POTENTIAL BENEFITS FOR PARATRANSIT PROGRAMS PROVIDED BY IMPLEMENTING AUTOMATIC VEHICLE LOCATION SYSTEM

by

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SUMMARY

With growing technological advances, it only seems reasonable to apply them to "real world" situations. Currently paratransit programs are functioning sufficiently, however, they could run more efficiently if they were upgraded. The purpose of this paper is to discuss the added benefits paratransit agency personnel and riders could receive if an Automatic Vehicle Location (AVL) system is incorporated into the paratransit program.

The objectives of this research were to provide a basic background on both Automatic Vehicle Location Systems and demand responsive programs. AVL systems are discussed including the various components, technologies and operations that are available. Demand responsive programs are briefly described, with emphasis placed on paratransit programs. The benefits and the limitations of a coordinated AVL system and paratransit program are also discussed. The key objective of this research was to answer the questions: "Why aren't more paratransit agencies implementing AVL technology?" and "What benefits are anticipated when a paratransit agency implements an AVL system?"

The research was approached through a series of telephone surveys and interviews with five transit agencies located within the United States. The five agencies were selected by their classification as an agency with either an operating AVL system within its transit agency or a paratransit agency with or without an implemented AVL system. Three survey forms were developed and used in order to question the agencies more accurately about their existing programs.

The results of the survey showed that there are currently no agencies that coordinate an AVL system within their paratransit program. However, two agencies contacted, Dallas Area Rapid Transit in Dallas, Texas and Tri-County Metropolitan Transportation District in Portland, Oregon are planning to implement an AVL system within their paratransit programs. The Mass Transit Administration (MTA) of Baltimore, Maryland and Tri-County Metropolitan Transportation District (Tri-Met) in Portland, Oregon both have AVL systems within their regular fixed-route transit agencies. And finally, Automated Dispatch Services, Inc. in Miami, Florida and Sioux Falls, Paratransit in Sioux Falls, South Dakota along with the Baltimore's MTA and Portland's Tri-Met all operate paratransit programs.

The paper produced a listing of recommendations for paratransit agencies to review before implementing an AVL system. This list included such suggestions as the following: consider your agency's wants and needs; learn from other agencies that have already established background information; take time to prepare; and promote your program to the community. By effectively planning the implementation of an AVL system, a paratransit agency has the potential to receive several benefits for both the agency and the users. For example, the agency can expect to increase schedule adherence, decrease vehicle-miles and vehicle-hours of travel and operational costs. Transit riders should expect benefits through increased response time between their requesting call and pick-up time, decreased ride time, and increased safety. The major limitations that the coordination have include the high expense and planning efforts to implement the system and the overall newness of the combination of AVL and paratransit.

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INTRODUCTION

Background

With the growth of "smart" highways, vehicles must also be upgraded to incorporate the smart technologies that are available. One technology that is rapidly growing is the use of Automatic Vehicle Location (AVL) systems. AVL systems are used to identify the location of a vehicle relative to its surroundings. It is most commonly used with fleets such as commercial, rental car, emergency, fire department, private, and transit. This paper concentrates on the use of AVL within transit fleets. More specifically, it concentrates on paratransit fleets. AVL is capable of providing a means for transit agencies to increase the quality of their services, efficiency of their scheduling, faith in their system, and the safety of their riders and drivers. With the increased system performances, the implementation of an AVL system into a paratransit or similar demand responsive program should create a more successful paratransit program. But, AVL is not used extensively within paratransit. This research will attempt to answer the questions: "Why aren't more paratransit agencies implementing AVL technology?" and "What benefits are anticipated when a paratransit agency implements an AVL system?"

Objectives

The four main objectives of this research were to:

1. describe the various types of AVL systems, their components, and their basic operations;

2. discuss paratransit and additional demand responsive programs which could incorporate AVL systems into the programs;

3. address the advantages and limitations of AVL applications within demand responsive programs and discuss available alternatives; and

4. provide recommendations for paratransit agencies considering implementing an AVL system into their program.

Scope

AVL systems can be implemented into various fleets, public and private. However, the scope of this paper is limited to paratransit and similar demand responsive programs. This paper is designed to provide a basic understanding of AVL systems including the various technologies available. The emphasis is placed on general system characteristics and transit agencies' opinions of their effectiveness to increase service quality and efficiency. This paper is not intended to provide a methodology for implementing such a system, but rather to mention the observed benefits and/or limitations that have resulted with the implementation of AVL systems based on operating demand responsive transit programs.

Method of Study

Literature Review

A state-of-the-art literature review was conducted in order to establish background information on AVL technologies and demand responsive programs. Included in this literature review was information on current AVL technologies, such as Navstar Global Positioning System (GPS), Loran-C, and Dead Reckoning systems. Information on potential applications of AVL, such as the application of AVL in commercial fleets and emergency fleets was also reviewed. Paratransit systems and similar demand responsive programs were also discussed.

Data Collection

Data collection took place in the form of personal interviews and three separate telephone surveys. In addition, the collection of brochures provided by those surveyed and interviewed were also employed. A copy of all three surveys can be found in the Appendix. The survey targeted a diverse group of transit agencies located within the nation. The agencies were classified into one of the three following categories:

1. transit agencies that have an AVL system within their fixed-route services;
2. transit agencies that have a paratransit program and no AVL technologies; or
3. transit agencies that are planning an AVL system within their paratransit program.

Table 1 lists the agencies contacted as they are categorized. In addition to transit agencies with and without paratransit programs or AVL systems, it was discovered advanced scheduling and dispatching software packaging companies should be contacted. On-Line Data Products, Inc. was contacted and interviewed.

Table 1. Contacted Agencies Classified into Three Categories.

Category 1	Category 2	Category 3
Mass Transit Administration of Baltimore, Maryland	Automated Dispatch Services, Inc. in Miami, Florida	Dallas Area Rapid Transit (DART) located in Dallas, Texas
Tri-County Metropolitan Transportation District in Portland, Oregon	Sioux Falls Paratransit of Sioux Falls, South Dakota	Tri-County Metropolitan Transportation District in Portland, Oregon

It should be noted that Dallas Area Rapid Transit is currently in its final stage of "debugging" its software and plans implementation upon the necessary corrections. Tri-County Metropolitan Transportation District is planning the implementation of an AVL system within its paratransit program by January 1996.

Organization of Report

The report is divided into five sections. Section 1 includes the introduction to the report. Section 2 addresses various Automatic Vehicle Location systems including individual types/technologies being implemented. Section 3 discusses paratransit services and other similar demand responsive systems. Section 4 examines the results of the telephone survey and discusses the benefits and limitations that were found. Section 5 provides conclusions followed by the recommendations/applications of results for implementing an AVL system into a demand responsive transit program. The conclusions and recommendations are based exclusively from the surveys and interviews.

AUTOMATIC VEHICLE LOCATION SYSTEMS

It is the purpose of this section to provide a brief yet detailed background on Automatic Vehicle Location systems. This section is divided into three subsections. The first defines AVL and answers the question "What is AVL and why is it important?" The second section describes the various types of systems that are being implemented. The final section addresses the potential applications of AVL systems both in the public and private sector.

AVL Defined

Automatic Vehicle Location (AVL) system is a term used to describe an electronic system that provides automatic position-tracking and status monitoring of individual vehicles within a fleet of vehicles. Through the location and monitoring of the vehicles, command and control of the entire fleet can be obtained (1). Within fleets, AVL allows schedule adherence to be monitored as well as two-way communications between the dispatcher and driver (2). AVL can also be used to monitor personal vehicle applications In personal vehicles it allows a central office to know precisely where the vehicle is for various reasons, such as, traffic monitoring or recovery of a stolen vehicle. These applications will be addressed later in this chapter.

The primary objective of AVL is to provide; 1) schedule adherence monitoring, 2) real-time vehicle tracking, and 3) assistance with computer aided dispatching (2). The information collected can benefit the system by furnishing future scheduling information to increase the efficiency of fleet schedules or it can produce information for congestion management or pretrip planning when using individual vehicles.

AVL Technology

Basic Communications

AVL systems maximize the use of communication between a controlled "smart" environment, individual vehicles and a central control center. The communications are provided through the use of equipment that varies between the type of AVL system being used. However, common communication processes between the vehicle and the central control center can be seen in Figure 1. The vehicle represented in is equipped with a location subsystem and an identification/status interface. The *location subsystem* is in control of reading the vehicle's location. The *identification/status interface* identifies the vehicle and the status of the vehicle, such as if there is a mechanical failure, if it is on schedule, etc. The vehicle location information, identification, and status are transmitted to the *communications subsystem* in the vehicle. At this point, the vehicle transmits this stored information to the communications subsystem in the central control center. The information is then transferred to the central processor. The *central processor* manages the information flow. Its primary functions are to process the vehicle's status and calculate the vehicle's position. It stores the relevant information for future reports and it develops the necessary displays and sends them to the *display/control storage* for future use (1). From the displays, the dispatcher can utilize the information received and respond to it by giving commands back to the necessary vehicles to maintain schedule adherence.

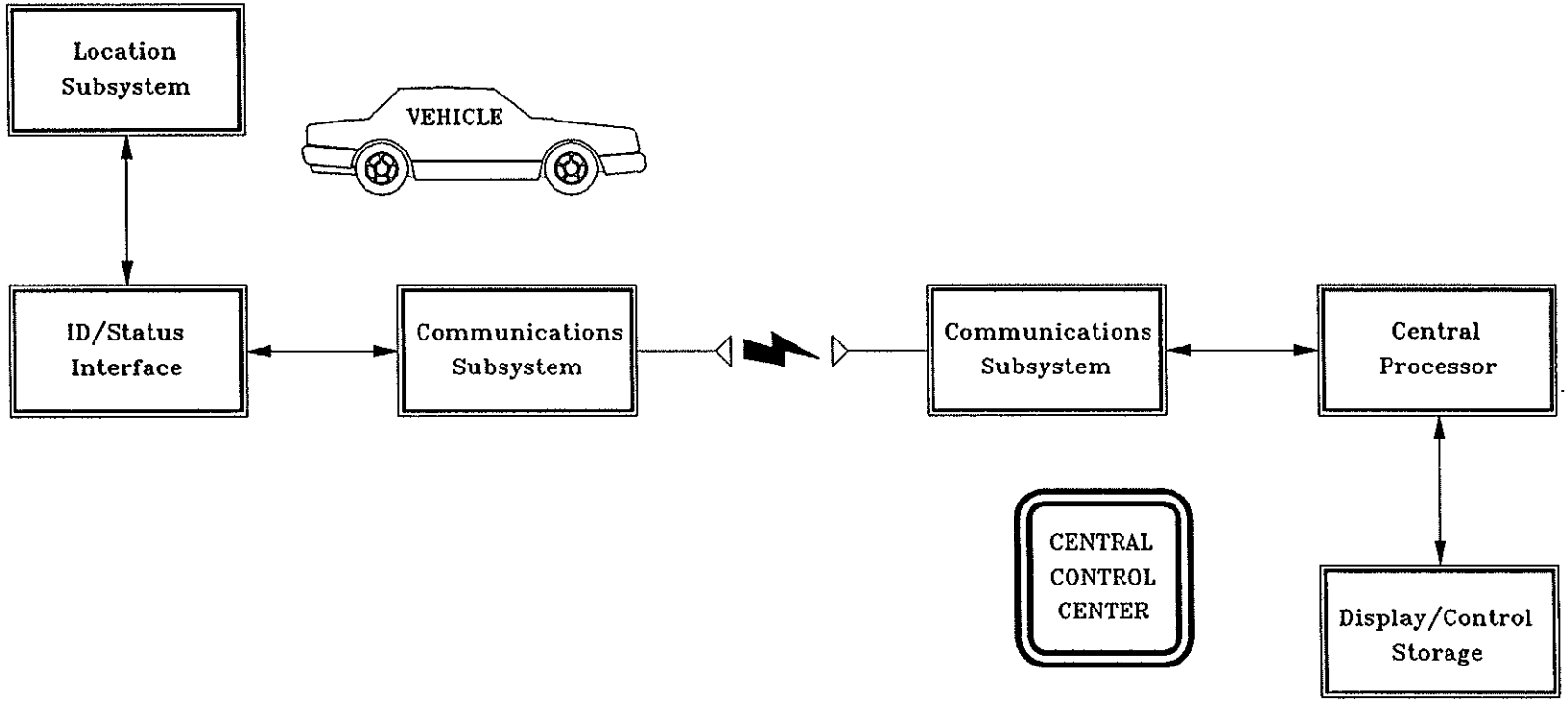

Figure 1. AVL Communications Between the Vehicle and the Central Control Center (1).

Components

With the growth of AVL systems, more and more companies are beginning to market new AVL systems. However, even with the broad range of different brands and technologies behind the various systems, several of the key components remain the same. A "generic" system consists of three primary components: transmitters, receivers, and the central control center. These are the controlling components for an AVL system and are briefly described below (3). Figure 2 is a theoretical example of a satellite-based AVL system's operations. Figure 2 shows the three components just mentioned and that are described below.

Transmitters. Transmitters can be a vehicle-based, ground-based, or satellite-based type. A transmitters primary function is to transmit or broadcast information. Vehicle-based transmitters are responsible for relaying their location back to the central control center.

Ground-based transmitters can be used in ground-based AVL systems to either broadcast their own individual locations to the vehicles or to broadcast the necessary information needed by the vehicle to calculate the vehicle's position. Some satellite-based AVL systems use ground-based transmitters to serve as intermediate data collectors between the vehicles and the central control center. This occurs when the vehicles do not directly transmit information back to the central control center (4).

Finally, satellite-based transmitters are used in satellite-based AVL systems in order to provide the vehicle with the information necessary to calculate that vehicle's location. It is possible for the satellite to transmit the location of the vehicle back to the central control center (as shown in Figure 2). However, it is generally more expensive than other means of transmitting that information. It is believed that there are currently no transit agencies using satellites to receive vehicle information due to high expense (4).

Receivers. The primary function of a receiver is to receive the transmissions from the transmitters. Like transmitters, receivers can also be vehicle-, ground-, or satellite-based. In a ground-based AVL system, vehicle-based receivers are used to collect information from the ground-based transmitters (4).

The vehicle-based receiver is used to receive the information that is transmitted from either ground-based transmitter (such as a beacon in a signpost/odometer system) or from a satellite-transmitter. The information received provides either the location of the vehicle (as in the signpost/odometer system) or the information needed to calculate the position. These calculations are done within the vehicle (4).

The ground-based receiver is generally some form of a radio receiver placed in the field. This receiver is responsible for receiving the information from the car. It then broadcasts/transmits the information back to the central control center (4).

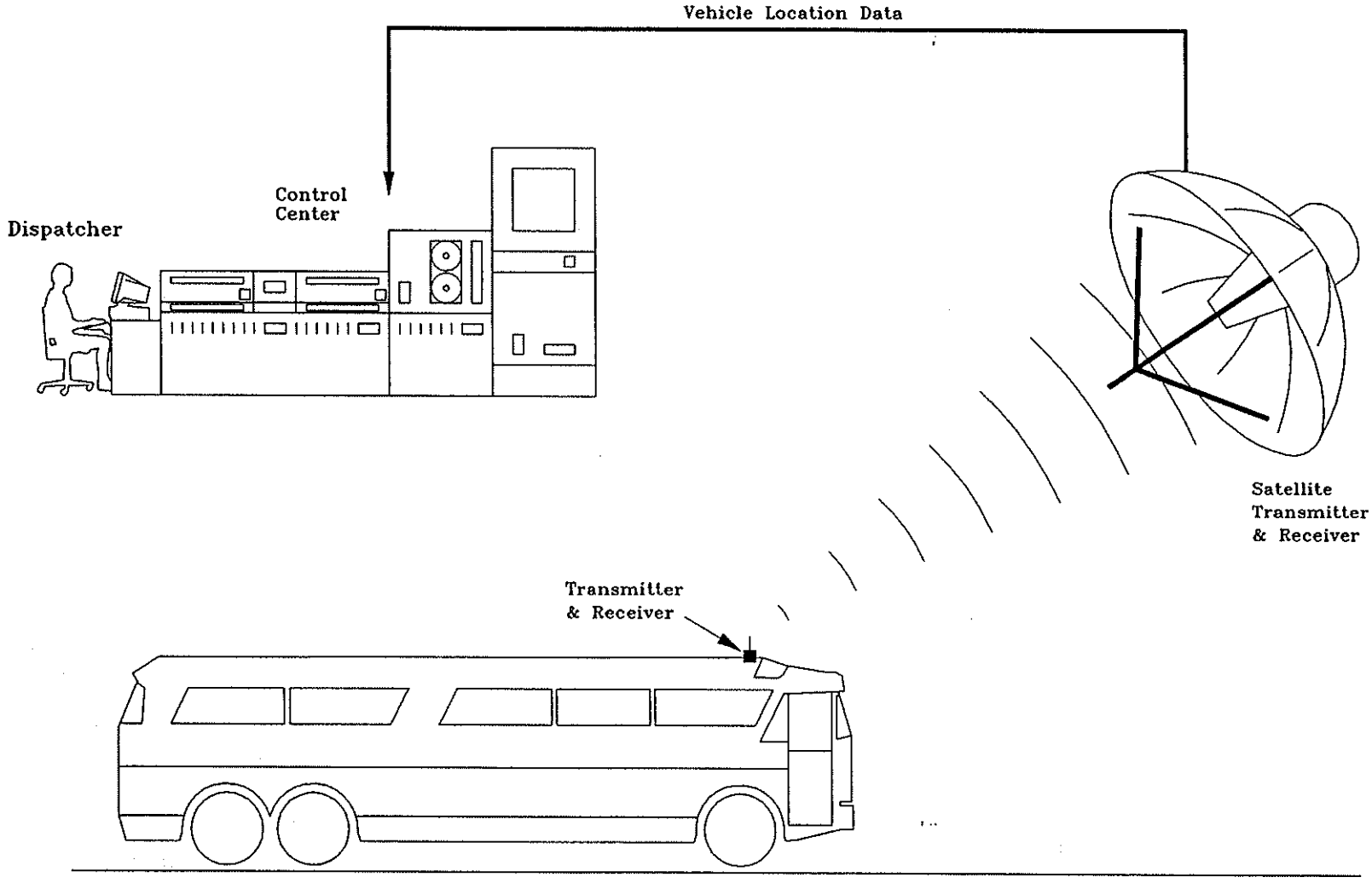

Figure 2. Components of an AVL System (Satellite-Based shown) (3).

The satellite-based receiver is fairly non-existent. It could be used to receive the vehicle locations and then to transmit that location back to the central control center (as shown in Figure 2). However, this technique is relatively more expensive than other radio frequency techniques. It is believed it may not be utilized (4).

Central Control Center. The central control center is where all the information comes to interact with people for the first time. The coded information that has traveled from the field, through the vehicle, to the receivers, becomes decoded to enable the employees to interpret and act upon. It is in the central control center where employees can visually see exactly what is transpiring in the field. For transit agencies, the central control center is where dispatchers can act upon the real-time information to provide any necessary scheduling or dispatching changes to maintain control over their fleet. For other AVL applications such as personal vehicle monitoring, the central control center provides the location where the analysis of individual vehicles can take place. This is useful for dispatching police officers to a scene or to simply monitor the flow of traffic (5).

Types of AVL Systems

There are two types of AVL systems available on the market. They are ground-based systems and satellite-based systems. These two systems contain a variety of technologies which allow the ability to locate vehicles. Ground-based systems can use one of several technologies to provide locator capabilities. The technologies focused on for this report include: signpost/odometer, dead reckoning, Loran-C, tri- or multilateration, and automatic vehicle identification (AVI). Satellite-based systems work on the same principle as the ground-based systems, however, they make use of satellites for the transmitters in place of ground-based type transmitters (5). The satellite-based system discussed in this paper is the Navstar Global Positioning System (GPS). All the mentioned technologies are described below.

Signpost/Odometer. The signpost/odometer system continues to be one of the most common technologies being used for AVL. See Figure 3 for a graphical representation of such a system. The system consists of a succession of beacons placed along predetermined routes. The beacons, generally placed on signposts, emit low-powered codes that represent their individual positions. As a properly equipped vehicle passes a beacon, the vehicle receives the broadcasted codes from the beacon and then assumes the beacon's location as its own. The vehicle is then "asked" for its location on preset increments referred to as polling. Vehicles are generally polled between every one to four minutes. If a vehicle is polled and not near a beacon, it uses odometer readings to approximate its distance from the last beacon passed.

The signpost/odometer system has several limitations. One of the primary disadvantages is the limitation of the preset beacon locations. This design prevents the tracking of a vehicle if it diverges from the preset route. Another limiting factor is the higher cost for maintaining the equipment. However, one of the key advantages in using a signpost/odometer system is that the equipment cost is reportedly lower relative to other AVL technologies (5).

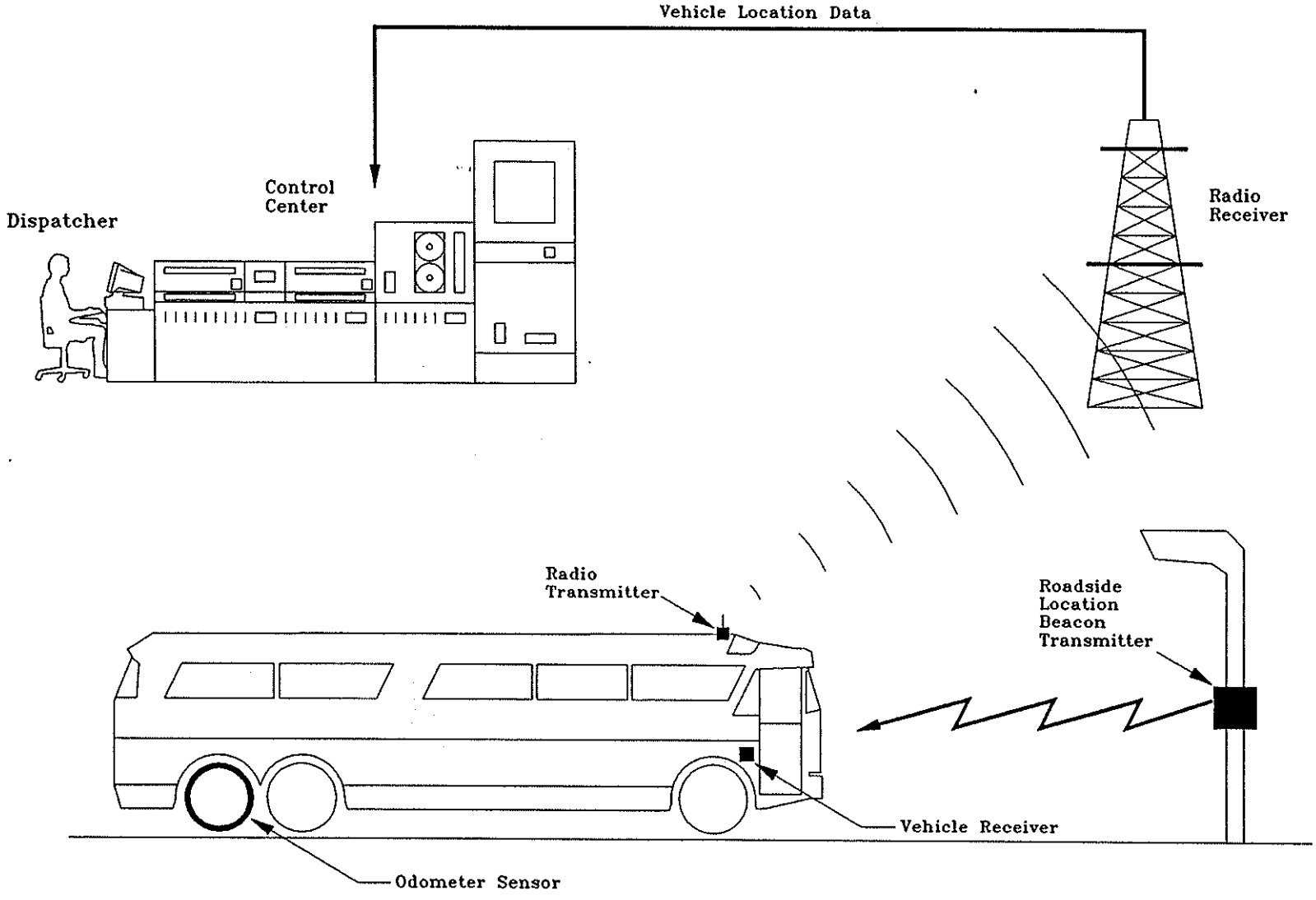

Figure 3. Basic Ground-Based AVL System (3).

Dead Reckoning (DR). Dead reckoning systems are based on the ability for the vehicle to accurately measure its distance and direction from an initial known starting point. The techniques that can be used to perform this task are to use odometer and/or wheel rotation readings for the distance traveled and to use compass readings for the direction. This information is stored within the vehicle until it is polled. Like the signpost/odometer technique, when a vehicle is polled, the stored information is transmitted to the central control center. The time period between transmittals, or "polling" time, is predetermined by the controller and again, is generally between one to four minutes (1,5).

Dead reckoning has many disadvantages. Most can be associated to its classification as a self-contained system. That is, the vehicle calculates its own location. When the vehicle is incapable of calculating its position, the corrections in the direction or distance traveled are performed manually by the driver. The driver must continue to manually input

the vehicle's direction and distance traveled until the vehicle can resume its tracking. In addition, the vehicle has a continuous buildup of errors within its location calculations. The error is directly proportional to the distance traveled (1). The advantage of a dead reckoning system is its low infrastructure cost.

Loran-C (Long Range Aid to Navigation). Loran-C, like dead reckoning, is also self-contained. It was originally used for navigation applications. It provides accurate readings within suburban and rural areas (1). It utilizes existing Loran-C transmitters to calculate its location and relays the information back to the central control center.

The primary disadvantages related to Loran-C include its limitations within urban areas. Maryland implemented a test study to prove that Loran-C is capable of operating within an urban setting (6). However, it produced inaccurate readings (locations) due to the urban surroundings. The environmental conditions that most affect the accuracy of the AVL system is susceptibility to radio-frequency and electromagnetic interference from close proximity to overhead power lines and substations in the area. In fact, it is recorded that the system can have a error as much as 1,000 meters (3280 feet)(5). One of the greatest benefits is that the infrastructure is already established due to its initial use in navigation.

Trilateration (Multilateration). The trilateration/multilateration technique utilizes three or more receivers (at different sites) to calculate the vehicle's position. These receivers are in fixed locations within a predetermined service area. By tri-angulation, each of the receivers measures the time of the arrival of a signal broadcasted by the polled vehicle. These times are transmitted to the central control center to calculate the vehicle's location (1).

PacTel Teletrac service, a private vendor, provides a system that uses tri-angulation and can determine the vehicle's location within 45 meters (150 feet) (5). Refer to Figure 4 for an illustration of the Teletrac subscriber-based radiolocation AVL system.

Automatic Vehicle Identification (AVI). AVI is a technology which can be used for AVL. The vehicles involved in the system are equipped with a tag or transponder which is capable of transmitting a code to sensors located in either roadbed loops or above the roadway. The vehicles can then be identified and the locations can be transmitted to the central control

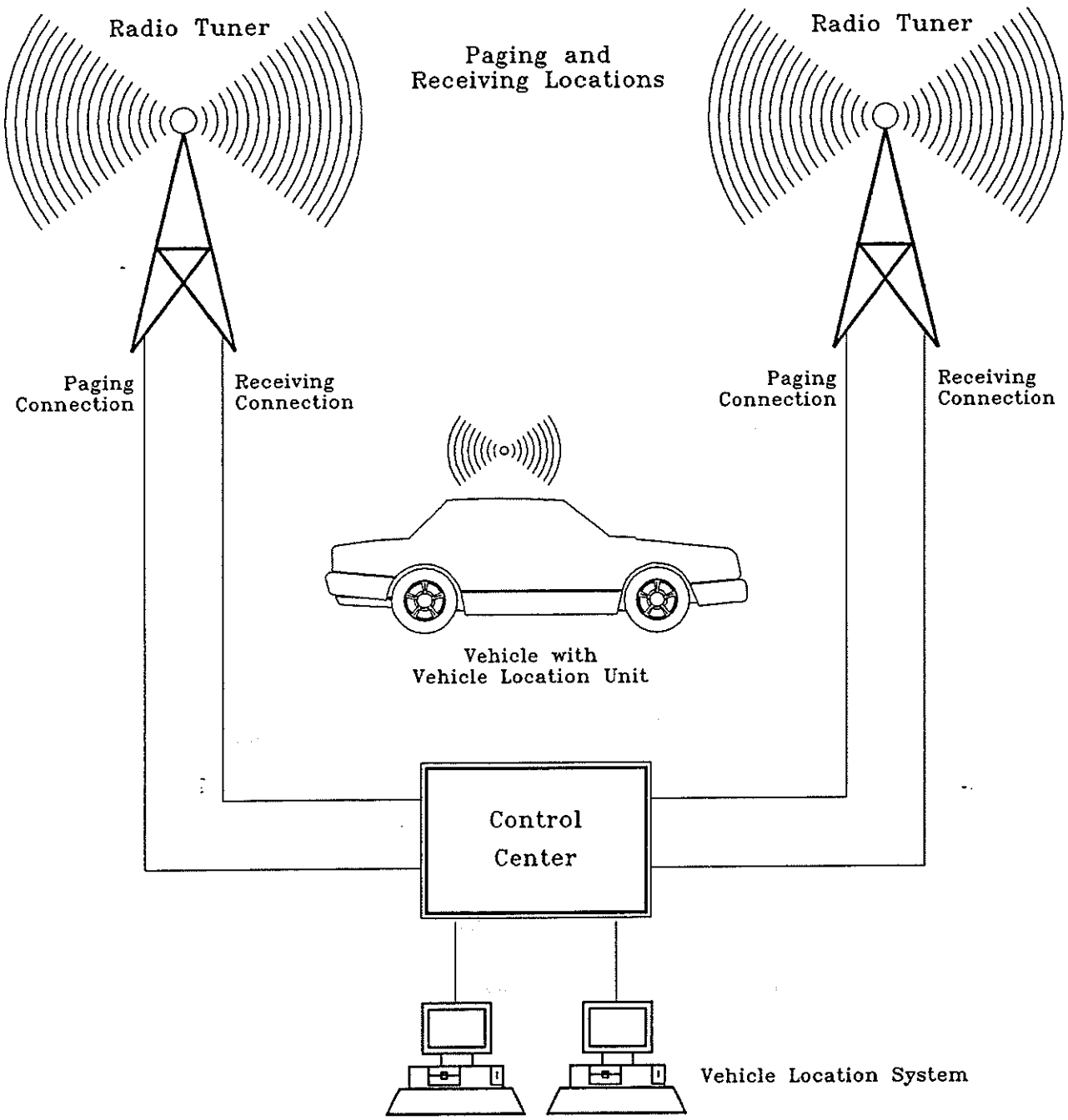

Figure 4. Basic Teletrac System Configuration (source unknown).

center. This technology is commonly used for personal vehicle applications such as traffic monitoring and personal safety (7).

Navstar Global Positioning System (GPS). The United States Defense Department developed the Navstar Global Positioning System (GPS) for military purposes. Currently they have allowed 24 of their satellites to be used for civilian purposes (5). The system is very accurate compared to the existing ground-based systems. Figure 5 is a graphical representation of the system's operation. As compared to a generic ground-based AVL system (see Figure 3), it can be seen that there are fewer communication barriers as well as much less infrastructure.

Its primary advantage is that it is not restricted to a preset service area. In addition, there is no cost for infrastructure or maintenance or a user fee for the use of the satellites. The only costs an agency is subjected to is the hardware and software required on the vehicles and in the central control center. The primary disadvantage is the newness of the system. It is still in either the planning, testing, or implementation stage in most agencies choosing to utilize GPS (5).

AVL Applications

One of the most common uses of AVL systems is to use the real-time data to improve a fleet management as well as its on-time performance (3). This generally concerns public fleets such as transit, trucking, and emergency fleets. However, other plausible applications include private fleets and personal vehicles. Several applications are already being implemented for AVL and they continue to grow. To keep within the focus of this paper, yet to provide some knowledge of alternate applications of AVL systems. The following section contains a description of common AVL applications.

Public Fleets

Emergency and Fire Department Fleets. The use of AVL systems is growing within emergency fleets. Quick response rates to potential trouble situations can be made possible by direct contact between the control center and transit vehicles via data link and radio communications which is offered by AVL systems (8). Rescue units, such as ambulances, are partaking in these benefits that AVL can offer. By having the ability to immediately dispatch the closest ambulance to a an crisis scene could mean life or death for the person(s) involved. Based on the statistics of a 1980 report by IEEE, it stated that research indicates that a heart attack victim has a 50% chance of recovery if basic life support measures are taken within four minutes of the attack. After a six minute period, the victim has less than a 10% chance of survival. In general, the difference between life and death for one-third of all heart attack victims is only two minutes (1). These statistics may be inaccurate for today's victim, however, it is the point of this story to note that the slightest increase in response time does make a difference.

Law Enforcement. With the use of AVL within law enforcement agencies, the services offered can be increased and improved. For example, officer safety is greatly increased with the use of continuous vehicle monitoring. If the officer signals that there is a problem

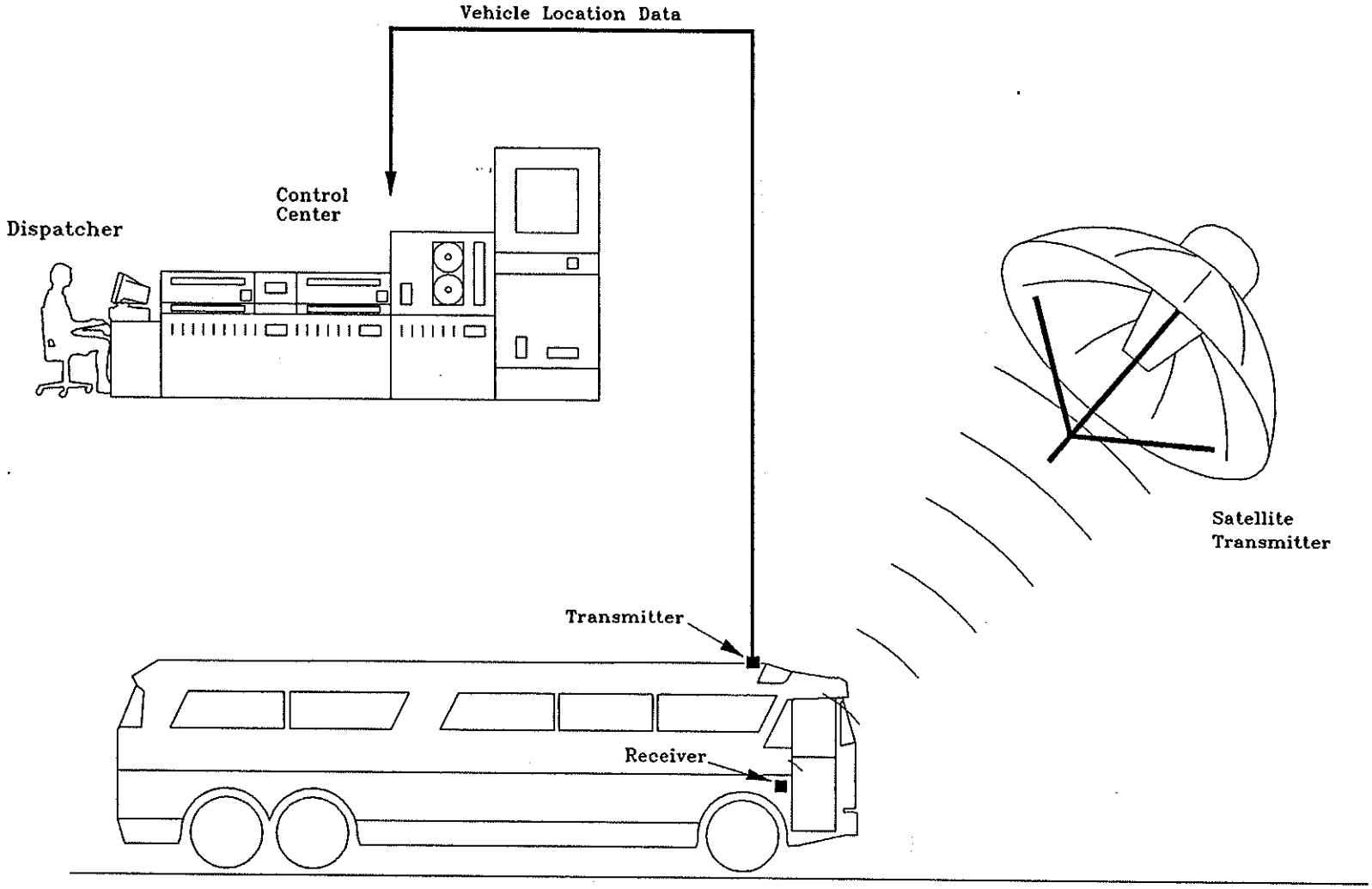

Figure 5. Common Satellite-Based AVL System (source unknown).

(through an optional manual alarm), the closest back-up patrol car can be dispatched immediately to assist the officer (1).

Improved response time by up to 20% (varying with the AVL technology being implemented) can dramatically increase apprehension time or incident arrival time. In addition, road blocks or other tactical maneuvers can be implemented quicker and more efficiently without consuming large amounts of communication time over the radio channels (1).

Car Rental Fleets. Car rental fleets are used as pilot studies to test AVL technologies. They generally charge a minimal extra amount for the user to rent. The user is then allowed to use the AVL system and in return agrees to be surveyed on his or her opinions about the various options and services. For example, is the system user friendly? is it accurate? is it convenient? etc. In addition to providing a good testing ground for new AVL systems, car rental fleets can use AVL as a marketing strategy to promote its ability to assist the unfamiliar motorist by providing him or her with a means to be navigated through the city, locate key areas of interest, and make reservations at restaurants and hotels from inside the vehicle. These features will depend on the type of AVL system being implemented as well as the optional software packages (9).

Transit Fleets. Transit fleets, such as buses, are more rapidly discovering the advantages of implementing an AVL system. AVL systems help buses maintain schedule, and in turn, enhance the overall transit system management capabilities (3).

Private Fleets

Commercial Fleets. Commercial fleets, such as the trucking industry, are currently maximizing the use of AVL systems. By enabling the main office/dispatcher the to monitor each individual vehicle, he/she is able to predict more accurate arrival and departure times, increase efficient schedules, have the ability to predict more accurately the arrival of an off-schedule vehicle. Overall, AVL allows a commercial fleet operation to run more efficiently and more productively (10).

Advanced Traveler Information. The use of AVL can be used to provide travelers with advanced information about numerous traveling concerns. As AVL is used to monitor traffic congestion, the information that is obtained from the field vehicles can be passed on to travelers as real-time traffic updates. This information can be passed on to traveler through pre-trip information systems (such as automated telephones and cable television) and encourage travelers to change their travel times, routes, or modes to avoid congested areas. Pre-trip planning and advanced traveler information systems can, in turn, assist with reducing traffic congestion (5).

Driver/Vehicle Security. From the users' point of view, AVL can provide driver and vehicle safety. As crimes increase , it becomes commonplace to hear about hijackings on our freeways or motorists being murdered for their vehicles. With the implementation of one form of private AVL systems, vehicles can be equipped with an AVL system that provides vehicle monitoring either from a police station or a separate private agency. The AVL system

can provide the driver with an emergency button/switch that allows the monitoring source to track the vehicle and to dispatch immediate help to the vehicle (11).

In addition, the system can offer vehicle theft recovery. This is accomplished by the owner purchasing AVL services. In the event the vehicle is stolen, the owner can call the proper monitoring agency which can activate vehicle tracking and, in turn, locate the vehicle. LoJack and PacTel provide this service with an exceptionally high return rate of stolen vehicles. Generally the only damages to the stolen vehicles are simply the ones incurred by "breaking into" the vehicle, such as a broken window and/or steering column. Thieves are aware of the existence of tracking devices, and in many instances, the stolen vehicles are simply parked for a day or so as a waiting period for the thieves to identify if the vehicle will be tracked. After this time, if the vehicle is not equipped with the location device, the thieves return to the stolen vehicle and proceed with their infamous routine (11).

PARATRANSIT AND DEMAND RESPONSIVE PROGRAMS

Paratransit Defined

Transportation can be classified by numerous systems. In the interest of this paper, transportation can be classified into three basic categories as follows: private, for-hire, and public or common carrier (12). AVL technologies can be applied to each of these categories. However, it is within the scope of this paper to focus on for-hire passenger transportation, commonly referred to as paratransit.

Paratransit is a service provided by either a public or semi-public transportation service. In general, paratransit modes do not offer fixed-routes or fixed-schedules due to its very small and/or scattered demand for transportation. In turn, it is a more specialized and flexible service. The vehicles are generally classified as low- or medium-occupancy highway vehicles. With smaller services, the atmosphere throughout the operations of paratransit services is much more personalized (12).

Paratransit provides transportation to eligible individuals who are incapable of utilizing a fixed-route or fixed-schedule transit system. The customers that most frequently use paratransit are those who are physically challenged, elderly or financially restrained.

Eligibility Requirements For Paratransit Users

Paratransit offers transportation to those individuals who, for one reason or another, are incapable of using a regular fixed-route transit system. Accessibility is the key issue to most limitations of using a fixed-route system. The Americans with Disabilities Act (ADA) of 1990 provides most of the requirements that must be met by transit agencies, the sponsoring paratransit agencies, and the individual users (13).

The ADA lists three categories for determining the eligibility of individuals who can use paratransit services. These three categories are outlined below. If a person is classified as one of the three eligibility categories, he or she is considered to be **ADA paratransit eligible**.

Category 1 Eligibility

Category 1 registrants are those individuals who are unable to utilize a fixed-route system that contains 100-percent accessibility. The registrants may have the following disadvantages: mental disabilities which prevent the ability to "navigate the system", visual impairments, and physical disabilities preventing them from either standing in a crowded vehicle or embarking/disembarking the vehicle (13).

Category 2 Eligibility

Under the ADA definitions for paratransit eligibility, "Category 2" registrants are people who could use a fixed-route service if it provided both facility and vehicle accessibility. The more accessible the transit services are, the fewer Category 2 registrants the paratransit service

will have to transport (14). Ideally, if transit systems become fully accessible for all Category 2 registrants, paratransit will no longer need to provide for them (21).

Category 3 Eligibility

The third category of eligibility is a combination of user disabilities with environmental and architectural factors that can prevent the use of a fixed-route system. Environmental limitations can include steep terrain, snow and ice, and severe air pollution. Architectural limitations can include the lack of curb-cuts or temporary construction. Environmental or architectural factors do not justify the need of paratransit services. However, by combining these factors with physical challenges, it can be seen that the user could be restricted from traveling to and from a disembarking station (13).

Paratransit agencies are given the option to ask clients to use the local transit system providing the route the user needs is fully accessible and is within three quarters of a mile to his or her origin/destination (15).

Standards for Paratransit Services

The ADA encourages all transit agencies which provide fixed-route services to enhance their buses to make them more accessible for physically challenged riders. In addition, the ADA requires transit agencies to furnish a paratransit service to those who are unable to use the local transit services (13).

By January 26, 1992, the ADA required transit agencies to begin the implementation of paratransit services. Paratransit services should be fully implemented by January 26, 1997, unless an "undue financial burden waiver" is granted by the Federal Transit Authority's (FTA's) Administrator (13).

The first step that must be taken by each paratransit provider is to determine whether an individual is ADA paratransit eligible. This step must have been completed by January 26, 1994. Transit agencies have the option to allow a more flexible eligibility requirement for the users within its service area. However, there must be a standard ADA eligibility form to allow those users to utilize other paratransit systems (13).

Operating Costs for Fixed-Route vs Demand Responsive Programs

As mentioned before, Category 2 registrants are those individuals that could ride fixed-route transit service if the facilities and vehicles were accessible. Transit agencies prefer not to invest in accessible equipment for their facilities and vehicles due to the extra cost. However, as stated by the *Accessibility Handbook for Transit Facilities*, "The accessibility plans should not be seen as an obligation but as an opportunity to make the system more attractive to all riders" (14). In addition, offering a trip on a fixed-route service is much less expensive than offering that same trip on a paratransit system. Table 2 shows a breakdown in the arithmetic mean, median and range of operation costs for transit and

Table 2. Operating Costs Per Trip and Per Vehicle-Mile, by Size of System (12).

Providers	Operation Cost	Statistical Breakdown	Fixed-Route Service Only	Demand Responsive Only
All Providers	Per Trip	Arithmetic Mean	$2.53	$3.55
		Median	$5.30	$3.64
		Range*	$1.43 - 12.62	$1.34 - 15.84
	Per Vehicle-Mile	Arithmetic Mean	$1.94	$1.09
		Median	$1.77	$1.39
		Range*	$0.91 - 3.67	$0.55 - 2.21
Small Providers (1 - 5 vehicles)	Per Trip	Arithmetic Mean	$3.03	$3.28
		Median	$5.54	$3.17
		Range*	$1.84 - 12.62	$1.69 - 17.25
	Per Vehicle-Mile	Arithmetic Mean	$1.63	$1.31
		Median	$1.65	$1.42
		Range*	$0.96 - 2.62	$0.74 - 2.21
Large Providers (6+ vehicles)	Per Trip	Arithmetic Mean	$2.40	$3.61
		Median	$3.01	$4.42
		Range*	$1.43 - 6.81	$1.01 - 12.51
	Per Vehicle-Mile	Arithmetic Mean	$2.08	$1.01
		Median	$1.78	$1.13
		Range*	$1.16 - 3.67	$0.51 - 2.09

* Range excludes 10% of cases at each end of array.

paratransit trips. The cost per trip and vehicle-mile are both examined as well as those trips provided by all, small and large providers.

Alternate Demand Responsive Services

It is important to address some other available demand responsive programs which are briefly described below. Many of these programs are either utilizing AVL benefits or could benefit from the implementation of an AVL system.

Dial-a-Ride

Dial-a-ride provides demand responsive services that provide door-to-door services through the use of telephone requests. Dial-a-ride offers travelers a minimum level of service while securing the least vehicle-miles and vehicle-hours of service (12). Dial-a-ride is a economical program that offers transportation to the elderly or physically challenged.

Jitneys

Jitneys offer very similar services to travelers as the dial-a-ride programs. However, jitneys are generally a private passenger car or station wagon. They provide a semi-demand responsive program in that the routes are commonly semi-fixed routes deviating only to provide door-to-door service. Scheduling can either be fixed or semi-fixed depending on the type of area being served. For example, urban areas usually do not have a fixed schedule as opposed to the semi-fixed schedule in rural areas (12).

Taxi Cabs

Taxi cabs supply demand responsive services. As opposed to the jitneys and the dial-a-ride programs, taxis have a higher operation and service cost. The reason behind the higher cost is due to taxis only serving one customer at a time (12). Taxi services are commonly contracted to provide alternative demand responsive services for paratransit services. In the event that taxi services could become subsidized, they could perform paratransit services without a contract.

Use of Computer Software to Enhance Paratransit

Paratransit can be enhanced with several strategies. By training with follow-up training sessions, personnel can become more secure with their positions as well as offer a greater contribution to the overall program. Increasing the size of the fleet may aid in providing more services to the persons in need. Incorporating higher technologies is another potential strategy that can increase the productivity of a paratransit program.

Automatic Vehicle Location systems are currently one of the highest technologies offered to aid transportation services. However, there are some alternatives other than implementing an AVL system to improve the quality of a paratransit program. By incorporating a quality software package into a transit or paratransit program, the benefits can be enormous for both the agency and the user.

Advantages of Real-Time Software Applications

As with most transportation services, real-time information is almost invaluable. This is more than an understatement when it concerns demand responsive scheduling and dispatching. By applying a practical real-time application software package to paratransit services, dispatchers can more readily control the number of riders per vehicle while decreasing the vehicle-miles of travel, the number of trips, and the hours of travel.

Both the user and the agency can receive shared benefits through the coordination of paratransit and real-time information. Two primary example of the benefits that can be provided include: providing a more accurate availability of vehicles/seating to users even while it dynamically changes as reservations are taken, and to negotiate the estimated times of arrival with the user while he or she is on the telephone. The negotiation between reservationist and user will eliminate the frequency of call backs as well as agreeing on a mutually optimal route selection (16).

Example of a Paratransit Automated Scheduling System

Paratransit Automated Scheduling System (PASS), is a routing, scheduling, dispatching, and reporting system. It began development in 1989 with the aid of veteran paratransit management personnel. Figure 6 outlines a schematic of its dispatching process. In addition, Table 3 provides the benefits they report to provide. Currently, 50 areas make use of the PASS program for use in their demand responsive programs including the Tri-County Metropolitan Transportation District, surveyed for this report (17).

Table 3. Benefits Obtained From the PASS Paratransit Scheduling System (16).

Time Savings	Money Savings	Increased Services
Automatic dispatching of information to drivers	Increased number of trips per vehicle	Increased on-time performance
Providing fast call status inquiry	Decreased employee hours	Decreased time between call and pick ups
Handling repetitive calls	Decreased fuel usage	Decreased ride time
Performing scheduling tasks	Decreased bus milage	Offering more services
Performing calculations	All of the "Time Savings"	
Compilation of statistical data		

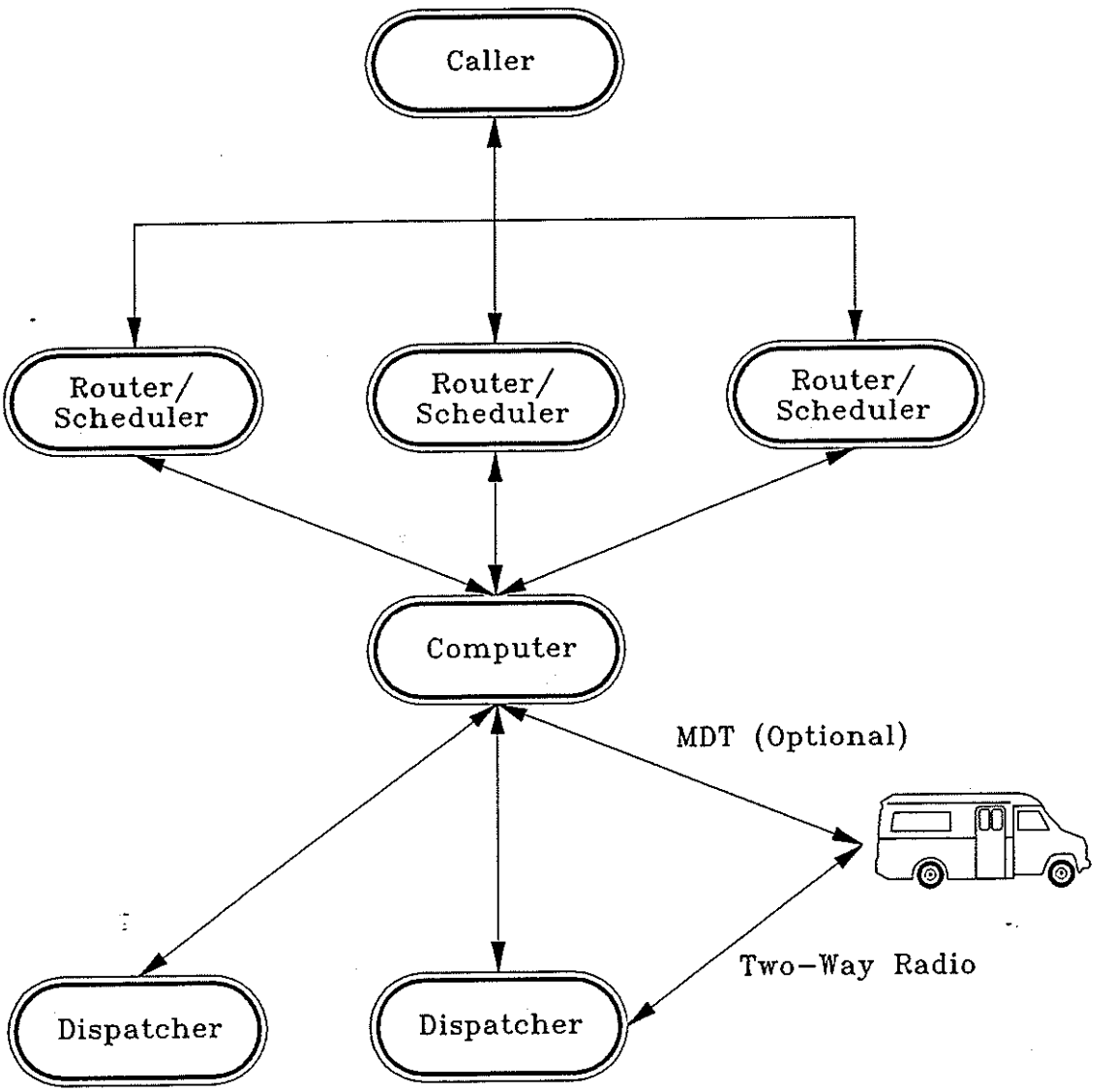

Figure 6. Schematic of the PASS's Dispatching Process (16).

PASS contains an interactive dispatching feature which allows the router or dispatcher to dynamically change and monitor a day as it progresses as any of the following situations occur:

- drivers accomplish tasks;
- cancels and "no shows" occur; and
- "same-day" reservations are taken (16).

The dispatchers and reservationists can also:

- see where each bus is at any given time both on a wall map and on a computer monitor having user friendly formats;
- dynamically change routes when a bus is late or breaks down; and
- be able to accurately answer inquiries, such as, "where's my bus?" throughout the day (16).

PASS has a newly added feature that appear to be a necessity to most who order the system. It is named the Mobile Data Terminal (MDT). It is an option which provides direct data interface between the dispatching center and the drivers. MDTs are two-way interface terminals that are placed within the paratransit vehicles directly to the existing radio. The features include a multi-line display and multiple status button. These features allow drivers to communicate with the depot via a standard radio link. The two main functions of the MDT are sending and receiving data. The MDTs are strictly optional and the information that is transmitted can occur with or without MDT's using PASS's existing voice communications (16).

New features are currently being incorporated into PASS for ADA rider-profile acceptance. As stated by the PASS demonstration diskette, the following will soon be available:

1. An ADA eligibility flag associated with each client and/or subscription trip.

2. The ability to define and display fixed-routes on the map screen.

3. The ability to indicate the nearest bus stop and times for a given trip request.

4. The ability to define the ADA ¾-mile buffer on each route and associated running times and to show, at reservation time whether a trip is ADA eligible at that time.

5. The reservationists will be presented with the information above and can then accept ADA status for that call or not.

Other available paratransit software packages are available as can be seen in Table 4. This report is not intended to promote or demote any particular software package. It is solely intended to provide an understanding of some of their qualities.

Table 4. Listing of Available Automated System Programs and Corresponding Vendors (5).

Vendor	Automated System Being Used
Automated Dispatch Services, Inc.	EMTRACK™
COMSIS Corporation	COMSIS Trip Planning System
Decision Sciences, Inc.	QUICK-ROUTE™
Easy Street Software, Inc.	EasyTrips™
Micro Dynamics Corporation	CADMOS-Pro +
Multisystems	DISPATCH-A-RIDE
Multisystems	MIDAS
On-Line Data Products	PASS
Philip G. Dorcas and Associates	Paratransit Scheduling Package
Paratransit Systems International Inc.	Rides Unlimited
UMA Engineering Ltd.	QuoVadis

SUMMARY OF BENEFITS AND LIMITATIONS

The surveys were conducted in an organized-interview format. The questions that were on the formal surveys (found in the Appendix) were used for the basis for the key points that were of interest. Due to the survey's interview format, there will not be a formal analysis of each question's results. The primary purpose of the surveys were to obtain background information on the various agencies contacted. This was done in order to make educated conclusions and recommendations about the coordination of AVL and paratransit agencies, not to provide a statistical or numerical analysis about each agency's program(s).

Reasons for Coordination

It has been determined by most all individuals who were interviewed that the future holds a strong need for paratransit to team with AVL technologies. It is believed that the combination of these two operations can produce necessary and exceptional benefits to all those involved including the agencies, employees, and the riders. But a key question is, exactly why implement an AVL system into a paratransit system?

Based on an interview with Todd Schoenrock, the Customer Service Representative for Paratransit Systems International, Inc., AVL can be a greater benefit to paratransit than to regular fixed-route transit programs. His reasoning is that fixed-route dispatchers should have a general knowledge of where each vehicle is providing they are not too far off schedule. Fixed-routes provide more fixed information which in turn provides an ongoing approximation of the location of each vehicle. Real-time information is not as critical for fixed-route systems. However, the trip information via radio frequency (RF) or satellite is essential to the "paratransit world" because the demand fluctuates more than the supply which makes the location of each vehicle more vital to the performance of the services (18).

Potential Benefits from Coordinating Paratransit with AVL

Based on the analysis of the interviews/surveys, it is apparent that there are a number of benefits that can transpire with the implementation of an AVL system into a Paratransit program. The key benefits that can be anticipated for the transit agency include the following:

- Knowledge of the exact bus locations anytime,
- Increased schedule adherence dynamically,
- Decreased vehicle-miles and vehicle-hours of travel,
- Decreased staff hours, and
- Decreased operational costs.

As to be expected, the reason for implementing an AVL system is to know the exact location of the equipped vehicles. To follow, an increase in schedule adherence is possible through the knowledge of each vehicle's real-time location. By providing better schedule adherence, the vehicle-miles and vehicle-hours of travel can be reduced as well as the staff hours required to operate the program. Through these reduced expenses, it can be seen that the operational cost are expected to decrease. Refer back to Table 2 for the relationship between

transit and paratransit operating costs.

The benefits are not restricted to the agency alone. The paratransit users should be able to foresee increased benefits in their services. Such benefits may include:

- Decreased time between call and pick-up time,
- Decreased ride time,
- Increased safety for both driver and user,
- Increased rider confidence, and

Through the increased efficiency on the behalf of the agency through the implementation of AVL, the rider may experience a decreased time between the initial call/reservation and the pick-up time. This will reduce the ride and wait time due to the more accurate scheduling. Increased safety may appear with the dispatchers ability to predict incidents as well as assist the police in any dangerous circumstances. This will increase the users confidence in the program.

Finally, through the above listed benefits, it seems that all those involved can expect to profit from the implementation of an AVL system into the paratransit program. Which leads to the final benefit:

- An opportunity to make the program more attractive to all involved.

The paratransit agency should recognize that it is providing a service to those incapable of receiving most opportunities to utilize other modes of transportation. In turn, the agency has the opportunity to make a crucial service more attractive to those who are fully dependent on it as well as those employees who work with it every day.

Limiting Factors When Introducing AVL Systems to Paratransit

In the opinion of the author, paratransit is a highly needed service in our communities. And as with most all of our daily lives, it is something that could use improving. However, with every positive effort, there is generally a sacrifice. In the case of coordinating AVL with paratransit, there are several hurdles that must be acknowledged. These include:

- Understanding AVL is relatively new within the transit world,
- Knowing a great deal of planning for implementation will be required,
- Training, change, and acceptance have to be met by the agency's personnel, and
- Remembering there are no AVL/Paratransit predecessors with a working system.

By acknowledging and working with the above factors, an agency can expect to have a more successful transformation. Yet there are two more significant considerations that must be evaluated before a system should be implemented. They are as follows:

- Some paratransit software packages are semi-comparable to AVL benefits, and
- AVL is generally more expensive than most or all available paratransit scheduling software packages.

In turn, many paratransit agencies may elect to implement a software package to determine if the benefits prove significant enough to either eliminate AVL as an option or continue to pursue it as an option.

CONCLUSIONS

As suspected, AVL technologies are not currently being implemented into a great number of demand responsive programs. This can be attributed to a number of reasons.

- Transit agencies do not know about AVL technology,
- Transit agencies do not recognize the potential benefits,
- Transit agencies do not have the necessary funding required, and/or
- Transit agencies are using alternate scheduling strategies.

Based on a 1993 survey conducted by Trimble Navigation, the most common concerns of transit authorities include the following (5):

- Improved schedule adherence,
- Maximum driver and passenger safety,
- Better vehicle utilization, and
- Real-time rerouting capability.

These are also concerns for paratransit programs. These issues can be addressed by the implementation of an AVL system.

Costs of Implementing Advanced Technologies into Paratransit Programs

It should come to no surprise that implementing advanced technologies into a demand responsive program will not be free. Or will they. The purpose of this report was not to report how and how much upgrading a paratransit program would cost. Table 5 includes a brief price listing of the options that can be added to such a program. However, based on interviews with numerous transit/paratransit providers, federal and local funding play a key role in the implementation of such higher technologies. Commonly reported were 80 percent federal and 20 percent local breakdowns. These numbers are not to provide guaranteed figures, but to encourage those interested agencies to pursue inquisitions with their local and federal government representatives to determine what funding may be available.

Primary Component to a Successful Paratransit System

There are no key answers to what makes a successful program. However, there has been one repetitious theme that seems to flow throughout the literature review and the personal interviews with transit agencies. That theme and substance to life is money. The developments and improvements in transit, paratransit, and demand responsive programs is primarily due to government funding and regulation (15). Without the funding, the programs and services would never have been implemented. However, the funding and regulation must continue to produce successful programs. In addition, involvement from the communities is critical in the success of public services.

Table 5. Costs of Scheduling and Dispatching Hardware and Software for Paratransit (6).

Vehicle Hardware & Software		**Operations Center Hardware & Software**	
In-vehicle computer & applications software	$1,750 - 2,000	Communications software and hardware	$10,000
GPS receiver unit and antenna	$800	Database reporting software	$5,000
Smart card reader/writer	$300	AVL software	$10,000
RF modem (depends on type of radio system)	$400 - 900	Scheduling/dispatching software	$30,000
		Additional computer hardware	$10,000
Total per vehicle cost	$3,250 - 4,000	Total operations center cost	$65,000

APPLICATIONS OF RESULTS

Below is a list of the top ten recommendations for an agency considering the implementation of an AVL system within their paratransit program. This is only a suggested list. In addition, the list is prioritized from high to low considerations, but the agencies should evaluate each recommendation and determine their own prioritization based on their customized services. Following the list are reinforced recommendations and advice for each of the following: AVL issues, paratransit issues, and software package issues.

General Recommendations

- **Consider the present wants and needs of the paratransit program.**

Agencies must first and foremost determine their programs' present state based on ridership, fleet size, service area, staff, etc. They must determine not only the desires or wants from their program, but their realistic needs (19).

- **Consider your future wants and needs ow the paratransit program.**

The future must also be considered when an agency is contemplating making a impressive upgrade to the program. These include not only the present issues, but also the expected growth of the program and the funding that may or may not be available in the future (19).

- **Do not start from scratch.**

The reoccurring recommendation several agencies provided was to learn from what information has already be researched, planned, implemented, etc. By using the experience of others, it is possible to prevent any possible failures (6).

- **Implement a software package *before* or *with* an AVL system.**

Most larger and somewhat more efficient agencies are currently using some type of software package. In addition, the agencies that are intending to implement and AVL system into their paratransit program are also implementing a compatible software packaged to assist in the scheduling and dispatching (17).

- **Take time to prepare.**

Benefits only come from well thought out plans. It was recommended to ensure all bases are covered before implementing a new system such as AVL. This will reduce the time to recover from a potential breakdown in the system's operation (20).

- **Obtain excellent consultants.**

Consultants are necessary to produce the proper specifications for a proposal. By obtaining excellent consultants, high quality specifications will follow. These specifications will provide the backbone for the planning and implementation of the new system (20)

- **Do not try to exclude vendors.**

The exclusion of vendors encourages the possibility of overlooking key elements in the new system. All proposals should be received as possibilities. They should be looked upon not only as the potential product, but also as means to become more educated about the system (20).

- **Promote your program to the community.**

Promotion of a public service is absolutely mandatory. By obtaining the support of the community, the benefits are twofold. Firstly, the public supports your efforts making the program a possible success. Secondly, the community and special interest groups are necessary for their influences on local government for government funding (12).

- **Work with your employees/employers to ensure a smooth transition.**

A smooth transition from an old to new plan of action is important to maintain high morale within the agency. This is also highly important when dealing with the public. Listening to employees and employers alike reduces any communication barriers that may exist. In is a common drawback within agencies that the personnel do not communicate effectively (21).

- **Prepare for growth pains.**

Paratransit and AVL will produce a new experience. It will be most difficult due to the newness of the coordination and the absence of a predecessor. However, another issue is how to use real-time information effectively. This will require learning and adjusting to the vast amounts of accurate information that has never been available without the use of AVL (22).

AVL Issues

It was agreed upon by all surveyed that Navstar's Global Positioning System provides the greatest benefits to the paratransit services. This should come to no surprise due to the GPS service area, it is all inclusive. All other AVL technologies have limited service areas for example the location of the beacons or receivers in the signpost/odometer and trilateration techniques, respectively. Loran-C does not have the restricted service area however, the environmental and architectural surroundings limit the accuracy of the system for land use (6).

One of the key issues in choosing an AVL system is the lowest cost alternative. Tri-County Metropolitan Transportation District just accepted a contract to install an AVL system. They did not restrict the contract to any specific AVL technology. Their result was a lowest bid for a GPS (6).

Paratransit Issues

Paratransit *services* do not need to change with the addition of an AVL system or the addition of an advanced scheduling and dispatching program. However, it has been reported that training the employees how to use and maximize the use of the new system are important. In addition, it is important to reassure the employees that the system will provided benefits. Agencies complain of dispatchers who do not want to learn a new method, they feel content and comfortable with a pencil and paper.

When deciding on what system will be right for a paratransit program, On-Line encourages paratransit agencies to make four lists (19). These lists will enable the agency to distinguish what is really necessary for the needs of their program. The list is as follows:

List 1: What do you currently **NEED?**
List 2: What are your future **NEEDS?**

List 1: What do you currently **WANT?**
List 2: What are your future **WANTS?**

Paratransit Scheduling Software Package Issues

It is important for a demand responsive scheduling and dispatching package to contain a few key functions. It is recommended that the software package can be capable of the following tasks:

1. Handling subscription rides, advanced reservations, and same-day reservations;
2. Handling any number of vehicles or service area;
3. Verifying critical information such as, trip lengths, service area boundaries, special equipment requirements, service hours, etc.;
4. Reproducing reports or data such as, daily reports, user defined reports, base section 15 data, etc.;
5. Graphically representing the service area; and
6. Accurately calculating the estimated time of arrival based on such factors as:
   - Distance,
   - Speed based on time of day and individual drivers,
   - Stop Times including pick up and drop offs,
   - Special equipment load times, and
   - Driver's necessary breaks and lunches.

Although most agencies were pleased with their software packages, the surveys suggest On-Line Data Products, Inc.'s PASS system is the most efficient. It had the greatest pronounced satisfaction by the transit agencies surveyed as well as excellent support from their own employees. Tri County Metropolitan Transportation District in Portland, Oregon (Tri-Met) decided to replace its former paratransit software package with the PASS program. According to Tom Chambers, Tri-Met's Manager of Road Operations and Communications, he believes it will provide the greatest benefits for its paratransit program especially in coordination with its new GPS Automatic Vehicle Location system.

Aside from overall benefits, Automated Dispatch Services, Inc. in Miami, Florida is currently using a self-developed software package titled EMTRACK. Bob Durkin, Operations Manager and System Installer stated that Miami's primary problem is not providing more efficient schedule adherence, but rather ensuring that riders are paying their user fees. He emphasized that they needed a program that would provide a means to check the identity of the riders as they embarked/disembarked the vehicles in order to properly bill them for the service they received. Currently, EMTRACK is being implemented into 25 areas (21).

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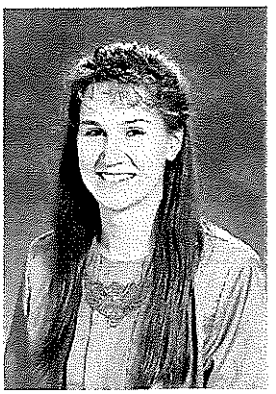

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APPENDIX

AVL with PARATRANSIT

Name:_____ Title:_____
Program Name_____
Agency/Department:_____
Address:_____
Telephone:_____ Fax:_____

Profile of System

1) Which of the following classifies the status of your demand responsive program?

   a. It has an AVL system.
   b. It had an AVL system.
   c. There are plans to implement an AVL system.

2) What type(s) of demand responsive program(s) do you have within your agency?

   a. Paratransit
   b. Other_____

3) How long has your program been in operation?_____
   _____

4) How long has your program used an AVL system?_____
   _____

5) What is the size of your program's service area?_____
   _____

6) How many demand responsive vehicles does your program have?_____
   _____

7) How many vehicles are equipped with AVL technologies?_____
   _____
   _____

8) Why did you decide to implement an AVL system?
   _____
   _____
   _____
   _____
   _____
   _____

Profile of Riders

9) What group(s) of people are the target of your program? (mark all that apply)

   a. elderly
   b. physically challenged
   c. residents excluded from fixed routes
   d. disadvantaged children
   e. human service clients
   f. Other_____
      _____

10) How many individuals make use of your demand responsive program(s)?_____

_____

11) What is the *average monthly* ridership for your program(s)?

_____

12) What factor(s) can the changes in ridership be attributed

a. better scheduling
b. more services
c. more efficient services
d. safer
e. less wait time
f. other:_____

_____

13) What impact has your AVL system had on ridership?

a. increased b. decreased
b. same d. unknown

Program Costs & Funding

14) What is the cost to the rider?_

_____

15) What was the estimated start-up cost of your AVL system?__

_____

16) What is the estimated annual operation and maintenance cost for your AVL system? ___

_____

System Funding

17) How did you pay for your AVL system i.e. federal, state, local, fares, etc.)?_____

_____

_____

_____

System Profile

18) Briefly describe the operation of your demand responsive program.

_____

_____

_____

_____

Program Drawbacks

19) What have been the pitfalls in the design, planning, and operation of your program?

Helpful Hints & Advice

20) In most successful operations, there has been one outstanding person or plan of action that has made a huge contribution for the overall "organizational philosophy". In the coordination of your demand responsive service and AVL system, who or what, if any, has made the biggest contribution to your programs success?

21) What would your advice be to an agency just considering or establishing an AVL system within their demand responsive program?

Additional Comments:

AVL

Name:_____ Title:_____

Program Name_____

Agency/Department:_____

Address:_____

Telephone:_____ Fax:_____

Profile of System

0a) Do you have a demand responsive program?
Yes No

0b) if yes, does it have AVL?
Yes No

0c) Does your transit program have AVL?
Yes No

1) What kind of AVL system are you using?_____
_____

2) How long has your AVL system been operating?_____
_____

3) What is the size of your service area?_____
_____

4) How many vehicles are equipped with AVL?_____
_____

5) What type of scheduling software do you use?_____
_____
_____

6) What type of communication do you have with the drivers?
_____
_____
_____

7) What is the estimated start-up cost of your AVL system?_____
_____

8) What is the estimated annual operation and maintenance cost for your AVL system? ___
_____

9) What decreases, if any, have you experienced due to the implementation of AVL?_____
_____
_____

System Funding

10) How did you pay for your AVL system i.e. federal, state, local, fares, etc.)?

_____

_____

_____

11) Why did your agency choose to implement an AVL system?

_____

_____

_____

Program Drawbacks

12) What have been the pitfalls in the design, planning, and operation of your AVL system?_____

_____

_____

_____

Helpful Hints & Advice

13) In most successful operations, there has been one outstanding person or plan of action that has made a huge contribution for the overall "organizational philosophy". In your AVL system, who or what has made the biggest contribution to your programs success?_____

_____

_____

14) What would your advice be to an agency just considering or establishing an AVL system?_____

_____

_____

_____

_____

15) What is the primary reason for not implementing an AVL system into your demand responsive program?

a. No apparent need.
b. Funding.
c. Don't want change.
d. Don't know too much about it.
e. Evaluating AVL in transit.

f. Other_____

_____

16) Do you feel an AVL system would improve your demand responsive program's dispatching? Why or why not?_____

_____

_____

_____

Demand Responsive

Name:_____ Title:_____

Program Name_____

Agency/Department:_____

Address:_____

Telephone:_____ Fax:_____

Profile of System

0a) Do you have a demand responsive program?
Yes No

0b) if yes, does it have AVL?
Yes No

0c) Does your transit program have AVL?
Yes No

1) How long has your system been in operation?_____
_____

2) How many vehicles does your program have?_____
_____

3) What is the size of your program's service area?_____
_____

4) What type of demand responsive services do you provide?

a. Door-to-Door
b. Other_____

5) How many individuals make use of your demand responsive program(s)?_____
_____

6) What is the *average monthly* ridership for your program(s)?
_____

7) What group(s) of people are the target of your program?

a. elderly
b. physically challenged
c. residents excluded from fixed routes
d. disadvantaged children
e. human service clients
f. Other_____
_____

8) What type of scheduling program(s) do you use for your paratransit program?_____
_____
_____

9) Do you have two-way communication with your drivers?_____
_____

10) What type of AVL system do you use?_____
_____
_____

11) How many vehicles are equipped with AVL?_____
_____

12) What is the primary reason for not implementing an AVL system into your demand responsive program?

a. No apparent need.
b. Funding.
c. Don't want change.
d. Don't know too much about it.
e. Evaluating AVL in transit.
f. Other_____
_____

13) Do you feel an AVL system would improve your demand responsive program's dispatching? Why or why not?_____
_____
_____
_____