

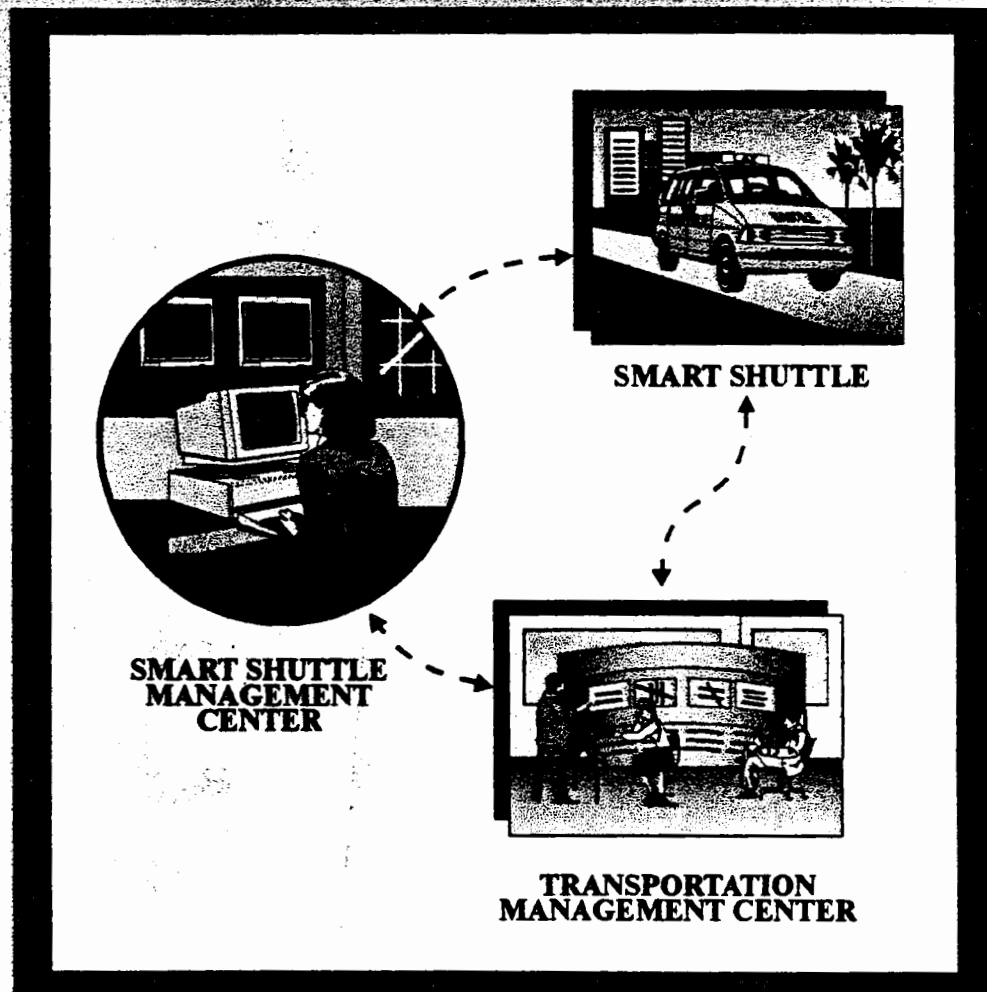
Smart Shuttle Technological and Operational Feasibility Study

Prepared For:

SCAG

**Los Angeles County Metropolitan Transportation Authority
City of Los Angeles**

March 21, 1995



DKS Associates

**Transportation Management & Design
CCS Planning and Engineering, Inc.**

**Technological and Operational
Feasibility Study for Smart Shuttle**

Final Report

prepared for

**the Los Angeles County
Metropolitan Transportation Authority
City of Los Angeles
Southern California Assoc. of Governments**

by

DKS Associates

in association with

**Transportation Management and Design
CCS Engineers**

March 21, 1995

TABLE OF CONTENTS

<i>EXECUTIVE SUMMARY</i>	1
1. INTRODUCTION	9
2. STUDY METHODOLOGY	12
3. TECHNOLOGY ASSESSMENT	18
OVERVIEW	18
SELECTION OF TECHNOLOGIES FOR ANALYSIS	23
TECHNOLOGY EVALUATION	27
4. COMMUNICATION ASSESSMENT	40
FUNCTIONAL REQUIREMENTS	41
AVAILABLE TECHNOLOGIES	45
CURRENT DEVELOPMENTS	46
COMMUNICATIONS ALTERNATIVES	55
RECOMMENDATION - UPGRADE PATH	61
GENERAL REQUIREMENTS FOR FUTURE EXPANSION ...	62
5. SERVICE CONCEPTS AND MANAGEMENT	65
6. IMPLEMENTATION PLAN	95
ASSUMPTIONS/SYSTEM DESCRIPTION	95
BUDGET ESTIMATES	97
FUNDING SOURCES AND STRATEGIES	99
PROCUREMENT STRATEGY FOR TECHNOLOGY	103

APPENDIX A: Historical Cost Data

APPENDIX B: Organization Model

APPENDIX C: Vendor Brochure Excerpts

LIST OF TABLES AND FIGURES

Table 2.1 Summary of Smart Shuttle List of Contacts	13
Table 2.2 APTS Reports	16
Table 3.2 Smart Shuttle Technological Features Survey	24
Table 3.3 Automatic Fare Collection: Vendor Surveys	34
Table 3.4 Automated Schedule and Dispatch Software	36
Table 3.5 Summary of Agency and Passenger Benefits	38
Table 4.1 Minimum Communications Requirements for Smart Shuttle	42
Table 4.2 Mobile Communications Equipment	41
Table 4.5 Viable Product/Service Data for Communication Requirements	49
Table 4.6 Cost Estimates for Communication Systems Alternatives	54
Table 4.7 Mobile Data Services	60
Table 6.1 Control Center	97
Table 6.2 Vehicle Equipment (50 Vehicles)	98
Table 6.3 Overhead Cost	98
Figure 3.1 Typical Smart Shuttle Operation	22
Figure 4.3 Typical System Components	43
Figure 4.4 Typical Mobile Equipment Configuration	44
Figure 5.1 Smart Shuttle Service Options	66
Figure 5.2 Service Management and Organization Options	83
Figure 6.4 Implementation Schedule	105

Executive Summary

Executive Summary

INTRODUCTION

DKS Associates, in conjunction with Transportation Management and Design, and CCS Engineers, was engaged by the Los Angeles County Metropolitan Transportation Authority (MTA), the City of Los Angeles and the Southern California Association of Governments (SCAG) to analyze the technological and operational feasibility of a Smart Shuttle system in the region. The underlying objectives of the Smart Shuttle concept is to increase transit's share of the travel market and/or replace ineffective fixed-rate services through provision of an alternative mode that is flexible, convenient and responsive to customer demand.

The purpose of this report is to evaluate Intelligent Transportation Systems (ITS) technologies as they relate to Advanced Public Transportation Systems (APTS) and Advanced Traveler Information Systems (ATIS), and to identify those technologies that would benefit Smart Shuttle services and could be immediately implemented for demonstration projects. This report also examines Smart Shuttle service concepts and identifies operational strategies to be used in implementing demonstration projects. In addition, the cost of each technology and potential funding sources were identified, and time lines for implementation of technologies were developed.

Executive Summary

TECHNOLOGY

Four advanced technologies were chosen for detailed analysis based on a survey of 11 transit agencies and discussions with the Smart Shuttle Technical Advisory Committee. Important considerations in evaluating options included:

- Benefit to Smart Shuttle service;
- Initial and ongoing costs;
- Risks associated with unproven technology, techniques or organizations;
- Flexibility for future expansion or alteration of the system;
- Adherence to the principle of modularity and open architecture;
- Provision of competition and multiple sources where possible;
- Legal and institutional consideration; and
- Involvement of private sector and contract services.

Selected technologies are summarized below.

- **Automatic Vehicle Location (AVL).** AVL provides continuous, real-time tracking of vehicles through electronic devices. AVL provides the potential for improving scheduling, dispatching and on-time performance, especially when integrated with Geographic Information Systems (GIS).
- **Automatic Passenger Counters (APCs).** This technology enables the collection of boardings and alightings data at each stop.
- **Advanced Fare Payment Media.** Advanced fare payment that increases payment options and reduces the time required for fare payment during a transit trip by automating the transaction.
- **Computerized Dispatching/Scheduling.** This technology enables the dispatcher to more efficiently perform the scheduling/dispatching functions. These systems include scheduling features which assign transit patrons to demand-responsive vehicles that are operating in shared-ride mode.

Executive Summary

COMMUNICATIONS

Three options were investigated in order to implement conventional radio for Smart Shuttle operations. These include sharing existing MTA infrastructure; leasing from private/public operators (Super Shuttle, Los Angeles County, Laidlaw, Prime Time); and acquiring dedicated radio from the FCC. Detailed review of each option indicated that the second option may be the most efficient in the short term, while the last option may provide the most viable alternative in the long term. The current capacity of the MTA system is limited and does not allow for sharing with the Smart Shuttle. Leasing from a private operator may be effective for the Demonstration Projects, but could be unreliable since it is too closely dependent on an individual operator's needs and requirements and might restrict future competition. Acquiring radio frequency involves a six- to nine-month application process and would cost from \$250,000 to \$500,000 to implement. This option may be the most cost-effective, long-term alternative.

TECHNOLOGY RECOMMENDATIONS

The following smart technology elements have been identified as essential for Smart Shuttle operation and are included in the preliminary implementation plan and budget:

- *Communications* -- digital radio and Mobile Data Terminal (MDT).
- *Automated Vehicle Location (AVL)* -- AVL utilizing global positioning satellite technology; and

Executive Summary

- *Scheduling and Dispatching* -- system with automated reservations and dispatching capabilities; scheduling component may be computer-aided or fully automatic.

Fare collection technology enhancements are deemed desirable, but not essential, to the demonstration. This technology includes deployment of various smart fare media with billing capabilities. Automated passenger counting and vehicle monitoring technology was not found to be significantly important for the Smart Shuttle demonstration. These technologies would be beneficial to a full rollout of the Smart Shuttle system.

SERVICE CONCEPTS

The service options have been separated into two general categories of service: demand-responsive and route deviation.

Demand-Responsive Concept

This concept includes the "many-to-many," "many-to-few," and "many-to-one" service option alternatives which may be defined as a shared ride service operating from any point to one or more within a single demonstration area, with enhanced transfer connections to points outside of the demonstration areas. A mix of automobiles and mini-vans (3 to 4 passenger) are recommended for this service option. A typical productivity expectation for general public demand-responsive services operating in purely many-to-many mode is up to 7 passengers per service hour. Using larger vehicles in many-to-few or many-to-one mode, the system can generate higher service productivity. Limited operating hours and

Executive Summary

constraints on destinations that can be reached directly tend to support higher productivity. Current operating costs range from \$18 per hour for taxi services under minimal regulatory requirements, up to the \$30-\$40 range for van-based paratransit services operated through service contracts with private providers. There is clearly a cost benefit in using existing taxi/shuttle owner/operators and franchise organizations to deliver an appropriate portion of Smart Shuttle trips.

Modified Fixed Route Concept

This service option alternative includes route deviation service and point deviation service. Route deviation service is fixed route service scheduled with extra recovery time (usually at terminal points) to accommodate mid-route deviations from the route as requested by passengers. Point deviation routes (or check point deviation) are semi-fixed with a relatively small number of designated time point bus stops where the service is scheduled to arrive and depart on a set schedule with demand-responsive operation between these points. Larger 15-20 passenger vans are proposed to provide adequate capacity in order to maximize cost-effectiveness and minimize the need for additional capacity deployment. In certain applications like "Intermodal Connection," small vehicles like 3 to 4 passenger mini-vans and automobiles may be deployed by utilizing available taxis. An expected productivity range for modified fixed route service is 15 to 20 passengers per hour, depending on the productivity of the fixed route segments and the dimensions, density and street network of the service area. Operating costs should be higher than taxi rates in the range of \$25 to \$40 per hour. There

Executive Summary

is clearly a cost benefit in attempting to utilize the owner/operator or franchise organization typical of jitney operations; this should be pursued.

Service Management and Organization Options

There are a variety of service management and organization options available to the implementation team for consideration on both a demonstration and full roll-out basis. The organizational structure contains three levels: sponsoring agency, day-to-day service manager or broker, and actual service provider. Within this structure there are various choices among the participating transit agencies and private contractors. The preliminary recommendation is to consolidate service management for all demonstration areas. This will minimize redundant overhead while maximizing economics of scale in the use of staff and technology systems.

BUDGET ESTIMATES

Specific unit cost of each recommended technogy is:

- Transit Control Center \$110,000
- GPS Transmitter \$700
- Logic Unit \$1,500
- Mobile Data Terminal \$700
- Radio \$1,100
- Lease Communication Channel .. \$150,000

FUNDING SOURCES

There are a large number of funding sources, some of which provide better chances of obtaining support than others. The following is a summary of potential funding sources available for this program.



Executive Summary

- Intelligent Transportation Systems (ITS)
- ITS Operational Test Program
- ITS Innovations Deserving Exploratory Analysis (IDEA)
- Technology Reinvestment Project (TRP)
- Mitigation fees
- Local motor vehicle registration fees

1. Introduction

Introduction

Faced with the need for improved mobility and air quality, the Los Angeles County Metropolitan Transportation Authority (MTA), in conjunction with the City of Los Angeles and the Southern California Association of Governments (SCAG), is investigating alternatives to the Single Occupant Vehicles (SOV) in the Los Angeles region. DKS Associates, in conjunction with Transportation Management and Design, and CCS, was engaged by the MTA to analyze the technological and operational feasibility of a Smart Shuttle system in the region.

In the past decade several modes of transportation have been added to reduce the dependence on the automobile and increase ridesharing. These include the Blue Line, Red Line, MetroLink and Dial-a-Ride services. In addition, private operators have been providing shared ride van services to the various airports in the region. The Smart Shuttle concept goes one step further by providing increased flexibility, reliability and efficiency, made possible by the merger of shared-ride services and advanced technologies. The underlying objective of the Smart Shuttle concept is to increase transit's share of the commuting market by providing an alternative mode that is flexible, convenient and responsive to customer demand. The success of such a program can offer a range of benefits to commuters, the public at large, and transit agencies. These benefits include reduced travel times, improved air quality, cost savings and increased mobility.

This report is the first of a two-part study being conducted for the MTA. This first part includes an assessment of the technological and operational

Introduction

feasibility of a Smart Shuttle system in the Los Angeles region. The second part will develop three prototype demonstration projects that could be implemented in three service areas in the City of Los Angeles. The main objectives of the feasibility study are:

- 1) Evaluate Intelligent Transportation System (ITS) technologies as they relate to Advanced Public Transportation Systems (APTS) and Advanced Traveler Information Systems (ATIS), and identify those technologies that could be immediately implemented for Smart Shuttle demonstration projects.
- 2) Examine Smart Shuttle service concepts and identify operational strategies to be used in implementing demonstration projects.
- 3) Identify the cost of each technology and potential funding sources and develop time lines for implementation of technologies.

2. Study Methodology

Study Methodology

The following is a brief description of the methodology and tasks undertaken in the preparation of this study:

1: Reviewed existing transit services and identified technology needs for demand responsive and route deviation Smart Shuttle service in the following functional areas:

- Trip request call-in
- Scheduling and dispatching
- Communications
- Automated vehicle location
- Fare payment

2: Identified and evaluated service options and applicable APTS technologies based on: interviews with vendors; product demonstrations; discussions with transit agencies and operators; and literature review of other Smart Shuttle type services. **Table 2.1** presents the agencies and vendors contacted for this study. **Table 2.2** provides a listing of the reports and documentation reviewed in the analyses.

3: Based on an evaluation of users' needs and considering the constraints and opportunities for Smart Shuttle services, recommended preferred system configuration and APTS technology to be implemented in the three demonstration areas.

4: Developed an implementation plan including cost estimates, funding sources, implementation schedule, and management plan. This analysis was conducted for a fleet of fifty vehicles¹.

⁽¹⁾ *Fifty-vehicle fleet size was chosen arbitrarily in order to gauge the magnitude of this project. The eventual size of the fleet to service the three demonstration areas will be determined in the second part of this study.*

Study Methodology

Table 2.1
Summary of Smart Shuttle List of Contacts

SYSTEM	VENDOR
Schedule & Dispatch	
1. CADMOS-Pro+	Micro Dynamics Corp.
2. COMSIS Trip Planning System	COMSIS Corp.
3. DISPATCH-A-Ride	Multisystems
4. EMTRACK	Automated Dispatch Services
5. Easytrips	Easy Street Software
6. MIDAS	Multisystems
7. Paratransit Scheduling Pkg	Philip G. Dorcas & Assoc.
8. QUICK-ROUTE	Decision Sciences
9. Trapize (QV) Module	UMA Engineering
10. Rides-Unlimited	Paratransit Systems International
Communication/AVL	
11. Vehicle Track Sys; UHF/Satellite/Cell	E-System
12. Trunk/Radio	JohnsonRadio
13. Richocet Radio/ Modem Network	Metricom
14. TrunkRadio Modems; Loc. Sys, PEMU	Motorola-VAR's
15. Project Northstar GPS, Cellular	NYNEX
16. Sensors, GPS, MDT, CAD, Ops S/W	Westinghouse
17. DGPS-AVL Manager Modem, EchoXL, CAD S/W	Trimble
18. Fleet Mgmt Sys.-RCC	II-Morrow/UPS

Study Methodology

SYSTEM	VENDOR
19. Sensors, MDT, Software	Unicom Signal
20. Chronos, GPS, MDT, CAD	Mobile Info Systems
21. Sensors, MDT, S/W	Motorola GPS Positioning
22. Cellular Technology	Air-touch
23. MDT, IQ-Modem GPS	Coded Communication
24. MDU, RLU	ElectroCom Automation
25. Comm, Controller VLU; Transit Control Head	Glenayre
26. Cellular Data Wide Area Network	McCaw Comm
27. Comm, Transit Control, FMS, GPS	Nav Data Systems
28. Wide Area Data Network	NexTel
Fare Collection	
29. Mobile Data Terminals; Radio Data Controllers	GMSI, Inc.
30. Automated Passenger Transaction and Vehicle Monitoring System	Echelon Industries Inc.
31. Automated Transit Pass (Smart Card)	IBM; Pacific Bell; Commuter Transport Services, Inc. (CTS)
32. Auto RideShare Matching (ARS) Pkg	CTS; Pacific Bell Info Sys
33. Fare-box, Autoscheduling, AVL System	Phoenix Transit System
Other	
34. EtakMap, Elec. Yellow Pages, Features	Etak
35. Audio & Video Display	SilentRadio

**Table 2.1 (cont.)
List of Contacts**

- Houston Metro
- OCTA
- New Jersey Transit
- Seattle Metro/Bellevue
- Winston-Salem, NC
- Baltimore MTA
- Dallas DART
- Ann Arbor, MI
- Minneapolis, MN
- Portland, OR
- Denver, CO
- Rogue Valley, OR
- Milwaukee, WI
- Ontario, CA
- Riverside, CA
- Santa Clara, CA
- St. Louis, MO

Table 2.2
APTS Reports

- Advanced Public Transportation Systems
- APTS Technical Brief Series
- APTS Project Summaries
- German Smart Bus Systems, Vol. 2, Appendices
- IVHS - A Paradigm Shift
- Mobility Management and Market Oriented Local Transportation
- Opportunities for Smart Cards in American Public Transit
- Smarter Transit Systems Can Lead to Smarter Riders
- Transit Opportunity in IVHS
- Advanced Public Transportation Systems: A Bibliography with Abstracts, 1985-1991
- Advanced Public Transportation Systems: The State of the Art-Update '94
- Bellevue Smart Traveler and Cellular Telecommunications
- California Smart Traveler Operational Tests
- German Smart Bus Systems: Potential for Application in Portland, Vol. 1, Technical Report

3. Technology Assessment

Technology Assessment

OVERVIEW

Intelligent Transportation System (ITS) is a term used to describe projects which apply advanced technologies and communication systems to improve the efficiency and capacity of the transportation network. The growth and interest in ITS applications in the transportation industry have been significant in the past several years. While only a few ITS applications have been deployed, several initiatives are currently being planned or are in operational tests.

Several technologies are included in ITS such as electronics, computer hardware and software, and communications. *The Strategic Plan for ITS America* identified six functional areas in which these technologies are applied. These are:

- Advanced Traffic Management Systems (ATMS)
- Advanced Traveler Information Systems (ATIS)
- Advanced Vehicle Control Systems (AVCS)
- Commercial Vehicle Operations (CVO)
- Advanced Rural Transportation Systems (ARTS)
- Advanced Public Transportation Systems (APTS)

Advanced Public Transportation Systems (APTS)

Smart Shuttle technologies are generally categorized under APTS. APTS provides advanced navigation and communication technologies in all aspects of public transportation. These include the application of advanced technologies to the deployment and operation of high occupancy vehicles, shared-ride vehicles, conventional buses, rail vehicles, and the entire range of paratransit vehicles. These systems enable transit agencies to make timely decisions and provide needed transit information to passengers and operators, to improve the

Technology Assessment

convenience, reliability and safety of public transportation. In addition, APTS will help transit agencies manage a safe and efficient fleet and transit services to satisfy a broad range of consumer needs. The range of APTS technologies can be placed into three major categories, including Smart Traveler, Smart Intermodal Systems, and Smart Vehicle. Each of these categories has applications that could enhance a potential Smart Shuttle system.

Smart Traveler

Smart travelers are individuals who have access to accurate, real-time information and make travel decisions involving high-occupancy vehicles and public transit. The technologies within this category emphasize the availability of information and making the use of public transportation more convenient for public transportation users.

Several types of technology were evaluated to determine their operational features and implementation feasibility for the demonstration phase and full rollout of the Smart Shuttle system. These include:

- Advanced/Integrated Fare Payment Media
- Passenger Information Displays (Smart Kiosks)
- Real-time Rideshare Matching
- Multimodal Trip Reservation and Integrated Billing Systems
- Annunciators (Talking Bus)

While all of these technologies are effective in enhancing traveler convenience, their benefit for a small system such as the one envisioned for the demonstration areas would not justify their cost. However, these technologies

Technology Assessment

become essential for a citywide or a regionwide Smart Shuttle system to attract ridership and enhance system performance. Several smart traveler projects are currently being implemented in the Los Angeles region. These include the Smart Kiosk and the smart card field operational tests. These projects should be considered for integration with the proposed Smart Shuttle after the demonstration phase has been successfully implemented (during the expansion phase).

Smart Intermodal Systems

Smart Intermodal Systems involve the coordination and integration of transportation services offered by multiple providers. These providers represent a variety of modes and various agencies. Integration is accomplished through electronic technologies that coordinates financial and other kinds of transactions.

Smart Intermodal Systems include the following:

- Computerized Telephone Information Systems
- Multimodal Smart Cards/Payment Systems
- High-Occupancy Vehicle Facility Monitoring
- Transportation Management Centers

These technologies increase the efficiency of transit management and operation. Similar to the smart traveler technologies, these elements will be more cost effective for a large countywide system.

Smart Vehicle Technology

The "smart vehicle" incorporates vehicle-based technologies to achieve more effective vehicle and fleet planning, scheduling and operations. In an effort to

Technology Assessment

improve efficiency and effectiveness of service provided, Smart Vehicle Technology focuses on the vehicle.

Smart Vehicle Technology would greatly enhance Smart Shuttle system performance in a cost effective way. The following technologies were further evaluated for implementation in the Smart Shuttle demonstration project:

- Advanced Communications Systems
- Automatic Vehicle Location Systems
- Transit Operations Software
- Computerized Dispatching/Scheduling Systems
- Automatic Passenger Counters

Smart Shuttle Concept

The degree of technological sophistication needed to implement a Smart Shuttle system will vary depending upon the type of service provided. At one end, the fixed route concept can function effectively with minimal advanced technologies. At the other end, the many-to-many service concept is a complex operation, and may require the most advanced software and hardware applications. These include real-time vehicle scheduling and dispatching systems, automated routing systems, audio/video text communication systems, automatic vehicle location, and large scale database management system. Other desirable but not essential features include electronic fare media and in-vehicle card readers. All of these technologies are currently in use in the public and private sectors, and can be readily adapted to fit the needs of a Smart Shuttle system.

Figure 3.1 shows a flow chart depicting the typical operation of an integrated Smart Shuttle system. Users request a trip by calling over the phone or through

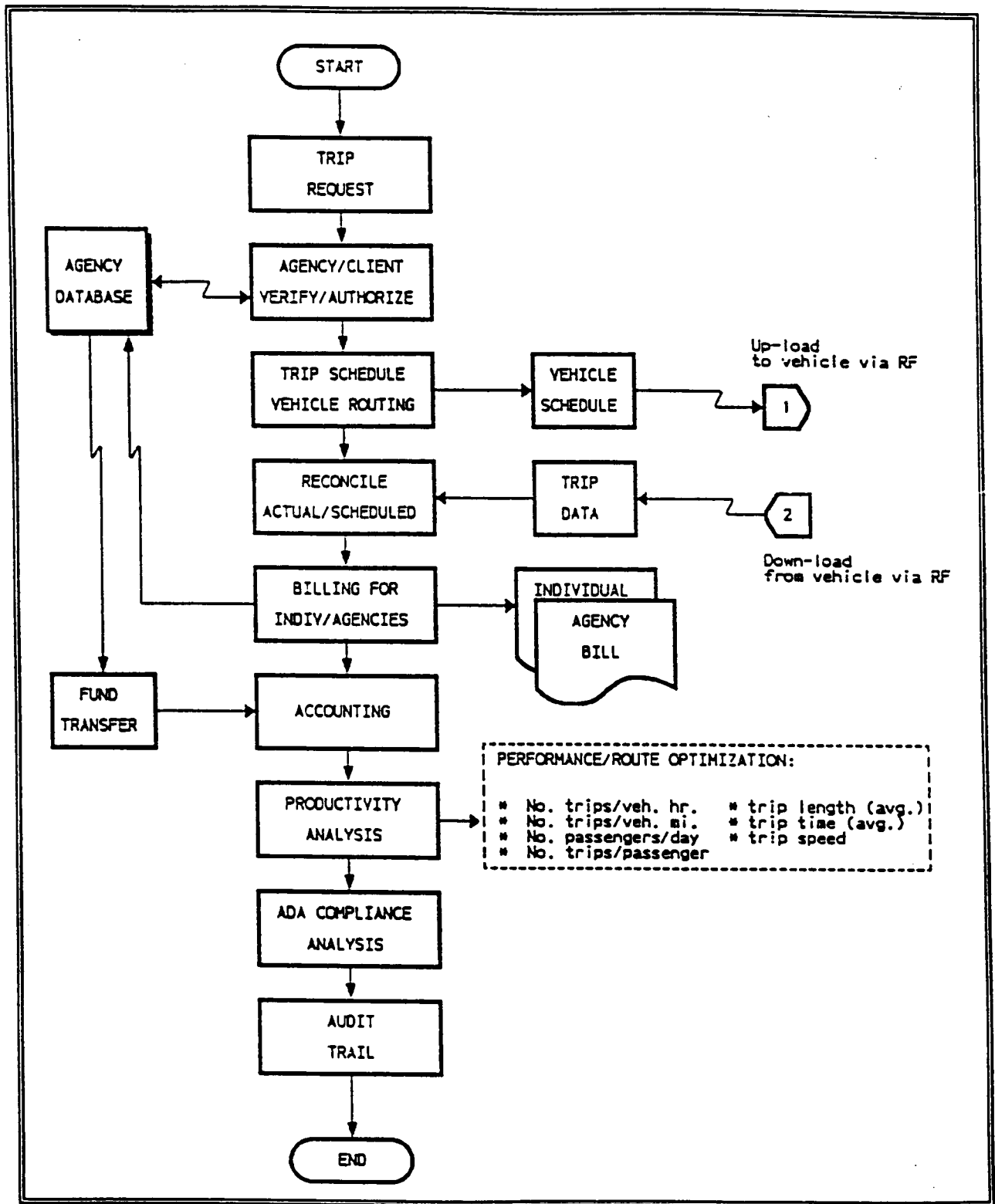


Figure 3.1
Typical Smart Shuttle Operation

Technology Assessment

a computer network. For first time users, the required information is entered into a database for instant retrieval the next time they call, using an ID number or user's name. Vehicle assignment, routing and schedule are automatically generated and dispatched to the driver, based on vehicle location and other trips data. Electronic fare collection as well as productivity analyses can be integrated within this system.

SELECTION OF TECHNOLOGIES FOR ANALYSIS

Four advanced technologies were chosen for detailed analysis on the basis of survey responses from eleven public transit agencies, and in consultation with the Smart Shuttle Technical Advisory Committee. The results of the survey (see **Table 3.2**) show the extent to which advanced technologies have already been integrated into fixed route and paratransit system operations. For example, nine of eleven respondents use computerized scheduling software; eight have installed automatic vehicle location systems; two use automated telephone reservations systems; and one uses electronic fare media. None of the eleven respondents are currently planning to pursue advance vehicle guidance systems or mobile image processing. The technologies selected for further review are discussed below.

**Table 3.2
SMART SHUTTLE TECHNOLOGICAL FEATURES SURVEY**

Agency	Type of Service	Phone Information & Reservation	Computer Scheduling	Electronic Fare Media	Central Database	Integrated Multimodal Net	Real Time Ride Share	Reg. GIS	Automated Vehicle Location System	Vehicle Guidance System	Image Processing	Meets ADA
Rogue Valley Mobility Manager, Central Point Oregon	Fixed & Paratran	Yes, not fully functional can't make reservat.	Yes, Easystreet Software	Magnetic stripe card	Yes, repeat customers on record	Yes, cabs not in system yet	None	Yes	No plans yet	No Plans	No Plans	Yes
Winston-Salem, NC Mobility Manager	Fixed Paratran	Yes, is fully functional	Yes, PASS Software	Magnetic stripe card by Spr. 95	Yes, repeat customers on record	Yes, para, fixed and cabs	n developmnt	Yes	GPS by Feb. 95	No Plans	No Plans	Yes
Milwaukee, WI., Smart Bus	Fixed	None	None	None	None	None	RT Operation	Yes	Yes, GPS system Trimble	No Plans	None	Yes
Denver, CO., Smart Bus	Fixed	None	Yes, Westing-house	Planning	None	None	RT Operation	Yes	Yes, GPS system Trimble	No Plans	None	Yes
Portland, OR., Smart Bus	Fixed	None	Yes, Westing-house	None	None	None	RT Operation	Yes	Yes, GPS system	No Plans	None	Yes
Baltimore, MD., Smart Bus	Fixed	None	Yes, Westing-house	None	None	None	RT Operation	Yes	Yes, GPS system	No Plans	None	Yes
Orange County Trans. Authority, CA	Fixed	None	Yes, Trapeze	None	None	None	RT Operation	Yes	Yes, GPS system	No Plans	None	Yes
Ann Arbor, MI., Smart Intermodal System	Fixed & Paratran	None	Yes, Trapeze	Planning	None	Planning	RT Operation	Yes	Yes, GPS system	No Plans	None	Yes
Minneapolis, MN Travlink Project	Fixed	None	Yes, Westing-house	None	None	None	RT Operation	Yes	Yes, GPS system	No Plans	None	Yes
Ontario, CA Athena Project	Paratran	Planning	Planning	Planning	Planning	None	RT Operation	Yes	Plannning	No Plans	None	Yes
Riverside, CA Riverside Transit Agen.	Fixed	None	Yes, Easystreet Software	Planning	Planning	None	RT Operation	Yes	Yes, Teletrac via cellular phone	No Plans	None	Yes

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RT = Real Time.

Technology Assessment

- *Automatic Vehicle Location (AVL)* - This technology provides an integrated dispatch center the capability to monitor the location of all fixed route and paratransit vehicles continuously in real time. AVL is usually integrated with digital communications and GIS mapping systems to streamline instructions from the dispatcher who is able to view vehicle itineraries graphically to the driver who has a mobile MDT that limits schedule paperwork. AVL technology should have a significant positive effect on Smart Shuttle service quality, productivity, and customer satisfaction, including:
 - Accommodating immediate service requests
 - Coordinating passenger transfers between modes
 - Maximizing the productive use of capacity created by last minute cancellations, no-shows and unanticipated time savings in scheduled vehicle tours
 - Monitoring schedule adherence and minimizing the impacts of schedule delays on passengers
 - Optimizing the assignment of route/point deviation pickups to particular vehicles

The operational advantages provided by AVL technology will tend to generate higher overall service productivity and increase the rate of passenger satisfaction.

- *Automatic Passenger Counters (APC)* - This technology allows for the automatic collection of passenger boarding and alighting information by bus stop or route segment by trip, time period, or day. Depending on the type of service, vehicle deployment strategy, and data needs, it may not be necessary to equip all revenue vehicles with APC technology. A number of transit systems equip only as many "data buses" as are required to survey the entire system by route or service subarea over a period of time.

APC technology offers significant potential benefits to the Smart Shuttle demonstration, including:

- Accurate information concerning utilization of transit services
- Faster response to market reaction to demonstration service components
- Handles Section 15 random trip sampling requirements

Technology Assessment

- *Advanced Fare Payment Media* - Prepaid fare collection methods have long been of interest to the transit industry. The advent of electronic debit cards (or "smart cards") greatly enhances the opportunity to provide convenient prepayment opportunities to the large potential market of discretionary riders including commuters and non-traditional part-time and evening students who may find tokens, punch tickets and monthly passes to be inaccessible or inconvenient. In addition to meeting consumer expectations for convenience, electronic prepayment media facilitate the use of more complex fare structures that depend on distance traveled or the time of day during which travel occurs.

Existing smart card technology uses paper or plastic magnetic strip cards that are similar to conventional credit cards. They may be contact or contactless, and may or may not be tied to the credit system via a banking institution.

- *Computerized Scheduling and Dispatching* - Because the scheduling function is central to the efficient delivery of demand responsive and fixed route service variations, a commitment to advanced scheduling and dispatching technology is particularly important to the success of the Smart Shuttle demonstration. Computerized scheduling systems can increase the speed of reservation transactions, improve the efficiency of trip assignments, maximize opportunities to utilize available capacity to accommodate immediate service requests, and provide real time information useful to maintain schedule integrity and rectify schedule delays. Such advanced technology has a direct and substantial impact of service quality and customer satisfaction.

Advanced scheduling packages enhance the decision making of dispatch personnel by providing relevant information concerning passenger reservations already in the system and the availability of vehicles at a given time. Most existing software packages are capable of accepting advanced trip reservations, subscription service requests (standing orders), and immediate service requests. Several systems are capable of assigning trip requests to shared ride vehicles with or without human intervention. Immediate trip requests can be dispatched via radio frequency (RF) communications with on-board computers.

Technology Assessment

TECHNOLOGY EVALUATION

As discussed previously, the Smart Shuttle concept relies heavily on advanced technologies to accomplish the desired responsiveness and efficiency that are the core of the successful operation of this system. The four technologies that are of importance to the Smart Shuttle system are:

- Audio/Videotext Communications
- Automated Routing, Scheduling and Dispatching
- Automatic Vehicle Location
- Electronic Fare Collection

Because the three Smart Shuttle demonstration projects will involve one or more of these technologies, it is essential to review the status of these technologies to determine whether they have reached a level of maturity where they can be used in a demonstration project without major risk.

Automatic Vehicle Location (AVL) Systems

AVL provides a means of continuously tracking the location of vehicles and is frequently combined with a dedicated radio channel to allow continuous communication with the central control room. Some transit agencies have purchased a combined AVL and advanced communications system, while others have purchased an AVL system to augment a communication system that is already in place.

AVL technologies can be generally classified as either ground or satellite-based. Examples of the various AVL methodologies and technologies that apply to transit and are currently available are discussed below.

Technology Assessment

Signposts and Odometer System

The signpost technique entails the installation of signposts at key points in the transit network. This may include intersections, bus stops, and other strategic locations along routes of interest. These electronic beacons or signposts consist of a low-powered radio transmitter that broadcasts identification codes unique to its location. A vehicle with a logic unit such as a mounted transceiver, receives this transmission, and this location code is sent to the control center.

As with other AVL technologies, the central computer can be designed to store all information regarding routes, time schedules, and distance between signposts. Programmed to poll vehicles continuously for an odometer reading, the central computer uses the signpost identification and the odometer readings to determine location information. With this, a comparison can be made to the pre-programmed information and thus, a minute-by-minute performance of a route or a vehicle can be viewed through its progression on a computer display terminal at central dispatch.

The central computer can be programmed to display real-time information for all vehicles or on an exception only basis. Because this is real-time information, schedule adherence can be determined. A comparison can be made between scheduled position and the vehicle's actual location. If deviations occur, the computer can be programmed to immediately inform the dispatcher and action can be taken to remedy the situation.

Technology Assessment

An advantage of the signpost technique is the relatively low cost and simplicity of receivers. However, for a demand responsive system such as Smart Shuttles where routes may not be fixed, more signposts will be needed to provide coverage for an entire area. As well, the lack of a prescribed routing limits application of the mileage element.

Trilateration System

The trilateration location technique entails the detection of radio transmissions from at least three fixed points. Range differences from one point to another establish the position of the vehicle with further refinements being made by using the vehicle's odometer and map matching similar to the previously discussed signpost system. This ground-based system employs existing standard navigation networks such as U.S. Coast Guard's LORAN-C, or Decca Navigator, or the Omega system as a basis. With these systems several long-range transmitters emit signals that cover nearly all of North America. Thus, locating a vehicle is not limited to pre-assigned transit routes. The vehicle can be located anywhere in the network. Although these systems satisfy the need for long-range transmitters, problems exist when there are signal interferences due to high-rise structures or due to area topography. The systems are reportedly accurate within 300 feet, or approximately 1,000 feet if there is interference. This would be sufficient for the demand-responsive services but not for the modified fixed-route concepts.

Technology Assessment

Global Positioning System (GPS)

Using essentially the same trilateration technique as above but space-based, Global Positioning Systems (GPS) use long-range transmissions from satellites which orbit around the earth. GPS can typically provide information regarding latitude, longitude, elevation, speed and heading of the vehicle. Because this technology relies on existing satellites and on-vehicle equipment, there is no need to install hardware along each route in the network and a vehicle can be located anywhere within the network. This provides for a greater area of coverage than with the signpost method described above where vehicle location capabilities are dependent upon the vehicle being near field elements for detection. The accuracy of such a system is estimated to be within 100 feet, even in areas where GPS signals are partially or sometimes blocked by obstructions such as tall buildings, hills and tunnels.

Hardware on board each vehicle includes a GPS antenna and sensors, a mobile data terminal and data modem. Communication requires dedicated channels with a single radio capable of switching between separate voice and data channels for smaller fleets (less than 50 vehicles). For larger fleets, a minimum of two channels will be required; one for voice and the other for data communication. At the central dispatch center, network controller, map server, map displays, computer aided dispatch (CAD) and integration are basic elements for a transit vehicle location system.

Technology Assessment

Automatic Passenger Counters (APCs)

APCs count how many people board and alight a bus. These counts also can be recorded by time of day. The information gathered from APCs is used for accurate ridership counts and future planning of schedules and routes. Vendors also are accustomed to leasing APC systems to transit agencies for the collection of data for the Section 15 reporting program required of transit systems receiving federal funding. The "typical" APC system uses two adjacent and horizontal infrared light beams or step treadle switches that span across the door steps of the transit vehicle. The passenger counting process uses a four-step logical sequence to detect whether a passenger is boarding or alighting.

Advanced Fare Payment Media

The purpose of advanced media is to make transit fare payment easier and quicker. It allows for multiple trips to be paid for in advance, as well as for variable fare structures by time of day, day of week, fare discount programs, etc. Ease of fare payment is also an important consideration in meeting the compliance requirements of the Americans with Disabilities Act (ADA).

Magnetic Stripe/Fare Debit Card

Paper farecards which have magnetic stripes are being used as a prepaid fare media by several transit agencies including the Bay Area Rapid Transit (BART) in San Francisco and the Washington Metropolitan Area Transit Authority (WMATA). The New York City Transit Authority (NYCTA) is in the process of introducing custom magnetic stripe cards for subways and bus fares.

Technology Assessment

One advantage of the technology from the user's viewpoint is that the magnetic stripe card can be programmed easily. This allows cards to be reissued and reduces costs. Also, if a card is damaged, a replacement card can be issued with the original identification number. The negative side of this flexibility is the ease of counterfeiting a card.

Advantages of magnetic cards in fare/multi-payment media:

- Its adherence to international standards, ensuring multiple vendor sources and competitive prices;
- Its lower per card cost (few pennies); and
- Its established track record as a transit fare card.

Disadvantages of magnetic cards in fare/multi-payment media:

- Its limited data capacity, which in turn limits its off-line capabilities;
- Its lack of on-board microprocessor, limiting its security capabilities;
- Its short life expectation relative to other technologies; and

Smart Cards

Smart cards have been defined in several different ways. A smart card is a chip and an integral operating system. The smart card must be inserted in a reader/writer machine that supplies power to the chip and the connection for communication. Smart card has the following characteristics:

1. Reusable but expensive (\$5 to \$12)
2. Better security
3. High flexibility due to large memory capacity
4. No large scale experience with transportation industry in North America
5. Limited international standard
6. Limited possibility for integration with other systems

In transit applications, smart cards combine the secure, cashless transactions and personalized applications that encourage passengers to use mass transit, while

Technology Assessment

providing transit authorities with the demographic information needed to meet government reporting requirements and to market to target groups. In the transit environment, smart cards can be used as debit, credit or stored-value cards.

Transit authorities which utilize smart cards may enjoy immediate benefits including:

- A multimodal mass-transit payment instrument for buses, trains, subways, light rail, ferry boats, parking, etc.
- Variable pricing, which is the ability to offer discounts and variable fares (e.g., during peak and off-peak travel times), thereby normalizing passenger flow

Another important aspect of smart card is its multi-functionality. With a smart card, the standard credit card can be converted into a tool that can be used for several functions.

The proximity card offers passengers a fast, highly reliable and convenient way of gaining access to stations and vehicles. Moreover, operators benefit from the enhanced system security gained by the card. Because there are no slots, the system is much less susceptible to vandalism. The cards, which do not require battery obtain their power from the reader field.

Technology Assessment

Table 3.3
Automatic Fare Collection: Vendor Surveys

Vendor	Cost	Communication	Capabilities	Current Users
Phoenix Transit Systems	- \$2,300 each - Smart Card Reader	Down load fare information at end of each day. Uses proximity data link.	Phoenix Transit "Smart Cards" capability of credit cards, read/write cards	Transit use LADOT Las Vegas Santa Fe Phoenix
Gandalf/GMSI	- \$75/each attached to MDT - Debit Card Reader	Fare information sent over "existing" radio network (encoded) in real time, similar to MDT data	Taxi environment, credit card fare payment, "Mag-Strip Card"	Taxi use Yellow cabs & checkered cabs in various cities. Chicago using a "smart card"
Echelon Industries	- \$5,000 each - Smart Card /Proximity Reader - Annunciator - Voice	Down load at end of each day	"Proximity Card," voice data management	Testing in LA

Therefore, they have a life span of approximately ten years. Because they are encoded with a unique, protected serial number, operator specified codes, and a patented method of data transfer, the possibilities for fraud or data corruption are virtually eliminated.

Automated Scheduling and Dispatching

Several computerized vehicle scheduling and dispatching systems are currently on the market. These systems are targeted at both taxi and paratransit vehicles' operation. In addition, several transit operators have developed their

Technology Assessment

own software and hardware to more effectively meet their specific needs. In general, these systems encompass the following technological features:

- Trip requests are initially entered into the computer system, which then assigns a vehicle to the request. In taxicab operations, a zonal system is typically used in which vehicles are represented in the computer as an ordered queue in a zone. Each vehicle is equipped with a Mobile Data Terminal (MDT). Through the MDT, the trip is offered to the first vehicle in the queue with the driver having the option of accepting or rejecting the trip.
- The MDT provides for two-way communications (text) between the driver and the dispatcher. In a taxi operation, the zone number in which the vehicle is located is updated by the driver using the MDT. With an AVL system, vehicle locations are continuously updated automatically.
- In paratransit operations, vehicle assignment is typically done on a pre-scheduled trip basis (ordering 12 hours in advance). Real-time scheduling/dispatching of shared ride services is of sufficient complexity that systems typically are used as guides for human dispatchers.
- Communication between the dispatch center and the vehicle is increasingly being handled digitally. Several taxicab systems feature computerized vehicle assignments and digital communications to in-vehicle terminals to notify drivers of the address of their next pick up.

It appears that the technology is relatively mature and reliable for computerized taxi scheduling and dispatching. A similar conclusion can be made for paratransit and shuttle systems which are dominated by pre-ordered trips. Significant improvements have been made over the past few years in real-time scheduling and dispatching of shared ride vehicles.

**Table 3.4
Automated Schedule and Dispatch Software**

VENDOR	PRODUCT	PROGRAM FEATURES	\$ COST	PRODUCT SUPPORT	AVL Ready	MDT Ready	OPERATING ENVIRONMENTS	Computer /Software Requirements	Customization Available	Labor/Training Requirements	Remarks
Micro Dynamics Corp	CADMOS-Pro+	Automated Schedule and Dispatch	7,500		Needs Interface	May Need Interface	Marion Cty, IN Paratransit; Des Moine Paratransit	DOS Platform, Novell Network <i>Trip Limits are hardware based</i>			
COMSIS Corp	COMSIS Trip Planning System	Automated Schedule	15,000 TO 30,000	1st Year, Then \$5,000 Per Year	Yes	Yes		P.C. based, Novell Network		2-Day Training	
Multisystems	DISPATCH-A RIDE	Automated Schedule and Dispatch; Install Area Map in GIS	60,000 <i>(multisite discount available)</i>	1st Year Free; Then Annual Cost	Not Yet	May Need Interface Depending on System	All Paratransit	Unix or P.C.-based; Currently DOS Upgrade to Windows	Installation Included in Cost <i>(including customization)</i>	Recommend 7 Days	Currently Being Installed in Riverside
Paratransit Systems International	Rides Unlimited	Operators Match a Vehicle for Trip Not Automatic <i>(for speed)</i>	5,500 to 30,000		No		Paratransit	P.C.-based, Novell or Work Groups for Windows; Windows-based	Customization Available Including Reporting Features	40 to 60 Hours of Training Recommended	Open Architecture Can Exchange Data Among Other Windows Programs
Easy Street Software	Easytrips	Auto Routing Allows Coding for Various Street Constraints	30,000	1 Year Free; 7½% Capital Cost for Maintenance Agreement	Yes	Yes	All Paratransit	P.C. Windows-based; Novell or Windows NT Network	Yes, Continually Upgrade Program	1 Week Training in Base Price	

**Table 3.4
Automated Schedule and Dispatch Software**

VENDOR	PRODUCT	PROGRAM FEATURES	\$ COST	PRODUCT SUPPORT	AVL Ready	MDT Ready	OPERATING ENVIRONMENTS	Computer /Software Requirements	Customization Available	Labor/Training Requirements	Remarks
UMA Engineering	Trapeze Qu.	Auto Routing	60,000	Percentage of Capital Cost	Yes	Yes		P.C.-based	Yes, Available; Part of Installation Services	Implementation Program Developed	
Automated Dispatch Services	EMTRACK	Automatic Routing Local Area Traffic Faders (Preset) into Routing Algorithm	45,000 10 User License	1st Year Free, then \$5,000/Year for 24-Hr. 800 Line Service	Can Work With Various Systems	Modify for Whatever Protocol Required	Paratransit and Ambulance Service	P.C. Novell Network	Customizing Available; Installation included--Two People for One Week	3-4 Days Training	System Has Back Up Server and Special Backup Data, So Complete Redundancy in System; Ability to Run Multiple Dispatch Services of Same Program.

Technology Assessment

Table 3.5
Summary of Agency and Passenger Benefits

Automatic Vehicle Location (AVL)
1. Increased Efficiency/Reduced Costs
2. Improved Data Collection
3. Improved Quality of Service
4. Increased Ridership/Revenues
5. Improved Passenger Information
6. Increased Security
Advanced Fare Payment Media
1. Increased Convenience for Passenger and Driver
2. Improved Database of Fare Information
Computerized Telephone Information Systems
1. Improved Quality of Customer Service
2. More Efficient Customer Service
3. Increased Ridership/Revenue
Computerized Dispatching/Scheduling
1. Improved Quality of Service
2. Increased Efficiency
3. Increased Flexibility
4. Increased Ridership/Revenue

4. Communication Assessment

Communication Assessment

This section presents an analysis of functional requirements for communication between the Smart Shuttle operations center and the shuttle vehicles; typical systems implementation and available technologies; and current developments that are feasible for Smart Shuttle.

The DKS/CCS/TMD team has studied the communications and related radio technologies applicable to the Smart Shuttle project. The following issues were considered in this study:

- Functional Requirements
- Performance - Equipment
- Inter-operability - System/Operator Entities¹
- Reliability & Maintainability
- Expansion/Upgrade Path

The objective of this investigation is to identify viable products or technologies that will fulfill the functional requirements of a large-scale deployment of Smart Shuttle vehicles. A comprehensive survey and assessment of potential technologies and products adaptable to the Smart Shuttle application was conducted. All feasible technologies, regardless of their market share or technological status were assessed.

¹ *Interoperability refers to the ability of operating entities such as shuttle bus drivers and taxi drivers to receive dispatch instruction from a different operating unit, when such interaction is desired.*

Communication Assessment

FUNCTIONAL REQUIREMENTS

Table 4.1 describes the characteristics of the data that needs to be transmitted between a shuttle vehicle and its Computer Aided Dispatch(CAD) center on a regular basis.

System Description

The mobile communications equipment for Smart Shuttle may include the following (Table 4.2):

Table 4.2
Mobile Communications Equipment

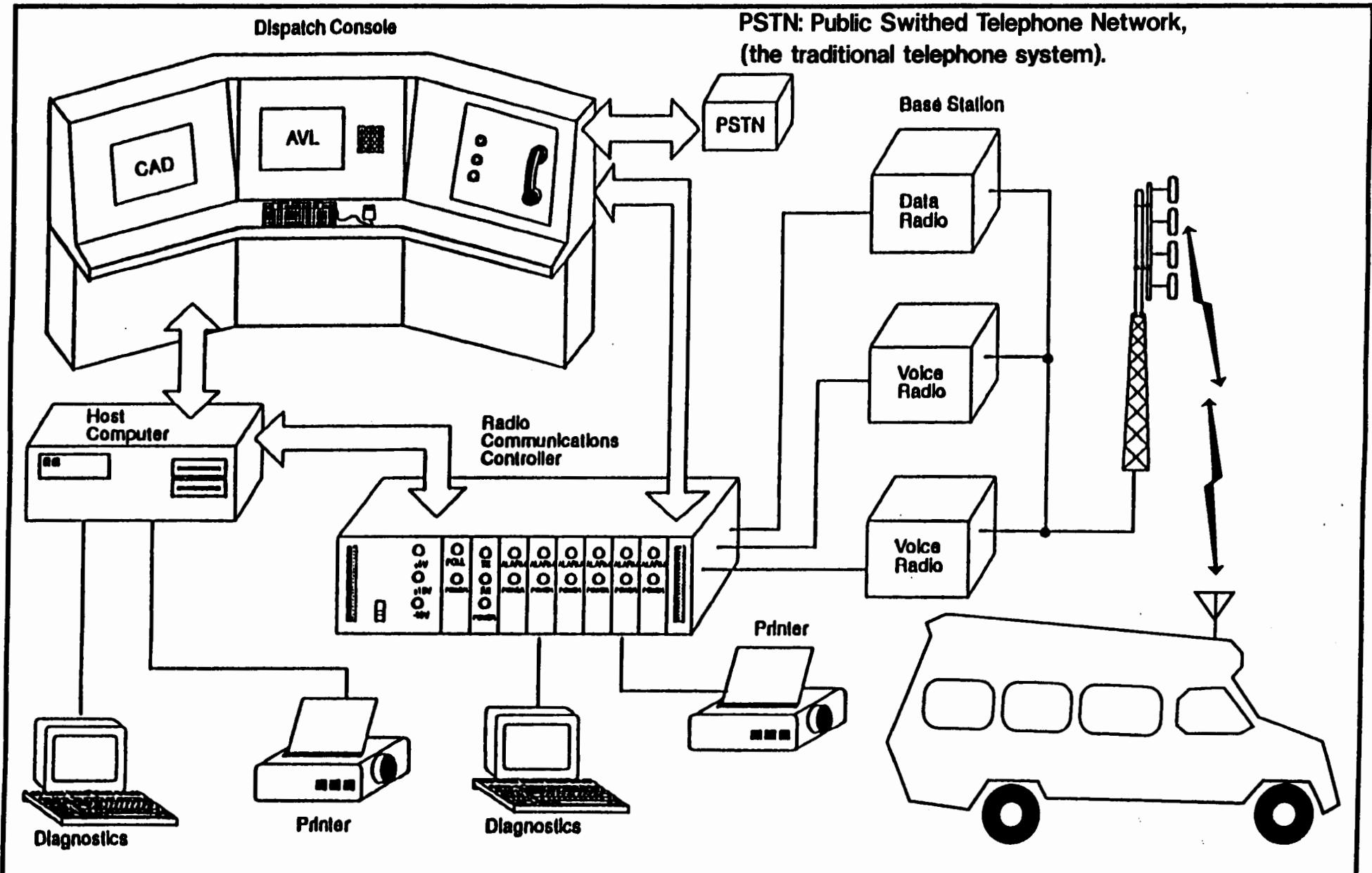
FUNCTION	COMMENT
Driver Interface	Mobile Data Terminal (sometimes called control head) combines all on-board controls and interfaces to radio unit
Automatic Vehicle Locationing (AVL) Sensor	Typically GPS
Two-way Radio	Commercial, Off-the-shelf
Fare Collection System Interface	Desirable, to speed up operator processing
Vehicle Instrumentation Interface	Possible operator/passenger safety consideration
Passenger Information Display/Annunciator Interface	ADA consideration

Some manufacturers combine AVL sensor and vehicle instrumentation, or other functions/components into a "vehicle logic unit." Figures 4.3 and 4.4 are representative of systems and on-shuttle equipment configurations.

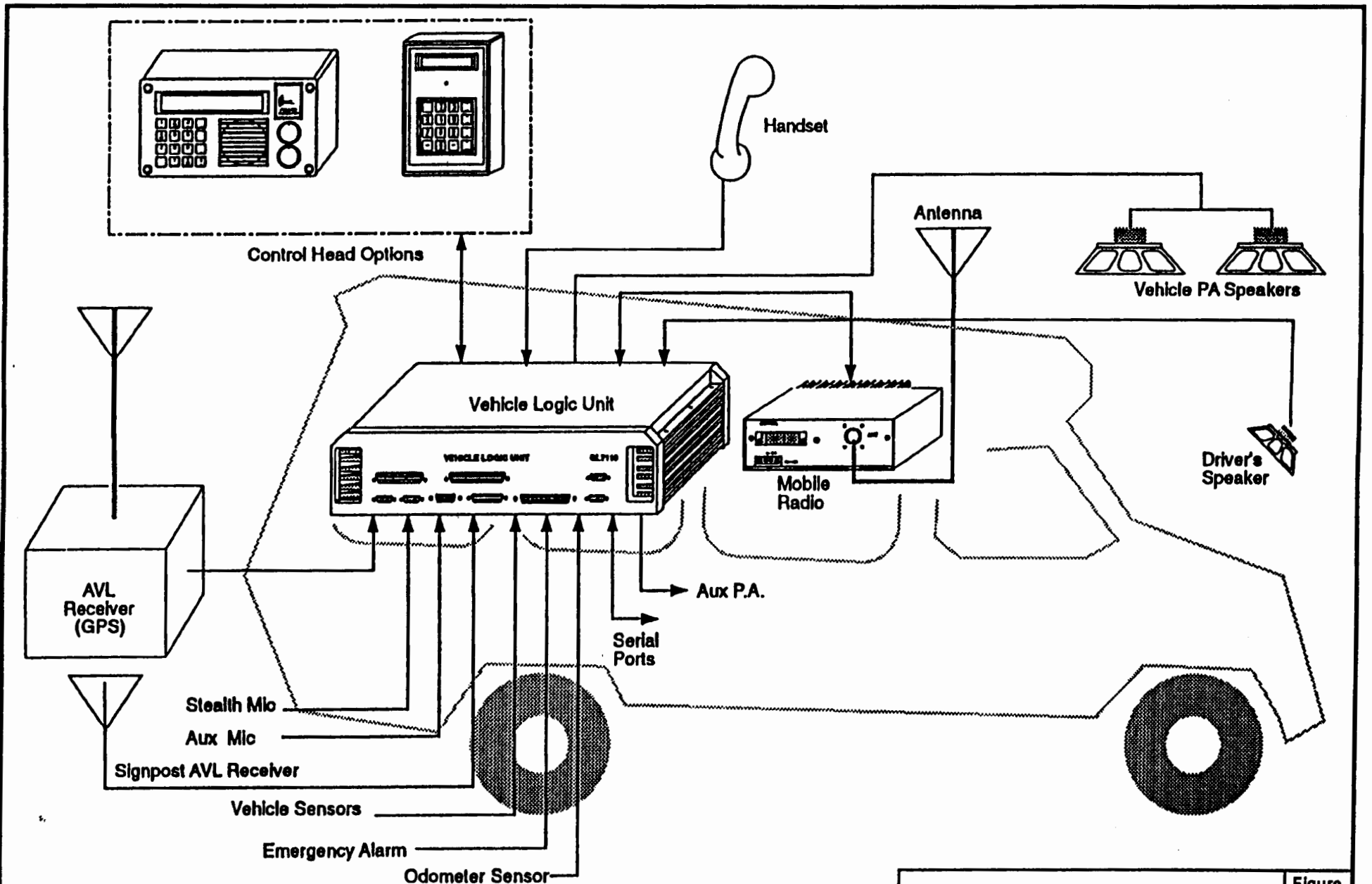
Table 4.1
Minimum Communication Requirements For Smart Shuttle

DATA ATTRIBUTE	DIRECTION,> MOBILE>CENTER CENTER>MOBILE	FREQUENCY OF TRANSMISSION	NUMBER OF BYTES PER TRANSMISSION	REQUIRED/ OPTIONAL/ FUTURE NEED
Vehicle ID & Location, Time	M>C, C>M	1-2 minute	10	R
Vehicle Velocity	M>C	1-2 minute	8	O
Manifest Download	C>M	Start-of-Day	1000	R/O
Pick-Up/Drop-Off/Passenger Count	M>C	after stop	20 Avg.	O
Fare Transactions	M>C	per Rider,End-of- Day	50	O
Dispatch Instruction, Inserts	C>M	As Occurs	40	R
Unscheduled Stop Reporting	M>C	As Occurs	30	R
Engine Instrumentation	M>C	5 minutes	10	O
Silent Alarm	M>C	As Occurs	10	O
Microphone	M>C	As Needed	Dig.Voice	R
Next Stop Data	C>M	As Needed	20	F

The break-down of data transmission requirements in Table 4.1 suggests that average data transmission length is between 100 to 200 bytes per transmission, at intervals of one or two minutes. The prevalent data rate is 1200 Bits per Second (BPS), with 2400 and 9600, or higher rates being implemented gradually as technology improves.



SMART Shuttle	Figure
Typical System Components	4.3



SMART Shuttle	Figure
Typical System Components	4.4

Source: Glenayre Digital Systems

Communication Assessment

AVAILABLE TECHNOLOGIES

Conventional Two-Way Radios

Conventional VHF and UHF mobile radios have been the main component of all mobile applications, particularly for public safety and government agencies, including transportation agencies such as the MTA. Most of the products and services offered for taxi, local and regional carriers use this radio.

Specialized Mobile Radio Services (SMRS)

Radio systems are typically a network of radio transmitter/receiver and repeater antenna towers owned and operated by a licensed business that charges a user fee. Subscribers usually contract this service for specific applications. Specific radios are required by providers to access this service. Fee structure is based on voice, and minutes of air time. This fee structure makes this an unattractive option.

Radio Common Carriers

A more general, wide range service typically is provided by a regional or national company that charges a fee for use of its communications facilities. NexTel is an example of this type of service provider. Generic equipment such as pagers, radio telephone and cellular phones, facsimile, and other data terminal devices can be used. RAM Mobile Data and ARDIS provide this nation-wide service through their proprietary radio modem/terminal. Usage and subscription fees are relatively high. This service is not structured for high volume use, such as a Smart Shuttle operation would require.

Communication Assessment

Mobile Satellite Services

Qualcomm in San Diego has been providing a combined radio location and mobile data service to long-distance trucking companies for over ten years. The system includes a dedicated two-satellite and ground station system. Because of its low accuracy positioning, this service is deemed not suitable for Smart Shuttles.

CURRENT DEVELOPMENTS

A number of divergent developments have occurred in recent years to achieve more efficient utilization of radio channels; most notable is trunking for radios. Through the use of digital signaling, channels are assigned by a computer that keeps track of active users on available channels. New users may share the channels without knowing which specific frequency they are assigned. The trend is towards fully digital transmission in trunking. E.F. Johnson, Ericsson GE, and Motorola are all developing equipment with proprietary technologies.

Spread Spectrum is a radio communication technique adapted from military application. It uses shared frequency space and provides a high degree of isolation from unintended users. FCC had allocated 3 bands for this technology where users are not required to be licensed when low power transmitter-receivers are used. Strictly speaking, this is a method of transmission, not a distinct communication system option. This technology has been adopted in mobile data terminals, fare card readers, and some mobile data services systems. Current

Communication Assessment

products are based on the 902-928MHz band. Higher equipment cost is a concern.

A few national and infrastructure-related developments in progress will affect the design and implementation of communications systems for a large-scale application such as being contemplated for Smart Shuttle. Specifically, the FCC has been planning a frequency 'Re-Farming', with the reallocation of bandwidth and frequencies to allow more efficient utilization of available frequency bands. The increase in the availability of channels is due primarily to advancement of technologies that are able to utilize narrower bands to transmit more information than before. This is mandated by the fact that more users, both public and private, are demanding channels. A sequence of channel doubling by reducing channel bandwidth is being implemented. In parallel to this "re-farming," two pseudo-governmental bodies -- Association of Public Safety and Communication Officials (APCO) and Telecommunications Industries Association (TIA) have jointly been developing standards for digital radio systems that will promote generic, inter-operable radio systems procurements for all public safety agencies. The fact that many transit operations in the nation are sharing communications resources with city or county public safety agencies will effectively give this standard universal applicability. This adoption is closely linked to the FCC frequency "re-farming" process; (gradual phases expected to start in late 1996 for a specific band in the 470 MHz).

Communication Assessment

On the other hand, the cellular providers are busily expanding their base station networks, to add basic voice and data - Cellular Digital Packet Data (CDPD) capability in major metropolitan areas, including Los Angeles.

Communication Alternatives - Assessment

Table 4.5 presents a summary of viable technologies for consideration in Smart Shuttle implementation.

Communication Alternative - Technology Reinvestment

Defense Conversion - Hughes, Loral, Rockwell - The development of non-defense application for Hughes' VRC and Rockwell's Radio systems are far from viable for deployment at this time. Similarly, national systems' architectures being defined will not be implemented in time for the Smart Shuttle prototype demonstration.

Table 4.5
Viable Product/Service Data for Communication Requirements

VENDOR	PRODUCT/SERVICE	BASE TECHNO.	PERFORMANCE	CAPACITY	COMPAT. UPGRADE	EXPANDABILITY	REILIA MAINT.	INTEROP. OTHER FUNCTIONS
Advan. Control Tech Albany, OR	Veh.Track.Unit UVHF/Satellite/Cell	Pager, CR,CDPD Spread Spectr.	3 100/mn	4	5 PC,Vax OS/2, Unix	4 16WS	3	3 EFMS,Mapinfo
Coded Comm. Carlsbad, CA	MDT,IQ-Modem,Comm. Controler, GPS	Spread Spectr.	4-5	4 4096	3	4	3	3 VD,Mag,AVL
ElectroCom Automt'n Arlington,TX	RLU, MDU	CR,EDAC	4	3	3	3	3	4 CNC.RDC,J1708
Gandalf MSI Brea, CA	Wireless NI,MDT, API	CR EDAC	3 50/mn	3 16 WS	3 TDM,SA	3 16S NW	3	4 Inst,SC,Mag,FC
Glenayre Charlotte, NC	Comm. Controller-VLU Transit Cntl Head	PMR	4 400/Mn	4	2 GL Bus	3	2	3 AVL,BSA
Nav. Data Systems New Orleans, LA	Comm.,Transit Ctrler, FMS, GPS	CR,Cell EDAC	3	2	2	3	4 R.Arch.	3 EFMS
WestingHouse-Trim. Baltimore, MD	DGPS-AVLManager,PSC modem,EchoXL CAD S/W	CR,PMR Spread Spectr, TCP/IP	4 300/Mn	4	3	3	3	2 AVL,CAD,FC

Terms: CR=Conventional Radios--UHF/VHF/HF; SS=Spread Spectrum; H/S=Hand Set, MDT=Mobile Data Terminal, SA=Slotted Aloha;
 Cell= Cellular Phone based, PMR=Private/Lic. Mobile Radio, ESMR=Enhanced Special Mob.Radio, EDAC=Enh.Digital Access Comm.
 EFMS=Emergency(public Service)Fleet Management System; Performance value= number of Vehicular updates/minutes.

Note: This table contains current data, which may be updated, or verified. Scores: 5=highest, 1=lowest

Communication Assessment

Voice Communications Requirements - Trunked radios have been in active use for many years. They are proven to be effective and efficient for vehicle dispatch applications. The availability of mature products and technologies of trunked radios by all major vendors makes it suitable for use by the Smart Shuttle operators. The operators may select any system that is compatible with their current operations.

Existing County Radio Communication Resources and Systems - Interviews and discussions with airport shuttle and taxi operator Super Shuttle/LA Taxi, LA Transit Operations Center, Laidlaw Transit (LADOT Commuter Express Contractor) and others indicated that adequate radio communication channel capacities exist for current modes of usage. Current needs are characterized by predominantly voice communications. In the case of Super Shuttle, two channels of private SMR with 5 radio antenna towers spanning 50-70 miles in the entire Southern California region provide adequate capacity for a fleet of 200 vans and 500 taxis. Los Angeles County MTA has an allocation of 15 radio channels that are expected to support a fleet of 6,000 buses communicating at two-minute intervals.

There is also an AVL system being implemented for the Freeway Service Patrol operation, requiring two-way data radio capability. The feasibility of

Communication Assessment

sharing these channels by Smart Shuttle was investigated. Both institutional and technical issues were examined in detail.

Freeway Service Patrol Radio System - The Los Angeles County Internal Services Department (ISD) is assessing its resources to provide a non-trunk digital mobile data service for the 200 truck FSP operation. A similar, more enhanced service can be made available for Smart Shuttle operation.

Operational Issues

The number of independent operators in a service area will affect radio channel requirements. It is desirable that each dispatcher's instruction be communicated only to the intended driver. Mobile Data/Display Terminals are each assigned a unique address. Therefore, only the designated driver can see the instruction intended for him/her. Architecturally, it requires more channels to provide for data communications if multiple operators are serving an area. Other considerations are:

- Compatibility of existing radio equipment used by operator
- Physical constraints on equipment placement and operation
- Load/Resource Sharing among operators/zones, logistics

Evaluation

The Automated Vehicle Location-Computer Aided Dispatch (AVL-CAD) communications market encompasses many segments, such as package delivery, airport shuttles, taxis, emergency response, and paratransit. Each market has its

Communication Assessment

own requirements that have led to voice/data radio systems with proprietary protocol and custom software structures, and this is a lack of standardization.

A communication technology that is based on common, open architecture should be the basis of the Smart Shuttle communication system. CDPD may be a viable future alternative. It is based on the existing cellular base station infrastructures. Plans for deployment in Los Angeles are being finalized by both Air Touch and McCaw/LA Cellular partners. In fact, when kiosks and Personal Data Assistants (PDA) become available for trip requests, CDPD would provide the most cost-effective medium of data networking.

APCO has been the coordination entity for frequency allocation/sharing, and in promoting radio equipment procurement standardization among federal, state and local agencies. APCO Project 16 and 25 are standard development projects, born of necessity on the part of a myriad of operating entities who share limited channel capacity. These developments are being carried-out in collaboration with the Telecommunications Industry Association (TIA), a standards-setting body for the wired-line phone industry.

The proposed approach for Smart Shuttle communication is based on a two-phase plan. First, select an existing, proven system from currently deployed systems that is open and flexible in its system architecture. Operational issues and requirements will be worked-out in this prototype phase. In phase two, specify a communication system that will be scalable, extendable, and expandable both in its over-all design and subsystems. This open architecture system will comply with

Communication Assessment

evolving digital radio standards, and/or infra-structures, so that future expansion in both coverage and density of mobile units will be accommodated easily. These two phases will match the proposed demonstration project and full roll-out deployment plan. Cost estimates are shown in Table 4.6.

Table 4.6

**COST ESTIMATES for COMMUNICATION SYSTEMS ALTERNATIVES
Smart Shuttle Demonstration**

OPTION	Target Radio Technology	Capital Eqm't Mobile/ 3 CAD Centers	CAD Centers Developent SoftWare/ Setup	Usage Fees, per month estimated	CAD/Vehicles Operational Cost -Eq'mnt (one-Time)	Maintenance Costs - per month	Annual Cost/ First Year
Purchase Service from LA County ISD	800MHz EDAC-based Digital Radio service	MDT GPS & Radios \$350,000/ \$130,000	\$65,000 \$10,000	\$ 3,000/ +Conversion (part)at full deployment	\$2,500/	\$3,500/	\$126,000/ \$161,000
Contract Turn-key Service from Vendor e.g. Super Shuttle	Conventional Radio with programed multiple access	MDT, GPS & Radios \$250,000/ \$45,000	\$65,000 \$25,000	\$ 2,250/ +conversion at full deployment	\$4,000/	\$4,000/	\$212,000/ \$240,000
Apply Separate System using antenna tower from Major Operator	APCO Digital Trunking System operated over new licensed channels	MDT,GPS & Radios \$50,000/ \$50,000	\$65,000 \$35,000	\$50,000/	\$5,000/	\$5,000/	\$160,000/ \$196,000

Assumptions: 50 vehicles total, serving three distinct zones. MDT's @ \$700, GPS & Antenna @\$650, Radio @ \$1,000-\$1,500; Control Unit at \$1,500 per vehicle installed.

Radio Tower-Antenna new: \$150,000; existing tower, \$20,000.

FCC license application-processing 6 months. Conversion applies to complying with FCC Refarming/APCO 25 Standard, as well as for large fleet communications through-put requirement.

Communication Assessment

COMMUNICATIONS ALTERNATIVES

The following six alternatives were evaluated for Smart Shuttle application:

- Data on Conventional Radio
- Enhanced Digital Access Communication
- Cellular Digital Packet Data
- Enhanced Special Mobile Radio
- Motorola Integrated Radio System
- AirTouch Teletrac System

Data on Conventional Radio

All current systems listed below have specifically designed control heads or Mobile Data Terminal(MDT) that interfaces with either conventional radio or trunked radios or both.

1. ElectroCom Automation
2. Gandalf Mobile Systems Inc.
3. Glenayre Digital System
4. Westinghouse Electric/Trimble (bought by E-System recently)

Three options were investigated in order to implement conventional radio for Smart Shuttle operations. These include sharing existing MTA infrastructure; leasing from private operators (Super Shuttle, Laidlaw, Prime Time); and acquiring dedicated radio from the FCC. Detailed review of each option indicated that the second option may provide the most viable alternative for the short term, while the last option may be needed for the long term. The current capacity of the MTA system is limited and does not allow for sharing with the Smart Shuttle. Leasing from a private operator may be effective for the short term, but could be unreliable since it is too closely dependent on the operator's needs and requirements. Acquiring a radio frequency involves a six- to nine-

Communication Assessment

month application process and would cost \$250,000 to \$500,000 to implement. This option is the most reliable and most cost-effective alternative.

Interviews and site visits to Super Shuttle, LA Taxi, Prime Time Shuttle, and MTA's Transit Operations Center identified the various levels of system sophistication and open architecture necessary to accommodate technology upgrades. This initial assesment is not very encouraging. Technology upgrades will require sound systems design and judicious selection of subsystem products to create a compatible and easily upgradable system that can evolve from prototype to full deployment along a coherent, smooth path.

Enhanced Digital Access Communication -EDACS, by Ericsson GE

This is also a viable medium for Smart Shuttle, albeit at a high usage fee. Commercial providers using this system exist. Monthly fees are variable but are expected to be in the range of \$75 - \$200 per mobile unit.

The Los Angeles County ISD has just put in place a county wide EDAC-based integrated radio system named CWIRS to serve the needs of various agencies including private tow truck operators under contract with Los Angeles County.

Cellular Digital Packet Data (CDPD)

CDPD was developed by a consortium of telecom & data communications companies, based on open architecture, for both base station and mobile unit

Communication Assessment

design protocols. There are six manufacturers producing both base-station and mobile radio units to its specifications. Both by design and field trial results, it has been shown that CDPD-based mobile data networks should provide the required performance and capacity needed to carry the communication load between multiple CAD workstations and thousands of mobile units.

American Airlines' SABRE, IVANS, an insurance company in Connecticut, and UPS are among large corporations planning to implement CDPD as their mobile data networks. Advanced Control Technology (ACT) of Albany, Oregon, demonstrated its AVL/CAD for public safety application during the past COMDEX show in Las Vegas.

The CDPD concept utilizes unused portions (in term of milliseconds of time slices within and between sentences and conversations) of cellular channels by adding a layer of hardware and software onto the existing cellular base station to relay short 128-byte digital text message packets. There are a few large scale CDPD pilot projects being undertaken around the country. In fact, Southern Cal Edison is sponsoring a pilot project in Los Angeles County, although it is strictly for its own use. The two local cellular providers AirTouch and McCaw Cellular/LA Cellular may be interested in supporting a high visibility project such as Smart Shuttle as their pilot project by building the CDPD layer in the proposed test sites, and by working with AVL/CAD vendors in implementing the required data link interface. A couple of AVL/CAD vendors are already working with Application Program Interface (API), using the Internet protocol (IP) to work

Communication Assessment

with the Connectionless Network Protocol (CLNP). CDPD has demonstrated low latency, about 20 milliseconds, and overhead response time of 15 milliseconds per packet. GTE Mobile Data service has introduced this service for six metropolitan areas in the US.

CDPD has not been implemented in the public transit area. However, some financial corporations are trying large-scale mobile site applications. During the November Comdex in Las Vegas, a couple of GPS-equipped vehicles were tracked via CDPD modems to work stations setup on the convention floor.

Enhanced Special Mobile Radio (ESMR)

NexTel has built a nation-wide network, though primarily regional SMR services, including the Los Angeles metropolitan area. It can provide a large variety of services, from paging and mobile data networking to cellular call services. Cost data is not available, since for high volume users, a complex fee structure is negotiated directly between the provider and the customer.

Motorola Integrated Radio System (MIRS)

This is a new system in early field use with equipment provided by Motorola. NexTel is providing mixed voice and data services to its current SMR users with MIRS equipment. Motorola has announced its product development effort for APCO-25 compatible version of radios, to be available in the near future.

AirTouch Teletrac

Communication Assessment

This is a service offered through a proprietary system. It is also based on trilateration on distances calculated from delay times of a mobile transceiver signal received by scattered receivers. A host computer does the calculation to determine the target location, then translates it into geocode for map reference. The system is quite effective and accurate in its positioning and communication. The main concern with this system is that it has not been proven for application in transit operations. Significant effort will be required to integrate scheduling and dispatching software with the Teletrac System.

The following Table 4.7 provides a detailed description of several mobile data services.

Table 4.7
Mobile Data Services

Service	MDT RadioModem	Air Time per Msg per KB per Month	Data Rate	Message Format	Interface Hardware Software	HostEqmt cost TelTie Line per Vehicle	Setup/ Monthly fees Host/ Per Vehicle	Comments Other Features
Ardis	Itronics T5000FFE built-in antenna	\$.05 + \$.30	2.4 KBps	Predefined and Free Text	X.25, CDPD PCMCIA MSDOS	\$10,000 \$4,000	\$1,200 \$1,500	
NexTel-SMR 800MHz digital cellular	Handset with MDT/PC		4.8 KBps	user defined		\$30,000 \$2000	Negotiated	PSTN TCP/IP
Ram Mobile	InfoTac	\$25/100KB	8KBps	Predefined FreeText(Out bound only)	SerialPort	\$200 \$3,000	\$1,000 \$900 \$50	Email, cc:mail Broadcast
Teletrac SpreadSpectrum 902-920MHz	CMX4500 CMX1000	\$40 Flat	9.6 KBps	Predefined	SerialPort	\$10,000 \$1,100	\$1,000 \$22	Integral radio locationing

Note: The ARDIS and RAM Mobile Data services are really intended for mobile information workers for anywhere communication in building, street, and vehicle.

Communication Assessment

RECOMMENDATION - UPGRADE PATH

Of the leading system vendors (integrator teams), with technologies already in use, one half are based on conventional mobile radios, and half are in the early stage of using digital infra-structures--ESMR, MIRS, or EDAC. However, these technologies have limited expandability and are restricted by the few channels offered through vendor-service providers. Some may involve FCC licensing processing. Current products based on conventional radios and the availability of shared public transit channels should be able to support communications requirements of AVL and CAD for fleet size up to 300-400 vans. Beyond that, a new technology such as CDPD will be needed to fulfill the data communications load requirements.

As the Los Angeles area is the leading site of communications technologies, the Smart Shuttle may benefit from being selected as a pilot roll-out project for a new type of mobile data service. A two-phase approach is recommended, a demonstration phase followed by full roll-out phase. The demonstration phase may be used to fine tune institutional and operational issues, with a configuration made-up of proven, current technologies. This may include acquiring a dedicated radio frequency or leasing from the CWIRS.

Communication Assessment

GENERAL REQUIREMENTS FOR FUTURE EXPANSION

The system should be able to co-exist with older analog systems, share the same segments of allocated RF spectrum and provide minimal interference with existing adjacent-channel analog systems as well as work properly.

Mobile units shall communicate in either a conventional or trunked radio system environment using clear (unencrypted digital), digitized voice, or data modes regardless of the manufacturer.

Data transmission between a public or private switched telephone network access point, SNA, X.25, or TCP/IP networks and Mobile Data Terminal equipments, over the RF Link are required. Data transmission shall operate at a speed of at least 2400 bps (9600 later) with minimal errors in transmissions.

All subsystems which comprise a radio system must be under control of a single network management scheme, regardless of manufacturer. The scope of the single network management scheme includes five basic elements of network

management:

- a) Configuration
- b) Fault
- c) Security
- d) Performance
- e) Accounting

Registration & Roaming are features that will allow added flexibility for supervisory and/or maintenance operations, as well as service zone/route changes by shuttle vehicles. Additional features include:

Communication Assessment

- Simulcast and Repeater Operation - These are features that make a system more flexible and make more effective use of radio channels.
- Digital Addressing-Signalling - Characteristic of digital implementation in radios.
- Changeable Configuration - Programmability for joint operability among distinct agencies.
- Talk Group Priority - A feature that will maintain isolation when multiple operators are serving the same area/zone.
- Talk Group Scanning - A feature that allows monitoring of available channel resource.
- Emergency Backup Options - Provision of continued service upon a system failure.

5. Service Concepts

SERVICE CONCEPTS AND MANAGEMENT

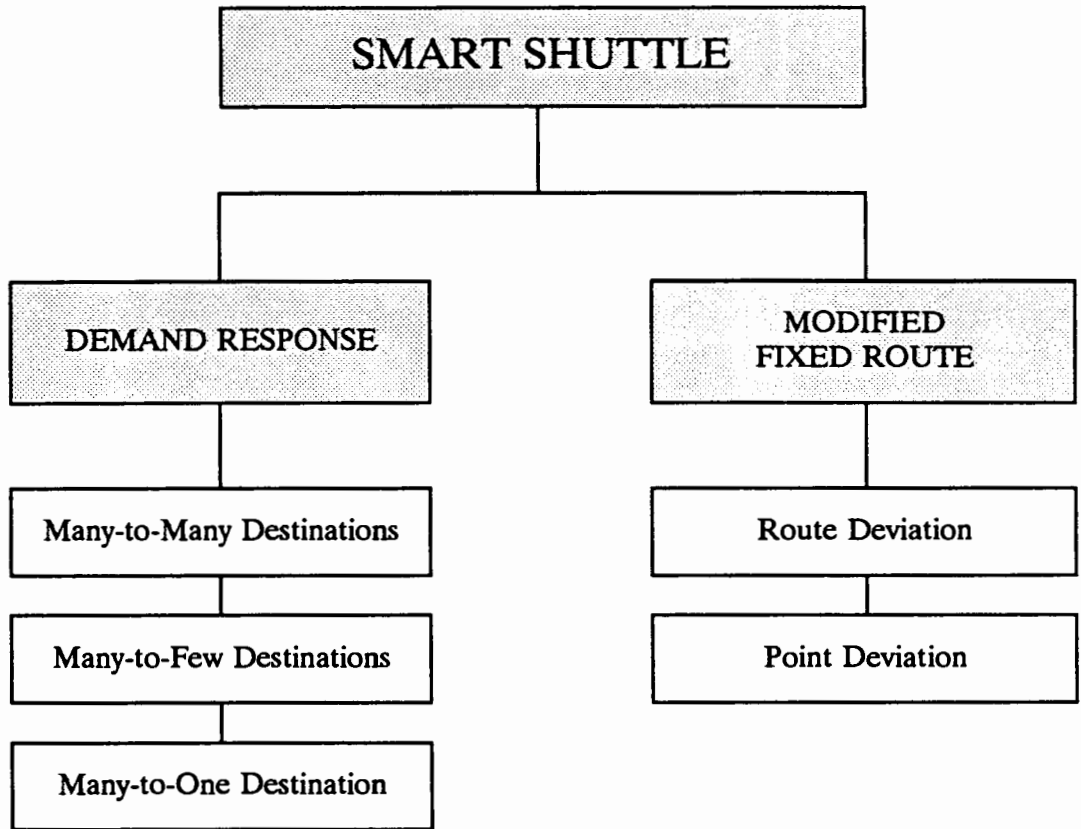
The Smart Shuttle service option alternatives are based on a series of interviews with local and other national operators, interviews with Smart technology vendors, and review of available documentation of other Smart Shuttle-type services. Each of the service concepts covers the following elements:

- Service Overview
- Vehicle Types Deployed
- Passenger Collection and Distribution
- Scheduling and Dispatching
- Organizational Structure/ Regulatory Issues
- Performance Expectations
- Key Smart Technology Applied

In addition, findings and recommendations are also included for service deployment, service management and organization, and fares and media. The service alternatives have a strong focus on developing private sector participation in both the day-to-day service management and service operation. Potential opportunities to share overhead through function consolidation that may result in agency operation have been noted.

The service concepts have been separated into two general categories of service: demand responsive and route deviation. Figure 5.1 presents the two overall service concepts with their various alternatives.

**Figure 5.1
Smart Shuttle Service Options**



Service Option Alternative: Demand Responsive

Service Overview. The "Many-to-Many," "Many-to-Few," and "Many-to-One" service option alternatives is a shared ride service operating from any point to one or more within a single demonstration area with enhanced connections to points outside of the demonstration areas. Given the likely impact such a service would have on the existing taxi operators and the political/legal consequences, *it will be imperative to insure the active participation (or opportunity to participate) of the current taxi permittees in each of the demonstration areas.* All three identified

Service Concepts

demonstration areas have existing taxi providers. Authorized fleet sizes range from 85 to 318 depending on the company or organization. It is significant that the entire San Fernando Valley (encompassing several times the area of the two Valley demonstration areas) has only 181 authorized taxis², while South Central Los Angeles has nearly 800 authorized cabs³. The City plans to add some 250 additional taxi permits⁴. In addition to the authorized taxi fleets, there are reportedly an additional 1,000 or more "bandit" taxi operators in the City.

In cases where the current cab fleet deployed is identified as insufficient for the recommended implementation plan, the options to increase the participating fleet will include:

- *Increase the fleet sizes for the existing cab permittees.* While some expansion is possible before reaching maximum authorized levels, LADOT's Franchise Regulation Division has indicated that further increases in the authorized levels would be possible where justified. To minimize financial impacts due to the short term demonstration period, the implementation study team should explore (1) temporarily expanding fleets through the advance purchase of replacement vehicles or (2) purchase of larger van-type vehicles that could be transferred to the

² Valley Cab (Delaware Titan Capital Corp.) 96 maximum/80+ current units; San Fernando Valley Cab (Babaeian Transportation Company) 85 max/55 current units. These cab companies serve only the Valley and LAX. Neither cab company currently has a Mobile Data Terminal-based (MDT) communications systems.

³ L.A. Taxi (Cooperative) 318 maximum/252 current units; Independent Cab Company (Independent Taxi Owners Association) 231 maximum units/231 current units; United Independent Cab Company (United Independent Taxi Drivers, Inc.) 231 maximum units/231 current units. The first serves central L.A. south of the Valley/west to Hollywood/south to South Central/east to City line and LAX. The second and third associations serve these areas as well as west to the L.A. line.

⁴ L.A. Yellow Cab (Golden State Transit Corp) is authorized a maximum fleet of 250 with none currently deployed. They are authorized L.A. south of the Valley/west and east to City Line/south to South Central and LAX.

Service Concepts

CityRide or Metro Access programs at the conclusion of the demonstration period. The availability of new vehicles is a clear incentive to induce greater participation of taxi operators, especially if they can retain them at the demonstration conclusion for the residual value. Further, the availability of MDTs on the vehicles is also an incentive for those taxi-providers currently operating without MDTs.

- *Introduce Additional Operators.* Additional operators can include companies or associations of independent owner/operators not currently operating in the area. There are no regulations that would prevent out-of-area taxi operators from providing prearranged taxi service (i.e., auto for hire). They can also participate in providing non-prearranged modified fixed route service under the City of Los Angeles' Public Transportation Vehicle (PTV) regulations.

Service hours are not set and may range from 24-hour to limited daily times depending on service application determined by the implementation study team. LADOT's Franchise Regulation Division and the Metro Access contractor, ASI, have indicated that taxi participation during the peak LAX times can be troublesome. They suggested that participating taxis not have LAX medallions. They further explained that use of current taxi drivers can also be troublesome because of the typical taxi driver mind set that they can make only two to four high-priced trips a day to meet their revenue objectives and are not attracted to the daily Smart Shuttle "grind." They suggested that consideration be given to (1) creating half shifts that would cover the out-of-pocket costs (largely vehicle-related) for existing drivers and (2) having the taxi companies/associations hire new drivers dedicated to the Smart Shuttle service.

Vehicle Types Deployed. A mix of automobiles and lift-equipped mini-vans (3-4 passenger) are recommended for this service option. In certain applications larger vans may be desirable. However, vehicles seating 15 or more passengers

Service Concepts

are considered no longer considered Public Transit Vehicles (PTV), but Motor Buses and subject to fixed route and schedule requirements⁵. Vehicle amenities should include comfortable seats on vans, active and passive service advertising, and low floors/wheelchair lifts on vans. Alternative fuels should be considered only where warranted (e.g., operator capability, long-term vehicle ownership).

Passenger Collection and Distribution. Demand responsive service offers attractive user access characteristics usually associated with highly personalized but expensive exclusive ride taxi service. Positive aspects include curbside access for passengers boarding and alighting when operating in many-to-many mode, and accommodation of reservations made in advance or real-time (i.e., immediate response). To be successful, Smart Shuttle operating procedures must capitalize on such attributes while minimizing schedule delays or excessive travel time that characterize many complementary paratransit systems catering exclusively to the mobility-limited passengers.

The advanced technology aspects of the demonstration will be useful in assuring customer acceptance of Smart Shuttle service. A GIS-based scheduling software package that makes accurate digitized maps available on screen to the dispatcher will help minimize unnecessary delays caused by driver difficulty locating a particular pickup address or failure to take the shortest route between passenger stops. The dispatcher will be able to transmit detailed routing

⁵ LADOT indicates that a waiver of this seating threshold for a demonstration is possible if warranted.

Service Concepts

instructions to drivers via mobile MDTs (consistent with the communications recommendation), thereby reducing the time required to manually record specific routing information. The MDTs will be similarly useful for transmission of trips dispatched in real time, cancellations, no-shows, and other instructions on the fly. Computer-aided trip assignment will facilitate shorter vehicle response times to real time requests, although it must be recognized that other factors such as service area dimensions, vehicle deployment density, and the level of passenger demand will affect response times as well. A recommended design guideline is that Smart Shuttle system capacity be sufficient to assure a maximum 15-minute response time to immediate service requests (note: the German FOCCS project achieved an 8-minute response time).

Passenger collection and distribution may be further streamlined by effective policies that encourage passengers to utilize Smart Shuttle resources effectively.

Passenger no-shows, last minute cancellation of reservations, and passenger unpreparedness to board promptly upon vehicle arrival are common operating problems experienced by complementary paratransit systems that focus on ADA-eligible patrons and older adults. These systems frequently attempt to minimize no-shows by restricting client access to service following repeated occurrences and progressive warnings. This approach may be less effective for a general public system due to the greater range of travel choices available to such users, lesser registration requirements for system users, and the administrative burden associated with the progressive notification process. An alternative approach may

Service Concepts

be to charge a fare for any trip reservation not cancelled at least one hour in advance of scheduled pickup. The additional fare would be collected when the customer books and completes his or her next trip on the system. This approach fixes economic value on the trip as a commodity, and is likely to encourage recurrent users to cancel unnecessary trips sufficiently early so that additional real-time trip requests can be accommodated.

If metered fares are employed, passenger boarding delays may be minimized through the use of current taxi tariffs, which allow the flag drop as soon as the vehicle reaches its scheduled pick-up point and time. If a flat fare or zone fare structure is used, a maximum vehicle wait time may be imposed. This policy approach is used by numerous complementary paratransit operations that experience significant delay when boarding customers with mental, physical or age-related disabilities. Typically, these systems advertise a 3 to 5 minute maximum waiting time, although the rule is often enforced only selectively to discourage customers who are chronically late for their scheduled pickup. Delays in passenger boarding also tend to occur when the scheduling process is incapable of defining a pickup window much below 30 minutes for waiting customers. With a more responsive system providing accurate, frequently updated pick-up times rather than windows (based on GPS proximity triggers), it will be possible to notify customers of impending vehicle arrival, and to enforce scheduled pickup

Service Concepts

times with metered dwell time or a fixed surcharge for unreasonable delays (greater than 3-5 minutes).⁶

Given the increasingly flexible travel arrangements used by Los Angeles area commuters, students, and other members of the general public, it is recommended that passengers without reservations who desire boarding be accommodated to the maximum extent practicable. This is a key factor both to preserve the cost-effective operating style of existing taxi operators, and to provide flexibility for commuters who may use more than one travel mode during a given work week. To avoid potential problems in delivering unscheduled passengers to specific destinations, at least two different street boarding programs should be considered during the demonstration:

- *Designated stops* -- Unscheduled passengers would be distributed in many-to-few mode to major transfer points, activity centers, or other locations consistent with the daily route.
- *Driver controlled stops* -- Driver discretion would be used to accept passengers without reservations and deliver them to desired destinations within schedule constraints. This strategy will place certain regulatory restrictions on who can pick up "non-prearranged" trips. Driver controlled stops would no longer fall under the "auto-for-hire" regulation, but rather the "public transportation vehicle."

Scheduling and Dispatching. Mature technology presently exists to support a Smart Shuttle operation that accepts reservations both in advance and real-time. The use of such technology will facilitate the integration of predominantly

⁶ A possible future enhancement in the Smart technology could include a GPS-MDT linkage that automatically displays the surcharge after the delay on-site, eliminating driver variance and credibility.

Service Concepts

prescheduled trips (including ADA) and standing orders for daily service with dynamically dispatched shared ride taxi operations. Acquisition of a scheduling package that incorporates the following features is recommended:

- *Order Taking.* Most existing paratransit software packages are designed around the concept of a customer identification file that contains much of the basic information necessary to book individual trips. Customer records can be located quickly using multiple variables and hot keys. Trip reservations are simplified through automatic transference of information in the customer file to the trip request file, including name, most common pickup address, recent travel destinations, fare or payment billing information, special assistance needs, and routing instructions. A rapid and efficient interface with the customer on the telephone at the time of reservation can thus be attained. This is critical both for system capacity and customer perception, as this may be the only time that the customer interacts with the provider other than when actually riding. It is also a key area where shared overhead may generate cost-savings to the provider and improved convenience for the customer.
- *Trip Assignment/Scheduling.* Decisions that allocate trip requests to vehicles have a dramatic influence on system efficiency and user satisfaction. Historically, demand responsive system operators employed one of two general strategies for trip assignment: (a) Dispatch trips dynamically across a network of relatively small geographic zones to individual vehicles using a queuing technique (taxi operators); or, (2) Employ a manual or semi-automated trip/routing optimization method in batch mode for advanced reservation systems, with open time periods accommodating same-day or immediate service requests (paratransit). Work on computerized scheduling algorithms for demand responsive service has been ongoing for over 20 years, and has benefitted from recent progress in the development of digitized mapping and GPS technology. It is recommended that the Smart Shuttle demonstration incorporate such technology advances in the following ways:
 - Some taxi fleets in the Los Angeles area have fully automated the *zonal/queuing technique* where trips are offered to the next driver through MDTs; and
 - A growing number of van-based paratransit systems (such as Phoenix Transit) utilize a semi-automated *trip/routing optimization process* by

Service Concepts

selecting a set number of vehicles that are closest to the requested trip origin (with GPS/GIS - see Section 3 below).

Depending on the Smart Shuttle application proposed by the implementation study team, either of these technologies will provide the necessary trip assignment/scheduling. Both options also allow for unscheduled street boardings to occur cost-effectively. The next step in the trip/routing optimization approach⁷ is where the process is fully automated -- that is, the system is capable of optimizing both the trip assignment and vehicle routing simultaneously. This level of technology requires enhanced computer processing and greater dispatch staff capability than may generally prevail in most dynamic taxi-based operations and many pre-scheduled paratransit systems. As well, the smaller taxi and mini-van sized vehicles will benefit less from full automation as their trips are less complex due to the fewer number of passengers on-board at one time. Full automation becomes more valuable when used with the larger vehicles employed with route deviation service options.

- *Vehicle Monitoring.* This activity is an integral part of the trip assignment process. Perhaps the greatest technological advances have occurred with the advent of Global Positioning Systems (GPS) automated vehicle locators. While the technology is new, it is being embraced rapidly in both the public and private sector,⁸ especially when directly integrated with a Geographic Information System (GIS). It is proposed that these capabilities be included in the service demonstration to address the following key issues that impact service quality and cost-effectiveness in many-to-many/few/one operation:
 - Allow for frequent and accurate updates in estimated time of arrival (ETA) for passenger pick-ups;
 - Allow for re-optimization of trip assignments and routings;
 - Provide accurate routing guidance to drivers;
 - Provide for automated notice to affected vehicles in the advent of traffic delays through interface with Caltrans freeway monitoring system; and

⁷ For the relatively short trip lengths that will be possible within the demonstration areas the fully automated trip/routing optimization approach will have less benefit than for the full roll-out scenario where longer, more complex routing in possibly larger vehicles will be required for cost-effective operation.

⁸ Several private Los Angeles taxi/shuttle companies are in various stages of deploying GPS.

Service Concepts

- Provide a check of accurate sign-in and zone operation by individual drivers.
- *Trip Dispatching to Vehicle Operator.* Most of the currently available systems are capable of automatic dispatching of trips to vehicles once assigned. The information transmitted to the mobile MDT can be fully customized to include a two-step offer/selection ("pitch and call") process for zone-based queuing systems. For unscheduled street boardings, the reverse process is not currently automated, but such enhanced capability is possible on a GPS/GIS base.
- *Analysis and Reporting.* Most of the existing technology has menu-driven and customized management reporting capability.

Organizational Structure/ Regulatory Issues. A review of the regulations impacting the service option included the City of Los Angeles (LADOT) and the California Public Utilities Commission (CPUC). We are in the process of confirming the following:

- CPUC is not involved if the service is provided solely within a single city. In this case it would be the City of Los Angeles. If there is any intercity service provided that does not use metered fares, CPUC would have regulatory authority. The key issue with CPUC regulatory authority is that it mandates an employer/employee organizational structure. This might impact the use of existing taxi permittees in the Smart Shuttle demonstration. Further, this presents a problem in the northeast Valley demonstration area where the City of Los Angeles surrounds the City of San Fernando. Any non-metered service to San Fernando under any circumstance might give CPUC regulatory authority according to interviews with several CPUC staff. However, operation as part of the regional public transit system will may make this issue moot.
- Operation of Smart Shuttle appears feasible under the existing City of Los Angeles "Public Transit Vehicle" designation (Municipal Code Section 7100). As noted above, at a 15-passenger level and above the current City code designates the vehicle as a Motor Bus, requiring operation of a fixed route and schedule. This would prevent operation of modified fixed route type services with larger vehicles, unless waived for the demonstration, something that LADOT staff have indicated is not likely to present a problem.

Service Concepts

Performance Expectations. A typical productivity expectation for general public demand responsive services operating in purely many-to-many mode is up to 7 passengers per service hour. Using larger vehicles in many-to-few or many-to-one mode, the system can generate higher service productivity, often in the range of 10-15 passengers per hour. Limited operating hours and constraints on destinations that can be reached directly tend to support higher productivity. Current operating costs range from \$18 per hour for taxi services under minimal regulatory requirements, up to the \$30-\$40 range for van-based paratransit services operated through service contracts with private providers. There is clearly a cost benefit in using existing taxi owner/operators and franchise organizations to deliver an appropriate portion of Smart Shuttle trips.

Key Smart Technology Applied. We are proposing the following Smart technology with the demand-responsive service option alternative:

- Scheduling and dispatching (required);
- GPS/GIS (required);
- Advanced communication systems (required); and
- Advanced fare payment systems (suggested).

Service Option Alternative: Modified Fixed Route

Service Overview. This service option alternative includes two variants on route deviation as described below:

- *Route deviation service* is fixed route service scheduled with extra recovery time (usually at terminal points) to accommodate mid-route deviations from the route as requested by passengers. After deviating from the route to make a pick-up or drop-off, vehicles return to the same point to continue the route without passing up any passengers waiting at designated stops. Passengers must call in to be picked up off

Service Concepts

route, but drop-offs are handled through on-vehicle requests. The route round trip running time must be expanded to include deviation time. As a result, the terminal recovery time expands and contracts based on the number of off-route deviations made per trip.

- *Point deviation routes (or check point deviation)* are semi-fixed with a relatively small number of designated time point bus stops⁹ where the service is scheduled to arrive and depart on a set schedule. No set alignment exists between these points (normally allowing for a faster operation than regular route deviation). Instead, vehicles operate in a curb-to-curb mode as required to serve passengers making advance/real-time requests for service. Passenger requests for pick-up are generally called in to a central dispatcher. Drop-offs are done as on-vehicle requests or through reservations. This is very similar to the successful San Diego "Direct Access to Regional Transit" (DART) service and the German FOCCS operation.

The implementation plan team will want to consider the following typical applications:

- Route or point deviation service *replaces fixed route service*, especially where the fixed route service is performing poorly and service access is a key deficiency. One application of this strategy would be coverage of low productivity route "tails" in the Northeast San Fernando Valley.
- Route or point deviation service may provide the local community-based service on a major corridor where it *supplements higher speed limited-stop fixed route service*. Potential applications include north-south corridors in West Valley like DeSoto, Canoga, or Topanga Canyon Boulevard or San Fernando Road or Glenoaks Boulevard in the Northeast Valley.

Service hours may range from all day to limited daily times depending on service application. Service frequencies can vary significantly, as well, depending on application. When operated by jitneys on major corridors, service frequencies are usually quite high, allowing customers to simply catch the next jitney and

⁹ Typically these will be set at the one-mile grid intervals to connect with the major cross-town bus lines.

Service Concepts

minimizing the impact of off-route operation. In many cities jitneys operate illegally as bandits with some success.

Vehicle Type Deployed. Larger 15-20 lift-equipped passenger vans are proposed to provide adequate capacity in order to maximize cost-effectiveness and minimize the need deploying additional capacity. The vehicle size was a key component in developing the successful German FOCCS service. Vehicles of this size may, however, compromise a Public Transportation Vehicle (PTV) designation from the City of Los Angeles due to the over 15-passenger vehicle seating, possibly requiring a waiver of the Motor Bus fixed route requirement (LADOT did not believe that such a waiver would present any problems for the demonstrations). In certain applications like "Intermodal Connection," small vehicles like automobiles and 3-4 passenger, lift-equipped mini-vans may be deployed by utilizing available taxi operators. Vehicle amenities should include comfortable seats, active and passive service advertising, and low floors/wheelchair ramps. Alternative fuels should be considered for contracted service since LADOT has established a successful track record with contractors. If the service will be contracted to an owner/operator group, the impact of this alternative fuel technology should be reconsidered.

Passenger Collection and Distribution. Route deviation service combines traditional posted and flag bus stop and curb-to-curb boardings and alightings to achieve effective passenger collection and distribution. Other aspects are quite similar to the discussion for demand-responsive service. For example, maximum

Service Concepts

response time for immediate service requests that involve route deviations should be 15 minutes or less where possible.¹⁰ Service frequency on the fixed route segments should be as high as can be justified by demand. Common operating problems such as no-shows and delays in passenger boardings should be minimized, with non-shows not more than 2-3 percent of total scheduled trips.

Scheduling and Dispatching. As noted earlier, it is clear that mature technology exists in the marketplace to support a Smart Shuttle system accepting both advance and real-time reservations. Acquisition of a scheduling package that incorporates the following features is recommended:

- *Order Taking.* Most existing software is capable of automatic client matching based on one or more variables, which can be easily changed. The client databases typically include recent trip-making origins and destinations (allows for instant repeat trip reservations) and payment information (may allow direct client billing). Other requirements are essentially the same as for the demand responsive service option.
- *Trip Assignment/Scheduling.* Depending on whether it is regular route deviation or point deviation service, this service option has some similarities to fixed route operations: operators pick up some customers at unscheduled regular bus stops and there is a timepoint on-time performance requirement for infrequent services. The dispatcher (can be the same one handling demand responsive duties) is responsible for identifying pick-up and drop-off locations, times, and vehicle assignment. Using a recommended GPS/GIS, trip assignment is a straight forward process based on the next available vehicle traveling in the right direction. Where infrequent service is being operated and a fixed schedule is guaranteed at timepoints, the process becomes two-step, but still manageable manually with an accurate GPS/GIS display and readout showing estimated arrival times at future timepoints.

¹⁰ As noted earlier, the German FOCCS operation was able to sustain response times in the range of 8 minutes. With frequent service this should be achievable in the demonstration areas.

Service Concepts

When and where vehicle capacity is no longer available on the next trip and the following trip will not meet the customer's needs, the demand responsive component (e.g., taxis) of the service should be used to serve the trip. This will allow for deployment of more cost-effective service capacity on the route/point deviation service option, knowing that additional capacity is available as needed. Periodic analysis of demand, capacity, and costs should be undertaken to ensure that the most cost-effective arrangement is in effect.

- *Trip Dispatching to Vehicle Operator.* Most of the currently available systems are capable of automatic dispatching of trips to vehicles via an MDT. This technology is currently working in the taxi environment, making it feasible for use by all vehicle operators.
- *Analysis and Reporting.* Most of the existing technology has built-in analysis and reporting if automated passenger counters are also installed. These will count all passenger boardings and alightings by exact location based on GPS/GIS¹¹ (meeting FTA Section 15 passenger mile counting requirements). With an active Smart communication capability, the APC system can provide real-time passenger boarding activity and on-board loads, enabling dynamic management of service capacity on heavy corridors (see Section 2 above).

Organizational Structure/ Regulatory Issues. As noted in the demand responsive service option, the CPUC is not involved, allowing an owner/operator option. At or below the 15-passenger vehicle size the service will fall into the Public Transit Vehicle (PTV) designation, eliminating the need for a waiver of the Motor Bus fixed schedule and route requirement.

Performance Expectations. An expected productivity range for modified fixed route service is 10 - 20 passengers per hour, depending on the productivity of the fixed route segments and the dimensions, density, and street network of the

¹¹ Currently the location subsystems for APCs are signpost-based. However, several firms are actively undertaking the changeover to GPS location systems. These systems should be available for operation in late 1995 or early 1996.

Service Concepts

service area. Operating costs should be higher than taxi rates in the range of \$25-\$40 per hour. There is clearly a cost benefit in attempting to utilize the owner/operator or franchise organization typical of jitney operations; this should be pursued.

Key Smart Technology Applied. We are proposing the following Smart technology with this service option alternative:

- Scheduling and dispatching (required);
- GPS/GIS (required);
- Advanced communication systems (required); and
- Fare payment systems (suggested).

Service Deployment Issues

There are service deployment issues that the implementation team may wish to consider in order to meet performance objectives. As the availability of operating funds continues to be limited in the MTA service area it will increase competition between and within modes and better financial performance will be required for continued funding. As a result, it will be incumbent that the implementation team take advantage of performance enhancing service design and policy opportunities. Based on meetings with vendors, discussions with service managers and operators, and previous experience of the project team the following suggestions are made:

- The length of the demand response trip needs to be limited in order to reduce unproductive deadhead time and mileage (empty return trips) and increase seat turnover and as a result increase revenue generation. There are several methods for restricting trip lengths, including:

Service Concepts

- Create small direct service zones with trips outside of the zone requiring a transfer in most cases.¹² For the Smart Shuttle this will require subdividing the demonstration areas into smaller zones. Trips out of the area can be focused at transit centers (e.g., Sylmar/San Fernando Metrolink Station, Chatsworth Metrolink Station, Warner Center Transit Center) and where riders can be transferred to regular fixed route¹³
- Fares can be structured to discourage longer trips on the Smart Shuttle. An out-of-zone fare surcharge (the zone refers to the previous comments) is one such example.
- As with demand responsive services, the control of the size of the direct travel service area (area where no transfer is required) is critical to developing good performance. As a result, the following strategies are suggested:
 - Operate modified fixed route services (route and point deviation) within defined corridors and minimize the amount of time or distance that a vehicle can deviate.
 - Develop individual point deviation services to include both traveler origins and destinations to allow customers to complete journeys without transfers. Further, the addition of scheduled locations that are not major activity centers will serve to increase operating time and cost without generating additional ridership and revenue. These locations should be included in the demand response area of the point deviation corridor.

Service Management and Organization Options

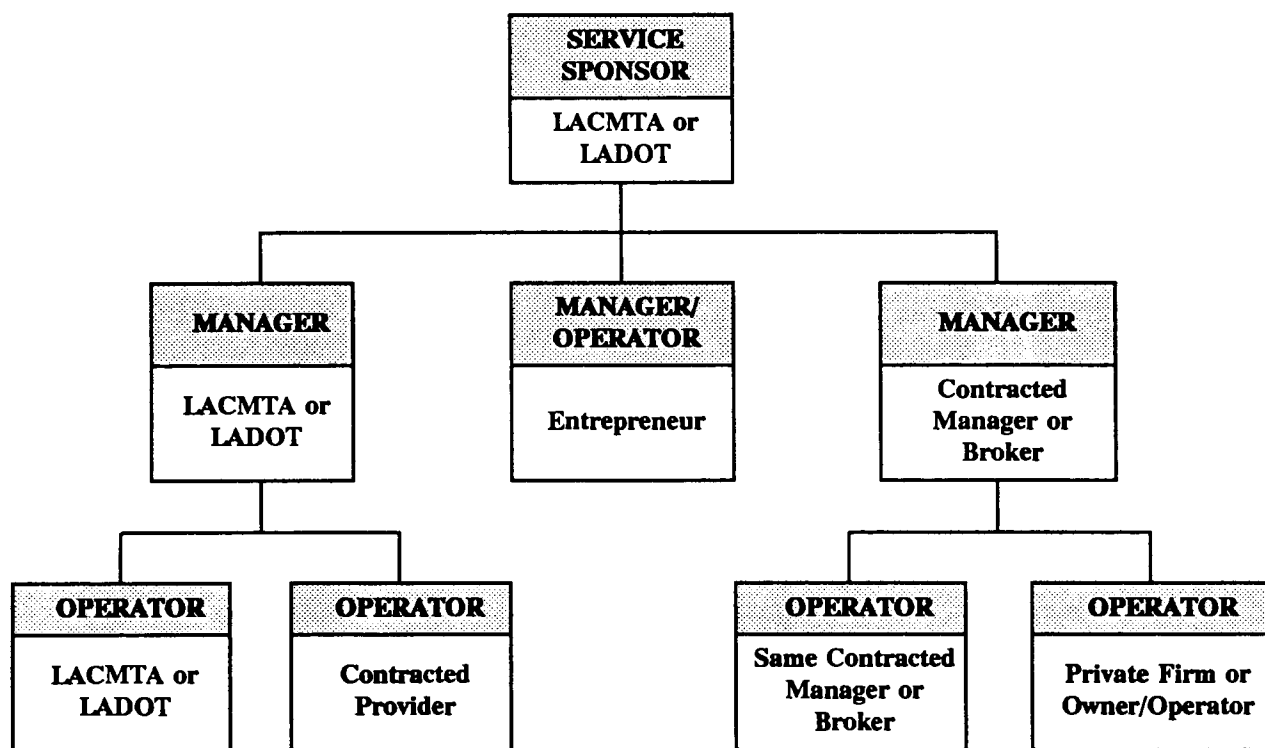
There are a variety of service management and organization options available to the implementation team for consideration on both a demonstration and full roll-out basis. The organizational structure contains three levels: sponsoring

¹² Exceptions can be made for large group trips or where there is significant bi-directional travel and larger vans are filled.

¹³ This transfer can also include those covered under ADA who can deal with a large bus lift/ramp or who are conditionally eligible for fixed route service.

agency, day-to-day service manager or broker, and actual service provider. Within this structure there are various choices among the participating transit agencies and private contractors as shown below in Figure 5.2.

**Figure 5.2
Service Management and Organization Options**



The Smart Shuttle "Service Manager" has been described as including the following daily responsibilities:

- Overall day-to-day program and service operator management;
- Interface with customers (i.e., reservations, information requests, complaints, billing);
- Service scheduling and dispatching to provider or directly to vehicles (decides who gets the trip);
- Data management and reporting;

Service Concepts

- Contracting with service operators (if not direct operation by service manager); and
- Technology support and maintenance, including service operator vehicle technology if installed for the Smart Shuttle.¹⁴

The service operator have responsibility for daily vehicle operation and maintenance, with trip dispatching in selected cases only. This will help maximize the opportunities for participation by a variety of existing service providers, including taxis and airport and other shuttle operators, as well as maintaining the possibility of community-based owner/operators.

There are several key service management and organization issues that will need consideration by the implementation team. These are discussed below:

- Consolidation of service management for all demonstration areas will minimize redundant overhead, while maximizing economies of scale in the use of staff and technology systems. This will also provide for easy diffusion of innovation learned during the course of the demonstration. At the same time this will possibly hamper the testing of a variety of service management options illustrated in the Figure 5.2 above.
- Should the trip dispatch function be consolidated at the service manager level or should individual providers still dispatch their own trips? There are several issues to consider:
 - If the service manager doing reservation intake does the dispatching then (1) they can immediately advise the customer as to trip ETA and provide updates from the GPS/GIS. This is likely to require MDTs in every vehicle and possibly separate communications capabilities in the vehicles for Smart Shuttle operation. One option would be to allow reservations, scheduling, and dispatching to be handled by an integrated service manager/provider, such as Super Shuttle or Prime Time.
 - There are service quality concerns if the dispatching is done by the service provider and control over the trip is lost by the service manager.

¹⁴ The recommendation is to install Mobile Data Terminals and GPS in each Smart Shuttle vehicle.

Service Concepts

In some service configurations this will not be a problem (e.g., where simple shared ride taxi is being tested in the demonstration area).

- Operating and capital costs will vary depending on (1) the need to install MDTs and GPS in each vehicle and (2) the potential cost-effectiveness impacts (e.g., reduced wait times).

Based on the above discussion, the following service operation scenarios be considered by the implementation team:

- *Entrepreneur* - this scenario calls for integration of the manager/operator in one private firm providing a one or more of the different service concepts¹⁵. In this scenario the service concept choices would be developed by the entrepreneur based on market and operating conditions. We suggest also allowing the firm to set fares within guidelines presented in their proposal. Restrictions on service provision should limit "cruising" of fixed route corridors to simply divert riders. The interface with the fixed route network should happen at key nodes (e.g., transit centers, rail stations, major transfer points, and major activity centers). The entrepreneur could execute contracts with local businesses, TMAs, or other groups/associations to provide special shared ride transit services (e.g., grocery stores could contract for regular point deviation services). Super Shuttle and Prime Time would be typical candidate entrepreneurs. Revenue guarantees or technology transfers may be required as an incentive to secure participation.
- *Private service manager/broker with separate private operator(s)* - this scenario is similar to the current broker/service provider structure in ADA demand responsive services. However, there are four significant differences in this Smart Shuttle scenario from the current ADA model:
 - The principal geographic focus of the demonstration is community and neighborhood based, as opposed to a more region-wide approach with ADA;
 - Service performance and the ability to generate competitive subsidies per passenger with other modes are critical to this Smart Shuttle scenario;

¹⁵ Only one entrepreneur is recommended for a demonstration area in order to provide adequate market incentives to the firm.

Service Concepts

- The service manager will need to be an aggressive marketer and seek out and develop new niche markets for the services;
- The potential service providers include (a) community-based owner/operators with the sponsoring agency providing the vehicles (likely as leases) and other key operating needs, (b) local and out-of-area taxis; and (c) local shuttle and demand response operators.
- Smart technology will be introduced.
- *Grow an existing demonstration area service* - take an existing service in the demonstration area like the Nickerson Gardens shuttle in South Central or the 12th Council District shared ride taxi (i.e., Chatsworth, Northridge, and Canoga Park) and expand it to cover more of the demonstration areas shuttle needs, along with the introduction of Smart technology. The existing provider selected should have solid operations management and extensive community outreach in order to effectively support the service growth and introduce the new technology.

These service manager/operator scenarios along with the service concept choices will need to be considered by the implementation team in identifying the optimal choice for each demonstration area.

Passenger Fares and Media Options

Determining the most appropriate fare media and structure for the Smart Shuttle service is a difficult decision. Such a decision will impact the potential success of the service and the ability of the Smart Shuttle service to truly achieve its stated goal of providing effective and efficient mobility options for the residents of the City of Los Angeles. Previously conducted public transit issue market research in the demonstration areas (e.g., South Central and the San Fernando Valley), has indicated the need for a clear set of fare policies and media opportunities that encourage Smart Shuttle use in itself and as a component of

Service Concepts

the regional transit network. At the same time, it will be important to control revenue collection and verify Smart Shuttle use due the complexity of recording and reconciling the revenue accounts of the various Smart Shuttle service providers.

Fare Media. We are suggesting consideration of a system similar to that operated by many current taxi companies/groups that is integrated with the Mobile Data Terminal (MDT). A wide range of media can be accepted, including Smart, mag-stripe, and credit cards as well as traditional transit media (e.g., vouchers, punch cards). At the same time we are also proposing that testing of RFID (Radio Frequency ID) cards be considered. Both mag-stripe (magnetic stripe) cards and read & write RFID cards have the ability to serve as an identification card for those eligible to use Smart Shuttle services and both media can be used to 'bill' eligible clients or organizations. These card technologies have been used successfully in several transit systems, including Santa Fe, Los Angeles COMMUTER Express, and WMATA Access. The ability to track trip-making of individuals using these cards will provide will help the Smart Shuttle demonstration evaluators to better document travel behavior and identify actual customer response to different service and fare media options.

There are multiple suppliers of magnetic stripe cards for transit use (e.g., Rand McNally, Mentor Engineering, Digital Printing Systems). The mag-stripe can contain a significant amount of user information such as the bearer's Social

Service Concepts

Security number or program ID, the amount of value remaining on the card, or the bearer billing address. The mag-stripe card specifications would be as follows:

- Width - 2.125 inches
- Length - 3.375 inches
- Corner Radius - 0.125 inch
- Thickness - 0.010 inch

The magnetic stripe should be 0.375 inch wide with the encoding characteristics for determining a cash value and a type of service or zone. This means the fare media for Smart Shuttle can have a designated value or be applicable only for travel in a zone.

A Smart Shuttle RFID fare card would have similar dimensions, but would contain read and write capabilities. The RFID can contain a value and also an identification number or other type of verification system. A RFID card would cost about \$3 to \$4 to produce, yet reduce the amount of potential user fraud. Readers for the RFID card would cost approximately \$200 to \$300 for each van or taxi. There are multiple manufacturers of RFID cards, as the cards contain simple microchips which record and store small amounts of data. Echelon, Agent Systems and AMTECH are all current producers of RFID cards.

Of the two options presented here, the RFID card offers much more security than the mag stripe card and has the added ability to provide a secure audit trail. For these reasons, we would recommend the RFID card. Further, the RFID card has advantages to the Smart Shuttle user in that value can be added on-board Smart Shuttle vehicles or at one of the retail sales outlets in the demonstration area. Unlike mag stripe cards, which have a failure rate of 5 to 10 percent, RFID

Service Concepts

cards have failure rates below 3 percent. The actual construction of the RFID card also makes it preferable to the mag stripe card, in that the RFID card is constructed of durable plastic with a useful life similar to credit cards. As a result, the card can be used repeatedly by Smart Shuttle users; the RFID card can be recycled through several users over time improving the production cost economies. In addition, the RFID card also has better potential than the mag-stripe for rail and fixed route bus service due to its low failure rate and its fast registration time, reducing boarding time over conventional media, including cash. The reduced boarding time potentially could result in reduced resource requirements in fixed route operations, as well as route and point deviation services.

Regional Fare Media Acceptance. It will be necessary for Smart Shuttle to offer users 'seamless' transfers to other regional services. For the purpose of the demonstration, transfer handling is proposed per the following:

- Regional providers will honor the RFID card as a 'flash pass'. In the longer term, some version of the RFID card might be integrated into the regional fare collection system; trains, buses, vans and taxis could be equipped with the readers.
- Fixed route 'flash passes' would be honored on Smart Shuttles for their base value (e.g., a full fare local pass would be good for \$1.35).
- Transfers will be sold for 25¢ on buses (10¢ for seniors and disabled riders) and will have a value of the basic fare for the originating route (up to \$1.35) that can be used toward the Smart Shuttle fare.
- Transfers to fixed route services from Smart Shuttle will be issued as on the fixed route bus modes; 25¢ for regular cash customers and 10¢ for seniors and disabled riders.

Service Concepts

The seamless transfer should include all MTA, LADOT, and Metrolink services in the demonstration areas.

Program Controls. The primary means of program control must come from the collection and distribution of the fare media. The RFID card affords the opportunity to control use and verify each trip. Cards can be verified when entered into the reader. Those cards that are no longer valid or have been misused, can be confiscated by the driver. The RFID card reader can also be used as a means of trip verification, as the reader can verify and store trips taken. The reader can be 'dumped' at the end of the service day or data can be sent during regular communication 'polling' of the MDT.

In the existing CITYRIDE and METRO ACCESS programs, the fraudulent use of program services takes place on the street with the driver of the service vehicle and/or conspiring riders. The introduction of the RFID card will minimize use of other media, including vouchers, flash passes, and other forms of scrip which can be duplicated or misused. The RFID technology incorporates the objective verification of the reader into the process, thereby eliminating or reducing the potential for fraud.

Readers will also have write capabilities, so drivers can add value on board vans or taxis. In addition to on-board the vehicle sales, a distribution network of retail sales outlets must also be established in the demonstration areas to offer potential users the convenience of buying the fare media where they shop or work. Control on these outside sales are handled by the RFID card encoding

Service Concepts

machines which will be handed over to participating sales outlets. These machines are very similar to those used by lottery agents in that they produce a card and store data on the cards produced. None have the accompanying software to incorporate the retail transaction (sale), but that effort could be incorporated by manual audit records.

It must be noted that a significant number of riders in the targeted demonstration areas have household incomes less than \$18,000, so many will likely choose to use cash for their fare payment even with an aggressive promotion of media card payment. For non-media card fare payment, the operator's record of each boarding via MDT including fare type will provide a necessary audit trail. The vehicle operators should also understand the capabilities of the GPS/GIS to document their daily activities.

Pricing. The successful jitney-style service that operates in the United States in the boroughs of New York or the suburbs of Miami, charge fares that are markedly below those charged by the regional transit agency. In New York, jitneys charge \$1.00 compared with regular MTA fares of \$1.25. In Miami, jitney fares are from 75¢ to \$1.50 based on distance traveled, but these fares are still below those charged by Miami's METRO system. A jitney service operated for less than a year in Los Angeles in 1982. Proposition A reduced MTA (then-

Service Concepts

SCRTD) bus fares below levels at which the jitneys were economically viable¹⁶, resulting in their demise.

The recent increase in MTA fares will likely result in a significant diversion of transit riders to other lower cost travel options. While low fares would attract ridership, it is the objective of the Smart Shuttle project to demonstrate that such service is economically viable. Thus fares will have to be both attractive to customers and generate sufficient revenue to meet performance objectives. In relation to other transit mode choices, Smart Shuttle fares should likely be priced between regular fixed route services and exclusive-ride taxis.¹⁷ In developing the actual tariff structure, we also suggest consideration of discounts when several persons make the same trip.

The travel needs of residents of Los Angeles are changing daily with the immigration to the City of many ethnic groups which have formed virtual 'City States' in areas such as South Central and certain areas of the San Fernando Valley. These 'self-contained' communities provide work, shopping, medical care, educational, and personal business opportunities for their residents within the boundaries of the community. In particular, the best potential market niches for the Smart Shuttle service may be those who cannot use the CITYRIDE or

¹⁶ The bus fares were lowered to 50¢, a level below the approximate 75¢ break-even point for the jitneys.

¹⁷ A future option for which we have not identified active technological development is metered fares for shared ride travel. With the advent of GPS/GIS, a system tracking individual traveler mileage (the minimum mileage independent of actual vehicle travel) may be feasible for future testing.

Service Concepts

METRO ACCESS services or those who find regular fixed route service to be inconvenient. These market niches include:

- Senior Citizens Not Eligible For CITYRIDE or METRO ACCESS;
- Ethnic Women Aged 50 and up; and
- Students Not Served By Yellow School Bus Services.

Such niche markets will respond to competitively priced service. As noted above, Smart Shuttle service priced between exclusive-ride taxi and regular fixed route service fares, will likely develop distinct market niches for its services.

6. Implementation Plan

Implementation Plan

This section presents a summary of the implementation plan for a Smart Shuttle system. This plan should be used by the implementation team as a guide in developing specific plans for each of the three demonstration areas. It includes the following elements:

- Assumptions/System Description
- Budget Estimate
- Funding Sources
- Procurement Plan
- Implementation Schedule

ASSUMPTIONS/SYSTEM DESCRIPTION

The implementation plan is based on several assumptions that address service management and operation institutional issues, service option choices, and technology introduction. These are presented below with accompanying detail provided to allow for easy modification should different assumptions be chosen.

This implementation plan and budget estimate assumes that service management for all demonstration areas will be consolidated in one control center. It also assumes that all vehicles will be purchased and outfitted with standardized technology chosen specifically for the Smart Shuttle operation.

Service Options

Previous sections have presented two basic service option groups for consideration as Smart Shuttles: *Demand Responsive and Route Deviation*. Any decisions regarding choice of service option or the volume of service to be provided will be made following the completion of the market analysis. For our

Implementation Plan

purposes here we have selected a service option scenario that includes both service option groups and anticipates a greater volume of demand responsive service than route deviation.

Recommended Technology

Previous sections have detailed the potential Smart technology applications. The following Smart technology elements have been identified as essential for Smart Shuttle operation and are included in the preliminary implementation plan and budget:

- Communications -- Digital Radio and Mobile Data Terminal [MDT] with Magstrip Reader;
- Automated Vehicle Location [AVL] -- AVL Utilizing Global Positioning Satellite technology; and
- Scheduling and Dispatching -- system with automated reservations and dispatching capabilities; scheduling component may be computer-aided or fully automatic.

Future Technology Enhancements

Fare collection technology enhancement are deemed desirable, but not essential, to the demonstration. This technology includes deployment of various Smart fare media with billing capabilities. Automated passenger counting and vehicle monitoring technology was not found to be significantly important for the Smart Shuttle demonstration.

Other technologies that would be beneficial to a full rollout of the Smart Shuttle system include: traveler information system; integrated trip reservation, scheduling and dispatching; multimodal smart cards; and integrated billing systems.

Implementation Plan

BUDGET ESTIMATES

The estimated budgets for implementation of the recommended Smart Shuttle system were developed based on discussions with vendors as well as through literature review. In addition, historical cost data for similar systems were reviewed for informational purposes only, *since technology costs have significantly decreased over the past few years*. Detailed cost information for each technology is provided in tabular form below and on the following pages.

**Table 6.1
Control Center**

<u>Item</u>	<u>Cost/Unit</u>
File server	\$ 8,000
Dispatcher workstations	\$ 3,500
Reservation workstations	\$ 1,600
Computer peripherals	\$ 6,000
Scheduling and dispatching software	\$60,000
Voice radio equipment	\$ 6,000
Office furniture	\$ 4,000
Lease communication channel (per year)	\$150,000

Note: These costs are for one center.

Implementation Plan

Table 6.2
Vehicle Equipment (50 vehicles)

ITEM		COST PER UNIT
1. Vehicles	Taxis (30)	\$20,000
	Vans (20)	\$50,000
2. GPS Transmitter		\$ 700
3. Logic Unit		\$1,500
4. MDT		\$700
5. Radio		\$1,100
6. Signs		\$ 100

Note: Average cost per unit is \$36,100.

Table 6.3
Overhead Cost

ITEM		COST PER UNIT/YR
1. Office Labor	Program Manager (1)	\$100,000
	Dispatcher (4)	\$40,000
	Clerks (20)	\$20,000
2. Rent and Supplies		\$24,000
3. Center Hardware Maintenance		\$35,000

Implementation Plan

FUNDING SOURCES AND STRATEGIES

Ultimately, the success of the proposed project will depend on its implementation and the ability to obtain funds from various sources. There are numerous sources of funding for this type of work.

The key issue in the implementation plan is flexibility. The implementation plan must be able to take advantage of funding opportunities with a flexible approach to implementation. The projects must reflect the emphasis of the source that is being tapped while fitting into the implementation plan.

Another key issue is that of inter-agency cooperation. A commitment from the MTA, SCAG and the City to cooperate with each other as well as with interest groups within the city will foster access to funding sources. Relationships must be established with Caltrans and FHWA. Partnerships with the private sector can generate additional interest. These cooperative efforts will, in turn, generate support for funding requests for this project.

There are a large number of funding sources, some of which provide better chances of obtaining support than others. Funds generated from non-City sources such as FHWA, Caltrans or MTA require the submission of applications that justify the proposed project and identify the amount of money being requested. These projects generally receive more attention if they offer a cooperative learning effort or strive to obtain a goal of the funding organization. The following is a summary of potential funding sources available for this program.

Implementation Plan

Federal Funds: ISTEA Funds

The 1991 ISTEA bill passed by Congress has a number of programs that are potential funding sources for APTS projects. This bill authorizes \$151 billion in funding over six years. Programs that could potentially fund the Smart Shuttle project include:

- Intelligent Transportation Systems (ITS): These funds are available to directly fund ITS planning and implementation including local agency APTS. This funding is particularly oriented towards projects involving transportation corridors. A total of \$166 million is available to State and local governments.
- ITS Operational Test Program: Another element of the federal ISTEA legislation is the Intelligent Vehicle Highway Systems Act, which provided for operational test of ITS technology. The ITS program consists of a range of advanced technologies and system concepts which, in combination, can improve mobility and transportation productivity, enhance capacity and safety, maximize the use of existing transportation facilities, conserve energy resources and reduce adverse environmental effects. The aim of the national ITS program is to deploy advanced technologies to help solve transportation problems and improve safety. An operational test integrates existing technology, research and development (R&D) products, institutional and perhaps regulatory arrangements to test one, and usually more, new technological, institutional or financial elements in a real-world test bed. Operational tests are conducted in an operational environment under "live" transportation conditions.

ITS operational tests are conducted as cooperative ventures between the USDOT and a variety of public and private partners, including State and local governments, private companies, universities and possibly others.

There are two categories of funds for operational tests: the Corridors Program and tests at additional sites not part of the Corridors Program. The four currently identified priority corridors are:

Implementation Plan

- A Northeast corridor along Interstate 95
- A Midwest corridor
- Houston, Texas
- Southern California (including Los Angeles, Orange and San Diego counties)

The Corridors Program is authorized at \$71 million in fiscal year 1992 and \$86 million per fiscal years 1993 through 1997, for a total of \$501 million over six years. The ISTEA states that at least 50% of the funds for the Corridors Program must be spent in the designated priority corridors. The remaining funds will be spent in the other corridors.

Each year, a portion of the authorized Corridors Program funding will be used to support previously approved, ongoing projects within the corridor sites. The amount of these funding commitments will vary from year to year. It is expected that approximately \$40 to \$60 million per fiscal year will be available to fund new operational test projects at the designated priority and other corridor sites.

In addition to the Corridors Program, the "Other IVHS Activities" category in the ISTEA is authorized at \$23 million for year 1992 and \$27 million per fiscal year for 1993 through 1997. Approximately \$10 million per fiscal year will be available from this category of funds to support additional operations tests at sites not designated for the Corridors Program.

By statute, the federal government's contribution to an operational test cannot exceed 80%. The remaining 20% must consist of cash, substantial equipment contributions or personnel services. Locally, Caltrans is interested in participating in the operational test program and has issued notices soliciting partners for proposals in the past. These proposals must be for projects in one of five areas, with one area being APTS.

- ITS Innovations Deserving Exploratory Analysis (IDEA): The ITS-IDEA program, funded by the Federal Highway Administration (FHWA) and the National Highway Traffic Safety Administration (NHTSA) of the U.S. DOT, is managed by the Transportation Research Board (TRB). The program is designed to produce new concepts and innovative products that would accelerate the development and implementation of ITS in the nation's highways, vehicles and inter-modal surface transportation and transit systems. The ITS-IDEA Program is not limited to innovations to produce hardware for ITS, but will include

Implementation Plan

concepts, methods, techniques, processes and systems that have potential to produce significant improvements for ITS, increase the public acceptance and use of ITS products and services and reduce potential institutional problems associated with ITS application.

Proposals can be submitted for either concept feasibility projects of applied testing and evaluation projects. ITS-IDEA proposals may be submitted anytime during the year. IDEA awards for concept feasibility projects will not exceed \$100,000 and must be completed within approximately 12 months. Awards for applied testing and evaluation projects may exceed \$100,000, but may not exceed \$250,000 based on specific tasks needed to perform the project. Examples of the types of innovations envisioned in the Department of Transportation's IVHS Strategic Plan include:

- Traffic management systems that monitor current conditions and adjust lane usage, speed limits, traffic signals and roadway ramp access;
 - Devices that permit the electronic collection of tolls, transit fares and other transportation user fees; and
 - Information, available from numerous sources (home TV, radio, personal computers at home and at work, public kiosks, handheld devices and others), that advises travelers and drivers about current and expected traffic conditions as well as transit locations and timetables, allowing them to make informed choices about destinations, when to leave, how to travel and what route to take.
- Technology Reinvestment Project (TRP): Eight (8) separate statutory programs, including the Advanced Research Projects Agency (ARPA) of the Department of Defense and the Department of Commerce's National Institute of Standards and Technology (NIST), are collaborating in the Technology Reinvestment Project to execute the programs authorized under the Defense Conversion, Reinvestment and Transition Assistance Act of Fiscal year 1993 and other legislation. Title IV of the 1993 Defense Appropriations Act provides funding for TRP activities, which includes \$91 million for year 1995 for the Regional Technology Alliances Assistance Program. This program could be used for either technology development or technology deployment activities, which could fit very well with Smart Shuttle systems applications in the Los Angeles region.

Implementation Plan

Mitigation Fees

Agencies in Los Angeles County may wish to supplement currently identified Funding Sources through various Development Contributions. This may include the provision of Smart Shuttle buses as mitigation to proposed development and/or the inclusion of Smart Shuttle in local Traffic Impact Fee programs.

Local Motor Vehicle Registration Fees

Funds accumulated from vehicle registration fees collected in the Air Quality Basins will be distributed by the Air Quality Management District (AQMD). According to legislation, any local project with a direct improvement on air quality may compete for these revenues. With a direct relationship between air quality improvements and increased ridesharing, Smart Shuttle should qualify for these funds.

PROCUREMENT STRATEGY FOR TECHNOLOGY

There are three potential approaches that need to be considered in formulating a procurement strategy for this project: the engineering-contractor approach; the program-manager approach; and the design-build-operate approach. Although the first approach fits the institutional model, guarantees the low bid, and is easily managed, it has some disadvantages that constitute fatal flaws. The engineer-contractor approach takes longer to deploy because tasks are carried out sequentially, sometimes with long gaps of inactivity. During those gaps in time,

Implementation Plan

specifications for equipment may become obsolete. The contract may also be the wrong type; the selection of the prime contractor is particularly important, for instance, because that organization will solicit the component parts, and it must consider the quality and maintainability of those components.

The program-manager approach uses a single person -- whether a staff member or a consultant -- who is selected on the basis of technical qualifications and who serves as the point of control. This approach avoids the low-bid mentality and the problems associated with choosing the wrong prime contractor. The contract would be a cost-plus-fixed fee contract, which is easier to modify and may reduce costs because procurements are broken up into appropriate packages. The program-manager approach would require reduced public-agency staff, and it should offer faster deployment because the program manager can use alternate procurement techniques. This approach is also somewhat consistent with institutional practice.

The design-build-operate approach deviates further from the classic approach in the transportation industry, but is not unusual in such other government arenas as the Department of Defense (DOD). This approach should significantly reduce delivery time, reduce demands on the public agency, and reduce costs through procurement efficiency. Again, selection of the designer, builder and operator should be on the basis of qualifications. The design-build-operate approach has some disadvantages, primarily institutional, such as the task of convincing those

Implementation Plan

involved that it is a reasonable approach and does not preclude the traditional bid procedures.

**Figure 6.4
Implementation Schedule**

	Start Date	End Date
1. Funding Application	Feb.'95	Mar.'95
2. MTA Approval	Apr.'95	Jun.'95
3. Select Consultant/Vendor	Jun.'95	Sep.'95
4. System Implementation	Sep.'95	Jan.'96
5. Demonstration Operation	Jan.'96	Jan.'98
6. Demonstration Evaluation	Jan.'96	Jan.'98

Appendix A: Historical Cost Data

APPENDIX A

Historical Cost Data

The following table provides cost comparisons between the Baltimore and Denver AVL systems. Both systems included GPS and radio/communications upgrade. The Baltimore system also included automatic passenger counting devices.

Feature	Baltimore (235 Buses)		Denver (650 Buses)	
	\$ per Bus	Total Cost	\$ per Bus	Total Cost
Communications System	\$10,320	\$2,424,285	\$11,350	\$6,811,350
Location System (GPS)	\$10,500	\$2,468,425	\$1,700	\$1,019,300
Central Processing Station	\$11,820	\$2,777,750	\$3,140	\$1,885,845
Software, Training, Misc.	\$1,080	\$255,305	\$480	\$287,500
TOTAL	\$33,720	\$7,925,765	\$16,670	\$10,003,995

**Table A1
Demand Response System Characteristics**

System	Service Description	Days/Hours Of Operation	Advance Reservations	Private Contractor	Fixed Route Svcs during Peak	Demand Response During Off-Peak
San Diego DART*	General public Dial-A-Ride	Monday-Friday 5:30 am-8:00 pm Sat, 6:00 am-6:00 pm Sat for Mid City only	One hour Advance Standing Reservation Accepted Riders transferring to bus have priority	Yes	No	Yes
El Cajon Dial-A-Ride	General public Dial-A-Ride	Monday-Friday 6:00 am-7:00 pm Sat., Sun. 6:00 am-6:00 pm	24 Hour Advance Reservation One Hour Advance, as schedule permits	Yes	No	Yes Plans for regularly scheduled shopping trips during off-peak
La Mesa Dial-A-Ride	General public Dial-A-Ride	Monday-Friday 6:00 am-11:00 pm Sat., Sun. 6:00 am-11:00 pm	No Advance Reservation Required Standing Reservation Accepted, Have priority over demand response service	Yes	No	Yes
Seattle Metro DART	General public Dial-A-Ride	Monday-Friday 5:30am-10:30pm Saturday 9:00am-11:00pm Sunday 9:00am-7:00pm	2 hour advance notice in selected areas In general, 24hr notice, actual practice 1 wk due to demand	Yes	No	Yes
St Louis DAR (Bi-State)	General Public in outer county. ADA Paratransit w/in City & Inner Co.	Monday-Friday 6:00am-10:00pm Saturday 8:00am-5:00pm Sunday 9:00am-4:00pm ADA Expansion planned	Yes May reserve 1 to 7 days in advance	No	No	Yes
Dallas DARTabout	General Public DAR	Monday-Saturday 5:00am-10:00pm	Yes 2 Days	Yes	No	Yes
Santa Clara Dial-A-Ride	General Public in Gilroy, San Martin, & Morgan Hill	Monday-Friday 5:00am-7:00pm Sat/Sun 9:00am-5:00pm	Yes 24 hrs.	No	Yes	Yes

* Summarizes data for five communities; Mid City, Paradise Hills, Scripps Ranch, Rancho Bernardo, and Mira Mesa

**Table A2
Demand Response Service Area Characteristics**

System	Service Area population (1)	Population Density per sq. mi. (2)	Connections to Regional Fixed Route Service	Regional Transfer Facilities	Is DART the ONLY local service	Is there fixed route shuttle service
Paradise Hills DART	68,039	9,489	3 SDTC* Routes 3 NCT* Routes 2 CVT* Routes	Enhanced Bus Stops (Benches, Shelters)	No	No
Mid City DART	132,632	10,509	8 SDTC* Routes	same as above	No	No
Mira Mesa DART	60,516	3,654	4 SDTC* Routes	same as above	No	No
Scripps Ranch DART	16,831	2,534	4 SDTC* Routes	same as above	No	No
Rancho Bernardo DART	35,688	3,438	2 SDTC* Routes 2 SDCTS* Routes	same as above	No	No
El Cajon Dial-A-Ride	92,241	6,450	Trolley Service 2 SDTC* Routes 9 SDCTS* Routes	Trolley Transfer Benches or Shelters. Transit Center with Full amenities	No	No
La Mesa Dial-A-Ride	52,400	5,822	Trolley Service 4 SDTC* Routes 1 SDCTS* Route	Trolley Transfer Benches, Shelters, other amenities	No	Yes
Seattle Metro DART	70,000	3,889	Yes	No	Depends on particular area	Limited shuttles in Lake Sammamish Plateau
St. Louis DAR (Bi-State)	Data not readily available	Data not readily available	Yes	Various Transit Center & Enhanced Bus Stops (Benches, Shelters)	No, limited fixed route regional service	No
Dallas DARTabout	352,114 * only persons dwelling 1.5 < mi from Fxd Rte eligible	2,700	Yes	Transit Centers with Full amenities	No	Yes
Santa Clara DAR	58,363 * only persons dwelling .25 < mi from Fxd Rte eligible	2,653	Yes	Yes Transit Ctrs, Benches	Yes	Yes During peak hours, system converts entirely to fixed route

Table A3
Demand Response System Operating Data Comparisons

System	Annual Ridership	Revenue Miles	Revenue Hours	Annual Op. Costs	Fare Revenues	Subsidy Requirement	Cost/ Hour	Cost/ Mile	Subsidy/ Pass	Pass/ Hour	Pass/ Mile
Paradise Hills DART*	124,219	296,315	20,991	\$343,490	\$93,348	\$250,142	\$16.36	\$1.16	\$2.01	5.9	0.42
Mid City DART*	109,894	204,927	18,101	\$333,835	\$81,974	\$251,861	\$18.44	\$1.63	\$2.29	6.1	0.54
Mira Mesa DART*	119,088	229,641	18,084	\$321,050	\$89,966	\$231,084	\$17.75	\$1.40	\$1.94	6.6	0.52
Scripps Ranch DART*	33,559	85,723	7,358	\$110,114	\$26,798	\$83,316	\$14.97	\$1.28	\$2.48	4.6	0.39
Rancho Bernardo DART*	21,506	53,006	3,734	\$82,229	\$16,977	\$65,252	\$22.02	\$1.55	\$3.03	5.8	0.41
El Cajon Dial-A-Ride*	23,000	92,000	7,500	\$271,700	\$45,000	\$226,700	\$36.23	\$2.95	\$9.86	3.1	0.25
La Mesa Dial-A-Ride*	52,400	105,320	7,520	\$421,476	\$68,060	\$353,416	\$56.05	\$4.00	\$6.74	7.0	0.50
Seattle DART*	64,800	150,000	14,400	\$400,000	\$19,500	\$380,500	\$27.78	\$2.67	\$5.87	4.5	0.43
St Louis DAR (Bi-State) FY 91/92	262,000	1,700,000	94,000	N/A	N/A	N/A	N/A	N/A	N/A	2.8	0.15
Dallas DART About	81,850	446,500	49,300	N/A	N/A	N/A	N/A	N/A	N/A	1.7	0.18
Santa Clara DAR	40,000	N/A	15,550	\$900,000	N/A	N/A	\$57.88	N/A	N/A	2.6	N/A

* FY 1992/93 year end estimates based on six-month actuals.

**Table A4
Demand Response System Fares and Transfers**

System	DART Fare Structure	Separate DART Passes Available (Y/N) List	Fixed Route Passes Accepted on DART	DART Transfers to Fixed Route? (Y/N), Cost?	Transfers Between Fixed Routes? (Y/N), Cost?
Paradise Hills DART	Adult \$1.75 E/D* \$0.60 >5 Yrs \$0.60 Return Trip Fare \$0.25 with transfer With Ready Pass and NOT connecting to regional bus, ADD Adult \$1.00 E/D* \$0.50 >5 Yrs \$0.50	No – May Use Regional Transit (RT) Pass	Yes – RT Pass	Yes – DART Ride includes free transfer to bus	Yes
Mid City DART	same as above, except: Adult \$1.50	No – RT Pass	Yes – RT Pass	Yes – DART Ride includes free transfer to bus	Yes
Mira Mesa DART	same as Paradise Hills	No – RT Pass	Yes – RT Pass	Yes – DART Ride includes free transfer to bus and Scripps Ranch DART	Yes
Scripps Ranch DART	same as Paradise Hills	No – RT Pass	No – RT Pass	Yes – DART Ride includes free transfer to bus and Mira Mesa DART	Yes
Rancho Bernardo DART	same as Paradise Hills	No – RT Pass	Yes – RT Pass	Yes – DART Ride includes free transfer to bus	Yes
El Cajon Dial-A-Ride	One-Way \$1.25 >6 Yrs Free	No	No	Yes, Credit for fare Paid	Yes
La Mesa Dial-A-Ride	Adult \$1.50 E/D* \$1.00	No	No	Yes, Credit for Fare Paid	Yes
Seattle METRO DART	Same as Fixed Route Peak: \$1.10; Off-Peak \$0.85 Sr: \$0.25 ; Student: \$0.75	No	Yes	Yes, Free Valid for 2 hrs	Yes, Free Valid for 2 hrs
St Louis DAR (Bi-State)	Adult \$3.00 per zone E/D* \$2.00 per zone ea zone @ 100 mi sq.	No	Yes + cash upgrade	Yes, Free	Yes, \$.20
Dallas DARTabout	Adult: \$1.75 Student: \$1.00 E/D*: \$.75	Yes \$54.00 unlimited \$17.50 11 Trip Card	Yes	Yes, Free	Yes, cash equivalent to \$1.75
Santa Clara Dial-A-Ride	Adult: \$1.00 Student: \$.50 E/D*: \$.25	No	Adult: \$30.00 Student: \$15.00 E/D*: \$5.00	No	No

**Table A5
Demand Response System Ridership Patterns**

System	Total Ridership	Avg. Wkdy Ridership	Local DART Transfers Within Sys Area	Demand Peaking Pattern	Transfer Trips (To/From Fxd Route)	Percent Transfer Trips
Paradise Hills DART	124,219	555	No	Some commute peaking		
Mid City DART	109,894	433	No	Some commute peaking		
Mira Mesa DART	119,088	494	Yes, Between Mira Mesa & Scripps Ranch DART	Balanced		
Scripps Ranch DART	33,559	165	Yes, Between Mira Mesa & Scripps Ranch DART	Commute peaking		
Rancho Bernardo DART	21,506	77	No	N/R	N/R	N/R
El Cajon Dial-A-Ride	23,000	85	800	N/R	N/R	N/R
La Mesa Dial-A-Ride	52,400	158		N/R	1,986	3.8%
Seattle Metro DART	64,800	230	N/R	Marked AM and PM Commute Peaks	N/R	N/R
St Louis DAR (Bi-State)	263,000 @ 80% E/D Ridership	1,200	100/day	AM, PM Commute Peak 11:00 Midday Peak	N/R	N/R
Dallas DARTabout	81,850	N/R	Yes	Mostly Commute Peaks	N/R	N/R
Santa Clara Dial-A-Ride		100	N/R	Mostly Commute Peaks	N/R	N/R

**Table A6
Demand Response System Evaluation Criteria**

System	Year Service Initiated	Standards for Continuing Service or convert to fxd rte?	DART Performance Standards? (Y/N)	Performance Indicators (Standards)	Same Standards as Fxd Rte?
San Diego DART*	1982	No	No	- pax/mi - subsidy/pax - farebox recov. - cost/mi	No
El Cajon Dial-A-Ride	1992 - Previously operated as subsidized taxi service	No intention of converting DAR into Fixed Route service	Yes		No
La Mesa Dial-A-Ride	1992 - Previously operated as subsidized taxi service	No intention of converting DAR into Fixed Route service	Floating Standards	- cost/pax,mi,hr** - pax/hr,mi - farebox recov. - % transfer/brdngs. - labor productivity measurements	No
Seattle Metro DART	Initiated 1985 Expanded 1993	Floating Standards	Floating Standards	- pax/hr - public perception - cost of service - new riders vs. transfer of riders from existing service	No
St Louis DAR (BI-State)	Demonstration 1985 - 1987 Expanded 1988	No formalized standards majority of riders incapable of using fixed route	No	N/A	No
Dallas DARTabout	1987/88	N/R	N/R	N/R	N/R
Santa Clara Dial-A-Ride	1974	Yes Has never met standards. Service is maintained as is only transit in area	Yes	2/3 of the average annual ridership of the top 2/3 feeder routes	Yes

**Table A7
Fixed Route Shuttle Service Area Characteristics**

System	Service Area population (1)	Population Density per sq mi (2)	Connections to Regional Fixed Route Service	Regional Transfer Facilities	Is Fixed Route Shuttle the ONLY local service
Poway Shuttle Routes 844/845	45,400	1,227	3 SDTC* Routes 1 SDCTS* Routes	Benches or Shelters.	No
El Cajon Shuttle Routes 871/872/873	92,241	6,450	Trolley 2 SDTC* Routes 2 SDTC* Routes	Transit Center with Full amenities Benches or Shelters.	No
Orange County TA Market Development Services	962,000	1,924	Metrolink Commuter Rail OCTA regional bus lines	Transit Center with Full amenities Benches or Shelters.	Yes

(1) 1991 census data for DART service area.
(2) 1988 County planning data for DART service area.

* SDTC = San Diego Transit
* SDCTS = San Diego County Transit

**Table A8
Fixed Route Shuttle Operating Data Comparisons**

System	Annual Ridership	Revenue Miles	Revenue Hours	Annual Op. Costs	Fare Revenues	Subsidy Requirement	Cost/ Hour	Cost/ Mile	Subsidy/ Pass	Pass/ Hour	Pass/ Mile
Poway Shuttle Routes 844/845	222,683	293,722	14,668	\$659,112	\$70,920	\$588,192	\$44.94	\$2.24	\$2.64	15.2	0.76
El Cajon Shuttle Routes 871/872/873	334,274	203,063	19,369	\$409,576	\$180,639	\$228,937	\$21.15	\$2.02	\$0.68	17.3	1.65
Orange County TA Market Development Services	555,000 **	551,472 **	28,275 **	\$1,100,000 **	\$115,700 **	\$984,300 **	\$38.90 **	\$1.99 **	\$1.77 **	19.6 **	1.01 **

** FY 1993/94 estimated.

**Table A9
Fixed Route Shuttle Ridership Patterns**

System	Total Ridership	Avg. Wkdy Ridership	Local DART Transfers Within Sys Area	Demand Peaking Pattern	Transfer Trips To/From Regional System	Percent Transfer Trips
Poway Shuttle Routes 844/845	222,683	801	Yes	Balanced	N/R	N/R
El Cajon Shuttle Routes 871/872	227,868	685	Yes	Balanced	N/R	N/R
El Cajon Shuttle Route 873	106,406	345	Yes	Commute peaking	N/R	N/R
Orange County TA Market Development Services	555,000	630	N/R	AM and PM Commute Service Only	N/R	N/R

* N/R = Not Reported

Appendix B: Organization Model

ORGANIZATION MODEL FOR COMMUNITY SMART SHUTTLE SERVICE IN THE CITY OF LOS ANGELES

Introduction

The most appropriate conceptual framework for the operation of SMART SHUTTLE services in the City of Los Angeles will be an association of operators who will operate vehicles owned by the group. Today, most major metropolitan taxi services are operated by associations which provide their members with a host of services including central dispatch, marketing, insurance, fuel and maintenance. Operation of the SMART SHUTTLE service would mirror these operations as drivers would band together for the purpose of lowering their operating costs while seeking to maximize their revenue opportunities.

An Organization Model

The shared ride taxi services in Atlantic City, New Jersey, operating mini and full-sized vans, also operate as associations. As these Atlantic City associations are the oldest operations of their kind in these United States, much information can be gained from their experience. The Atlantic City associations also have stringent rules and regulations to which members must adhere. It is these rule and regulations that make the Atlantic City operations so different than those unregulated and undisciplined operations in the boroughs of New York and elsewhere. In Atlantic City, drivers operate their service with uniform fares, uniform pick-up rules, and uniform service standards. This self-regulation results in more opportunity for the individual member of the association as well as more public acceptance and reliance on the service concept.

The operating Organization For Los Angeles

The SMART SHUTTLE operation in the City of Los Angeles would benefit best from the establishment of associations that duplicate the Atlantic City model. Similar associations can be created in Los Angeles from the existing taxi associations that exist today (LA Taxi Cooperative, United Independent, Bell and the other associations both company-based and ethnic-based). Membership for the SMART SHUTTLE associations could be created from those drivers who have been unable to gain use of a taxi from one of the existing associations. Also, using the company and ethnic based associations as the "pool" for SMART SHUTTLE drivers would enable the service to begin with a group of drivers who have knowledge of the City and of the operation of vehicles for public hire.

Other associations could be formed later from the ranks of college students, livery drivers, courier service operators and from civic and ethnic organizations. As the service will not require a need to confirm Commercial driver's License, there will be multiple opportunities to develop driver pools.

The associations must also be charged with the responsibility to be "self-policing" in order to minimize the on-street regulation by the City of Los Angeles or the MTA. Those agencies

sponsoring the SMART SHUTTLE demonstration would be wise to obtain guarantees from those who receive any capital or operating support that the association by-laws will include rules of conduct and operation. Those rules at a minimum should include the following:

- Adherence to a formalized fare policy
- A driver dress code
- Vehicle cleanliness and safety standards
- Vehicle operating standards
- A customer complaint resolution process
- Minimum service standards

The rules that associations adopt for their membership should serve the same purpose with individual operators as do liquidated damage clauses in competitively contracted service agreements. Consequently, these standards should include effective remedies to ensure compliance by their membership. Prior to any association receiving office sanction to be a SMART SHUTTLE operator, the group must adopt minimum standards such as those listed above. In addition the association by-laws/regulations should follow the standards of the sponsoring agency. The sponsoring agency should also have remedies to ensure compliance by the association at large. At a minimum, vehicle safety inspections and driver training should be undertaken. A service manager/broker could provide this role in addition to support the SMART technology on the vehicles.

The SMART SHUTTLE operating organization should also receive official City of Angeles sanction as it would operate under what can be best described as a "sub-franchise" agreement. This status would not be exactly like the taxi cab franchises, but structured much like those agreements. The SMART SHUTTLE franchises for the purposes of the demonstration may be few in number but if the concept proves itself the potential number of franchises may be significantly greater than the existing nine taxi franchises.

As potential opposition to the operation of SMART SHUTTLE service may exist among the nine franchisees, the demonstration of the new service would be jeopardized unless the first associations are "spawned" from the existing pool of drivers. It is recommended that the genesis for the organizational model be developed for the company-based model for the service demonstration. Following the potential success of the demonstration then the sponsoring agencies can seek to develop other associations from the ethnic, civic or employment groups mentioned earlier.

The sponsoring agencies should also consider other transportation service programs which are in need of additional vehicle resources so that program coordination could take place. For example, the City of Los Angeles' CITYRIDE Program is constantly oversubscribed in the San Fernando Valley. It may be possible to coordinate SMART SHUTTLE activities to meet the CITYRIDE demand that is not adequately being met today. Other social service and employment transportation needs may also benefit from the enlistment of SMART SHUTTLE vehicles in their operations.

The operating organization for SMART SHUTTLE service must be able to have the flexibility to expand and contract based on marketplace demand for service. The organization must also be devoid of the types of overhead that drive operating cost well beyond the ability of the service being provided to return its fully allocated costs. Overhead is also kept to a minimum for their is no benefit to the association membership by having a large and unproductive administrative function. The association organization fits these criteria as it is truly "market driven". The sponsoring agency will want to establish minimum service levels to insure full coverage, while allowing a "market driven" responses to capacity needs.

Developing Community-Based Ethnic-Based SMART SHUTTLE Associations

The multi-ethnic Los angeles community has many well-positioned and financially-capable ethnic organizations which could serve as associations for the operation of SMART SHUTTLE services. Participation of these would augment the existing taxi associations. The concept of community or ethnic-based associations would have merit for the SMART SHUTTLE operation as these groups could develop self-sustaining transportation programs from their own communities or ethnic groups.

Under the ethnic-based association concept, the sponsoring agencies may be able to have less financial responsibility as many of the ethnic groups not only have the ability to develop needed manpower for the service many also have their own ability to finance vehicle acquisition and operating costs. While much has been written about the West Indian Jitney-type services in New York, a lesson in organizational success can be learned from their operation. Not only have West Indian immigrants banded together to form associations to provide this service they have also generated ridership from the West Indian community which helps sustain the services.

In Los Angeles, a similar concept would have merit as research supports the concept that many in the ethnic pockets of the City (East LA, Little Tokyo, Chinatown, Koreatown, South Central, Fairfax, Watts, etc.) rarely travel beyond the boundaries of their own communities. For some, it is the language barrier that confines them, while their needs are met in their own neighborhoods. For a Russian immigrant in the Fairfax area, it is possible to find every type of food, entertainment, and social opportunity right in the community, so little travel may take place beyond the boundaries of Fairfax. For those travelling inter-community or inter-neighborhood, MTA's regional transit services will continue to be available.

The type of ethnic-based association proposed for the SMART SHUTTLE service could capitalize on the ethnic vitality of Los Angeles. The ability of the SMART SHUTTLE to meet localized transportation needs would be enhanced by having a driver who not only speaks the local language, but also lives in the community and understands personal travel needs.

To develop such ethnic-based associations, the sponsoring agencies must first identify those existing organizations that have the type of membership and financial capability to support the

SMART SHUTTLE. Those organizations with broad membership would be able to recruit the driver pool necessary and would be able to sustain services by promoting its use to its own membership. There are some churches in Los Angeles which have memberships which exceed 30,000 while some ethnic organizations have memberships which constitute almost an entire ethnic background.

Many ethnic organizations have their own financial service capabilities as well. It may be possible for the SMART SHUTTLE sponsoring organizations to tap into those financial resources to start demonstration projects or to at least establish the associations to operate the service through loan/insurance guarantees or minimal fixed subsidies for the demonstration. The ability of these organizations to provide all the necessary financial resources would move the SMART SHUTTLE concept so much closer to the realization of being self-sustaining and truly free-market operated.

Appendix C: Vendor Brochure Excerpts



UMA Systems Inc.

5080 Commerce Blvd., Mississauga, Ontario, Canada L4W 4P2
Telephone (905) 238-0007, Fax (905) 238-0038

December 14, 1994

File: 001-00

Telephone: (213) 627-0491
Facsimile: (213) 627-9761

Mr. Peter Everett
Transportation Engineer
DKS Associates
1055 West 7th Street
Suite 2850
Los Angeles, California
U.S.A. 90017

Send by:	
Facsimile	<input type="checkbox"/>
Regular Post	<input checked="" type="checkbox"/>
Courier	<input type="checkbox"/>
Hand Deliver	<input type="checkbox"/>

Dear Mr. Everett:

RE: UMA'S SOFTWARE PRODUCTS

We appreciate your request for information on our software products and services.

UMA's software system, *TRAPEZE™*, consists of a variety of integrated planning and operational map based components. It currently has three major components.

TRAPEZE™-FX, a schedule builder, vehicle/driver crewing and rostering system for fixed route operations.

TRAPEZE™-QV a 'real time' demand responsive scheduling and dispatching system designed for special needs (e.g. disabled and elderly) operations.

TRAPEZE™-CI, a passenger information system consisting of timetable information (e.g. next bus) and itinerary planning.

Other 'add-on' products include bidding, ridership/schedule adherence analysis, corridor/demographic analysis, passenger information, monitoring (for AVL). There are also a number of utilities such as map-edit, and database translators.

With the direction towards advanced public transport systems, the products can be effectively interfaced and take into consideration a client's internal architecture to fit with other systems including onboard devices (such as automatic vehicle location, mobile data terminals and pagers), commercial software products (e.g. word processors, spreadsheets, database management systems, digitized base maps) and other "inhouse" systems (such as corporate databases, long range planning, timekeeping, payroll, executive information)

UMA also offers service programmes that are designed to suit each client and complement the software products. These services include project management, planning and feasibility studies, system/operational analysis, application design, customization and implementation, client training and support and other product/system integration.

Since 1990, UMA's *TRAPEZE*TM System has been installed in over 60 small to large operations, most of which are currently in North America.

UMA Systems Inc. is a group of experienced software architects, programmers and implementation and client support specialists who are dedicated to the development and implementation of software products designed to enhance operations involved in transporting people and goods.

The Smart Shuttle project that you mentioned appears to be very interesting and one for which our product could be effectively applied.

We would welcome the opportunity to demonstrate our products for you and others involved in the project.

Thank you for your consideration.

Yours very truly,

UMA SYSTEMS INC.

for Chris Pyres
Fran Fendelet
Marketing Manager
Transportation Software

FF/cr
encl.

UMA SYSTEMS INC.

INNOVATIVE SOFTWARE PRODUCTS

for

FIXED ROUTE, RAIL & PARATRANSIT OPERATIONS

- * *trip building*
- * *vehicle & driver assignment*
- * *rostering/bidding*
- * *client registration/booking*
- * *real-time scheduling and dispatching*
- * *routing*
- * *automated mapping*
- * *corridor/demographic analysis*
- * *passenger counting/ridership analysis*
- * *reporting/interfaces*

We offer comprehensive services to support our products.

For more information, please call (905) 238-0007

5080 Commerce Blvd., Mississauga, Ontario, L4W 4P2

Since 1990, UMA Systems Inc., located in Mississauga, Ontario has become a leading developer and supplier of innovative software products for the public transport industry.

UMA's products provide solutions for fixed route, rail, longhaul and paratransit (demand responsive) operations of virtually any size. The products offer clients a variety of capabilities including trip building, vehicle and driver assignment (scheduling), rostering/bidding, client registration/booking, batch/real-time vehicle and crew scheduling, dispatching, automated mapping, and routing. *TRAPEZE™*, a software system is quickly gaining acceptance and is being recognized as the system that will set new standards for the transportation industry. The *TRAPEZE™* software system consists of a variety of applications and utilities to support fixed route and demand responsive operations. Two of its major components support fixed route scheduling/runcutting/rostering and demand responsive scheduling/dispatching operations.

The development and integration of the automated mapping component in early 1992 added another important dimension to scheduling operations. It responded to an industry, which is relying increasingly upon geographic information, with a much more extensive solution by providing the mechanisms to define and geocode locations (e.g. bus stops or client's location), determine distances and simulate vehicles' locations.

UMA has also developed other component products, which enable their users to compare or analyze the planned and actual data and provide meaningful input during the decision making processes. These integrated products include corridor/demographic analysis and passenger counting/ridership analysis. The passenger counting/ridership analysis system which can be interfaced with a variety of data collection devices is used to relate 'on-street' information with the generated schedule data. The corridor/demographic analysis system enables the analysis of census or other statistical data along a chosen transportation corridor.

Ultimately, the products must have the ability to efficiently 'share' or port the data to or from other systems to provide a complete solution for the client. The reporting capabilities respond to the client's specific requirements at all levels from the user to management. The interfacing capabilities have enabled UMA to successfully export the data to 'off-the-shelf' systems, such as word processors, spreadsheets and desktop publishers, as well as others, such as timeroll, payroll, automatic vehicle location/radio, passenger counting and timetable publishing.

UMA's products are designed for the micro-computer environment and have been developed using principles and techniques that take advantage of the latest hardware and software technology, which tends to advance at a rather dramatic pace. The products easily adapt to the hardware and software trends, as well as each client's environment by considering the client's current requirements, the future plans, and the need to minimize obsolescence.

The success of these products is due not only to the products themselves, but also to UMA's long term commitment to support both products and clients. Extensive service programs, including system analysis and design, customization, hardware and software implementation, client training and support, and other product integration are designed to support the product and the requirements specific to each client's operation.

UMA's products have been installed for more than fifty transit operations throughout North America and internationally. Some of the many operations where the products have been implemented include Toronto Transit Commission (Toronto, Ontario), Mississauga Transit (Mississauga, Ontario), Southeastern Pennsylvania Transit Authority (Philadelphia, Pennsylvania), Metropolitan Atlanta Rapid Transit Authority (Atlanta, Georgia), Milwaukee County Transit System (Milwaukee, Wisconsin), Alameda Contra Costa District (Oakland, California) and Central Ohio Transit Authority (Columbus, Ohio).

UMA is dedicated to the development, implementation and support of software products for public transport and will continue to provide viable solutions in the years to come.

TRAPEZE™

UMA's software system, *TRAPEZE™*, consists of a variety of integrated planning and operational map based components. It currently has three major components.

TRAPEZE™-FX, a schedule builder, vehicle/driver crewing and rostering system for fixed route operations.

TRAPEZE™-QV a 'real time' demand responsive scheduling and dispatching system designed for special needs (e.g. disabled and elderly) operations.

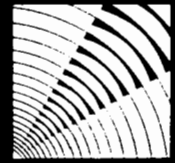
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With the direction towards advanced public transport systems, the products can be effectively interfaced and take into consideration a client's internal architecture to fit with other systems including onboard devices (such as automatic vehicle location, mobile data terminals and pagers), commercial software products (e.g. word processors, spreadsheets, database management systems, digitized base maps) and other "inhouse" systems (such as corporate databases, long range planning timekeeping, payroll, executive information)

UMA's Systems are supported by a group of experienced software architects, programmers and implementation and client support specialists who are dedicated to the development and implementation of software products designed to support operations involved in transporting people and goods.

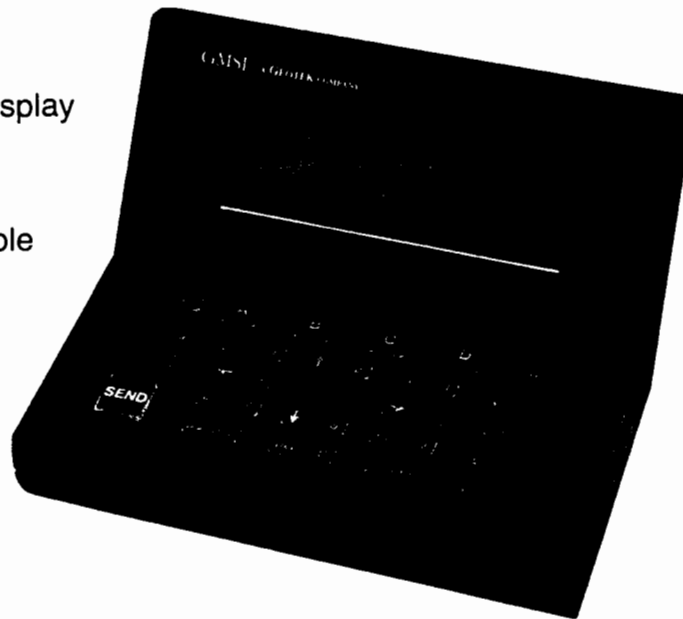
UMA's service programmes are designed to suit each client and complement the software products. These services include project management, planning and feasibility studies, system/operational analysis, application design, customization and implementation, client training and support and other product/system integration.



MDT 4023 - Mobile Data Terminal

Graphical Display

Programmable
Soft Keys



Full Peripheral
Support

Rapid and
Convenient
Upgrades

The MDT 4023 is GMSI's fourth generation taxi and paratransit mobile data terminal. The MDT 4023 keeps the speed, flexibility, reliability and proven software of previous GMSI MDTs and adds many industry firsts to make your drivers and dispatch operation even more effective.

Enhanced Screen

- Bit map graphical display.
- Supports different languages.
- Single and double height characters.
- The most readable display in the industry.

Serviceability

- Downloadable forms.
- Update the message forms at any time.
- Rapid firmware upgrades using a laptop computer; no chip replacement required!
- Update forms and firmware without removing the MDT from the vehicle.

Soft Functions Keys

- Menu based functions.
- Easy to learn and easy to use.
- Programmable menus and soft keys.
- Optimum flexibility.

Peripheral Support

- Three serial ports, in addition to the radio and power ports, which can support integral GPS and odometer readers and external printers and smart card readers.
- Optional magnetic swipe credit card reader.
- Interfaces with UHF, VHF, 800 MHz and 900 MHz mobile radios.

***And works with the fastest data network
in the industry!***

MDT 4023 - Mobile Data Terminal

Specifications

Physical	Item	Width	Height	Depth
Size (in/mm)	Terminal	8/202	4/104	6.75/175
	Display Characters	variable	variable	
	Radio Modem/Controller	6/152	9.3/237	1.5/40
Weight	2.2 pounds (1000 grams)			
Enclosure	High impact resistant black plastic (polycarbonate resin base)			
Electrical				
Power	13.8 Vdc nominal; full operation over 7.0 Vdc to 16 Vdc			
Current	Less than 1000 mA @ 13.8 Vdc			
CPU	10 MHz Z180			
Memory	128 kbytes of reprogrammable memory (Flash ROM), expandable to 256 kbytes 32 kbytes of RAM, expandable to 64 kbytes			
Transmission Speed	3600 to 4800 bits per second			
Communication Protocol	Outbound - Time Division Multiplexed (TDM) Inbound - Slotted Aloha			
Communication Control	Automatic message acknowledgments and selective retransmissions			
Transmission Technique	Modified phase delay			
Error Detection and Correction	Parity checks, longitudinal checks, block checksum characters, and packet merging.			
Ports	Radio modem/controller has 3 serial ports, terminal port, radio port, power port. Emergency switch connects to radio modem/controller power port. Magnetic card reader connects to terminal.			
Programming	The MDT is programmed through the serial port, and from the host computer for forms and prompts.			
Environmental				
Temperature	Operating: -4° to +122° Fahrenheit (-20° to +50° Celsius) Storage: -22° to +160° Fahrenheit (-30° to +70° Celsius)			
Humidity	To 99% non-condensing.			
Vibration	Exceeds MIL-STD-810D requirements for land mobile environment.			

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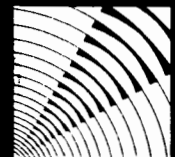
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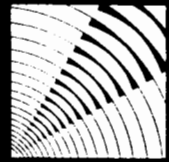
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All specifications are subject to change without notice. - 10/31/94





MDT 4022 - Mobile Data Terminal



The MDT 4022 is GMSI's fourth generation taxi and paratransit mobile data terminal. The MDT 4022 keeps the speed, flexibility, reliability and proven software of previous GMSI MDTs and adds many industry firsts to make your drivers and dispatch operation even more effective.

The MDT 4022 is specifically designed for installations where space is at a premium and additional mounting flexibility is required. The separate display and keypad units can be installed in different positions; for example, the display can be mounted near eye level and the keypad can be mounted on the console.

Serviceability

- Downloadable forms.
- Update the message forms at any time.
- Rapid firmware upgrades using a laptop computer; no chip replacement required!
- Update forms and firmware without removing the MDT from the vehicle.

Peripheral Support

- Three serial ports, in addition to the radio and power ports, which can support integral GPS and odometer readers and external printers and smart card readers.
- Optional magnetic swipe credit card reader.
- Interfaces with UHF, VHF, 800 MHz and 900 MHz mobile radios.

***And works with the fastest data network
in the industry!***

MDT 4022 - Mobile Data Terminal

Specifications

Physical	Item	Width	Height	Depth
Size (in/mm)	Keypad	2.9/74	4.1/105	1/25
	Display	8.25/210	2.5/65	2/50
	Display Characters	0.11/2.8	0.19/4.9	
	Controller	6/152	9.3/237	1.5/40
Weight	2.2 pounds (1000 grams)			
Enclosure	High impact resistant black plastic (polycarbonate resin base)			
Electrical				
Power	13.8 Vdc nominal; full operation over 7.0 Vdc to 16 Vdc			
Current	Less than 1000 mA @ 13.8 Vdc			
CPU	10 MHz Z180			
Memory	128 kbytes of reprogrammable memory (Flash ROM), expandable to 256 kbytes 32 kbytes of RAM, expandable to 64 kbytes			
Transmission Speed	3600 to 4800 bits per second			
Communication Protocol	Outbound - Time Division Multiplexed (TDM) Inbound - Slotted Aloha			
Communication Control	Automatic message acknowledgments and selective retransmissions			
Transmission Technique	Modified phase delay			
Error Detection and Correction	Parity checks, longitudinal checks, block checksum characters, and packet merging.			
Ports	Radio modem/controller has 3 serial ports, terminal port, radio port, power port. Emergency switch connects to controller power port. Magnetic card reader connects to display.			
Programming	The MDT is programmed through the serial port. Forms can be downloaded over the radio.			
Environmental				
Temperature	Operating: -4° to +122° Fahrenheit (-20° to +60° Celsius) Storage: -22° to +160° Fahrenheit (-30° to +70° Celsius)			
Humidity	To 99% non-condensing.			
Vibration	Exceeds MIL-STD-810D requirements for land mobile environment.			

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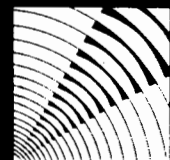
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MDT 4000 Series

Mobile Data Terminal

The MDT 4000 Mobile Data Terminal provides mobile personnel with simple low cost access to their dispatch center using mobile data communications.

The MDT 4000 provides the functionality and intelligence of a personal computer in a rugged and attractive package developed specifically for the mobile environment. The integrated one piece design has a full function typewriter style keyboard, large information display, numeric keypad and task selection keys.

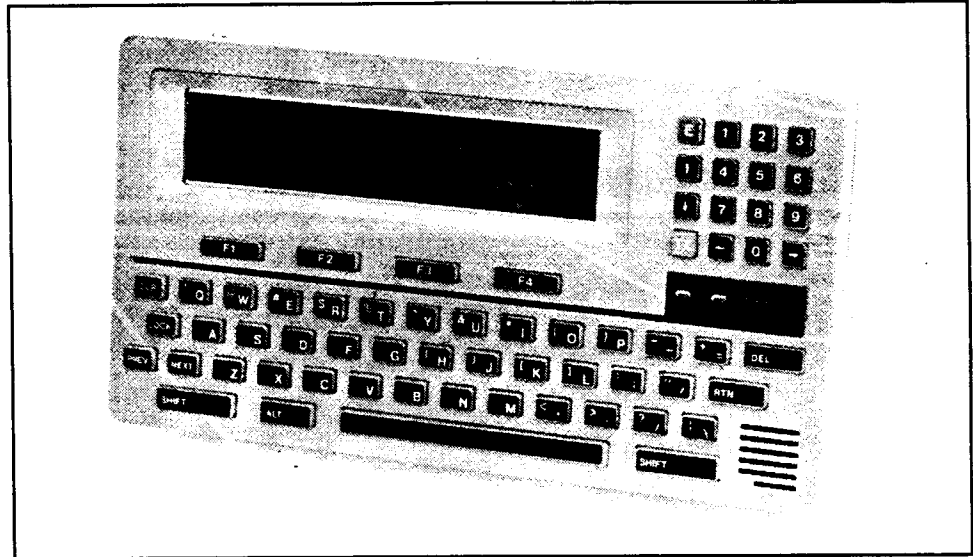
The MDT 4000 has option menus that allow the user to quickly and easily select a desired task.

The user can generate messages with the built-in easy-to-use text editor which provides unlimited message creation capabilities, or by selecting pre-programmed messages, or completing pre-defined forms that are permanently stored in the memory of the MDT 4001.

Supports a wide variety of applications...

Ease of Use

- large message display area
- easy to follow option menus for task selection
- tone to indicate each incoming message
- LED to indicate queued incoming messages
- LED to indicate communication link status
- full typewriter keyboard
- punctuation, symbol, and alpha numeric data entry keys
- text editor to create unique messages
- display and keypad backlighting



- user adjustable display contrast settings
- user error indications and messages

Messaging

- user-generated text messages
- pre-programmed quick select coded messages
- custom fill-in-the-blanks forms
- user selectable message classification levels
- dedicated key for maximum priority emergency messaging

Message Storage

- user controlled storage area for reference messages
- stored messages can be edited and re-transmitted as often as desired

Flexibility

- custom coded messages
- custom input forms
- cursor appearance changes automatically for different tasks
- supports both upper and lower case letters
- cursor or numeric selection of list entries

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Systems Inc.
A Geotek Company

MDT 4000 Series

Specifications

Offices

Physical

Size: Width: 10 in (254 mm) Height: 5.2 in (132 mm) Depth: 2.2 in (56 mm)

Weight: 2 pounds (890 grams)

Enclosure: High impact resistant plastic
Grey colour to reduce direct sunlight heat absorption

Electrical

Power: 12 Vdc nominal; full operation over 9 Vdc to 18 Vdc

Current: Less than 500 mA @ 13.8 Vdc in operation
Less than 250 mA @ 13.8 Vdc in idle mode

Display: Supertwist Liquid Crystal Display (LCD)
4 lines by 40 characters per line

Backlighting: 100,000 hour life-span emitting diodes (LED) for display and keyboard/pad

CPU: Intel 80C88

Memory: 64 kbytes of program memory (ROM)
Up to 64 kbytes of pre-defined message ROM
8 kbytes of RAM expandable to 32 kbytes
non-volatile RAM expandable to 8 kbytes

Terminal Interface: Serial link, RS 232 signal levels

Environmental

Temperature: **Operating:** -22° to +140° Fahrenheit (-30° to +60° Celsius)
Storage: -50° to +160° Fahrenheit (-45° to +70° Celsius)

Humidity: to 99% non-condensing

Vibration: exceeds MIL-STD-810D requirements for land mobile environment

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Printed in Canada



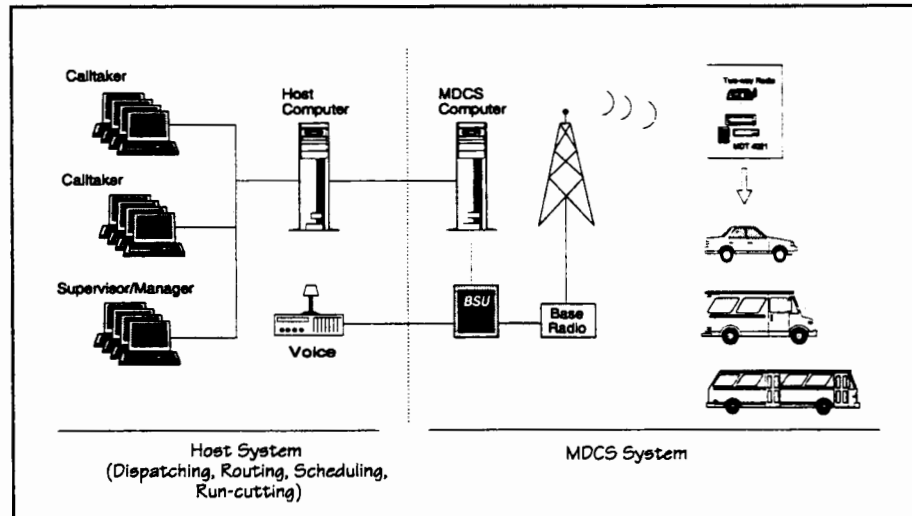
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A Geotek Company

Mobile Data Communications System

Introduction

Gandalf Mobile Systems Inc. (GMSI) announces its Mobile Data Communications System (MDCS) - an efficient, cost-effective method of real-time fleet management for the ground transportation industry. MDCS provides bi-directional messaging between an office computer system (dispatch, routing, scheduling, run-cutting etc...) and a fleet of vehicles using data communications over a two-way radio.



The Mobile Communications System is fully compatible and can be interfaced with a variety of hardware and software products. For instance, vehicle routing and scheduling, maintenance monitoring, customer billing, accounting, data dispatching and real-time on-board data collection are a few of the possible applications that could be enhanced by the MDCS. Hardware products such as card readers, automatic vehicle location receivers, odometers, fare box readers, printers, and vehicle monitoring sensors can also be easily interfaced with the MDCS.

System Configuration

The MDCS computer is connected to the fleet operator's existing base radio system via GMSI's Base Signalling Unit. At the other end, mobile data terminals (MDTs) are installed in each vehicle by connecting them to the vehicle's existing mobile radio. The MDT allows the driver to communicate with and receive information from the host system via the MDCS. Even though the MDCS eliminates the need for most voice communications, it retains voice as a backup system.

Typically, GMSI's MDCS and your company's office software products reside on separate microprocessors.

This will not pose a problem, however, because there are several efficient methods of communicating information between the two separate platforms. One method of communication is by using an ASCII file transfer. A second method is by creating a database interface as the messaging stream.

Data Collection

One of the primary functions of GMSI's MDCS is to automate the collection, validation, transference and storage of driver, passenger and trip information in real time. The MDCS collects and stores the following types of information:

- content, time and date of all messages to and from the driver
- vehicle's odometer reading
- time and date of driver logon and logoff for shifts and breaks
- vehicle, passenger and trip identification

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Mobile Data Communications System

- time and date of such activities as passenger pickup and dropoff, site arrival and departure, passenger call-out, no-shows and boarding and alighting
- amount collected and the method of payment of fares

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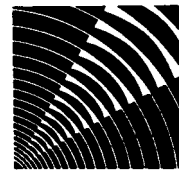
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Winston Salem, North Carolina

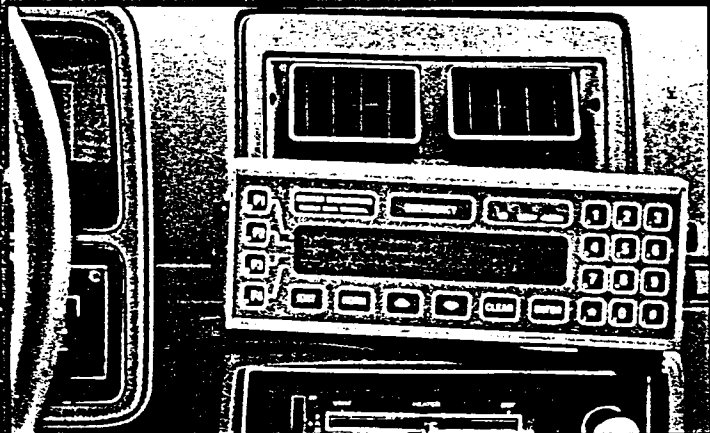
On-Line Data Products
Ms. Marsha Moore
(602) 4883-3822

D15

COMPUTER ASSISTED DISPATCH



CENTRAL DISPATCH SYSTEM



MOBILE DATA TERMINALS

MENTOR
engineering inc

THE COMPLETE SOLUTION



COMPUTER ASSISTED DISPATCH

Get The Edge

Adding a Computer Assisted Dispatch (CAD) system to your trunked or conventional radio system will:

- Reduce voice traffic congestion
- Improve data security and accuracy
- Increase the speed of information transfer
- Generate revenue through greater efficiency
- Reduce paperwork

Mentor's CAD System

Combine Mentor's PC based host, PC Radio Modem and Mobile Data Terminals for a complete CAD system:

- Send addresses, messages and other information to your vehicles
- Job and vehicle status messaging
- Assist your dispatcher in optimal vehicle selection
- Custom report generation
- Collect, store and send data from your vehicles

The Complete Solution

Providing all the hardware and software for both your host and vehicles ensures:

- component compatibility
- software flexibility at the user level
- competent system support

Eliminates the cost, time and effort involved in building a system from multiple suppliers.

To Fit Your Application

Software flexibility at the user level lets you customize virtually all system parameters and text fields to provide the solution for your needs. Mentor's CAD system can be used for a large variety of mobile data applications such as:

- Taxi
- Police
- Fire
- Courier
- Service Vehicles
- Delivery

SYSTEM FEATURES

General

- Complete message handshaking with error checking for accurate information transfer
- System checks for a free channel before transmitting to ensure that data does not interfere with voice communications
- All radio parameters (attack time, link drop turn around time, ack time, etc.) can be adjusted to suit your radio system's characteristics

PC Software

- Operates on IBM or compatible (286 and up)
- Customize your own data entry forms
- All system events are archived and time stamped for custom report generation
- Display active jobs, vehicle status and location, job history, and data entry forms

Mobile Data Terminal

- Built-in radio modem
- Designed for operation in harsh environments
- Stores multiple messages
- Printer interface
- Interface for PC keyboards
- User programmable status messages
- DTMF pad for use with dial access unit
- 4 line x 40 character display
- Input for hidden emergency switch

PC Radio Modem

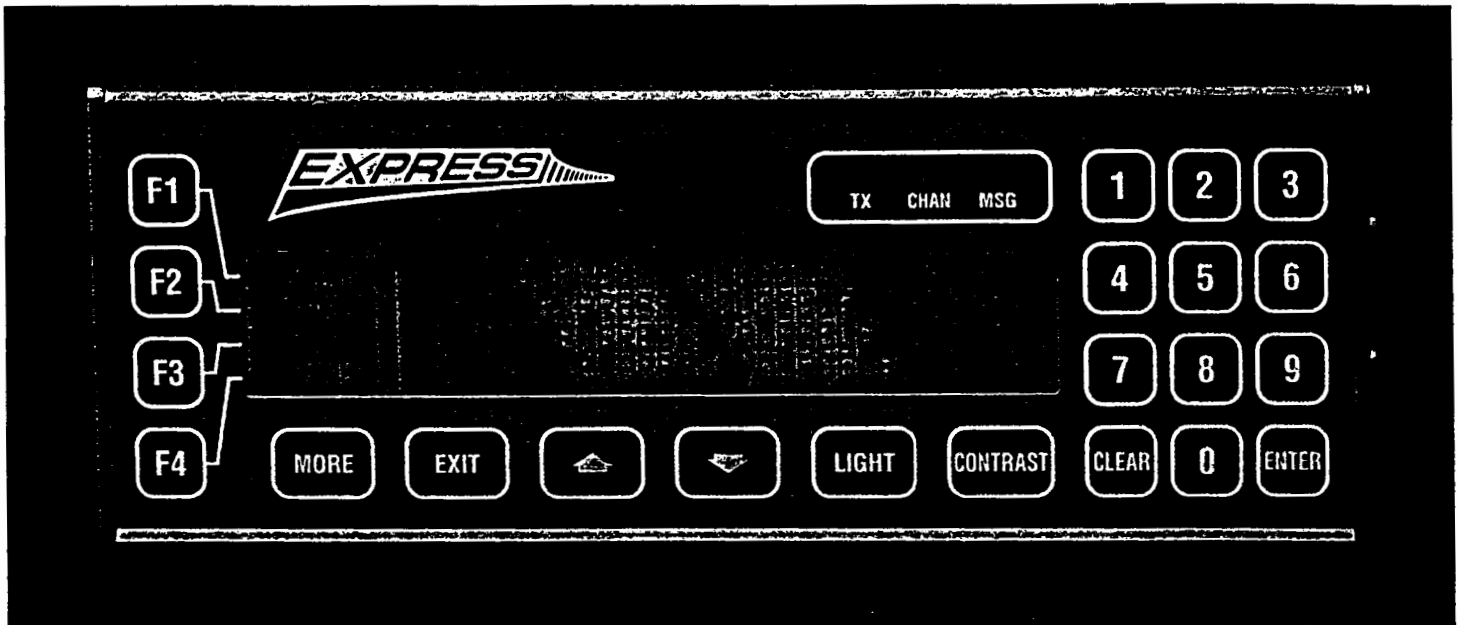
- Contains all control circuitry required to interface host PC to base station radio

MENTOR
engineering inc

503, 609 - 14th Street N.W.
Calgary, Alberta Canada
Ph. (403) 283-6763
F. (403) 283-6763



EXPRESS Mobile Data Terminal



But my application requires . . .

No Problem. At Mentor we believe that every customer's application is unique, so we designed our *EXPRESS* MDT from the ground up with flexibility in mind.

Form Based Operating System (FbOS) – This unique operating system provides the background for your application software. Combine FbOS with the Customer Application File and you have a mobile data system that is tailored to meet your needs.

Customer Application File – This file contains a number of tables that define how the *EXPRESS* MDT will function. Once your application is defined, we simply modify these tables for your application and load them on the *EXPRESS* MDT operating system.

Forms and Fields – The Customer Application File allows up to 16 forms to be defined. Each form contains one or more fields which can be used for a variety of purposes:

- Display information sent from the Host.
- Input data to be sent to the Host.
- Display information from peripheral devices such as GPS receivers, card readers, load sensors, etc.
- Display the numeric sum of other fields.

Programmable Function Keys / Software Menus – Design your software menus and function keys to have as many or as few functions as your application requires.

Up/Down Keys – Allow paging up or down through information in long forms.

Keyboard – If your application requires text entry we have a PC style keyboard option.

What About The Host Software?

As with any mobile data system, the *EXPRESS* MDTs work in conjunction with a host computer system. Whether you require a complete system or wish to add mobile data to your existing system, Mentor Engineering has the solution.

Interface Development Kit

There is no need to forego the investment already made in your existing computer hardware and software. Mentor Engineering has developed the **Interface Development Kit** to provide you with all of the tools necessary for integrating *EXPRESS* MDTs into your existing system. This kit:

- Provides a standard set of interface software routines usable on any software system.
- Reduces the time and costs involved to integrate mobile data into your system.
- Reduces the software modifications required on your existing system.

Total System Solutions

Should you require a complete system, Mentor Engineering can provide:

MCAD – Mentor's Computer Assisted Dispatch system is a PC based dispatch system designed for smaller systems of 30 or less vehicles.

Third Party Software – Mentor Engineering is aligned with various software companies who have integrated *EXPRESS* MDTs into their software systems. Please contact Mentor Engineering for more information.

EXPRESS YOURSELF EXPRESS YOURSELF EXPRESS YOURSELF



EXPRESS Mobile Data Terminal

EXPRESS MDT Peripheral Equipment

For many systems, a mobile data terminal may be only part of the solution. To accommodate the addition of peripheral equipment for special functions or system upgrading, the EXPRESS MDT has multiple RS232 ports, a keyboard interface port and field programmable software. The following outlines some of the peripheral equipment which can be interfaced to the EXPRESS MDT:

GPS Receivers: Integrate GPS receivers into your system for Automatic Vehicle Location (AVL) tracking.

Mobile Keyboards: Mentor offers a keyboard for those applications requiring significant text entry.

Bar Code/Credit Card Readers: These devices simplify data collection.

Mobile Printers: Print out invoices, receipts or instructions.

Load Sensors: Record load information for applications such as cement delivery, trucking, or waste disposal.

Smart Taxi Meters: All fare and other meter information can be collected for various management control functions.

The flexibility of the EXPRESS MDT lets you start with a basic system and add functionality as required.

EXPRESS MDT Communications

The EXPRESS MDT has been designed by engineers experienced in both mobile radio and data communications, resulting in an MDT that is extremely versatile when it comes to interfacing to your radio equipment.

The EXPRESS MDT offers:

- A built-in packet radio modem, containing the intelligence and control circuitry required for interface to virtually any model or style of conventional or trunked radio.
- Built-in intelligence eliminates all redundant overhead in your data messages. Communications efficiency is far greater than found in dumb ASCII terminals.
- CRC16 error checking and message handshaking with automatic message retransmissions ensures accurate, error free communication.
- Channel busy monitoring allows for voice and data to share the same radio channel without interfering with each other.
- For use on alternative data networks, it has an RS232 port for interfacing to 3rd party equipment.

Mobitex Network Compatible

EXPRESS MDT Specifications

General:

- ◇ 4 x 40 LCD display with back lighting
- ◇ Sealed membrane keypad with back lighting
- ◇ Rugged metal case
- ◇ LED indicators for TX, Channel and Messages

Internal

- ◇ Built-in Bell 202 FSK modem with automatic gain control (AGC) and automatic TX level
- ◇ Motorola CMOS MC68HC11 microprocessor
- ◇ 2 RS232 ports
- ◇ 1 keyboard interface port (RJ11)
- ◇ 2 definable inputs
- ◇ 2 definable outputs
- ◇ 64K Flash EPROM
- ◇ 512 bytes EEPROM
- ◇ 32K RAM
- ◇ Internal 5 tone paging encoder (optional)

Size/Weight:

- ◇ 9.25"W x 3.5"H X 1.75"D
- ◇ 235mmW X 89mmH X 44mmD
- ◇ 30 ounces / 750 grams

Temperature/Humidity

- ◇ -40°F to + 150°F / -40°C to +65°C
- ◇ 0 - 95% non-condensing max

Power

- ◇ 9 - 18 VDC
- ◇ Complete transient protection

Your local authorized Dealer is:

Mentor Engineering, Inc.

#503, 609 - 14th Street N.W.
Calgary, AB, Canada T2N 2A1
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Fax (403) 283-6749



- ① **ADVANCED FARE PAYMENT** (SMART CARDS, RF (PROXIMITY) CARDS, MAG. STRIPE CARDS)
- ② **AUTOMATED VEHICLE MONITORING** (GLOBAL POSITIONING SATELLITES AND DEAD RECKONING)
- ③ **SPEECH SYSTEMS AND CONTROL** (AUTOMATED STOP ANNOUNCEMENTS, GREETINGS AND PROMOS - DIFFERENT LANGUAGES)
- ④ **TRANSFERS, RECEIPTS AND PROMO PRINTING**
- ⑤ **AUTOMATED PASSENGER COUNTING** (ONS AND OFFS BY STOP)
- ⑥ **RADIO** (LOCAL AND OR WIDE AREA RADIO)
- ⑦ **VISUAL DISPLAYS AND CONTROL**
- ⑧ **TRANSFER SCANNING**
- ⑨ **SECURITY MONITORING**
- ⑩ **VEHICLE MECHANICALS MONITORING** (INCLUDING EQUIPMENT INTERFACE TO FAREBOXES, BUS BLIND CONTROL, ETC.)

NOTES

Subsystems 1 and 2 are being tested in revenue service. Subsystem 3 will be implemented in fall 1994. Subsystems 3, 4, 5, 6, 7, and 8 will be in revenue service in mid 1995. Subsystems 9 and 10 are programmed for testing in the fall of 1995

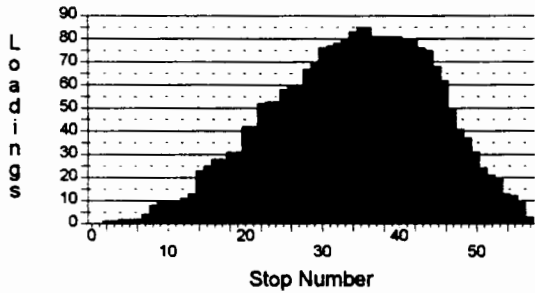


- INCREASED REVENUES (NEW RIDERS, CORPORATE RETAIL PROGRAMS, COMPREHENSIVE FARE CLASSES AND PAYMENT SYSTEMS, TRANSIENTS/ VISITORS, PROMOTIONS, TRANSFERS)
- REDUCTION IN LOST REVENUES (FRAUD, THEFT, SHORT FARES, ETC.)
- GREATER SELECTION OF FARE PAYMENT PROGRAMS AND IMPROVED EQUITY BETWEEN PROGRAMS
- IMPROVED CUSTOMER SATISFACTION
- FASTER BOARDINGS (RELATIVE TO CASH TRANSACTIONS)
- IMPROVED SCHEDULE ADHERENCE
- MORE RELIABLE AND CONSISTENT STOP ANNOUNCEMENTS
- REDUCED EQUIPMENT DOWNTIME
- INTERAGENCY FARE INTEGRATION AND ACCOUNTING
- AUTOMATED PASSENGER COUNTS - SECTION 15 REPORTS
- IMPROVED DATA FOR DRIVER TRAINING AND ACCIDENT ANALYSES
- DRAMATIC IMPROVEMENTS IN DATA AVAILABILITY AND ACCURACY - IMPROVED ROUTING AND SCHEDULING
- IMPROVED ACCURACY OF TRANSFER LOGS AT REDUCED COSTS
- IMPROVED SECURITY THROUGH TRANSACTION MONITORING

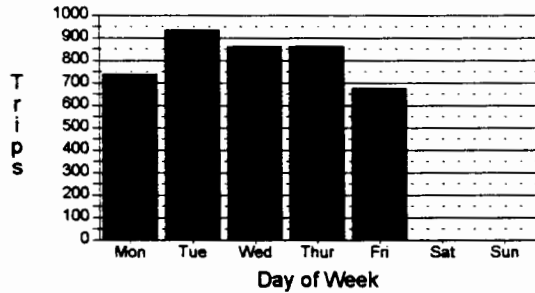


SMART TRAVELER FARE CARD PROGRAM LADOT ROUTE 448 PERFORMANCE AND SERVICE AREA STATISTICS

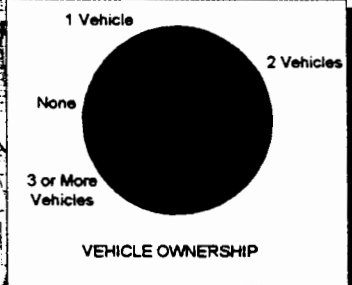
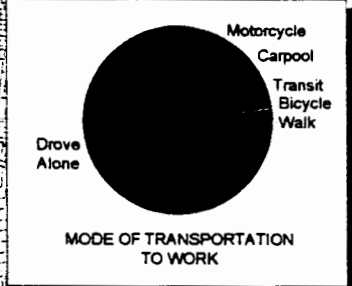
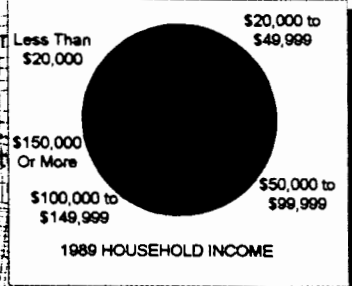
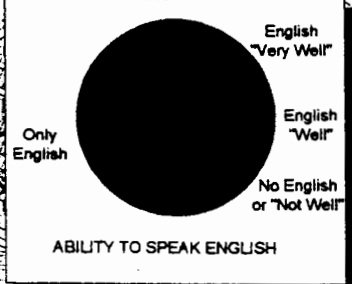
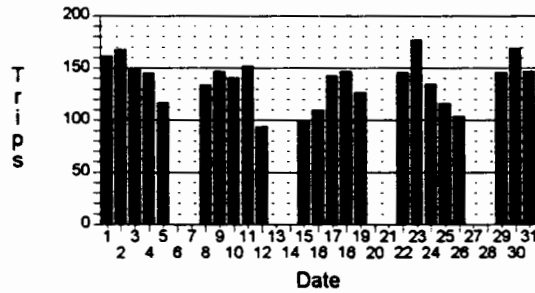
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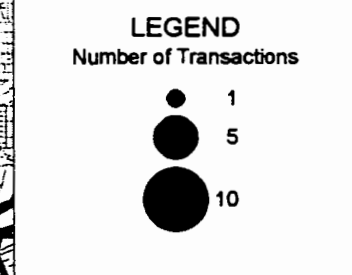
ACCUMULATED DAILY RIDERSHIP



DAILY TRANSACTIONS: AUGUST



SHOWN ABOVE
Select socioeconomic data of population served within 0.25 miles of Route 448 (Palos Verdes).





TWENTY COMMONLY ASKED QUESTIONS ABOUT THE FARETRANS VMS

WHAT DOES THE FARE TRANSACTION AND VEHICLE MONITORING SYSTEM DO?

The system attempts to address the needs of the passenger, the driver, and management in an integrated manner. The core of the system is a fare transaction unit which can utilize any fare card technology, including Smart cards, RF or proximity cards, and mag. stripe (VISA type) cards. The system allows any conceivable (non cash) fare transaction to be implemented. Other elements of the system include:

- **Automated Vehicle Location** - Global Positioning System (GPS) Receivers are used for distance based fares, stop announcements, schedule adherence checks, etc. If your system already has a GPS we can tie into its operation.
- **Automated Passenger Counting** - Ons and offs are recorded at both stairwells. Combined with location (GPS) data, Section 15 reporting can now be fully automated.
- **Speech and display systems** are available to announce bus stops, promos, and generate marketing revenues.
- **A Printing system** is provided to accommodate transfers and receipts and increase marketing revenues.
- **Local or wide area radio** is used for data up-loading and down-loading.

The net result is that the unit provides, ultimately, complete control over all passenger transactions while addressing various management, operator, and vehicle control needs.

HOW DOES ECHELON'S PASSENGER TRANSACTION AND VEHICLE MONITORING SYSTEM COMPARE WITH OTHER PRODUCTS?

We know of no other product that accommodates the range of functions that the Faretrans VMS does. There are AVL/AVM systems that are essentially a radio and a GPS receiver. These systems are available for a cost of \$15,000 to \$25,000 per bus. Dedicated Automatic Passenger Counting Systems can be purchased for \$4,000 to \$7,000 per bus. Stop announcement systems are available for \$5,000 to \$10,000 per bus while transfer printers can be purchased for \$3,000 to \$5,000 per bus and systems that monitor and record vehicle speeds cost \$1,500 to \$2,500 each. To the best of our knowledge there are no integrated transfer printing/scanning systems available, no systems that provide for miniaturized VCR (for security) recording and no systems that down-load and up-load data using local area radio.

HOW EFFECTIVE AND RELIABLE IS THE SYSTEM?

The Passenger Transaction Units (PTU) have been in use for five months on three bus systems. The passengers have been extremely enthusiastic. The transit agencies have been cooperative, positive, and enthusiastic. Twenty-one buses have operated for about 17,000 bus hours without a single in service failure of any on-bus equipment. About 600 fare cards have been issued and over 15,000 transactions have been logged using the RF proximity card. One RF card has failed. Over 15,000 transactions have been logged on the Smart Card system. Fourteen Smart cards have failed.



CAN FARETRANS VMS BE INTEGRATED WITH THE EXISTING REGISTERING FAREBOX?

This is relatively easy task if the fare box vendor can be encouraged to cooperate, to enhance the agency's operations. However, connections to the fare box are not required for effective operation since the passenger counter records all boardings and alightings.

CONSIDERING SPACE LIMITATIONS HOW CAN FARETRANS VMS BE ACCOMMODATED?

The control unit can be easily located behind the driver or in the radio compartment or in various other available spaces. The driver and passenger consoles are each less than 6" x 7" x 1". Effective placement is easily accommodated.

HOW MUCH DRIVER INVOLVEMENT AND MAINTENANCE ACTIVITY IS REQUIRED?

Although the system can be used to monitor driver activity this is left to the discretion of the agency. The system is designed to operate without driver interaction of any kind—if this is required. However, it is possible to recharge fare cards on the bus (as well as remotely). This periodic card recharging requires the driver to press 1 to 4 buttons depending on the type of fare card. No routine maintenance is required except for a periodic dusting for cosmetic purposes. Built-in system diagnostics identify failed modules in the event of failure.

IS THERE A MANAGEMENT REPORTING SYSTEM AVAILABLE TO SUPPORT THE HARDWARE?

Much of the management reporting is based on Geographic Information System (GIS)/Desktop mapping. It is completely menu oriented for ease of use. It can also be customized to address the unique needs of each agency.

IS THE SYSTEM READILY AVAILABLE?

A system can be made operational in 6 months.

WHAT DOES THE PASSENGER TRANSACTION AND VEHICLE MONITORING SYSTEM COST?

The cost of a unit ranges from \$4,000 to \$8,000 depending on the functions provided and number of units to be supplied. Software, engineering and installation costs range from \$75,00 to \$250,000 depending on the functions supplied, the size of the system, and extent of software customization. We estimate that these costs can be recovered in 1 to 3 years as a result of increased revenues and reduced costs.

HOW CAN WE VERIFY ANY OF THE ABOVE?

Please feel free to contact any or all of the following agencies.

FTA	Sean Ricketson	202 366 6678	LADOT (Transit)	Mike Uyeno	213 485 7433
				Dave Rzepinski	
Caltrans	Margaret Moilov	213 897 0188	Torrance Transit	Bob Meyers	310 781 6924
University of Southern California (USC)			Gardena Transit	Jim Mills	310 217 9547
University of California at Berkeley (UCB)					
Dr. Jim Moore		213 743 0857			



HOW IS ON-BUS INFORMATION PROCESSING HANDLED?

The core of the processing system is a 40 MHZ 486 CPU. The system is a DOS based operation with a standard ISA bus. This is the most open architecture available today. Numerous serial, parallel, digital and analog I/O ports allow for considerable expansion potential. This approach minimizes cost, maximizes modularity, minimizes dependence on individual vendors and makes for easy maintenance.

HOW ARE FARE TRANSACTIONS ACCOMMODATED?

The Faretrans VMS is designed to accommodate Radio Frequency (Proximity) Fare Cards, Smart Cards or Magnetic Stripe (VISA type) Cards. The choice of fare card depends on the needs of the agency. Any conceivable type of fare can be accommodated. For example, debit cash, debit trips, monthly, weekly or daily passes, corporate limited or unlimited travel cards, etc. Cards are secured by encryption systems and can be recharged in a variety of ways—on the bus by the driver, remotely, i.e., when the on-bus unit is instructed (by radio) to recharge a card upon passenger usage, or via an "outlet" where tickets, etc are dispersed. The system also recognizes cards that are stolen or lost.

HOW DOES THE AUTOMATED PASSENGER COUNTING (APC) SYSTEM WORK?

The unit uses an array of infra-red beams in both the front and rear stair wells. The sensors are linked to the vehicle location system and door opening switches. Boardings and/or alighting passengers can be recorded for each stair well. This provides load profile data, peak load counts and all Section 15 data. The accuracy of the counts (based on limited tests exceed 97%). This performance has been achieved even in (APC) count units developed by Echelon staff in the early 1970's.

HOW DOES THE VEHICLE LOCATION SYSTEM WORK?

The heart of the vehicle location system is a Global Positioning Satellite (GPS) receiver. Without differential corrections over 90% of the successful readings can locate a bus within a city block. With differential correction this can be improved to a few meters (although we're not sure why an agency would need this level of accuracy). With an odometer subsystem, well over 95% of the location fixes are well within ½ of a typical city block. The GPS is used in combination with other technologies for passenger counting, stop announcements, transfer issuance and approvals, distance based fares, schedule adherence advisories, speed monitoring, marketing and promo announcements, passenger monitoring, etc. If the vehicle location system is integrated with a wide area radio system real time vehicle location can be provided. However, it should be pointed out that the vehicle location system can be used with stored, schedule data to advise (on a dynamic basis) the drivers on schedule adherence.

WHAT IS THE APPROACH TO COMMUNICATIONS?

The system is presently designed to accommodate two communication subsystems.

- In the local area radio approach, a miniature spread-spectrum transceiver is used to upload and download data to and from the bus—as it enters the garage. This allows for loading of the bus with new route and schedule data, new passenger, fare card data and so on. The collected data is downloaded without operator intervention.
- In the wide area radio approach the movement of data to and from the bus is done via a digital radio. (Although a limited amount of data can be moved on a voice radio this is not a recommended approach).

Design work is underway to use spread-spectrum radio for all bus communications.



DOES THE SYSTEM ACCOMMODATE DISPLAYS?

The system as presently designed allows any message to be displayed on an in-bus or out-of-bus display. The present system uses a 1 or 2 line 18 - 24 character scrolling system. The display can be any stored message where the message is prompted by the driver, the time, location, etc. Although it is possible to control the bus destination signs, no work has been done on this. It would be necessary to work with those vendors to integrate their systems.

HOW IS THE PRINTING SUBSYSTEM USED?

The high speed printing system was originally designed to print "receipts." When a passenger places money or a cheque in the fare box, the Passenger Transaction Unit recharges the card with a prompt from the driver. The unit then automatically issues a receipt. For defective or problem cards, a receipt is automatically printed. The printer is also used to issue transfers (for those still using cash) and code the transfers with a bar code (to be later scanned). Marketing promos can also be added to the transfers.

CAN THE SYSTEM ACCOMMODATE SPEECH?

A core element of the system is a high quality speech synthesis unit and associated **dual channel** amplifiers. Speech can be provided in any language and is produced on the basis of location and/or time of day, bus route and/or number, or by driver intervention. The speech can be used for greetings, announcements, stop announcements or promotions/marketing. The system, as designed, will even allow a person to be greeted by name upon presentation of a fare card if this is required.

WHAT IS THE NATURE AND FUNCTION OF THE PASSENGER AND DRIVER INTERFACES?

The passenger interface unit accommodates the fare transaction. A display is provided and the unit contains a speaker and the fare card reader/writer. The passenger is provided information on money or trips left and advice on use of the fare card. The passenger unit is also designed to accommodate a keypad which can be used for distance based fares and/or surveys. The driver interface unit contains a display, a keypad and a speaker. With this unit the driver is provided detailed information on fare transactions, keys for recharging fare cards, and menus for changing various system parameters. The units are both relatively small and can be positioned and controlled for ease of use.

WHAT IS THE NATURE OF THE MANAGEMENT/REPORTING SYSTEM?

The management and reporting system is shaped by the following factors:

- **Geographic Information System (G.I.S.)** - This allows the user to review performance on a geographic basis;
- **Menu Selections** - The use of menus allows for ease of use. Any staff member **should be able** to access any aspect of the system with little or no training;
- **Exception Reporting** - Although there are standard reports—once operating standards are defined the user can focus on producing reports that highlight exceptions;
- **User Customization** - Each transit agency is, in some respect, unique. The management reports ought to reflect the needs and practices of the individuals that use the system.



December 12, 1994

Mr. Peter Everett
DKS Associates
1055 W. 7th Street
Suite 2850
Los Angeles, CA 90017

Dear Mr. Everett:

Thank you for your request for information on our paratransit software system, MIDAS. I have enclosed a complete product overview and customer list of Multisystems' MIDAS for your review. I encourage you to call our customers and ask them about our products and support.

MIDAS features *real-time, fully-automated* scheduling capabilities. It is available as a PC-based system and operates in either UNIX or Novell network multi-user environments.

We would welcome the opportunity to further demonstrate the benefits of MIDAS to you and your colleagues. If you have any questions, or would like to arrange a demonstration, please call me directly at 617-864-5810, ext. 203.

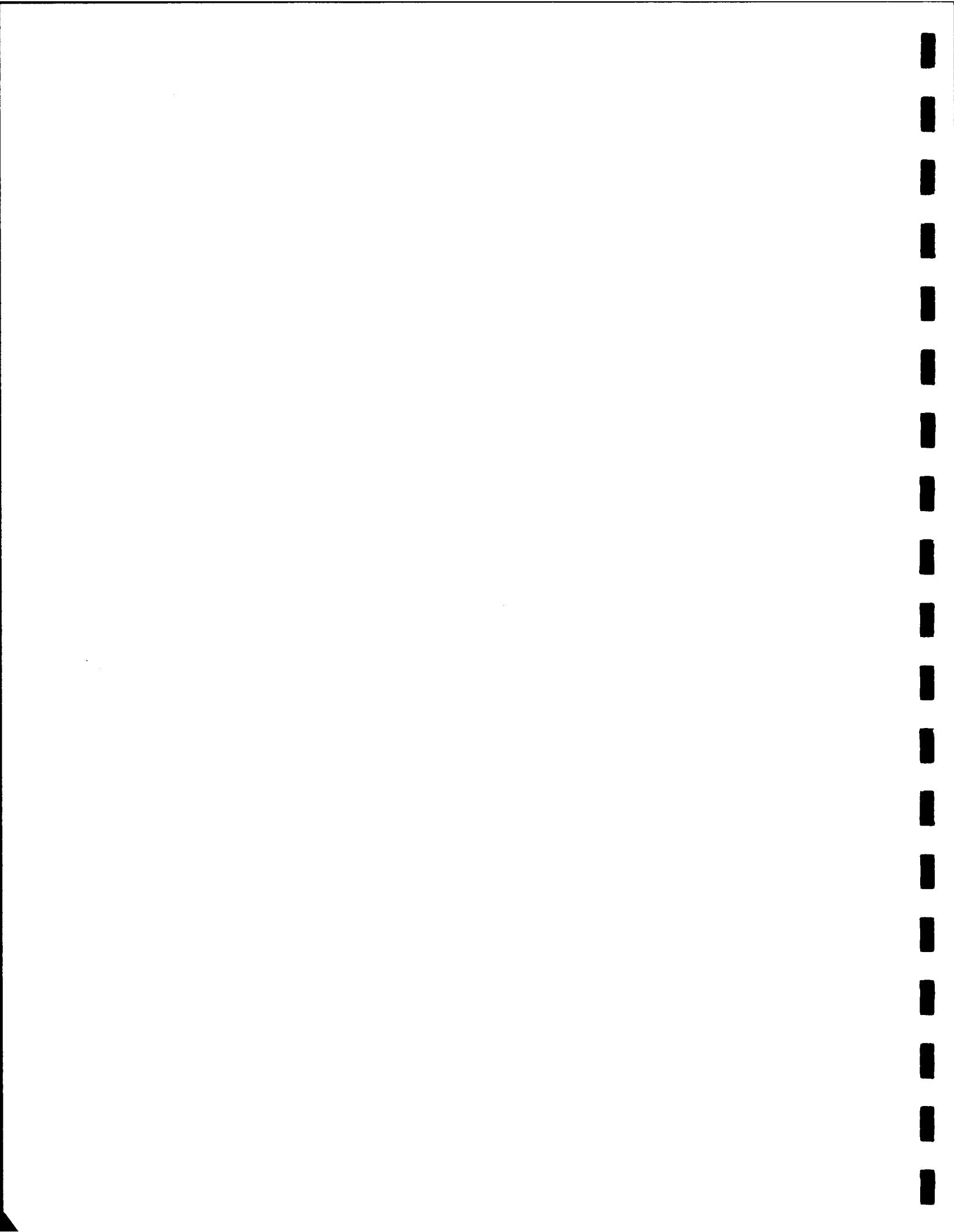
Thank you very much. I look forward to talking to you soon.

Sincerely,



Kurt D. Dossin
Director of Marketing
Multisystems, Inc.

Enclosures



The Company

Multisystems is a respected leader in the passenger transportation industry offering a full complement of consulting and planning services, specialized application software products, and management and operations services.

For over two decades, Multisystems has worked closely with public agencies and private companies to find cost-effective, state-of-the-art solutions to their specific transportation requirements. The Company's vast industry experience extends to

virtually all modes of passenger transportation including bus and rail transit, commuter rail, paratransit, taxi service, vanpooling and commuter ridesharing, pupil transportation, airport ground transportation, commuter boats, automated guideway transit and others.

Headquartered in Cambridge, Massachusetts, Multisystems was founded in 1966 by Civil Engineering faculty members of the Massachusetts Institute of Technology. The Company continues its close ties with

the academic community and, on certain projects, draws upon the experience of that community's independent transportation consultants.

Multisystems employs a core staff of 30 professionals in its Cambridge office, including transportation and management analysts, systems analysts, programmers, and operations specialists. The privately-held, employee-controlled firm has a regional branch office in Alexandria, Virginia, and a growing number of field offices.



Planning and Management Consulting

Multisystems' Planning and Management Consulting group offers extensive expertise in the areas of transportation systems planning, analysis, implementation, and management.

Over the years, Multisystems has undertaken projects for a wide range of clients, including the U.S. Department of Transportation, state transportation agencies, municipalities, transit authorities, paratransit

agencies, human service agencies, commuter ridesharing organizations, taxi companies, public school districts, and school bus and private bus companies.

The group's project experience includes management and performance analysis, performance audits, strategic long-range and short-range planning, feasibility studies and alternatives analysis, supply and demand modelling, policy analysis, fi-

nancing and privatization studies, computer needs assessment, data collection and analysis, service marketing and pricing, and market research.

Multisystems also provides consulting for operations activities such as system implementation planning, routing and scheduling, driver training, preparation of vehicle specifications, and fleet maintenance management.

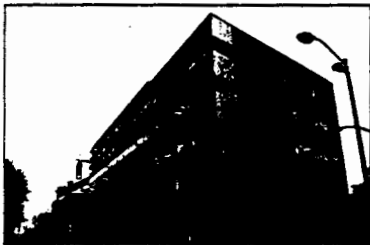
Application Software Systems

Multisystems provides a full range of transportation-related software products which are compatible with a variety of computer platforms - from mainframe to personal computers. These user-friendly products are categorized into nine application areas:

- Transit Operations Control (Vehicle Scheduling/ Runcutting/ Dispatching/ Timekeeping)
- Transit Data Collection and Route Analysis
- Transit Passenger Information
- School Bus Routing
- Route Generation, Street Network Management, and Map Production
- Paratransit Scheduling/ Management
- Fleet & Facility Maintenance and Inventory Management
- Financial Management and Administration
- Project Management

In addition to the Company's own software offerings, Multisystems serves as the exclusive U.S. distributor for a complete line of transit software developed by its Canadian partner, GIRO, Inc. of Montreal. Multisystems provides "full-service" support for the GIRO family of products, which includes the popular HASTUS vehicle scheduling and runcutting system.

Multisystems software products are currently in use at a variety of agencies and companies worldwide. Their



flexibility and ease-of-use ensures a cost-efficient solution for operations of all sizes. The Company's commitment to customer satisfaction is backed by a dedicated staff of computer hardware and software professionals who provide on-going support for off-the-shelf products, customize existing products to meet specific client needs, and design new custom solutions as required. In addition, through strategic alliances with firms which provide complementary hardware and software products, Multisystems also offers complete turnkey management information systems.



The HASTUS vehicle scheduling and runcutting system offers fast, mouse-driven, interactive color graphics.

Management and Operations Services

Multisystems' Management and Operations Division provides transit and paratransit operations management services through its wholly-owned subsidiary, Transportation Management Services, Inc. (TMSI), based in Alexandria, Virginia.

TMSI offers extensive experience with a variety of services including fixed-route and demand-responsive public transit, specialized transportation for the elderly and disabled, paratransit brokerages, commuter shuttles, commuter ridesharing, park-and-ride shuttles, parking lot management, and pupil transportation.

TMSI's "turnkey" operations provide complete services including vehicles, supervisors, drivers, vehicle maintenance, fuel, insurance, and administrative support. TMSI also provides programs for preventive maintenance and driver training.

As a broker of specialized transportation for several public agencies, TMSI offers expertise in client

registration, ticket sales, trip reservations and scheduling, contract negotiation, carrier payment, service monitoring, and a variety of administrative duties.

In addition, TMSI's field operations personnel provide a unique "hands-on" resource for Multisystems' consulting and software development staff.



The Company is an industry leader in specialized transportation services for the elderly and disabled.

MULTISYSTEMS

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Cover photo courtesy of Gary Davison, Niagara Frontier Transit Authority,
Buffalo, New York.

MULTISYSTEMS

SOFTWARE PRODUCTS OVERVIEW

Founded in 1966, Multisystems combines over two decades of software development and technical consulting expertise to provide a comprehensive set of application software products specifically designed for the passenger transportation industry and organizations with vehicle fleets.

In addition to the Company's own transit software offerings, Multisystems is a licensed Value Added Reseller of Caliper Corporation's powerful TransCAD Geographic Information System (GIS) software. Multisystems' products are internationally-recognized for both their capabilities and ease-of-use. The following products are available through Multisystems.

<i>Application Group</i>	<i>Software Product</i>
■ Transit Operations Control (bid processing, dispatch control, timekeeping)	BID/DISPATCH
■ Transit Data Collection and Route Analysis	VAX SERVICE PLANNING SYSTEM CHECK*MATE inTRANSIT
■ GIS, Route Generation, Street Network Management, and Mapping	TransCAD
■ Paratransit Management (client registration, vehicle scheduling and dispatching)	DISPATCH-A-RIDE MIDAS
■ Fleet Maintenance and Inventory Management	FLEET*MATE
■ Financial Management and Administration (accounting, management of fixed assets, grants, and personnel, and tracking of revenues, ridership, and driver performance)	ABS Accounting System FIXED ASSETS GRANT CONTROL REVENUE/RIDERSHIP OPETS PERSONNEL
■ Project Management (costing and scheduling)	M*TRAK MULTITRAK MULTITRAK/C

TECHNICAL CHARACTERISTICS, LICENSE FEES, AND OTHER SERVICES

Most of Multisystems' software products operate on 386- and 486-level IBM PCs (and compatibles) running under DOS, UNIX and Novell networks. Some of our products also operate under OS/2, as well as DEC and PRIME minicomputers and/or on IBM mainframes. In addition, our inTRANSIT data collection and analysis system is available on Macintosh Powerbook laptop computers.

License fees are typically dependent upon the number of users and the operating system environment. The license fees typically include a warranty period, telephone support, and user documentation. On-site training and annual support contracts are also available.

Multisystems can also provide the hardware on which these products run. This includes computers, terminals, boards, back-up devices, printers, and modems. The concept behind the "turnkey" system is three-fold: 1) "one-stop" shopping, 2) guaranteed software/hardware compatibility, and 3) below-list prices.

For More Information

Write or Call:

Kurt D. Dossin
Director of Marketing
Multisystems, Inc.
1050 Massachusetts Avenue
Cambridge, MA 02138-5381
Tel: 617-864-5810
FAX: 617-864-3521

11425A05.DOC

FLEETSERVICE PRODUCT DESCRIPTION

The AUTO-TRAC Fleetservice System provides complete Automatic Vehicle Location (AVL). The AUTO-TRAC supplied components of the Fleetservice System are:

- * Fleetservice Control Center
- * In-Vehicle Tracking Unit

The following provides a summary of the function of each of these components.

FLEETSERVICE CONTROL CENTER

The AUTO-TRAC Fleetservice Control Center functions run on two IBM PC compatible computers. The Fleetservice Mapping Controller manages the map display and manipulation, the real-time vehicle reports of location and status. The Fleetservice Communications Controller manages all communications to and from the vehicle, controls the AUTO-TRAC base station GPS reference receiver, and routes vehicle locations to the Fleetservice Mapping Controller.

FLEETSERVICE MAPPING CONTROLLER

The Fleetservice Mapping Controller provides the operator with easy-to-use menu functions. A mouse or keyboard may be used to access the functions. Different geographic areas can be displayed on each monitor. Most systems use one to four monitors. Up to 16 monitors are supported if required by the application.

Each monitor can dynamically display all vehicles in any specific geographic area or track one or more vehicles with several types of map control. A variety of map functions are available to control the specific geographic area and detail displayed on each monitor. The specific geographic area can be as large as the entire world or as small as a section of a city block.

The Fleetservice system provides high definition color street and road maps. Maps are available for all of the United States, most of Canada and many other areas of the World. Digitized maps can be created to provide coverage of other areas where only paper maps are currently available.

The size of the displayed geographic area on the monitor can be set by two different options, Zoom and Magnify. Zoom allows the operator to select the size in miles or kilometers (e.g. if 12 miles is selected the screen will display a 12 mile wide area). Zoom moves the view either closer or farther away using the same latitude and longitude as the map center. Magnify allows the operator to move to a smaller specific area within the displayed map. The operator uses the mouse to select the area to be enlarged.

There are several functions to display a different geographic area. The view may be moved North, South, East or West in full-screen or half-screen increments. This allows the operator to easily view the adjacent section of the geographic area being displayed. The view may also be moved by selecting a new Center for the map. This allows the operator to quickly see the vehicles around the particular point selected.

The view may be changed to a specific Point as the center. Entering an address both centers the map and places a reference symbol on the map. A symbol represents the status or type of call. The operator has a visual reference of the incident location and can identify the closest vehicles.

The levels of detail displayed on the maps are easily controlled. The operator can set the limits at which streets, street names, highways, highway names, interstates and interstate names are displayed. This allows the operator to see more information and detail at close range and to remove detail at larger distances to control screen clutter. The operator can request information about a specific street. The street's Address range of each block can be displayed. The Streets' name can be requested if the detail level setting causes the name not to be displayed.

Any monitor can be set in either Area or Vehicle mode. Area mode allows the operator to view a specific geographic area (e.g. Dallas County). Any vehicle in the selected geographic area will be displayed on the monitor until it leaves the area. The Vehicle mode allows one or more specific vehicles to be tracked on a monitor. There are four Vehicle modes. The first Vehicle mode is to "follow" one or more vehicles at a constant zoom range. The system automatically moves the map as the vehicle position changes. The second Vehicle mode option is "zoom". This is used to follow a group of vehicles. If a vehicle goes off the displayed map the system automatically "zooms" out to keep the vehicles on the displayed map. The third Vehicle mode option is to keep the map focused on a specific geographic "area". Vehicles will be displayed as they move into the area. This allows a portion of the fleet to be assigned to a specific monitor for viewing. The fourth Vehicle mode option is to identify a "point" on the map to always be in view. As vehicles move toward this point, the map is "zoomed in" and as they move away from this point, the map is "zoomed out". This allows an incident location to be identified and fleet movement observed with respect to the given incident location.

The Fleetservice Mapping Controller can keep several files on the vehicles being tracked. It records each vehicle's status and location for future reports and review. It keeps a chronological log of all daily activities and vehicle updates. This information can be printed for auditing or review.

The color of a vehicle's symbol can be set to correspond to the vehicle's status. An identification label can be displayed adjacent to the vehicle symbol. The label information may be from the vehicle data base or from the vehicle location data. The label's information options include: vehicle number, data base ID, unit ID, license number and note. This allows the flexibility to display a short vehicle number or a longer identification; such as, driver's name.

FLEETSERVICE COMMUNICATIONS CONTROLLER

The Fleetservice Communications Controller manages all data messages to and from vehicles. The Fleetservice Communications Controller can monitor any combination of eight telephone lines or base station radio controllers concurrently. Communications is initiated by either the In-Vehicle Tracking Unit or the Fleetservice Communications Controller.

The information received from the VTU is: vehicle status, speed, heading, latitude, longitude and satellites being used. Status switches (e.g. alarms, warnings, trailer disconnect) are also received if applicable.

The Fleetservice system allows the operator to change the operation of the In-Vehicle Tracking Unit such as, automatic reporting intervals. The VTU interval timer can be set to send location messages as frequently as once a second.

The Fleetservice Communications Controller can send data messages to a mobile data terminal attached to the In-Vehicle Tracking Unit.

The Fleetservice Communication Controller monitors real time GPS data that is received by AUTO-TRAC's base station GPS unit. This information is used to improve the location accuracy of the vehicles. The controller also monitors GPS status and displays a graphic illustration of all satellites which are in view.

IN-VEHICLE TRACKING UNIT (VTU) FLEET-TRAC V

The Fleet-Trac V is a radio interfaced tracking unit that is installed in the vehicles being tracked. It consists of a GPS receiver, a GPS antenna, a microprocessor, and controlling software. It connects to a radio modem and radio to transmit vehicle locations to a central site. The unit receives signals from three or more GPS satellites to calculate its latitude, longitude, speed and heading. It uses the results to make operational decisions. The processed message can then be sent to the Fleetservice Control Center or to a mobile data terminal.

The Fleet-Trac V has seven external ports, one for the radio modem, one for a mobile data terminal, one for a dead-reckoning device, and one RS232 port to connect to an annunciator system and another port which can be RS232 or J1708 (transit standard) depending on user requirement for monitoring external vehicle functions.

The transmission of location information is initiated in four different modes from the Fleet-Trac V:

- * Periodic - The VTU reports at a specified time interval (e.g. once a minute). The time interval can be changed from once a second to once a day.
- * Continuous - This is a second time interval that is normally smaller than the periodic interval. Continuous operation may be initiated by the driver, the situation, or the FCC. The mode is typically reserved for emergencies. The time interval can be changed from once a second to once a day.
- * On Request - The FCC requests the vehicle location or the driver initiates an action that sends the location.
- * By Exception - The VTU determines the location should be sent based on specified events, such as the vehicle speeding.

The "By Exception" mode can be programmed to send location information for many conditions; such as:

- * The vehicle is stopped too long.
- * The vehicle is outside its boundary.
- * The vehicle is speeding.
- * An input signal is recognized:
 - * The alarm is triggered.
 - * The light bar is activated.
 - * The truck is disconnecting the trailer.

The VTU is programmable and can be custom designed to fit specific needs.

IN-VEHICLE TRACKING UNIT (VTU) CELL-TRACKER

The Cell-Tracker is a cellular network interfaced tracking unit which is installed in the vehicles to be tracked. It consists of a GPS receiver, a GPS antenna, a cellular transceiver and antenna, a modem, an operator keypad, a microprocessor, and controlling software. The unit receives signals from three or more GPS satellites to calculate its latitude, longitude, speed and heading. It uses the results to make operational decisions. The processed message is then sent to the Fleetservice Control Center (FCC).

The Cell-Tracker keypad allows the operator to transmit status information to the Fleetservice Control Center. The keypad has four status keys and a key to initiate continuous operation. The status keys may be labeled to represent any desired function; such as, at location, in service, out of service, and emergency. When these keys are activated, the location and status are sent to the Fleetservice Control Center for display and appropriate action. The operator keypad also provides visual feedback about the unit's operation, including: ready, message received, continuous mode, and error.

The transmission of location information is initiated in four different modes from the Cell-Tracker:

- * **Periodic -** The VTU reports at a specific time interval (e.g. once a minute). The time interval can be changed from once a second to once a day.
- * **Continuous -** This is a second time interval that is normally smaller than the periodic interval. Continuous operation may be initiated by the driver, the situation, or the FCC. The mode is typically reserved for emergencies. The time interval can be changed from once a second to once a day.
- * **On Request -** The FCC requests the vehicle location or the driver initiates an action that sends the location.
- * **By Exception -** The VTU determines the location should be sent based on specified events, such as the vehicle speeding.

The "By Exception" mode can be programmed to send location information for many conditions; such as:

- * The vehicle is stopped too long.
- * The vehicle is outside its boundary.
- * The vehicle is speeding.

An external switch can be monitored to activate the VTU and place it in continuous mode. This capability can be used to indicate that the vehicle has been stolen, used as a hidden panic button, or used as a similar emergency indicator.

The Cell-Tracker effectively utilizes the cellular airwaves by making location transmission decisions based on the operation conditions. For instance, duplicate locations are not sent when a new position can not be calculated; such as, in a parking garage or tunnel.

The VTU is programmable and can be custom designed to fit specific needs.

FLEET-TRAC V
TECHNICAL SPECIFICATIONS

Operational Characteristics

Time to Fix on GPS:

- Warm Start * 30 Seconds
- Cold Start * 75 Seconds
- Voltage * 12 Volts
- Power * 6 watts. .45 amps at 12 volts

GPS Characteristics

- GPS Receiver * 5 discrete channels
4 channels for position computation, 1 channel for searching for new satellites
- GPS Antenna * Passive or active in a variety of packaging

*Typical Accuracy

- Position * <10 meters corrected
- Velocity * <1 MPH

Environmental Characteristics

- Operating Temperature * -10 + 70 degrees C
- Humidity * Up to 95% non-condensing
at 38 degrees C
- Altitude * -400 to +20,000 Ft.
- Package * Splash-proof

Physical Characteristics

- Dimension * 9.7" x 4.9" x 2.7"
(247mm x 69mm x 125mm) Box
- With Bracket: * 9.7" x 6.2" x 2.7"
(247mm x 69mm x 157mm) Box
- Interface * RS232-communications (radio modem)
* RS232-mobile data terminal
* RS232-for auxiliary devices
* Four inputs - trigger, high or low
* Four controlled low current outputs

* GPS accuracy is subject to changes.

CELL-TRACKER
TECHNICAL SPECIFICATIONS

Operational Characteristics

Time to Fix on GPS:	
Warm Start	* 30 Seconds
Cold Start	* 75 Seconds
Voltage	* 12 Volts
Power	* 6 watts .45 amps at 12 volts

GPS Characteristics

GPS Receiver	* 10 discrete channels 9 channels for position computation, 1 channel for searching for new satellites
GPS Antenna	* Passive or active in a variety of packaging

Cellular Phone Characteristics

Wattage	* 3 Watts
---------	-----------

*Typical Accuracy

Position	* <10 meters corrected
Velocity	* <1 MPH

Environmental Characteristics

Operating Temperature	* -10 + 70° C
Humidity	* Up to 95% non-condensing at 38° C
Altitude	* -400 to + 20,000 ft.
Package	* Splash-proof

Physical Characteristics

Dimension	* 9"D x 8"W x 3"H (228mm x 203mm x 76mm) Box
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Vehicle Operator Keypad

- * Four status inputs
- * Continuous operation initiation input
- * Four indicator lights

Signal Interface

- * One switched input

* GPS accuracy is subject to changes.

FLEETSERVICE CONTROL CENTER
HARDWARE/SOFTWARE

A. Fleetservice Mapping Controller Computer

Intel 486 66 MHZ & 8 MB Internal Memory
I/O card with 2 Serial/ 1 Parallel/ IDE Control
200 MB Hard disk
3.5 Floppy Disk Drive
120 MB Tape Backup Drive

- * Monitor Controller for 1-4 VGA Monitors
- Enhanced Keyboard
- Track Ball
- * VGA Monitors (1-16)
- Power Outlet Strips

- * The number of controls and monitors are options.

B. Fleetservice Communications Controller Computer

Intel 486 66 MHZ & 4 MB Internal Memory
I/O card with 2 Serial/ 1 parallel/ IDE Controller
44 MB Hard Drive
3.5 Floppy Disk Drive
Monitor Controller VGA
Controller Board for up to 8 RS232 Communications Ports

- * Modems (1-8)
- Enhanced Keyboard
- VGA Monitor
- GPS Base Reference & Connections

- * The number of modems is dependent on the number of telephone lines installed.

C. Software

MapInfo for DOS
Required Maps
AUTO-TRAC's Real time Fleetservice
AUTO-TRAC's Communications Control Pac

- * Specifications may change without notice.

CadPak

The Complete Computer Aided Dispatching
and Automated Vehicle Locating System

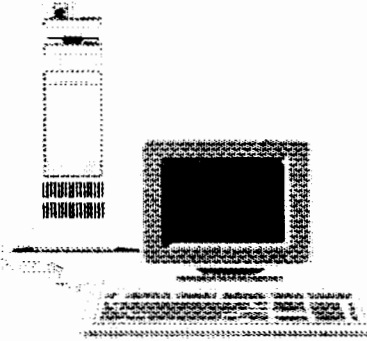
by **Advanced Control Technology**

"Leadership in Automation, Communication and Information Systems"



CadPak Packaged Systems Include:

- ✓ One (1) OS/2 Presentation Manager
CAD Workstation Host with DB2 Database
- ✓ Cellular or *RacoNet* Communication Gateway
- ✓ Color Map Displays & Geobase of User's Area
- ✓ Ten (10) Ruggedized PC Mobile Data Terminals
with Radio Modems and GPS Receivers
- ✓ **CadPak** CAD/AVL Application Software
- ✓ Documentation, Startup Assistance & Training



CadPak Dispatch Workstation
and Communication Gateway

CadPak Packaged Systems Provide:

- * Call-Taker Service Order Creation & Review
- * Geospotting of Call Service Orders on Map
- * Geospotting of Vehicle Resources on Map
- * "Point and Click" Digital Dispatching of
Customer Service Orders to Selected
Vehicle Resources
- * Dynamic Status Monitoring of Service
Orders and Vehicle Resources
- * Two-Way Digital Messaging
- * Database Records Management
- * Mobile Data Terminals featuring *Windows*
for Pen **CadPak** Electronic Workorder
Form Displays



CadPak Color Map Displays

CadPak Packaged Systems Enable:

- ✓ Low-cost CAD/AVL Pilot System Evaluation
- ✓ System Expandability to Full Fleet Deployment
- ✓ State-of-Art Dispatching Technologies
- ✓ Customized Application Development Services from the
Leader in Graphical Based CAD/AVL System Integration

CadPak In-Vehicle



Mobile Data Terminal

Advanced Control Technology, Inc.

2830 Ferry Street - P.O. Box 1148 - Albany, OR 97321
Telephone: 503-967-8000 - FAX: 503-967-4196



Advanced Control Technology, Inc.

Company: Advanced Control Technology, Inc.
(ACT)

Product Name: Computer Aided Dispatching (CAD) and
Record Management Systems (RMS)
for Vehicle Fleet Management

Industry: Public Utilities

Segment: Gas, Water, Steam, Electric, Telephone, CATV

Description: ACT's Computer aided dispatching (CAD) systems for public utility service department vehicle fleets provide the computer interface to customer service department call taking systems to optimize the messaging and dispatch of field resources in response to customer calls for service. These vehicle Fleet Management Systems provide Automated Vehicle Locating (AVL) techniques utilizing Global Positioning System (GPS) technologies. Graphical dispatch computer workstations provide geographic mapping displays of both the available service vehicle unit's position as well as the geopositioning of the service call's location. Dispatcher personnel use the graphical workstations to select and digitally dispatch available vehicle resources to the calls for service. Digital dispatching to the selected vehicle is provided by a communications controller computer which routes the message via the utilized wireless wide-area network link (trunked radio, conventional radio, cellular, satellite, etc.) to the assigned vehicle's onboard mobile data terminal. The CAD Host Computer provides for automated records management (RMS), relational database management and interface to other computers within the users computing environment.

Target Market: Public Utilities vehicle fleet operators seeking CAD, RMS, and information systems integration.

Language: C, C++

Hardware: IBM, DEC, HP, Data General, Unisys, Sun Microsystems

Operating System: RISC, VMS, OS/2, UNIX, DOS, Windows

Contact: Jerry Stockweather - Project Mgr. Fleet Management Systems

Address: P.O. Box 1148
2830 Ferry Street

City, State & Zip: Albany, OR 97321

Full Phone: (503) 967-8000; FAX (503) 967-4196

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Advanced Control Technology, Inc.

ACT Dispatcher Workstations

Summary of Operations

Advanced Control Technology's Dispatcher Workstations integrate on a single computer screen all of the information needed for fleet dispatching. The screen is divided into separate "windows", each of which showing a different type of information. The windows display a color street map, a summary of calls, a summary of units, a list of pending calls, details about a call, and messages and prompts. The workstations also include all of the commands necessary to perform fleet dispatching operations.

Color-Coded Street Maps

The color street map shows the locations of high-priority and low-priority calls by using different colors. Each call marker is labeled with the call number. The map also shows the location of units. Each unit marker includes the unit identifier and the marker color indicates the units status (e.g., Enroute, At-the-Scene, In-Service, Out-of-Service, Emergency). Temporary map features such as blocked roads or detours can be easily added. The map also has overlays showing the boundaries of districts, routes, and service areas. Each workstation shows only the calls and units assigned to the dispatcher's agency or area of operations. However, the dispatcher can also switch on or off the display of other "foreign" units located in the same area but being managed by other dispatchers.

The dispatcher can control the map display by using the following features:

- District Maps*
- Precinct Maps*
- Zoom In*
- Zoom Out*
- Map Zoom/Pan (Changes map scale and area)*
- "Foreign" Units On/Off*
- Low Priority Calls On/Off*
- Units On/Off*
- Calls On/Off*
- Find Unit (draws map centered on selected unit)*
- Find Call (draws map centered on selected call)*
- Find Address (draws map centered on address)*

When a dispatcher reviews a call, the computer automatically finds the call and redraws the map with the call at the center of the map. The map shows all units near

the call, along with their status. The dispatcher selects available units for dispatch by pointing the cursor to units on the map (or in the Units List) and presses a single key on the mouse. The computer generates automatically a dispatch message and sends it to the mobile data terminals in the selected unit(s). The units acknowledge receipt of dispatch messages by pressing a function key on their terminals to execute a status change (Enroute). When this happens, the color of the unit marker on the dispatcher's workstation map changes. When the unit arrives, the unit executes another status change (At Scene). The workstations make dispatching operations much easier and certainly faster.

Current Calls Window

Another window displays a summary of current calls. The summary shows the call number, the call type (in plain English), its priority, and which unit(s) are assigned to the call. The dispatcher may sort the Call List by call number, by call priority, by call status, or by precinct. The dispatcher may scroll the Call List and select calls for review or other operations in any order.

Units Managed Window

This window displays a summary of units managed by the dispatcher. The summary shows the unit identifier, the unit type, its communications equipment, and its assigned call. The dispatcher may sort the Unit Roster by assigned call number, unit identifier, status, or unit type. The dispatcher may scroll the Unit Roster and select units for dispatch or other operations (e.g., status changes).

Details Window

This window displays details about a single call. The workstation will automatically display details for the recommended next call. Alternatively, the dispatcher may select a specific call for review.

Dispatcher Mouse-Selectable Commands

- Review Call*
- Dispose Call*
- Cancel Call*
- Start Dispatch*
- Change Unit Status (for non-automated units)*
- Change Unit Location (for non-automated units)*
- Remove Unit from Call*
- Send Message to Unit (to MDTs)*
- Read Messages from Units (from MDTs)*
- Request Current Locations of Available Units*
- Request Current Location of Selected Unit*

For More Information Call:

Advanced Control Technology
P.O. Box 1148 - 2830 Ferry Street
Albany, Oregon 97321
(503) 967-8000 - FAX (503) 967-4196



Advanced Control Technology, Inc.

NEWS

ADVANCED CONTROL TECHNOLOGY, INC.
2830 Ferry Street
P.O. Box 1148
Albany, Oregon 97321
Contact: Tom Sharp (503) 967-8000 - FAX (503) 967-4196

FOR IMMEDIATE RELEASE

#

ACT Introduces CadPak Computer Aided Dispatching and Automated Vehicle Location System

ALBANY, Oregon – October 1, 1994 – A new system product by Advanced Control Technology, Inc. (ACT), simplifies the implementation of fleet dispatching and vehicle tracking systems. CadPak is a graphical based Computer Aided Dispatching and Automated Vehicle Location system (CAD/AVL) that is a packaged, expandable, low-cost alternative to customized fleet management systems. ACT will display the CadPak system in the McCaw Cellular booth at *Comdex/Fall '94* in Las Vegas, November 14-18, 1994.

The CadPak system provides service workorder creation and location spotting as well as vehicle position tracking on a geobased color map workstation display. Other major system features include "point and click" dispatching of service workorders to selected fleet vehicles, two-way digital messaging, pen-based electronic workorder form displays and database records management. CadPak is well-suited for either small stand-alone systems or for a pilot system evaluation which is then upgradeable to accommodate much larger vehicle fleets.

(over)



EASY STREET

EASYTRIPS™

COMPREHENSIVE SOFTWARE FOR PARATRANSIT

SO, WHAT IS "EASYTRIPS"?

EasyTrips™ is a computer software program, explicitly designed for Paratransit operations. It is an information manager that can perform many different functions. It takes client reservations. It develops routes and schedules. You can dispatch vehicles and drivers. It generates reports and billings, monitors vehicle, driver and client activity. It tracks vehicle maintenance, client complaints, maintains records of driver training and experience. The list continues but, in brief, EasyTrips™ does everything you are ever likely to need to operate a Paratransit service.

EasyTrips™ is "modeling" software. Insofar as software can, it creates a model of your operation and allows you to input the various factors that make your operation unique and thus adjust the nature of the model to suit your circumstances and needs. Once EasyTrips™ 'knows' the details of your operations it can advise you of the most cost-effective means of allocating scarce resources. Best of all, it does it quickly and easily taking full advantage of the latest developments in the speed and power of personal computers. By letting the computer store and retrieve (and act upon) the large volume of information it takes to operate a paratransit system, humans are relieved of the burden of remembering all the myriad details. The manager has more time to manage and plan. The dispatcher position becomes well-informed (and less stressful!). The drivers become more efficient and the clerical workload is minimized.

If you have already invested effort in GIS (maps), EasyTrips™ can make full use of this investment. You can operate as a single user or on as large a network as you may require. EasyTrips™ can also be configured for Taxi operations, for brokerage or for volunteer services. It is a unified system, encompassing all the necessary aspects required for paratransit (and beyond), and if there happens to be something truly unique about your system, we will be happy to discuss custom software to meet your needs. Once you have used EasyTrips™ for just a short while, you are going to wonder how you ever managed without it.

Nice and Easy

EasyTrips™ includes:-

Client Registration and Reservation - Everything you wanted your software to know about your clients but were afraid to ask for. EasyTrips™ answers in seconds.

Dispatching - Ride 'shotgun' on any vehicle in the fleet at any time throughout the day. With EasyTrips™ it's almost like being there!

Grouping - How about assigning 1,000 trips traveling at different times with a host of different constraints onto 30 vehicles? If you're doing it manually - lots of luck and you'll need a big map, plenty of paper, a large box of pins and inexhaustible patience. EasyTrips™ can provide optimal results in minutes.

Routing and Scheduling - The shortest distance between two points isn't always a straight line - especially if there's a river in the way. EasyTrips™ provides driving paths along the street network and you won't get your feet wet!

Reports and Output - you might run out of paper before you exhaust the many reports you can obtain. EasyTrips™ includes a fully featured ad-hoc report generator.

Billing - Billing modules are generally unique to a particular provider - EasyTrips™ contains standard reports or we can customize for you (free of charge, too!).

ADA - A full registration questionnaire is included and the program automatically determines geographic eligibility on a trip by trip basis. Soon to be released, a comprehensive and seamless join to fixed route schedules.

Maps - There are maps and then there are 'intelligent' maps. Of course the basic street network has to be accurate (your own GIS may well be the best information available) but then we 'educate' the map - with driving speeds, traffic signals, one way streets and a host of other details. Using EasyTrips™, you can almost see the asphalt!

Think of EasyTrips™ as being to a paratransit operation what word processing software is to a secretary - an invaluable addition to improve productivity, reduce errors and just generally make things run more efficiently and more smoothly. It will promote more productive use of your vehicles and drivers and its use will result in real reductions in operating costs or, alternatively, additional capacity within your existing budget. Higher on time performance, better customer relations, less hassle. EasyTrips™ is tried and tested, it is clear, quick, intuitive and easy to use and, much like the word processor, it will soon become an indispensable and integral part of your daily operations. You're just going to fall in love!

EASY STREET

EASYTRIPS™

COMPREHENSIVE SOFTWARE FOR PARATRANSIT

CLIENT REGISTRATION AND RESERVATION

- ✓ **Clear, logical, intuitive data entry screens.**
- ✓ **Recall a client from the database by account #, telephone # or last name.**
- ✓ **Enter all pertinent personal client details.**
- ✓ **Record normal home address and/or an optional alternate address.**
- ✓ **Note disability details, special needs and specific driver comments.**
- ✓ **Automatically locate clients on the street network.**
- ✓ **Automatically verify ADA eligibility - by category and geography.**
- ✓ **Recall regularly used destinations**
- ✓ **Record trip purposes.**
- ✓ **Repeat past trips changing only minimum trip information such as date of travel.**

Nice and Easy

- ✓ **Schedule the trip 'on the fly' (while the client is on the telephone) on the most logical vehicle in any time frame - immediate or 14 days or more in advance.**
- ✓ **Specify maximum ride time and expected dwell time at pickup location**
- ✓ **Set up complex subscription patterns - every third Tuesday and every other Thursday.**
- ✓ **Activate/suspend clients for defined periods.**
- ✓ **Record funding eligibility and period of authorization - uniquely to a single trip.**
- ✓ **Enter ADA eligibility factors from a comprehensive questionnaire.**
- ✓ **Specify guests or Personal Care attendants.**
- ✓ **Recall and review all past trips for the client.**

Typically a trip can be booked and, if it is a demand response trip, scheduled within around 1 1/2 minutes (on slower computers it will take longer) and thus the entire transaction can be accomplished in a single telephone call, eliminating any need to call clients and confirm their appointment times.

EasyTrips™ is designed to quickly recall, record or edit client and trip details. It includes many "short-cuts" to reduce keystrokes and simplify data entry. There are two 'classes' of data which are generally entered - basic data such as names, telephone numbers and so on, and also data which govern the scheduling of the client and/or the trip such as maximum ride times and the like. It performs these functions so that it can 'recognize' the very human element of paratransit - the need to balance operating efficiency with the constraining features of client needs and characteristics.

EASY STREET

EASYTRIPS

COMPREHENSIVE SOFTWARE FOR PARATRANSIT

ROUTING AND SCHEDULING

- ✓ Take complete 'manual' control of vehicle scheduling or have EasyTrips™ do the hard work for you. You may perform manual, "computer assisted" or fully automated routing and scheduling.
- ✓ Selectively route only certain groups of clients.
- ✓ Create Route Masters which can be used over an extended period of time - say three months or so and which automatically adjust to cancellations and additions to the schedule.
- ✓ Control multiple fleets (for example different counties) with different driver and vehicle resources.
- ✓ Add demand response clients, either during the trip reservation process or at a later time in 'batch' mode.
- ✓ Mark drivers or vehicles as absent or 'off road' on particular days and automatically re-adjust the schedule.
- ✓ Automatically prevent the routing of clients whose funding has expired or who have been suspended for some reason.

Nice and Easy

- ✓ **Recognize that different drivers have different levels of expertise and take this into account during the scheduling process.**
- ✓ **Specify which vehicles can 'overnight' at a driver's home.**
- ✓ **Optionally refine the routing using the street map and develop a set of driving path instructions - "Turn left on 1st St and go 0.33 miles (50 seconds); turn right..."**
- ✓ **Optionally produce route maps - especially useful for novice drivers along with the driving instructions.**
- ✓ **Optionally produce comprehensive driver manifests.**

We call our routing and scheduling module "Gathering" because this is where all the many different 'pieces' of client, trip, driver, vehicle and street-map information are gathered together. Almost all the data input to EasyTrips™ comes to bear in this algorithm so that all the 'global' and all the individual client "rules" or constraints are obeyed and/or recognized.

Consequently, the user doesn't have to remember all the individual little 'quirks' and details which pertain to individual clients. At all times EasyTrips™ will observe the rules laid down and, while observing those rules, will produce an effective and efficient schedule - one that is achievable, adheres to on-time performance stipulations, maximum ride times, vehicle capacities, driver capabilities and a host of other factors and it will do it in minutes.

Typically, Masters are produced every so often - say once every two or three months - from the subscription trips currently in the system. Each individual "day" is derived from the relevant Master (or it can be developed from scratch) and this then becomes the basis for adding in demand response trips. Alternatively, subscription and demand response trips can be routed in batch mode all together.

Once a schedule has been either newly developed or derived from the Master, then the pickup and dropoff times remain relatively 'fixed'. If a new trip or a will-call return is then scheduled (say, on the day of service), then it must 'work around' the existing trips since the clients who have already been scheduled will very likely have been advised of their trip times.

EASY STREET

EASYTRIPS

COMPREHENSIVE SOFTWARE FOR PARATRANSIT

DISPATCHING

- ✓ Automatically produce a readily understandable visual chart of daily vehicle activity so that the dispatcher can clearly see not only what is happening (or supposed to be happening) now but also what happened previously and what is due to happen throughout the rest of the day.
- ✓ Allow the dispatcher to quickly retrieve the most minor details about a particular trip. Who requested it? Who to contact in an emergency? Who's paying for it? Do they have special needs? When is the vehicle due to arrive?
- ✓ Thus the dispatcher can readily move from the 'big picture' down to the finest of details - with a minimum of keystrokes.
- ✓ Schedule demand response trips and/or will-call return trips 'on the fly'.
- ✓ Supply the dispatcher with a series of tools to assist with either retrieving information or with dealing with emergencies such as a vehicle breakdown.
- ✓ As the schedule develops, allow the dispatcher to update with actuals - cancellations or no shows, early/late arrivals, voucher (coupon or ticket) numbers and so on. Then react to new requests in the light of those changes.

Nice and Easy

VEHICLE/ROUTE SUMMARY
 VEHICLE: 220 FORD VAN ROUTE: ES100/R1001812.DSP
 CAPACITY: 10 EXPECTED RUN TIME: 08:10 NIMS
 ALLOCATED: 0 ROUTE RUNS 05:10 TO 14:13
 SPARE CAP: 0 DRIVER: CROGAN, WILLIAM L.00
 LAST "20": 0 STATUS REQUESTED AT: 08:00

ROUTE/CLIENT DETAILS		
PICK UP:	G BEVELL	2121 Salem Ave Sw 05:10 08:55
PICK UP:	E FURROU	511 King George Ave Sw 07:01 09:00
PICK UP:	U ARQUILLA	110 Mountain Ave Sw 09:05 09:00
PICK UP:	H OVERSTREET	705 Marshall Ave Sw 09:07 09:00
PICK UP:	C KEGLEY	1026 Campbell Ave Sw 09:10 09:00
PICK UP:	R SEXTON	1142 Minona Ave Sw 09:13 09:00
PICK UP:	F CARTER	2355 Denniston Ave Sw 09:17 09:00
PICK UP:	L DUNFORD	2632 Westover Ave Sw 09:21 09:00
PICK UP:	M DAVIS	1027 Fareham Rd Sw 09:26 09:00

DETAILS REMOVE CLIENT INSERT CLIENT NO SHOW/CHCL MAP INS PRINT UP/DOWN FRG

The above screen capture shows a few of the many facilities available to the dispatcher - a tour list with arrival/departure times at each stop point, zoom maps of an individual trip's origin and destination, menus for working with trips and/or retrieving information and so on.

In addition to these paratransit tools, EasyTrips™ can be configured for "taxi-style" dispatch. Taxi trips are very different in nature to paratransit trips - frequently, they lack much of the information and data which we expect with paratransit trips. They may have no specified destination and hence no drop-off time. We may not even know the client's name. The taxi dispatch module blends together these 'unknown' trips with the much more precisely defined paratransit trips and is geared specifically at the needs of the taxi operator who runs mainly taxi-style trips with the addition of some paratransit trips.

Both paratransit and dispatch tools have much in common and are comprehensive in their ability to aid and complement the dispatch function. To the extent possible, they allow the dispatcher to manage events rather than be managed by them. The information is readily to hand and the tools to act (or react) to changing circumstances gives him or her a very high degree of control over the day's events.

EASY STREET

EASYTRIPS™

COMPREHENSIVE SOFTWARE FOR PARATRANSIT

REPORTS, BILLING AND OTHER USEFUL STUFF

- ✓ EasyTrips™ includes a powerful and fully featured report generator - an ad-hoc reporting system which allows you to create report formats, filter and select data and so on.
- ✓ Many standard reports and statistics are available throughout the system. Trip reports, attendance reports, tour statistics and many other useful listings are available which can be viewed on-screen or printed as needed.
- ✓ Billing modules are generally unique to a particular provider, however, most of the time, they are usually relatively minor variations on a billing system which we have already encountered. We customize billing modules free of charge since we anticipate this need and build it in to our base cost. Typically a billing system will automatically generate trip costs according to a pre-defined set of rules and then produce listings or invoices as necessary. The user is allowed to edit and manipulate the trips if needed but most of the processing is done automatically 'in background'. We have also worked with electronic submission of Medicaid claims and the like.
- ✓ Mobile Data Terminals - In-vehicle units which receive/transmit data from/to the dispatch computer - are fully developed with EasyTrips™ although, if a different manufacturer's MDT is specified than one which we have used so far, there may be some custom software required to interface to that MDT.

Nice and Easy

- ✓ **Automatic Vehicle Location equipment is also fully integrated with EasyTrips™ and incoming positioning data is automatically integrated with the routes.**
- ✓ **EasyTrips™ also contains a full complaint/commendation module which allows the user to record and track complaints, accidents and such.**
- ✓ **Vehicle Maintenance can also be recorded and tracked through an add-on vehicle maintenance program.**

EasyTrips™ is a full-featured software program, designed specifically for the many wonderful, sometimes strange, features and needs of paratransit operators and their clients. The richness of the program's many functions reflects the diversity and variability of the unique needs of operators in different locations, funded in different ways with often different local policies and constraints.

As software programmers, we find it challenging and intensely absorbing - there is never a site that does not have some new 'angle', some new insight into paratransit, some subtly different requirement. This does, after all, reflect the diversity of humans themselves - whether they be clients, providers or local governing bodies. No other industry that we know of has quite the number of unique twists and turns!

In large part, it is up to the software to "move towards" the provider insofar as it is practical to do so, but it is equally necessary for the users to, in some fashion or another, "move towards" the software. We have attempted in our design of the program to make this migration as simple as possible and we have also adopted the philosophy that custom programming - to one extent or another - is a feature of the industry which, if we are to continue to be responsive to its needs, we must willingly undertake.

We not only do this willingly, we welcome it! Inputs such as these serve to continually improve the product for the benefit of all concerned - existing sites as well as new ones.

We have rarely encountered an individual in paratransit who does not have a deep and abiding understanding and feeling for the clientele they serve. We also try to reflect this in our software by building in the features which recognize the meaning and ultimate purpose of paratransit operations - to serve a population of people, frequently less fortunate than ourselves but each of whom have their own particular needs and circumstances. It is indeed challenging but it is also very rewarding (and it can also be fun!).

TEAM A·D·S

Automated Dispatch Services (A.D.S.) is a service company providing specialized services in the transportation field. These services range from call-taking, routing, scheduling and dispatching to vehicle monitoring and driver training.

A.D.S.' origins are in software development. Development of the EMTrack computer-aided-dispatch (CAD) system began in 1987 and was initially sold to ambulance and paratransit companies and government agencies throughout the United States. The experience gained during the consulting portion of the software installation prompted A.D.S. to open its own dispatching center.

The doors opened in the Miami Dispatch Center in 1989, the client was an ambulance company running 200 rescue and routine calls per day. The challenges of dispatching ambulances prompted A.D.S. to adopt the philosophy that continued enhancements to the computer software were integral to providing good service. Among other things, a rugged system, capable of running 24 hours a day and 365 day a year was necessary. Furthermore, ease-of-use and flexibility were primary requirements so that A.D.S. could expand its dispatch center.

Today the Miami Dispatch Center dispatches over 6500 calls per day for eight different companies. Different types of ambulance and paratransit calls are simultaneously handled through one integrated computer system. Call taking personnel are easily able to access information for any of the types of calls.

Through the experiences gained in growing not only the Miami Center, but also the turnkey software systems and other centers, A.D.S. has formed a team capable of taking on any new transportation problem. This is accomplished by combining automation and management skills to create easily understood and manageable procedures for the employees.



Learn the Advantages Team A.D.S. Can Offer

You can run your company more efficiently -- and therefore more profitably -- with the help of the unique customized, computerized, copyrighted dispatch services of Team A.D.S.

If transporting clients, delivering products or making service calls is part of what you do, Team A.D.S. can do for you what we do for our Emergency 911 clients -- dispatching their units faster and more economically than they can do it for themselves.

We tailor our services exactly to each client's needs. For example, we can:

- Handle transactions during any or all segments of every 24-hour day
- Suggest the best vehicle for each transaction
- Plot the fastest delivery route for each driver on each trip for any given day or hour, factoring in traffic patterns and disruptive weather
- Track your inventory, each driver's time, each vehicle's use and maintenance schedule
- Send you printed and/or electronic records of all your transactions every day, week or month according to your preference
- Provide audio tape records of every transaction, from initiating phone call to final disposition
- Link you to our system, at no cost to you, so you can monitor your ongoing transactions from your office telephone at any time

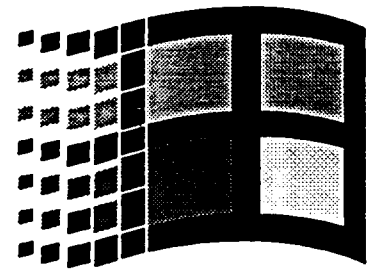
When Team A.D.S. handles your dispatch, your customers never know it. We answer their calls only with your firm's name.

You have no start-up cost, no equipment cost and no initiating fee when you sign on with Team A.D.S. What's more, we bill you only for each revenue-producing transaction. If your client is not available for transport, if your customer refuses to accept a product delivery or is not at home when your repairman keeps an appointment, you are not billed for that dispatch transaction.

In three full years of operation, no client has ever cancelled our services.



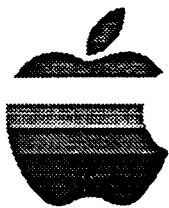
Cadmos-Pro+ Systems Software and Hardware Specifications



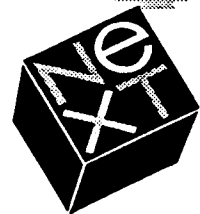
MICROSOFT
WINDOWS
COMPATIBLE



NOVELL



1995



MDC

Micro Dynamics Corporation
3114 Tamarack Ct. • Suite 906
Evansville, Indiana 47715
Phone: (812) 477-3090



MDC

Micro Dynamics Corporation

P.O. BOX 5306

Evansville, Indiana 47716-5306

Phone: (812) 477-3090

Note: Address change above!

CADMOS Pro+

Labor Saving Features Pricing and Information guide.

Thank you for a "Request for Proposal" up-date concerning a possible *CADMOS Pro+* dispatching solution for your operation. Micro Dynamics Corporation provides computer solutions to many areas of the transportation industry, including Paratransit, Taxi, Trucking Companies, Delivery Services, etc. Micro Dynamics Corporation is a family owned business that has been delivering very powerful, cost effective business solutions since 1987.

Micro Dynamics Corporation is a systems integrator for PC products, Novell Networking, Apple Macintosh products and the new NeXTSTEP™ Mach Unix Computer systems, plus large RACK mounted dispatch hardware for systems handling 5000 to 10,000 trips a day. Micro Dynamics Corporation provides both "off the shelf" and totally customized solutions or we can provide consulting services for systems integration of network system designs as well as comprehensive training and support for all our clients.



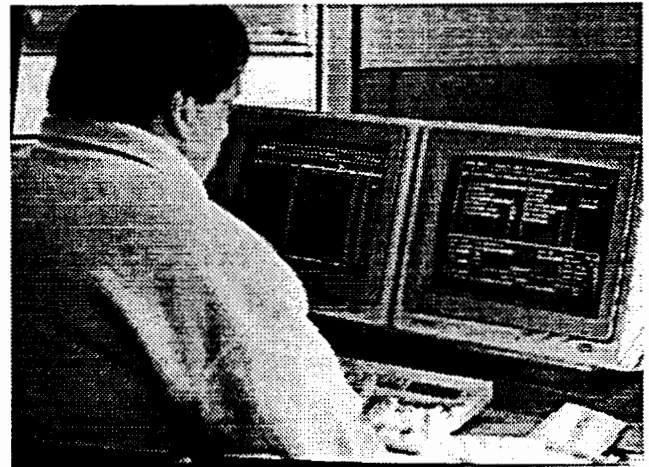
CADMOS Pro+ is our new updated version of our older industry standard *CADMOS PRO*, that has undergone major improvements including exceeding the requirements of an Immediate Demand-Response [Dial-A-Ride] Dispatching solution and Pre-scheduled Paratransit dispatching solution that you might require. *CADMOS Pro+* operates as a true multi-user 4GL Database system that can track over 10,000 trips per day, 200,000+ clients, over one year of historical data, etc. **using the appropriate hi-speed computer equipment**, plus *CADMOS Pro+* is fully compatible with an IBM PC AT (or 100% compatibles) and Novell Netware.

Reservation clerks are always in control of any call taking situation because *CADMOS Pro+* permits many types and combinations of trip requests to be processed with one basic set of entry screens. Reservations may be scheduled for pick-up within 60 minutes of calling in or months in the future for any visitor that comes to town. Standing Orders, Slot Scheduling, Pre-Scheduled, Immediate scheduled, Will-Call, and multiple Return Trips are easily processed by *CADMOS Pro+*.



Training time takes about (1) hours per module, and does not require extensive documentation manuals. With the built-in HELP screens, dispatching functions are quite easy to learn, especially when the Dispatch Workstation(s) are equipped with Dual 17" SVGA screens (OPTIONAL) to permit any dispatcher to always see the dispatch board, while entering calls or editing other information on the second SVGA screen. Dispatchers may switch the dispatch board screen from a 25 line screen to a 60 line screen to allow a greater number of trips to appear on the dispatch board. **CADMOS Pro+** does not use the "window overlay" concept to "hide" important information from the dispatcher at critical times like other systems.

The Street Management Data Base system is complete with longitude-latitude reference tables for each of the street segments to allow the addition of (Optional) Automatic Vehicle Locator (Loran or GPS) Units, Mobile Data Terminals (MDT's), and ANI monitoring systems. A separate dedicated Access server option, with 17" SVGA Color monitor for viewing the "Post Board Operations" and verifying who is in any zone, vehicle locations, etc. may be added to the file server.



Operators may manually enter any type of Mapsco, ADC type map books, street ranges with zip code references, map reference page numbers, map grid references. You may also purchase our ready made Tiger File Data Base containing the street names, ranges, zip code references and longitude-latitude references (GEO-Coding) from Micro Dynamics Corporation to reduce this manual entry time.

The optional "Instant" Graphical Street Mapping Software Module, permits the dispatcher to locate the nearest cross-street on a VGA Graphic map in under five (5) seconds. The dispatchers have access to mapping by pressing a single function key. Newly constructed housing areas can be surveyed and the data manually entered, then with our Graphical map editor and with a commercial MAP-CAD product such as **MAPInfo™**, you can create additional map drawings and import them to your ever expanding Street Mapping data base.

MAPInfo™ based products cost around \$ 3,000.00 and can provide up-dating capability of the map data and changes that can be exported to our system. Interesting enough, most of our competitors use **MAPInfo™** as part of their system.

CADMOS Pro+ can provide remote access to the central data base by the use of our Novell Access Servers, connected by telephone lines from remote sites. Multiple printers may also be attached to the central file server or to individual printers attached to any work station on the premises or **at any remote work station location** as necessary.

The 486DX2/66 MHz EISA File Server system with the SCSI type hard drive and SMC Ultra 32C EISA network cards are a dynamite combination for maximum throughput of data and report generation. Duplicate systems or remote work stations may be located in other communities or with other providers, all interconnected through hi-speed bridging circuits and modems. Users login into the systems would not have any idea as to where the data is being stored or accessed, since this is totally transparent to them.



The critical requirement for the **CADMOS Pro+** software system to provide reliable service is to purchase Novell Tested and Approved hardware with heavy duty power supplies, SCSI type full size Hard Disk Drives, etc. Ninety (90) percent of all database crashes are caused by not having heavy duty grounded electrical outlets on separate breakers with battery backup capability to maintain the power to the computers during brown outs or power disruptions. The complexity of the newer operating systems that run under Novell requires that the File Server hardware meets the Novell requirements of **being fully Novell certified and also Novell BTRIEVE certified.**

The enclosed literature outlines what the basic **CADMOS Pro+** package contains and also list?s the expansion module options available, that will enhance the overall performance and ability of the package. You may not need all the **CADMOS Pro+** expansion modules such as the Graphical map option, thus you could select just those expansion modules you will need and save some more money. The 1994 **CADMOS Pro+** Software only solution has been discounted from the old 1993 pricing as follows:

Description of New Software	1994 Pricing
CADMOS Pro+ basic 10-user software module	\$ 7,595.00
Address Management module with empty GEO tables. . .	\$ included
Graphical map with Tiger file GEO code information. . .	\$ 3,495.00
Software installation and training at the job site.	\$ <u>1,695.00</u>
Total for system software: \$ 12,785.00	

Note: The software listed above is included with the purchase price of our File Server system. Refer to Section 2.2 for details.

I have enclosed brochures explaining in greater detail the new **CADMOS Pro+** features and a copy of the proposed hardware solution that we sold to Terminal Taxi in Dallas. We have included the cost proposal, that detailed the recommended hardware to handle up to 3,500 individual trips or more a day, provide complete history of all runs, and provide Street Management system address ranges, zones, etc. This system will have the necessary file server processor power to handle all the trip reporting, call processing, and dispatch activities that are required and can be expanded to connect to Gandolf's Mobile Data Terminals or to Motorola's InfoTEC 2-way pagers using Celiular networks.

Terminal Taxi located in Dallas Texas, was installed June of 1994, and will be adding Caller-ID later this year, plus they chose to manually entered their street ranges, zip codes, etc. using the Dallas MAPSCO book to save on the cost of the Graphical Map option or purchasing the Tiger File Ready Made data base option we offer. When Terminal Taxi placed their order, we sent them our Management Entry program disk to install on their existing computer, so that vehicle, customer, driver, and MAPSCO information, etc. may be entered and be ready when we delivered and installed the system about three(3) weeks later.

Please contact me at (812) 477-3090 for any further information.

Sincerely,


 Paul D. Buroker, Sr.
 President





TAKE COMMAND OF TOMORROW



**THE COUNTYWIDE INTEGRATED
RADIO SYSTEM (CWIRS)**

LOS ANGELES COUNTY







Radio Systems

Specialties

- ◆ Conventional radio (mobile & portable)
- ◆ Base stations & repeaters
- ◆ Simulcast
- ◆ Digital & trunked radio
- ◆ Mobile data terminals
- ◆ Command & control consoles
- ◆ Antennas
- ◆ Facility management
- ◆ Personal pager services
- ◆ Logging recorders
- ◆ Uninterruptible power systems
- ◆ Battery plants

Related Fields

- ◆ Fiberoptics
- ◆ Microwave (digital & Analog)
- ◆ Telephone/PBX systems
- ◆ Vehicle tracking systems

Services

- ◆ System design & integration
- ◆ Project engineering
- ◆ Engineering studies
- ◆ Consulting
- ◆ Frequency/spectrum management
- ◆ FCC/FAA coordination
- ◆ Licensing
- ◆ Interference analysis
- ◆ Planning
- ◆ Installation support
- ◆ Testing & troubleshooting
- ◆ Field & shop maintenance
- ◆ Drive-in service
- ◆ Cost estimating
- ◆ Procurement support
- ◆ Documentation

Radio Systems Product Manager
Radio Systems Division
(213) 267-3034
Fax (213) 262-4607





MEET ALL OF YOUR RADIO COMMUNICATIONS NEEDS...

From routine problems to major disasters, now and in the future, CWIRS puts you in command.

Every day you must respond to changing events. These unexpected happenings may be routine problems within your agency. Or they can be major emergencies demanding outside help. And every so often, they may be part of a serious catastrophe, affecting not only you but the entire county.

Whatever the immediate situation, big or small, you need reliable, clear communications. You must be able to reach the people you want — without waiting, with the assurance that your message will be transmitted.

Until recently, it would be difficult for you to attain these objectives. The county has simply grown too fast for your radio communications equipment to keep pace. In fact, obsolete radio systems have become a countywide problem, demanding a comprehensive solution. That is why we have developed the Countywide



Protecting a county park, these rangers can immediately relay information about a suspect to headquarters via the readily available trunked lines.

Integrated Radio System (CWIRS). So you and other County employees can communicate better both within and between organizations. CWIRS covers not only your jurisdictional area, but the entire LA County.

The Many Advantages of CWIRS

CWIRS is a "trunked simulcast" network that makes the best use of communications resources. Because it is a "trunked system," all user radios have access to all channels on an "as needed" basis. In that sense, CWIRS is similar to a public telephone system. "Simulcast" means that the broadcast covers the entire area. There are no dead spots or places where communications might be lost. A trunked simulcast network can handle substantially more traffic than the older technology. And it presents you with many benefits never before possible.

Individual User Control

You and your users will continue to have and control your own contained subsystem. The system architec-



Public Works employees can rely on CWIRS for both routine projects and for the critical coordination of resources during a disaster.

ture links individual networks without hampering its purity in any way. Thus you are "in" the system and simultaneously independent of County supervision. In fact, your own intra-communications will benefit from enhanced, upgradeable equipment that can expand with your growth.

Availability

CWIRS is a multi-channel system, capable of handling many more users than any available conventional system at any one time. You have virtually unlimited access to any user in your organization at any time. Even during a disaster, critical channels will be open. And the central dispatcher can contact every user on the system. Most importantly, because assignments to the system are software-based, they can be changed as needed.

Interoperability

Unlike a conventional radio system with dedicated channels and a dispatcher, CWIRS operates much like a telephone system. You can call other CWIRS subscribers and you can also interface with other County radio sys-





At the Hall of Records Dispatch Center this dispatcher has access to all system users, a valuable capacity for broadcasting emergency information. The backup dispatch center is located at the County Emergency Operations Center.

tems, such as Fire and Sheriff and local, state and federal mutual aid networks.

For the first time, the dispatcher can communicate with thousands of County employees. Routinely, this interoperability can save time. During an emergency or disaster, it can save lives.

Security and Privacy

Whenever you call someone, you have access to many channels. These channels change with each transmission. While you are aware only of your continuous conversation, this "channel hopping" prevents monitoring and offers a greater degree of privacy. If you require additional security, voice encryption is an available option for your operation. Traceability further ensures that only authorized users have access to the system. Every user has an identifying address. It is impossible to use the system without transmitting appropriate identification to the recipient. As an added safeguard, the systems manager can disable any lost or stolen units.

Voice and Data

You can transmit both voice and data over the CWIRS network. And with the use of digital technology, mobile data terminals can transmit digitized information.

Economies of Scale

Consider the prohibitive expense of developing a new total radio system on your own: frequency availability, microwave systems, repeater equipment, site acquisition and development, FCC licensing, environmental impact studies and system maintenance. With CWIRS, you receive it all in one integrated multi-channel system.

Reliability and Maintenance

CWIRS provides redundancy, alternate routing and fail soft equipment to ensure reliable service. The County furnishes all training and equipment maintenance.



The latest hand-held equipment available through CWIRS gives users unprecedented communication ability.

Ready for the Routine, Prepared for a Disaster

CWIRS connects you for the challenges of day-to-day living in a huge metropolitan area. But it also prepares you for the big crisis that can paralyze other avenues of communication. In any eventuality, you can rely on CWIRS to get your message through.



Countywide Integrated Radio System (CWIRS) covers the entire LA County.



HOW CWIRS WORKS

CWIRS is the largest public communications system of its kind in the world.

CWIRS consists of two trunked Simulcast Radio Systems, linked by a multi-site coordinator. Each is a 20 Channel, 800 MHz Enhanced Digital Access Communications System (EDACS™). The Basin System provides radio coverage for metropolitan Los Angeles as well as the San

Gabriel and San Fernando Valleys. The countywide system provides radio coverage for the entire County of Los Angeles.

Individuals can communicate between the two systems, never losing communication.

Here is how CWIRS works for one transmission between two users.



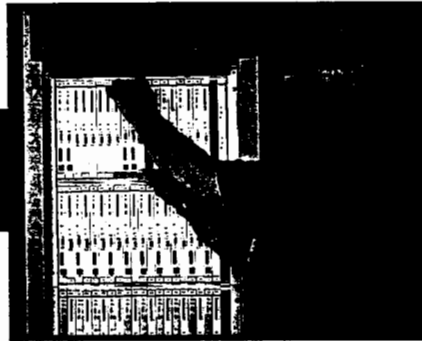
With CWIRS, you can place calls to many other users as easily as with a telephone system. A call to a dispatcher can put you in touch with any talk group.

Placing the Call

Just press the radio's transmit switch and talk. CWIRS automatically assigns a free channel and connects the call. Without channel tie-ups or stepped-on messages, you have immediate access to your people.

This ease-of-operation is especially welcome during a major emergency. When an earthquake, mud-slide or other disaster strikes, you can quickly respond.

You will find that your user-friendly radio can be programmed to have exactly the features you need.



Transparent to the user, the computerized multi-site coordinator automatically ensures a clear path and keeps your two-way traffic together.

Processing the Call

Each call passes through a central system controller. This computerized controller directs all audio traffic through the system to the radio transmitter equipment located at mountaintop sites for transmission.

Most importantly, this entire process takes place transparently within milliseconds. You can focus entirely on your message and not on the process.



It only takes 250 milliseconds for your call to reach its destination via a clear channel, allocated by the multi-site coordinator.

Receiving the Call

The party receives the call. Use of the system is as simple as adjusting the volume.

Arrange for a Demonstration Today.

We invite you to become a part of this major investment in your future. Call (213) 267-2751 to arrange for a demonstration...and take command of tomorrow.





StarFinder™ GPS 700

Intelligent Vehicle Logic Unit

The most complete, powerful, and cost-effective AVL and monitoring subsystem.

A fleet equipped with StarFinder™ GPS 700s can report hundreds of vehicle locations per minute—at accuracies as good as 50 feet—on a single radio channel. All without an external modem.

In addition, the StarFinder GPS 700 can control the public address system and many public radios, so you don't need separate control panels. It can also switch automatically between voice and data.

Among the StarFinder GPS 700's vehicle monitoring software modules are

silent alarm, engine status, vehicle speed, unauthorized use, and route and schedule adherence. You can upgrade by loading these programs from a PC—no need to swap PROMS. Just connect the PC to the unit's service port.

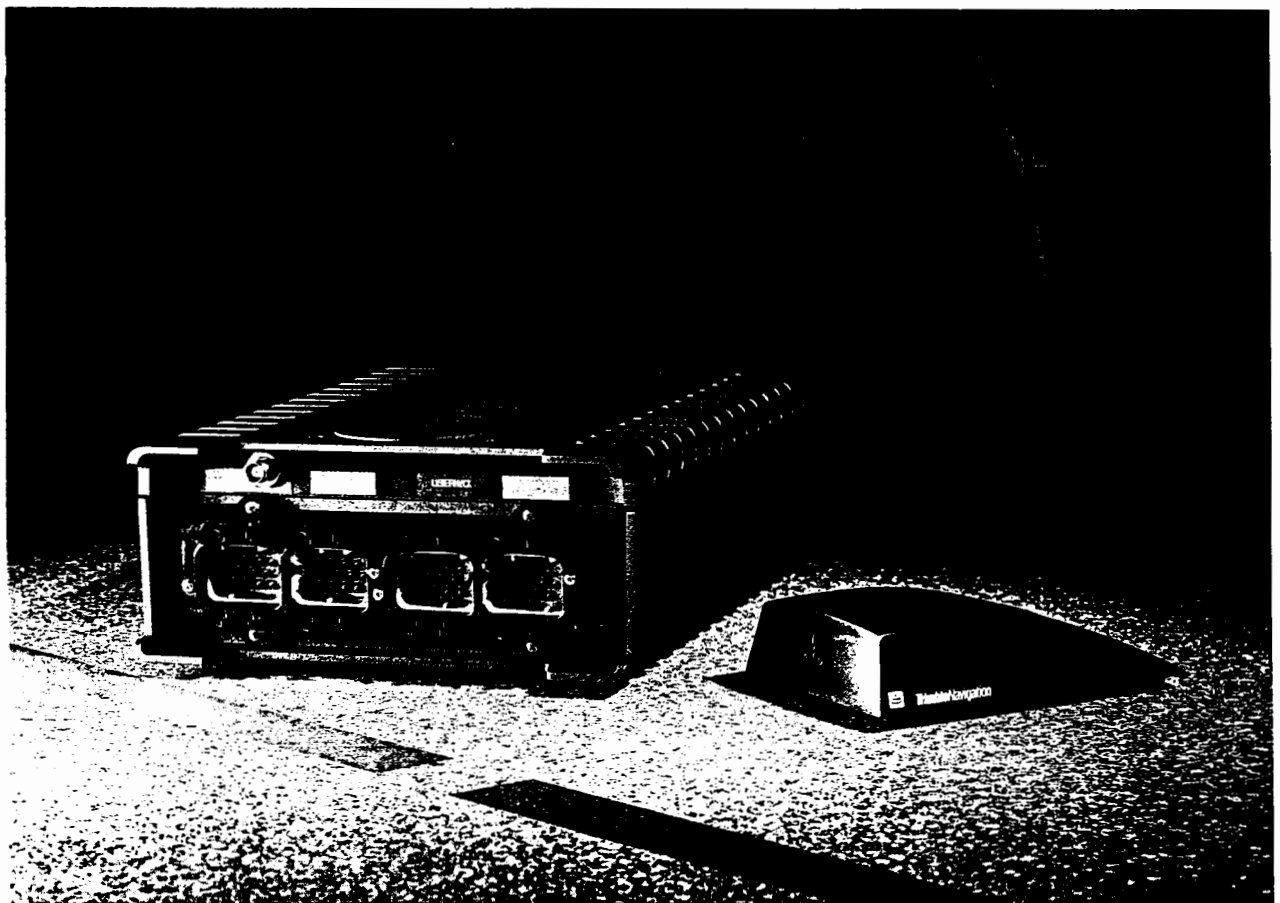
Connectivity to other vehicle electronics is designed in. You can connect devices using industry standard EIA-232, EIA-485, SAE-J1708, or one of the discrete digital or analog lines. You can even make all of these connections at the same time!

The packaging is rugged. The cast aluminum case and automotive-style locking connectors will stand up to even the toughest conditions. And the entire design was tested to Milspec standards.

The StarFinder GPS 700 is compatible with the Spectra series of radios from Motorola and with the WestCAD dispatch software from Westinghouse Electric Corporation.

The Trimble GPS receiver embedded in the StarFinder GPS 700 locates vehicles in all weather conditions, on or off prescribed routes. When combined with Trimble's 4000RL differential reference locator it can be as accurate as 50 feet 95% of the time. For really difficult "urban canyons," the StarFinder GPS 700 has a calibrated dead reckoning option.

The StarFinder GPS 700 is the ideal solution for the most complex and difficult fleet-management problems.





StarFinder™ GPS 700

Intelligent vehicle logic unit

GPS Specifications

Receiver:	L1 frequency, C/A code (SPS) 6-channel, continuous tracking, differential ready
Antenna:	Antenna with built-in preamplifier
Position data:	Latitude, longitude, speed, time, direction of travel
Acquisition:	1.5 minutes (daily power on) 3-second nominal reacquisition after 200-second blockage Updates once per second
Accuracy:	GPS position with differential: 5 meters (1 Sigma) under steady-state conditions GPS position without differential: 15 meters under steady-state conditions

Modem Specifications

Data rate:	4800 bits per second
Bandwidth:	12.5 kHz channel
Handshake:	X-on/X-off
Error rate:	Nominal 1 in 10 ¹²
FEC:	Reed-Solomon up to 42 bits per block

Interface Specifications

Radio:	Radio control interface Radio handset interface DTMF interface
Radio protocol:	Packetized TDMA Slotted ALOHA for emergency access
Serial I/O:	Four EIA-232 serial ports (MMI, service computer, and two reserved application-specific ports)
Digital I/O:	Four high-current outputs Three TTL outputs Sixteen inputs
Bus standards:	EIA-485, SAE-J1708
Audio:	Five audio input signal lines Two PA audio output signal lines
Miscellaneous:	Gyroscope and odometer interface Debounced silent alarm interface Ignition sense with programmable turn-off delay

Environmental Specifications

Power:	15 W typical, 9-32 VDC
Temperature:	Operating -30°C to +60°C Storage -40°C to +85°C
Shock:	Mil Std 810E, method 516.4, procedure I
Vibration:	Mil Std 810E, method 516.4, category 8, procedure I
Humidity:	Mil Std 810E, method 507.3, procedure III
Dust:	Mil Std 810 E, method 510.3, procedure I
Sand:	Mil Std 810E, method 510.3, procedure II
Altitude:	-400 to +5,000 meters
Packaging:	Receiver: splash-proof, dust-proof cast-aluminum housing with locking automotive connectors Antenna: low profile, weatherproof, high-impact polycarbonate wedge designed for single-hole or flange mounting

Applications Specifications

Processor:	Motorola 68332
Memory:	512k Flash EPROM, 512k SRAM
Operating system:	VRTX
Software modules available:	TDMA management Route and schedule adherence Vehicle speed monitoring Unauthorized use indicator Dead reckoning J1708 vehicle engine monitor Silent alarm/Covert microphone

Physical Characteristics

Receiver:	
Dimensions:	13.5" W x 9.6" D x 3.75" H
Weight:	20 lbs
Antenna:	
Dimensions:	4.5" W x 6.4" L x 1.6" H
Weight:	0.5 lbs

Note: All civilian GPS receivers are subject to degradation of accuracy under Department of Defense imposed SA (Selective Availability). Differential GPS can correct this degradation.

Specifications subject to change without notice.



TrimbleNavigation

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Christchurch, New Zealand
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Fax: +64 3-371-3417



HRB SYSTEMS



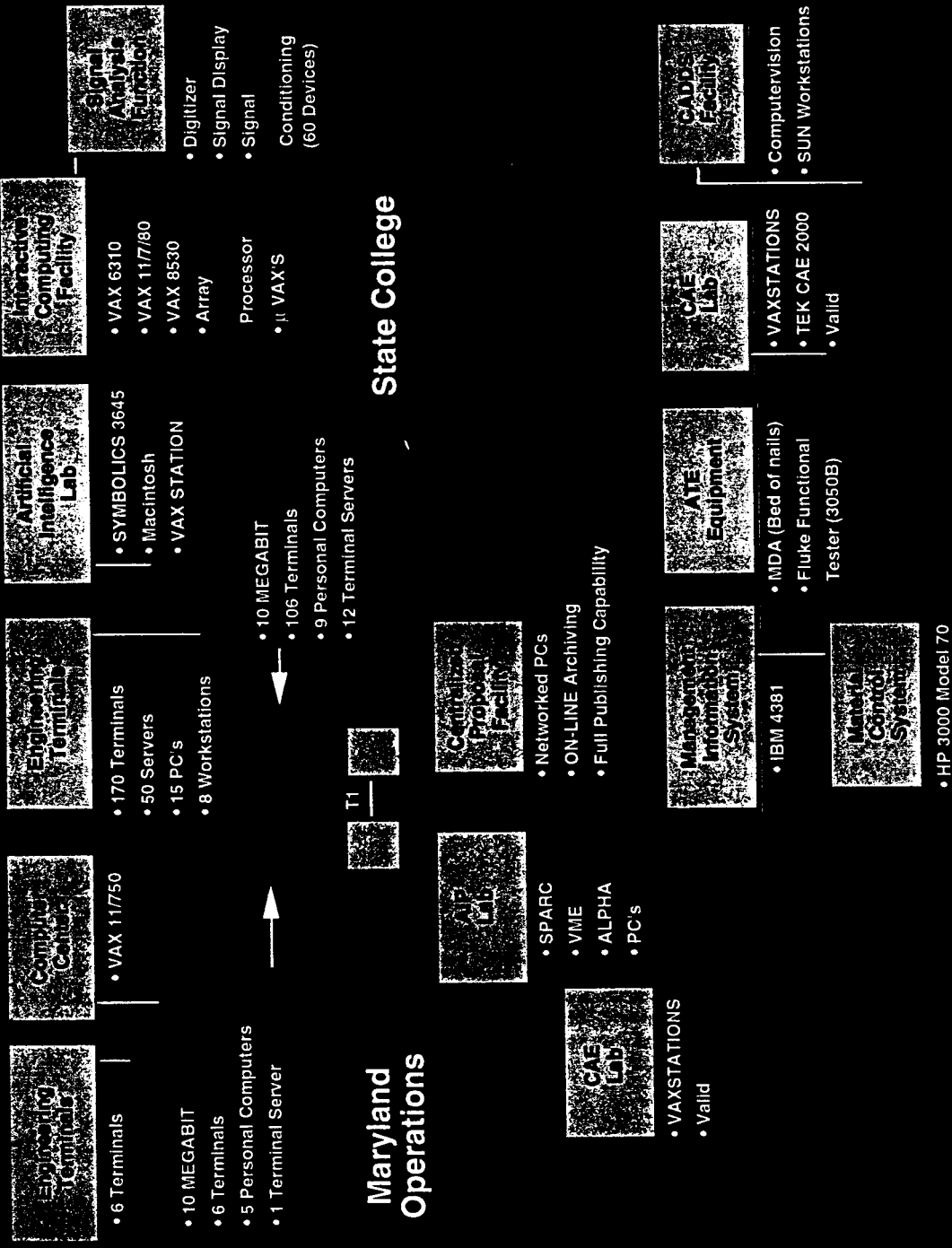


Technical Staff

Total employees	838	Software engineers	156
Employees with technical degrees	58%	Hardware engineers	105
Employees with secret/top secret clearance	80%	Systems engineers	96
Employees with special access authorization	70%	Field engineers	198
		Technicians	46
		Operations services	237



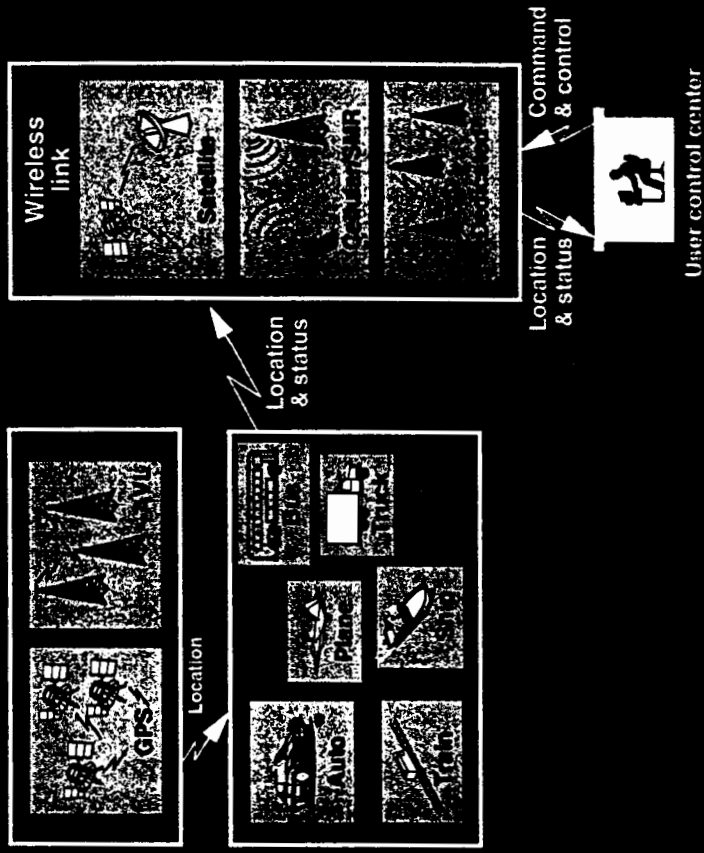
HRB's Engineering Resources Solve Modern Business Problems





Extensive Mobile Data Communications Capabilities

System Architecture



Applications

- Fleet management
- Dispatch
- Vehicle security
- Resource tracking
- Public safety
- Remote sensors

Key Technologies

- Computer control
- Vehicle tracking
 - GPS
 - AVL
 - Dead reckoning
- Communications
 - Cellular
 - UHF/VHF
 - Satellite

Features

- Tailored system solution
- Complete integration services
- Training and support available
- One-stop shopping

