete assessment of the software would require extensive operational comparisons which are beyond the scope of this study.

While a complete assessment of the software was not accomplished, Gandalf appears to have the most successful product according to comments from taxi companies. None of the packages, however, have the operational ability to schedule shared rides and simultaneously dispatch real-time. Such a capability will be especially important for ADA transportation.

ADA transportation services require software capability to schedule subscription shared rides and to insert real-time dispatches into a schedule. ADA will also call on modern dispatch/scheduling packages to accomplish the following:

- Determine passenger eligibility,
- Provide complete reporting and billing information,
- Authorize fare cards,
- Exchange data immediately between the vehicle and the dispatch office,
- Suggest alternate service within a service time-window, and
- Confirm approximate pickup time and the identification of the responding vehicle.

These features are under development at both Aleph and Gandalf.

The taxi companies contacted in this study use Gandalf, Motorola, or Aleph packages. The following list summarizes comments most often made by management for improvements to dispatch software and hardware:

- The street address database must be accurate to minimize exceptions (unzoned fares). Interactive GIS technology would facilitate geo-file maintenance by visually displaying and modifying zone structures and boundaries. Current systems use card image for batch processing of gee-files. This early 1980s technology should be replaced by interactive Geographic Information Systems (GIS).
- Better coding is needed for overlapping streets (name changes at intersections), intersections, and culde-sacs.
- Unless the software protects against it, duplicate orders may occur when people call back and replace an order if a cab is late-or arrives too early for the passenger to be ready.
- The software must be able to identify drivers who skip fares by turning their MDTs off. An unauthorized toggle switch allows the driver to turn the meter off while in a zone! pick up a street passenger, and maintain his queue position.
- Enhancements to software could include driver recordkeeping, driver "personals)" messaging functions ("call home"), driver differentiation (corporate customers could get better drivers), and vehicle differentiation..

Table 4.4
Taxi Dispatch Software/Hardware Requirements

Vendor Name	Software Name	Operating system	Software Costs	Hardware Requirements	Hardware Costs
Gandalf	Cabmate	SCO-UNIX DOS Emulator	$2-3,500 (per cab)	Intel PC 386-486/33 360-I .2G HD	(see Software Costs)
Motorola	TaxiPak	UNIX	$2-3,500* (per cab)	DEC 3100 100-500 HD	(see Software Costs)

- Amount includes cost of software and hardware.

- As systems change, vendors must supply accurate documentation, prompt support, and training.

- Reformatting of the call-taking screen would improve efficiency,

- Dua1 voice announcements are desired by call-takers who work two taxi services.

- Drivers would like better radio frequency receivers. Some digital messages must be repeated several times before they are properly read by the MDT.

- Drivers want the capability to check their posting or queue position:

- Supervisors want a display (preferably for all to see in the dispatch room) which shows service levels for answered calls. The display could show, for example, the percentage of calls answered within a set time, say 20 seconds.

- Supervisors need a computer monitor to simulate the activity of the call-takers. The monitor could schematically show the arrangement of the call-takers, and the color of the symbolic call-taker position would indicate whether a call-taker is answering a call, dispatching a call, or waiting for a call.

These suggestions focus on. relatively inexpensive changes that can make significant improvements to the way that taxis are dispatched by computer. For the most part, they improve the effectiveness of call-takers, supervisors, and drivers. They make little or no impact on passengers. Concepts to improve passenger service and community mobility will be discussed in Section 5.

4.5 paratransit Interviews and Site Visits

Automated scheduling and dispatch technology is relatively new to the paratransit industry. Some operations have been utilizing computer-assisted or computer-aided software applications to assist in scheduling and routing passengers for shared-ride services. Unlike the taxicab automated computer dispatching systems, these software packages do not have an automated scheduling algorithm. In other words, they do not have the capability to determine the most efficient route to assign to a passenger. A scheduler is still needed to manually assign the passenger to a route and to complete the trip sheets.

Th'e more advanced softwareapplications, with the automated scheduling function, have been implemented in a limited number of operations primarily because the software is just being developed and modified to meet the needs of the paratransit industry. This technology is more comparable to the taxicab computerized dispatching technology except that taxis provide real-time, exclusive-ride service while paratransit is typically subscription; shared-ride service. Fully automated systems are especially usefu1 in mid to large size paratransit operations and when scheduling is done on a real-time basis.

The interview pool originally contained 20 operations but some were eliminated from the survey for various reasons. One of the main reasons is that several paratransit operations, such as the Tidewater Transportation Commission in Norfolk, Virginia, have purchased the software (Comsis CTPS) but have not yet installed their new system. Another example is Van Trans in Tucson, Arizona. It purchased "386" personal computers on the advice of its software vendor. After installation it discovered that the processing unit was not adequate to handle the demands of its system; therefore,. it is upgrading to "486" units and will be installing PASS, a software application developed by On-Line Data Products, Inc.

The interview pool was then reduced to eight survey participants who comprised a total of ten operations. Of the ten operations, two are operated by a local government directly, five are operated by a local authority, two are managed by private management company, and one is owned and operated by a private company. The specialized paratransit systems installed in these operations have a range of automated capabilities, but most of the operations do not use all the features that the software offers.

The telephone survey and on-site visit (Table 4.5, similar to the taxicab interviews contained questions about the operation, types of service provided, type and costs of the computer scheduling system, and scheduling statistics.

System characteristics are diverse, and the operations are located in a variety of geographic regions. All provide shared-ride service. TWC Ambulette provided limited shared-ride service, The majority serve mentally and physically disabled persons and the elderly, and obtain referrals from multiple agencies.

Scheduling system *characteristics* include type of hardware and software, vendor name, year installed, system costs, and system reliability. Nine paratransit scheduling software packages are used by the ten sites. Orange County, California, uses TRANSMAX, a package developed as part of an FTA-funded demonstration project in its Consolidated Transportation Services program (advanced reservations only). The company that developed this software is no longer in business; therefore, Orange County has no software support. It is currently evaluating paratransit scheduling software. In its Dial-A-Ride demand-responsive service (real-time scheduling), Orange County developed its own fully automated software (CATS) in-house. ATE Management Company (ATE-Ryder) also developed its *own* scheduling package that is currently not on the market and is only for use in paratransit operations under its management. The other vendors include Automa ted Dispatch Services; Modeling Systems&.; On-Line Data Products; Para transit Systems International, Inc.; and PtMS. The majority of operations have installed their software within the past four years, with theexception of the TRANSMAX system which has been operating for ten years.

Depending on capacity needs, personal computers, minicomputers, or mainframes support the software. Some of the programs, such as Planet (Scandia Transport Systems, Inc.), are designed to only run On mainframes or minicomputers. Such programs may not be the most suitable for smaller paratransit operations which can operate their scheduling system with a personal computer at a more economical cost. Smaller operations that anticipate growth should consider processing speed and future networking needs before purchasing equipment, Three of the operations surveyed run their software on either a minicomputer or a mainframe. The remaining seven operate their programs with personal computers.

The cost of systems vary depending on the size of the paratransit operation. The software, hardware, and operating systems costs for these 10 sites range from $25,000 to $1 million. In the case of Orange County's CTSA operation, its costs appear considerablv lower since its CATS program was developed in-house. This does not reflect the true cost since personnel time devoted to developing the software is not included in the cost figures. Also, some of those interviewed used existing hardware and had little or, no expense in this area.

The level of satisfaction with the scheduling software ranges from poor to excellent. For many of the Operations, it is too soon to determine what the long-term level of satisfaction will be because the majority of sites are testing new software. The users understand that fine-tuning is necessary in the early stages of development of a product, and modifications need to be made to customize the software to meet individual site needs.

Table 4.5
Paratransit Interviews and Site Visits

Operation Characteristics				Computer Scheduling Systems						Scheduling Statistics			
Operation Name	Location	Types of Service*	# in Fleet	Host Computer	Software	Software Vendors	Year Software Installed	Estimated System Cost (Total)	Reliability of System	# of Call Takers B / A**	# of Dispatchers/ Schedulers B / A	Calls Taken (Daily) B / A	Call Time (sec) B / A
PARATRANSIT INTERVIEWS													
Glendale Transit	Glendale AZ	SR	10	IBM PC Compatible-386	PASS	On-Line Data Products	1991	$50,000	Good	4 / 5	NA	600 / 600	30 / 120
Kitsap Paratransit	Brenerton WA	DA/MA/SR	35	IBM PC	Rides Unlimited	Paratransit Systems Int'l, Inc.	1988	Unk.	Unk.	Unk.	Unk.	Unk.	Unk
Manattee County Area Transit	Bradenton FL	DA/MA/SR	24	Dell PC & Prime Vax Mainframe	Emtrack	Automated Dispatch Services	1991	$40,000	Unk.	2 / 3	1 / 1	60 / 60	300 / 120
Orange Co. Trans. Service a) CTSA	Garden Grove CA	DA/MA/SR	69	IBM PC Compatible-486	CATS	Developed In-House	1988	$25,000	Good	1 / 1	4 / 4	100 / 200	180 / 180
b) Dial-A-Ride	Garden Grove CA	SR	161	Prime Vax	TRANSMAX	Transmax	1982	$1,000,000	Excellent	NA / 9	NA / 6	NA / 1500	NA / 120
Valtrans	Van Nuys CA	DA/MA	42	IBM PC/Compatible	ATE-Ryder	ATE-Ryder	1990	Proprietary	Excellent	5 / 4	4 / 2	350 / 450	60 / 20
TWC Ambulette Service, Inc.	Long Beach NY	DA/MA/SR	21	Dell PC-386	Emtrack	Automated Dispatch Services	1991	$75,000	Excellent	4 / 3	NA	180 / 180	90 / 30
Utah Transit Authority	Salt Lake City UT	DA/MA/SR	25	VAX Mainframe	Scooter	Modeling Systems, Inc.	1988	$7,000***	Good	NA / 3	NA	NA / 200	NA / 30
PARATRANSIT SITE VISIT													
Pomona Valley Authority a) Get About	Pomona CA	SR	20	IBM PC Compatible	PIMS	Automated Business Solutions	1990	$35,000	Poor	5 / 2	3 / 1	Unk. / 550	90 / 60
b) Valley Connection	Pomona CA	SR	15	IBM PC Compatible	PIMS	Automated Business Solutions	1990	$35,000	Poor	5 / 2	3 / 1	Unk / 500	90 / 60

* DA = Disabled Persons
ER = Exclusive Ride
MA = Multiple Agencies
PD = Package Delivery
SR = Shared Ride

** B/A = Before/After Computerized Dispatch

*** This figure includes the cost of the software only. It is not the total system cost.

Unk. = Unknown

Note: Limited information available on scheduling statistics.

Again, since the specialized paratransit software is available new to the paratransit industry, before/after scheduling statistics were not readily available for most of those contacted. Some operations managers provided estimates. Four reported reductions in personnel. For example, Valtrans in Van Nuys, California, reduced its call-takers/schedulers from a total of nine to six.

Many of the managers interviewed indicate an increase in productivity with the automated system, The before/after figures of calls taken daily remained the same, but the call-taker's time on the telephone with a passenger was significantly reduced. For example, TWC Ambulette Service, Inc., reported that since many of its calls are from repeat customers, the call-takers only need to pull up their file that contains billing and other pertinent tnformation and then obtain additional information relating to their destination place and time.

Some bperations reported that they were closer to the projected pickup time for demand-responsive passengers after automated scheduling Prior to automation, some passengers could be riding on a route for up to one hour before arriving at their destination.

It is difficult to determine exact dollar savings. Some operations reduced the number of personnel. Most reported that the routes are more efficient and less mileage is put on the vehicles, which translates into less wear and tear and lower gasoline expenses. Due to automation, the photocopy machines also get less wear. The sites contacted had not conducted cost-benefit analyses and could not provide the research team with actual cost reduction figures.

Overall, those contacted indicated that scheduling packages facilitate the management of the operations. The capability to readily produce reports is of great assistance to the operations managers. It is very time consuming to manually compile ridership data to fulfill the FTA and other reporting requirements.

Most of those interviewed responded that the drivers, schedulers, and dispatchers did not readily adjust to the computerized scheduling system, but an adjustment period was anticipated. After this adjustment period, all reported that staff were very satisfied with the automation.

Some reported that the passengers are more satisfied since the pickup is on time or close to the scheduled pickup time. Others respond that the scheduling system had no impact on customer satisfaction. One site, Glendale Transit, distributed a survey to assess ridership satisfaction after automation. Eighty-eight percent of those responding (15 percent response rate) reported that the vehicle response time was improved, and arrived closer to the scheduled time (within 10 minutes of the quoted arrival time).

4.6 Paratransit Scheduling Software Review

ATE Management and Service Company recently completed a survey of paratransit computer dispatch software for Westchester County, New York (ATE 1991). With their permission, the results are included in this section. ITRE researchers have extended the results of the ATE survey by including additional software products and discussions on the importance of scheduling and billing.

Of the 11 systems ATE initially considered, five were eliminated from detailed evaluation. Reasons for elimination included the following:

- Coresoft Corporation's STAR-3 is used primarily for school bus routing.
- Multisystems, Inc.'s DISPATCH-A-RIDE lacks computer-assisted scheduling.

- Phil Dorcas and Associates (PSP-25 program) was Unavailable after repeated contacts,
- SRI International no longer provides support for its GO-TRAN paratransit package.
- VISTA's E&H Mobility Module has manual geodata file entry and no control for overbooking.

The six paratransit packages that were included in their assessment are

1. Aleph,
2. Comsis PARIS (since their ATE survey, PARIS was renamed CTPS),
3. Giro-Giro/Acces (distributed by Multisystems),
4. Ketron-PARMIS,
5. Modeling Systems, Inc.--Scooter, and
6. Paratransit Software-PARRAS.

Of most importance in evaluating the suitability of paratransit software is whether or not it can accomplish real-time, shared-ride scheduling. All of the examples listed can schedule rides on an advanced, overnight basis, but only CTPS,Giro/Acces, and Scooter appear to have real-time, taxi-like dispatch capability. Paratransit must be able to handle real-time scheduling for shared rides if it is to broaden its services to the general public and effectively carry ADA passengers. Thus, scheduling software must be able to dynamically insert a trip request into an existing shared-ride schedule while maintaining constraints and optimal routes.

There are several other important features that the prospective user of paratransit software should look for according to the ATE evaluation. One feature concerns the geodata file. Manually defined and maintained files are less desirable than those based on GIS technology using DIME or TIGER files. At the cost of some complexity in construction and updating, DIME and TIGER files will provide better accuracy and consistency in the geodata file than manually constructed address files.

Another featurein software evaluation involves the method in which the software matches the demand of trip requests with the supply of vehicles. Ideally the software will allow the user to apply either of two ‘common methods: ride availability matrix or an interactive automated scheduling algorithm. Giro/Acces, PARMIS, PARRAS, and Aleph do not provide for bothoptions; the Comsis PARIS and Modeling Systems Scooter packages do.

In addition to the software packages identified in the ATE study, the lTRE team learned of other specialized paratransit scheduling software from paratransit operators and from the literature review. The vendor and the software names are listed below:

- ATE-Ryder
- Automated Dispatch Services-Emtrack
- Easy Street--Easytrips

- On-Line Data Products, Inc.--PASS
- Paratransit Systems International, Inc.--Rides Unlimited
- Scandia Transport Systems, Inc.--Planet

A complete assessment of the software features of this second group was not made. Table 4.6 provides some information about system requirements and costs. In addition, some research team observations and software vendor comments are provided below:

Paratransit Systems International, Inc., reports that its software, Rides Unlimited, can schedule on a real-time basis, but the software assists the dispatcher in determining where there are openings.

Easy Street's Easytrips appears to be a comprehensive package that automatically schedules demand-responsive trips and can import GIS maps. This software has not yet been tested in a paratransit situation, but it is used extensively for urban goods delivery. The City of Greensboro, North Carolina, through its paratransit provider (GATES), is preparing to install this software.

Planet, a Swedish software product which is now being marketed in the United States, resembles in kind, cost, and complexity taxi-automated dispatch systems. It is advertised as an advanced scheduling and real-time planning system for demand-responsive passenger transit. Much of its operation is automatic-dispatching, assignment allocation, and monitoring of driving schedules. Passengers may be private customers using a normal taxi service or disabled persons who are sponsored by a local agency. In principle, any kind of demand-responsive passenger service can be handled, as well as normal taxi services and passenger-requests for fixed routes. The system includes passenger eligibility checks based on passenger code numbers, phone numbers, or other information. This software has not yet been tested in a paratransit operation.

On-Line Data Products, Inc. (PASS), and ATE-Ryder report that their software package have a feature that locates specific addresses rather than having to categorize addresses by zone or street segment. The addresses are not, however, related to map coordinates.

Comsis uses MapInfo, a popular geographic information system package, with DIME files to construct the geodata. Modeling Systems' Scooter also has innovative approaches to meeting paratransit software needs through an interactive map display of the service area and windowing features.

During the investigation, ITRE researchers also determined thatvirtually all of the software products contain records and billing modules. These features will be vital to support ADA requirements. However, the features must be flexible. The format of ADA records has not been set, and management may also wish to have records in customized formats to track productivity. Billing must be flexible to ensure equitable fare calculations which may be based on zones, mileage, or passenger load according to local and other policies.

The vendor must be dedicated to continued support and improvement of the software and be willing to adapt the software to the client's needs. Refer to Table 4.7 for a list of the main features of the scheduling software described here.

Table 4.6
Paratransit Scheduling Software/Hardware Requirements

Vendor Name	Software Name	Operating System	Software/Operating System Costs	Hardware Requirements	Hardware Costs	# Days of Training Provided*
Aleph	Aleph	AMOS	$80,000	MiniComputer 310 HD	$65,000	54
ATE-Ryder	ATE-Ryder	DOS Novell	Not on Market	IBM PC compatible 200-500HD	NA	NA
Automated Business Solutions	PMS	DOS Novell Windows (optional)	$8,400 $16,500	IBM PC compatible 286-486 80-500 HD	$20-25,000	3 4
Automated Dispatch Services	Emtrack	Unk.	$60,000 $150,000	IBM PC compatible 386-486 320-650 HD	$15,000-40,000	Unk.
Comsis	CTPS	UNIX	$35,700	Mini Computer 300 HD	$17,750	3 5
Easy Street	EasyTrips	DOS	$25,000	IBM PC compatible 386-486	$5,000	3 5
Ketron	PARMIS	DOS	$24,250	IBM PC compatible 286-386	$25,000	Unk.
Modeling Systems	Scooter	AT&T Mini	$40,000	MiniComputer	$20,500	Unk.
Multisystems	GIRO(ACCES	VAX VMS	$80,000	Micro-VAX 328 HD	$100,000	10
On-Line Data Products. Inc.	PASS	DOS Novell	$24,250	IBM PC compatible 386-486	$5,000	10
Paratransit Software	PARRAS	DOS	$18,000	IBM PC compatible 386 100HD	$24,250	Unk.
Paratransit Systems Int'l Inc.	Ride-3 Unlimited	DOS Novell Windows	$18,500	IBM PC compatible 286-486 200-500 HD	$20,000-25,000	314
Scandia Transport Systems. Inc	Planet	VAX VMS	$500,000**	Micro VAX		40-200

*Training cost is included in base cost
**Full system cost

Table 4.7
Paratransit Scheduling - Software Features

Aleph (Aleph) - comprehensive paratransit package - complete client registration module - complete reporting and billing system - automated scheduling techniques to assist order taker - variable parameters for scheduling - just batch mode for scheduling function - just manual street entry to construct geodata file - no custom report generator - poor hardware support for Alpha computer system	**Easy Street (under testing)** - custom report generator and billing - relational data base and C programming - geodata from DIME files and MapInfo and Atlas GIS - real-time dynamic scheduling - one month reservation - microcomputer platform - no vehicle reports	**On-Line Data Products, Inc. (PASS)** - produce data reports - same day and next day scheduling - ADA tracking - geocarded mapping - statistical analysis capabilities - graphic displays
Automated Business Solutions (PtMS) - coordination of multiple funding sources - scheduling and routing demand response and subscription trips - real time dispatching - client registration and (ADA) certification tracking - transaction accounting - agency and client billing - performance monitoring - user defined reporting	**Ketron (PARMIS)** - custom report generator - DIME file geodata construction - comprehensive and flexible order taking - comprehensive reporting and billing system - easy program modification - batch mode automated scheduling - batch mode reconciliation of no-shows and cancellations	**Paratransit Software (PARRAS)** - complete billing and reporting system - report generator - simplistic automated scheduling - no geodata file - manual mapping of trip/client origins and destinations
Automated Dispatch Services (Emtrack) - call taking capability for same day or pre-scheduled calls - batch scheduling - real time dispatch capability as a stand-alone or integrated with batch scheduling - capable of simultaneously dispatching to multiple fleets - menu driven report generator for customized reports - library of standard reports	**Modeling Systems (SCOOTER)** - complete automated scheduling - custom report generator - DIME file construction of geodata - interactive service map display - dynamic demand responsive scheduling - one hour or 15 minute ride availability with alternate routes automatically displayed - reporting and billing system - easy program modification - windowing options for common business applications	**Paratransit Systems Int'l, Inc. (Rides Unlimited)** - Microsoft Windows environment - produces operations and financial billing reports - integrates routing subscription, advance reservation, and real time requests - combines multi-modal transportation in one computer system - scheduling and dispatch component - comprehensive reporting system
Comsis (CTPS) - variety of automated scheduling options - custom report generator - complete client registration module - meets all billing and special need requirements - geodata file constructed from DIME files and MapInfo GIS - comprehensive vehicle availability file - comprehensive customer complaint module - demand responsive dispatch: 1/2 hour lead time or immediate scheduling	**Multisystems, Inc. (GIRO/ACCES)** - automated scheduling for demand responsive trips - custom report writer - option to store frequent standing order and demand responsive trips - complete reporting and billing systems - manual geodata file construction and maintenance	**Scandia Transport Systems, Inc. (PLANET)** - systematic order taking - planning based on clients' individual needs and demands - manual or automatic dispatch - handling of several independent vehicle fleets simultaneously - support of various mobile data concepts - systematic follow-up of productivity - capacity to integrate fully with other systems - higher service level - improved transport quality and efficiency

Note Information on software features gathered through interviews with vendors, company brochures, and an ATE Management and Service Company survey.

5. Future Prospects for Computer Dispatch

The development of computer dispatch technology has occurred quickly in the past decade, and it is likely that it will continue to do so in the near future. It is appropriate, therefore, to consider how this technology soon will be useful to support changes in public transportation services.

There are three perspectives from which to consider future uses of computer dispatch. The first is the enhanced use of computer dispatch within the taxicab industry. The second is the development of computer scheduling in the paratransit industry, particularly for special paratransit services. Finally, the Mobility Manager concept depicts a new level of public transportation services. The extent to which computer dispatch will enable mobility managers to be effective needs to be addressed.

5.1 Future Enhancements to Taxicab Computer Dispatch

There are two major trends that seem highly certain in the future use of computer dispatch in the taxi industry. One is wider adoption of computer dispatch by more companies. The other is new ways to improve its effectiveness.

As indicated in Chapter 3, currently only about 40 taxicab companies in North America have installed computer dispatch technology. However, as the technology has recently been refined and as the prices of the hardware and software decrease, one can expect that more companies will install computer dispatch. This trend is supported by the fact that taxi companies-like businesses in general-have widely adopted computers for accounting and recordkeeping as the price of computers has decreased in recent decades. We expect the same trend to occur with computer dispatch.

This predicted trend is also supported by the findings of this study. Taxi operators uniformly praised the benefits of computer dispatch even while sometimes expressing some past frustration with its reliability and dependability. These benefits include quicker response times for passengers, quieter rides for passengers and drivers, elimination of dispatcher favoritism toward certain drivers, and complete management information on each taxi trip. These advantages produce two economic benefits that are important to taxi operators. One is improved market share owing to the quicker response times. More passengers mean more cabs on the street and more profits for the company. Second is improved ability to attract and retain more and better drivers. Attracting drivers and retaining them is a major challenge for most taxi companies; computer dispatch can aid companies in attracting drivers. Both of these economic benefits argue for more companies purchasing computer dispatch if for no other reason than to compete with those companies that already have it.

The spread of computer dispatch is likely to include companies that do not purchase computer dispatch systems. One possible mechanism for the adoption of computer dispatch is for one taxi company to offer computer dispatch services to other taxi companies. This has been attempted by taxi operators in Tampa, Florida, and Seattle, Washington. The competitive nature of taxi operations inhibited a successful cooperative endeavor. However, the economies of scale argue strongly for taxi companies in the same metropolitan area but with different prime service areas to be served by the same computer dispatch system.

It is worth noting that wider use of computer dispatch will expand the already substantial economic benefits that accrue to the riding public. As we estimated in Chapter 4, there is each year about $44 million in travel time savings for the U.S. public because of reduced waiting time for taxicab service. These benefits accrue with only about 10,000 of the nation's 170,000 taxicabs computer dispatched. If computer dispatch spreads to include only 25 percent of the industry (42,500 taxis), the economic benefits of reduced wait times would increase to about $186 million per year. These benefits result from improving the efficiency of taxi service relative to passenger call time. It is aiso apparent that cornpu ter dispatch will be used in new ways in the taxi industry Some of these new uses are discussed below.

Passenger codes can be given to regular passengers. A few companies have already recognized that a passenger's trip request data--such as address, name, and phone number--can be pre-stored in the computer and not reentered each time the passenger calls. One company has marketed this service as "QuickCall." The passenger is given a unique but memorable number--such as the last five digits of his or her phone number-and merely gives this number to the call-taker. The call-taker inputs this number and immediately sees on his or her screen the complete trip request information for the caller. After confirming the information, the call-taker sends the trip request to the computer, and the caller hangs up.

Two benefits result from this feature. One is improved accuracy. By avoiding the need to re-type the address, name, and telephone number each time the passenger requests a trip, the company decreases the chance of typing the information incorrectly. More importantly, however, is the quicker service provided the caller: a normal call without the passenger code takes about a minute; with the passenger code, the same call takes about 10-15 seconds.

Passenger codes are so efficient and attractive to customers and companies alike that some companies attribute 20 percent or more of their business to them and want to establish more. Seventy percent of the dispatches for one Florida company are for passenger codes.

Locator *numbers* are similar to passenger codes. Numbered phones with direct lines to the dispatch office are placed in hotels, restaurants, and other high taxi trip generators. Picking up the phone automatically connects the caller to the dispatch center, and the locator number next to the phone identifies its location. The caller does not have to specify an address, just the number and his or her name. The call-taker who answers the locator call enters the locator number, confirms the address and dispatches a taxi. The call-taker may also give the approximate response time and the taxi vehicle number to the caller.

Locator phones could be replaced by special locator devices that combine telephone buttons and a readout device. The passenger would only have to press a single button; in a few seconds the device would indicate the number of the taxi that had been dispatched to pick up the caller. The information might appear on a screen or digital readout, or it might be printed on a slip of paper that the passenger could tear off and retain. Such a device could encounter vandalism, and for this reason it should be placed where it can be monitored.

One'step beyond the passenger code is for the passenger to enter his or her trip request directly into the computer dispatch system without interacting with a call-taker. The caller could call the taxi company and directly enter his or her trip information in response to synthesized voice directions by using push buttons on the phone. This step ,is similar to many systems already in place outside the taxi industrv. Likewise, callers with computer terminals (agency representatives or mobility managers) could input their trip requests by following instructions on their computer screens. These concepts may or may not involve the use of a passenger code.

The next leap beyond special passenger codes and locator numbers depends on "911" technology. When the customer's phone call is answered; perhaps by a synthesized voice, the computer automatically matches it to the address of the telephone location The call- taker need only verify the call, or a synthesized voice may repeat the information to the caller for verification before the computer automatically dispatches a taxi to pick up the caller. With synthesized voice technology and automatic dispatch the entire service request could be accomplished without the aid of a human call-taker or dispatcher, and staff reductions approaching 40 percent could occur according to company owners.

Taxi management is cautious , however, about synthesized voice and "911" technology. They want to see it proven by others before they invest in it. They are also concerned about the loss of "human contact with customers. This could be overcome by having the caller push the # key, for example, for a voice operator. Before "911" technology can be implemented, privacy and other legal issues must be overcome.

Thus far, the passenger codes, locator numbers, and "911" technology only cause minor impacts on passenger service. Call-time is reduced from 60 seconds to perhaps 10 seconds. While management would see quick call times as a big, gain in call-taker efficiency, and while they are a convenience to the caller, they do not make a big impact on travel time for the passenger. Only taxi response time reductions can create significant service improvements. In-taxi travel time cannot be changed significantly by technology; it is dependent on travel distance and traffic conditions.

The key to reduced taxi response time is automatic vehicle location *(AVL). One* of several methods (geo-positioned satellites, Loran C, or Teletrac) can locate vehicle position on the coordinates of a map within 100 feet or better. Then address matching features of GIS software can measure the distance of the vehicle relative to the person calling, Thus, AVL, permits the assigning of theclosest vehicle to thecustomerand an extremely accurate estimate of the taxi arrival time. This technology will make significant reductions in response time. Estimates suggest response times averaging four or five minutes instead of the average 10 to15 minutes currently. AVL will also eliminate the current practice of vehicles posting and queuing in zones, The computer and AVL system will always know where the vehicles are. Consequently, "long hooding" will be eliminated, i.e., drivers will not be able to say they are somewhere they are not.

Guaranteed service is at hand. Computer dispatch already enables companies to provide reasonably accurate estimates of predicted pickup times when a caller requests a taxi. These estimates are based on recent response times for trips in the caller's pickup zone. With AVL technology, very precise estimates will be possible because the vehicle position, distance to the pickup, and approximate driving speed are known. This information enables the taxi company to go one step beyond estimating the pickup time; the company can guarantee the pickup time or forfeit the cost of the fare. Any lost revenue is offset by the improved market share that such a service guarantee produces. At least one taxicab company is planning to introduce a service guarantee based on current computer dispatch technology without AVL.

Regardless of the promises of AVL, management reaction is mixed. Some taxi owners see it as unnecessary: "Cab drivers know where they are; the company does not need to know." Others see AVL as the next major technical advance to reduce response time and improve taxi service to customers. Some-owners estimate that it will take at least five years to develop a prototype AVL system for taxis and another five to make it affordable. In any event, European and U.S. companies are making rapid progress in AVL to support shared-ride paratransit service, AVL technology is already being widely used in transit systems, police cars, and other emergency vehicles, especially in Europe and Japan. .

Recordkeeping features of computer dispatch are very robust as discussed in Section 3.4. A complete itinerary of the trip can be recorded including each call-taker and driver action as well as vehicle distance covered. Since passenger codes are already in wide use, the passenger's name, address, and distinguishing service needs (foreign language driver, specially skilled driver, wheelchair) can be pre-stored and used. The recordkeeping features also mean that taxi companies can follow the precedent of airlines in offering discounts to frequent travelers. This type of customer-oriented marketing has been missing in the taxi industry. With it, however: taxi companies can possibly make significant improvements in their market shares.

Furthermore, the method of payment or a charge account number of a corporate customer can be stored so that the user can be billed at a later date. The billing features coupled with accurate measurements of distance traveled are very important features for possible ADA applications of taxi computer dispatch.

The many available features of computer dispatch-passenger identification and database, efficient call-taking and dispatching, service confirmation, quick taxi response, billing, recordkeeping, vehicle location, guaranteed service-will eventually permit efficient shared-ride service to be provided. While the other enhancements to taxi service discussed here will improve the level of service given to traditional exclusive-ride taxi passengers, shared-ride dispatching will allow taxi companies to provide rapid, inexpensive public transportation services, especially for ADA eligible passengers.

According to one taxi owner and a paratransit provider in the Los Angeles area, taxis can reduce the cost of social service trips by 60 percent with shared-ride scheduling and dispatching. According to these operators the current average taxi fare is $7 compared to the average cost of $10 for a shared-ride social service tip. With shared rides in taxis, ADA social service travel costs could be driven below $7 per passenger. Savings are more apparent when considered with respect to ADA cost estimates for Los Angeles and Orange County. If only fixed-route buses are used to meet ADA, $150 million in vehicles and related equipment would have to bought. If county social service transportation were used, $100 million. If existing taxis and their unused capacity were used with a central dispatcher (broker or mobility manager), only $70 million in new vehicles and equipment (computer dispatch and AVL technology) would have to be purchased. (Recall the market estimates for Los Angeles in Section 4.1.)

Unfortunately, several barriers exist to using taxis in shared-ride service. First, and most importantly, Gandalf and Motorola, which are the two primary vendors for computer dispatch, do not include shared-ride functions in their software. Aleph does, however, have a prototype shared-ride function being tested in Maryland. Second, matches for shared-ride service would have to be made carefully. The traditional taxi rider is used to exclusive service; additional passengers cannot be placed in a taxi indiscriminately. One solution is to ask the passenger's permission, or to market shared-ride services to special groups such as ADA eligible passengers, commuters, airport passengers, etc. Third, if a shared-ride taxi is to be used for ADA eligible passengers, taxi companies would have to become more amenable to keeping detailed Section 15 records. Fourth, public agencies must be willing to relinquish their traditional social service market and funding to taxis. In the Los Angeles area, for example, cities receive $40 million in "Proposition A" revenues to support their own specialized transit. These funds would be threatened if taxis became involved. A centralized broker or.Mobility Manager might help overcome these barriers as discussed in Section 5.3..

5.2 Future Development of Paratransit Computer Scheduling

During the data collection the research team was able to gather information on scheduling both general public paratransit and special. paratransit services. While our information is not complete, it is appropriate to provide some observations regarding automation of scheduling for paratransit services.

First, as discussed in Section .21, the scheduling of-paratransit trips is considerably, more complex than the dispatching of traditional,,exciusive-ride taxi trips. The major difference is that both the pickup and the drop-off for each trip must be considered simultaneously with the same information for all other trips. In addition, for special paratransit services each trip requires substantial recordkeeping, such as the passenger's certification information, the agency subsidizing the trip, and the trip length.

As discussed in Chapter 4, computers commonly automate recordkeeping, particularly the client records and certification information. Some systems have also experimented with computers to assist in scheduling, while a few systems have tried fully computerized scheduling systems. It is fair to say, however, that fully computerized scheduling is still in the development stage and that the complete integration of client recordkeeping and scheduling is still in the future. A recent request for proposals from Los Angeles County seeks vendors to develop an integrated recordkeeping and scheduling package.

It seems apparent, therefore, that one future application of computer dispatch technology will be to schedule paratransit trips. This step is the same as the scheduling of shared-ride taxi trips discussed in Section 5.1, except for the scheduling of special paratransit trips that are more complicated than general paratransit trips.

5.3 Mobility Manager

This report defines the state-of-the-art of taxi dispatch and paratransit scheduling. In sections 4.4 and 4.6 the technologies are reviewed and a host of suggestions are listed for software and hardware improvements. While these improvements will bring significant changes to taxi and paratransit services, they will have only a marginal impact on the mobility of a community unless they can be used with an entirely new concept in service delivery. Fortunately, such a blend of technology and service delivery is close at hand.

Figure 5.1, which repeats Figure 1.1, illustrates what is happening in the taxi and paratransit industry. Already some taxi companies provide shared rides while paratransit operators are experimenting with real-time dispatch. Except for shortcomings in dispatch and scheduling software, there is no reason why general public and ADA passengers should not be offered the opportunity for shared-ride, immediate response service. Distinctions between exclusive-ride, rapidly dispatched, privately owned taxi service, and shared-ride, advancescheduled and publicly owned transportatian agencies are fading, especially as communities react to the requirements of ADA and electronically integrate public and private transportation providers. The opportunity is now available for passengers to think more about the service they need rather than which provider to call. Such a paradigm shift represents a new way of improving mobility. The technological elements are present not only for a new transportation system, but also for passenger behavior changes.

The key to success for major improvements in public mobility is information access and *control,* and the Mobility Manager promises to facilitate this change. Ron Fisher, director, Office of Research, Training and Rural Transportation, Federal Transit Administration (FTA), discusses features of the Mobility Manager in his 1990 concept paper (UMTA 1990). According to Fisher the goals of a Mobility Manager are to provide competitive alternatives to single occupant auto travel and to provide special population groups greater mobility.' For the general public the Mobility Manager accomplishes these goals by providing the following features:

- Electronic links between all urban modes to provide the public with travel alternatives superior to the auto,

- Complete price and service information on local transportation options through a single point of contact via a telephone call,

- Access to the Mobility Manager by phone or through a computer network, and

- Travel arrangements for the user by directly contacting a provider's dispatching system as long as the provider meets financial, safety, and fare standards.

For social service agencies and other sponsors of traditional shared-ride transportation, the Mobility Manager offers additional advantages:

- Broader travel options to client groups by linking public and private services,

- A financial clearinghouse to standardize and reduce administrative overhead to sponsoring agencies,

- Simplified user access and eligibility validation with such technology as passenger codes and 911 caller identification,

- Documentation of all passenger trips, and

- Improved advance scheduling and real-time dispatch response.

While no one provider, agency, or organization currently operates with all of the proposed features of a Mobility Manager, a few are developing. They include Automated Dispatch Services in Miami, Tidewater Transportation in Norfolk, and Rogue Valley Council of Governments in Oregon (USDOT 1992). In addition the International Taxicab and Livery Association (ITLA) recently completed a conceptual study of the Mobility Manager (Parker 1991). The biggest test of the Mobility Manager concept will occur in Los Angeles, where selected paratransit and taxi services will be integrated electronically (Los Angeles 1991). Of immediate importance is ADA transportation. Ultimately as the concept is proven, general public transportation will be offered and many of the 400 Los Angeles area providers, including taxis, paratransit operators, buses, private shuttles, commuter and light rail lines, and other modes, will be linked electronically.

As the concept of a Mobility Manager matures, it will extend to large systems. This will be made possible with the continued development of real-time, shared-ride, automated dispatch technology. Unfortunately none of the software systems examined in this study have a robust real-time dispatch capability for shared rides in day-to-day service. Only modest subscription-type shared-ride features are available in Gandalf and Motorola systems, and they are infrequently used since taxis primarily market exclusive ride service. Aleph, however, will demonstrate real-time, shared-ride features in the spring of 1992, and Gandalf is at work on the feature. At least one company which uses Motorola dispatch technology has pioneered shared-ride, many-to-one service and is very interested in extending Motorola capabilities to include many-to-ma? shared-ride service with real-time response.

Current technical features of taxi computer dispatch are ready for use by the Mobility Manager to serve'either the general public or ADA passengers. Through passenger codes or 911 technology, the passenger who is calling the Mobility Manager can be automatically identified, and quick-response databases can validate passenger eligibility. 'The databases already exist for corporate and regular users of individual taxi companies. For ADA passengers the databases must be extended to cover the entire community. Computer dispatch systems already have the capability for automatic billing of regular corporate clients or individuals. It is a straightforward! though complicated, extension to accommodate ADA passenger billing because Section 15

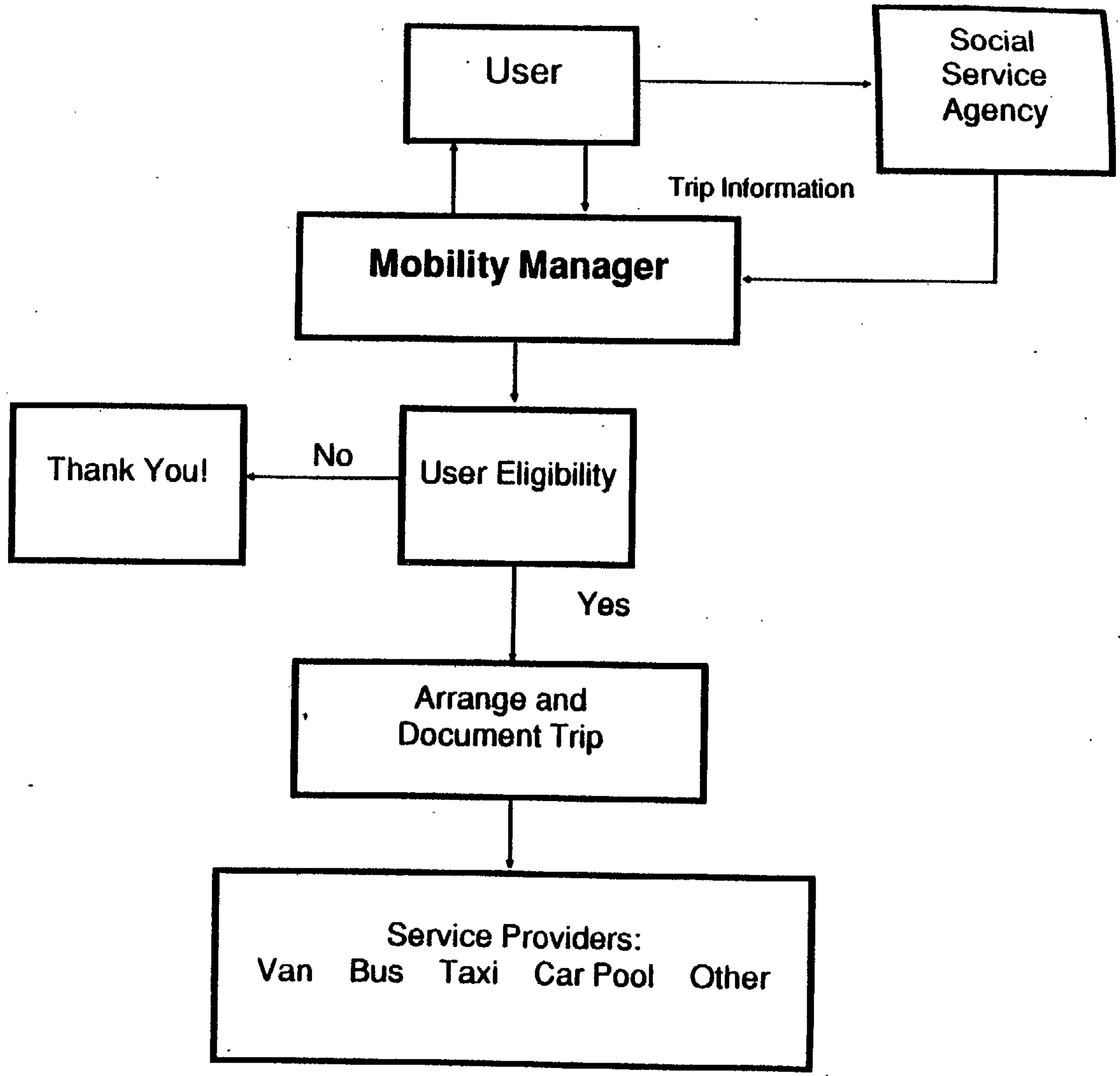

Figure 5.1
Mobility Manager Concept

Source: Jeffrey Parker & Associates. 1991 reporting requirements add significant data requirements on ADA travel. Inexpensive and effective smart cards and other fare media, however, are being developed which will facilitate the entire billing procedure. As discussed in Section 5.1, current taxi dispatch systems allow advanced booking for travel or real-time response within 10 to 15 minutes. To reduce response time much below 10 minutes, automatic vehicle location systems will have to be used. Such systems will also facilitate shared-ride service because the vehicle location can be automatically tracked, and new requests for service can be inserted into existing trip schedules.

Besides the technical features of computer dispatch which are ready for the Mobility Manager, what might be called institutional elements are also ready. Computer dispatch systems have multiple fleet features which provide up-to-the-second service information on all vehicles, drivers, and passengers. One dispatching system with one group of call-takers can serve more than one operator-a critical element for linking modes under the Mobility Manager concept. For taxi service, however, passengers request a particular company, and the call-takers dispatch a vehicle from that company. Under the Mobility Manager concept the passenger calls and requests a type of service, not a specific company or operator. The Mobility Manager dispatches the closest vehicle (taxi, van, or bus) which meets the passenger's service requirements and tells the passenger what vehicle to expect and what time the vehicle will arrive for pickup. Competition between operators for the fare can also be allowed by the Mobility Manager. Current dispatch systems have competitive bidding features which can be used by the Mobility Manager to ensure that passengers have not only high quality service, but also competitively priced service.

In summary, software and hardware which successfully implement the Mobility Manager concept will have to efficiently accommodate subscription service, demand-responsive service, shared rides, automated dispatch and, scheduling, Section' 15 reporting requirements, and passenger identification devices such as smart cards. While no combination of software and hardware currently integrates alI of these features, taxi computer dispatch systems come close. It is interesting to note, however, that the major development activity for system integration seems to be occurring in the paratransit sector which serves ADA trips. Taxi dispatch vendors appear to be more reserved in their reaction to the apparent technological need for effective methods for real-time, shared-ride dispatch.

6. Conclusions and Recommendations

This research describes an assessment of computer dispatch technology in the taxi and paratransit industry.On-site and telephone interviews with taxi and paratransit companies and hardware and so ttware vendors have determined the following:

- Current operating capabilities of computer dispatch systems,
- The costs and economic benefits of these systems,
- The suitability of computer dispatch technology for the mobility manager concept, and
- Future technological directions for computer dispatch.

The information contained in this report will enable public and private transportation managers to make well-informed decisions concerning the purchase and use of automated computer dispatch and related technologies like smart cards and automatic vehicle locators.

This research is'particularly important to paratransit operators because the Americans with Disabilities Act guarantees mobility to ail disabled persons. As a result, paratransit operators must provide higher volume, quicker response, shared-ride service to its clientele who include the general public as well as the disabled. As paratransit operators improve their service, they will look to the standards set by taxi operators who have successfully used automated computer dispatch for nearly eight years in the United States.

The operating capabilities of computer dispatch technology streamline daily operations. Passengers can call a taxi company and within 30 to 45 seconds have a taxi dispatched to them after giving origin, destination, and other information to the call-taker. Special passenger codes for regular customers and locator numbers at hotels and other high volume taxi locations can reduce call time to 10 seconds. Further efficiencies in passenger call processing will occur if 911 technology is adopted.

Before automat& computer dispatch, response times were often 30 minutes or more as dispatchers shuffled slips of paper and radioed voice instructions to drivers. After automated dispatch response times fell to the 10- to 15-minute range. Guaranteed response within 10 minutes is being considered by at least one taxi operator, Passenger codes, locator numbers, and 911 technology, however, will have only marginal impact on response time. Improved response time must wait for technology improvements which will be able to Iocate and dispatch the nearest vehicle instead of the next vehicle in the queue posted to the origin zone. With automatic vehicle location and nearest vehicle dispatch, response time can drop to four minutes.

Currently no automatic dispatch system includes an operating shared-ride dispatch and scheduling algorithm. The technology is rapidly changing, however, and the likelihood is high that by the end of 1992 automated shared-ride dispatch and scheduling will be in operation. Demonstrations are scheduled by at least one vendor for May 1992. The successful development of shared-ride dispatch software is essential if this technology is to be useful to paratransit operations.

Without automated shared-ridedispatching and scheduling, taxi and paratransit operators cannot adequately and efficiently serve both the general public and the huge markets defined by ADA. According to one taxi owner and paratransit provider, if the unused capacity of taxis was utilized with shared-ride scheduling and dispatching, the cost of social service trips would drop by 60 percent. Such economic benefits could be returned to the public as lower contract fees for social service transportation, and they could help pay for the new technology.

Clearly transportation managers must carefully weigh the costs and economic benefits of computer dispatch and related technologies. Computer dispatch helps taxi companies to reduce costs and keep pace in a growing and competitive field. While computer dispatch systems are not inexpensive, the investment can be recouped by fleet expansion and more taxi driver leases. Systems average about $1 million for a company with 300 taxis, and overhead costs increase for maintenance and computer programming. While taxi owners did not provide data on actual dollar savings during the interviews, they did say computer dispatch led to consolidated fleet operations and computer sharing with resulting reduced fleet costs, especially relative to ihe increased volume of passengers arid increased fleet size. Automated computer dispatch greatly contributes to more cost-effective taxi service; otherwise, the largest companies would not have developed and installed the technology. On a national scale about 30 taxi companies have invested upwards of $30 million over seven years. The current estimated savings in travel time to passengers, however, is approximately $44 million annually, a savings resulting entirely from private investment.

It must be emphasized that private investment and a profitable return on that investment have lead taxi owners to set the pace for developing automated computer dispatch technology. As the technology is enhanced and adopted by paratransit services, public funds must be invested. Some of these funds will come from traditional sources such as FTA Sections 18, 16b2, 9, and 3. Other new sources may have to be created, especially local dedicated sources. Fortunately, the improved productivity of paratransit computer dispatch will create its own funding source. Given that paratransit demand usually exceeds supply and that paratransit operators will be able to maintain their contracted service rates with client agencies, the increased ridership at lower per-ride costs will generate a direct cost savings which can be used to offset the cost of the new technology. This “in-house” paratransit funding mechanism &analogous to taxi owners using increased income from additional leases to pay the cost of computer dispatch. Without adequate funding, operators literally wilI be “left out of the action” created by ADA.

As this report demonstrates, the current focus of the paratransit industry is on technology-smart cards, au toma tic vehicle location, real-time dispatch and scheduling for shared rides, integrated reporting and billing, minimum time and distance routing for pickup and delivery of passengers, guaranteed and confirmed service, 911 passenger identification and validation, geographic information system database maintenance, graphic displays of service areas with relative passenger and vehicle locations, and other exciting items.. Such “micro-level” improvements are vitally important; however, they will not in themselves improve public mobility appreciably.

Innovative thinking is also needed about the service delivery system and area mobility. Creative concepts like the Mobility Manager are needed to impact the way people think about their transportation choices. Such concepts can then apply the new technology to affect people’s travel behavior and give them viable choices to the single occupant automobile. Thus, such concepts as the Mobility Manager and the associated new technology must focus on the way transportation service information is acquired, processed, and made available before people choose their mode for a trip.

Automated computer dispatch taxi service is a precursor of the Mobility Manager. Already passengers can quickly call for rapidly responding taxi service as discussed above. Automated dispatch also has the capability for other major functions of the Mobility Manager including brokering, fare and ride validation, passenger eligibility, billing and reporting, and magnetic fare media processing. However, the technology must also provide shared-de, real-time dispatch and scheduling in order to become the heart of a Mobility Manager. This improvement will become reality during 1992.

Furthermore, as the technological "haves" and the "have nots" (the participating operator partners in the Mobility Managerand those who do not join) position themselves in the mobility rnarketplace, such issues as unfair competihon, discrimination, equal access to funding, small business opportunities, and other concerns will have to be addressed, Fundamental institutional questions must be answered about the structure of the Mobility Manager. For example, is it a public or private entity? Are there participant fees, or are charges based on delivered passengers? Can a successful Mobility Manager franchise turnkey systems in other cities? What financial and legal responsibility does the Mobility Manager have with respect to passenger service, injury, and liability? As technological problems are solved, answers must be provided to these questions and others as the Mobility Manager and its stable of technology serve the community.

Future technological directions for automated computer dispatch are being set by the markets promised by ADA. In the Los Angeles area alone, over 400 operators may need automated computer dispatch to become effective partners of a Mobility Manager. Other large cities promise similar markets. Industry estimates place computer dispatch, scheduling, and information management **systems** sales at $200 million per year over 10 years--all as a result of ADA.

In the near term the next major advance will be the addition of real-time, Shared-ride scheduling to existing automated computer dispatch algorithms. This improvement will also require changes in the way vehicles are located and dispatched in order to assure rapid response and service validation. One inexpensive approach is to integrate the automatic data transmission and processing capabilities of automated computer dispatch with automatic card readers. Other approaches rely on more sophisticated and expensive automatic vehicle location technology such as geo-positioned satellites, Loran C, and Teletrac.

Other near-term technology improvements in automated computer dispatch include better billing procedures to correspond to Section 15 and ADA requirements, geographic information system editing of geo-files, smart card reader attachments for taximeters, and 911 caller identification with synthetic voice response.

The pace of technological change in the taxi and paratransit industry is rapid. Such change is exciting-new products and concepts for service delivery literally appear every month. Such rapid change also generates concern about the longevity of innovations and their integration. Will better products come along? Will they ail fit together when purchased? Crucial questions remain to be answered in future studies about such issues as common design specifications, physical connections, input/output formats, communications structures, and protocols. As many new products become available, there is concern in the industry about which products are best suited for operators' needs and whether the technology will greatly change within reasonable payback periods.

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Appendix A: Telephone Survey Form

Telephone Survey
Operators of Computer Dispatch Taxi Systems.

DBA Name: ______________________

Contact: ______________ Title: ______________

Street Address: ______________________

Mailing Address: ______________________

City: ______________ State: ______ zip: ______

Phone: ______________

#Jurisdictions Served: ______________ # Fleets Served: ______________

Names: ______________ Names: ______________

Types of Services:

Do you use the computer to dispatch anything other than exclusive fide? (i.e., shared fide, disabled persons, multiple agencies; package delivery, etc.)

Are you working on a feat-time basis? ______

If not, minimum advance reservation time? Minimum cancellation time? ______

# of years using computer-dispatch'? ______ What month/year did you begin? ______

I-low automated is your system?
A: totally automated (all by phone, never speaking to real person ______
B: caller speaks to person who enters info into computer, then lets computer take over ______

What software are you using? ______ Version? ______

What hardware are you using? ______

Did you purchase any options to the basic software package? If so, which ones? ______

If software and hardware were purchased from different sources, what factors influenced that decision?

Cost of System:

Software ______________________ **Hardware** ______________________

Annual Maintenance Agreement __________ **Upgrades** ______________________

Do you do in-house programming? __________ **For what purposes?** ______________________

How many other systems did you preview? __________ **Which ones?** ______________________

Why did you choose your system over the others? ______________________

Operating Statlstlcs: (Peak Time)	Before Computer Dispatch	After **Computer Dispatch**
#vehicles	______	______
# calls-takers per shift (during peak hrs)	______	______
# calls per day (ma% avg on busiest day, i.e., New Year's eve)	______	______
Avg time to get info by phone	______	______
Avg time saving after computer installed	______	
Dispatch time to get info to driver	______	______
Response time to pick up rider after call is taken	______	______
# of special call locations (hotels, bus stations, etc)	______	______

% **of** calls that **can't be located in computer** ______

Driver turnover	______	______
Call-taker turnover	______	______
Dispatcher turnover	______	______

Impact of System:

On drivers? ______________________

On dispatchers? ______________________

On management?

On passengers?

Major advantages of computer dispatch system:

Major problems (current or past)

What are, the technology needs for the future?

Do you have improvements planned for the near future?

Assuming you had your present knowledge of computer dispatch systems, what would you do differently if you had to do it all over again?

Five years from now, what technology do you think we will have?

Appendix B: Site Interview Questions

Company Name and Address

Related Activities

Service Areas

Special Considerations

Taxi Operations
Permits
Contract drivers

Summary Statistics
vehicles
call takers
#dispatchers
#calls dispatched/24 hours
calls dispatched/year
Call takers time/call
Driver acceptance time after dispatch
Pick up time
#exceptions/day
zones
#Quick Calls/day
computer messages/ hour
social service call/day
zones
square miles
County or city of operation

Computer Dispatch System
Hardware vendor & model
Software & version
Special features
Reasons for implementing computer dispatch system

Costs & Benefits of Computer Dispatch

Problems With Computer Dispatch

Personnel Impacts

Dispatcher Impacts

Driver Impacts

Future Needs
Caller id
911 (caller id & address automatically)
Faster equipment
Automatic vehicle locator
Synthesized voice
Regular customer id
Automatic trip sheet/day
Credit cards
Personal check validation
Social service account
Smart card
Shared ride

Appendix C: Addresses of Companies Contacted

1. Computer Hardware/Software Vendors

Aleph Computer Systems
Berkeley, CA
Contact: Ray Zhang

ATE Ryder
Cincinnati, OH
Contact: Richard Szymanski

Automated Business Solutions
Media, PA
Contact: Stephen Pellegrini

Automated Dispatch Services
Miami, FL
Contact: David Brown

CODAPRO Computer Corp
Holbrook, NY
Contact: Toni Repole

Computer & Accounting Systems
Greensboro, NC
Contact: Chris Oates

Comsis
Pittsburgh, PA
Contact: Brian S. Butler

Easy Street
Raleigh, NC
Contact: David Young

Gandalf
Raleigh, NC
Contact: Greg Davis

Haldi, Inc.
Trancometer
Irvine, CA
Contact: Roger Neal .

Modeling Systems, Inc.
Atlanta, GA
Contact: Geoffrey N. Berlin

Motorola Data Systems
Schaumburg, IL
Contact: Michael Wapner

Multisystems, Inc.
Cambridge, MA
Contact: Kurt D. Dossin

On-Line Data Products, Inc.
Scottsdale, AZ
Contact: Marcia Moore

Paratransit Systems Int'l Inc.
Bremerton, WA
Contact: Jeff Forville

Planet
Portland, OR
Contact: Bob Peter de Perlet

2. Taxi Contacts

B&L Service, Inc.
Yellow Cab
Fort Lauderdale, FL
Contacts: Jesse Caddis
Joe Davis

Baker & Drake
Reno, NV
Contact: Julie Drake

Barwood Taxi
Kensington, MD
Contact: Lee Barnes

Broadway Cab
Portland, OR
Contact: Chris Orcutt

Checker Cab
Detroit, MI
Contact: Jeff Priest

Eights Cab
North Miami, FL
Contacts: Zigmond Zilber
Al Gandero.

International Taxi and Livery Association
Kensington, MD
Contact: **Al LaGasse**

Mears Transportation Group
Orlando, FL
Contact: John Mears

Taxi Systems, Inc.
Gardena, CA
Contacts: Mitch Rouse
Richard Barker

Transportation General
Red TopCab
Arlington, VA
Contacts: Neal Nichols
George Pakidis

Yellow Cab Cooperative
San Francisco, CA
Contacts: Jim Steele
Natan Dwiri

Yellow Cab
Anaheim, CA
Contact: Jim Higgins

3. Paratransit Contacts

Community Transportation Association of America
Washington, DC .
Contact: Charles Dickson

Glendale Transit
Glendale, AZ
Contact: Janet Davis

Kitsap Paratransit
Bremerton, WA
Contacts: Barbara Singleton
Gary Cree

Manatee County Area Transit
Bradenton, FL
Contact: Charles Clayman

Mayflower Contract Services
Pamona, CA
Contact: Jim Watson

Orange County Transit Authority
Los Angeles, CA
Contact: Liz Mahoney

Tidewater Transportation District
Norfolk, VA
Contact;. Jeff Becker

TWC Ambulette Service, Inc.
Long Beach, NY
Contact: George Magee

Utah Transit Authority
Salt Lake City, UT
Contact: Jerry R. Jensen

Valtrans
Van Nuys, CA
Contact: Bob Dooley

NOTICE

DOT-T-92-23