Assessment of Software for Computerized Paratransit Operations

JOHN R. STONE, ANNA NALEVANKO, AND JEFFREY TSAI

The background and current issues regarding computerized reservations, scheduling, and dispatch in the paratransit industry are developed. After an overview of the scheduling process, which is the critical function of automated paratransit operations, features of selected software products are reviewed. The major considerations for selecting alternative software products are discussed. This comparative assessment of software is particularly useful for paratransit operators who plan to buy new software systems.

Nowhere is the promise of intelligent vehicle highway systems (IVHS) more tantalizing than in public transit. The promise of IVHS in the transit sector is so appealing that both FTA and IVHS America have placed a special emphasis on its development. Advanced Public Transportation Systems (APTS) is one of five program areas within IVHS America, the private nonprofit organization that the U.S. Department of Transportation has made responsible for promoting advanced transportation technology. It is also a top research and development program within FTA.

The advent of APTS is very timely for the transit sector. In urban and rural areas the transit industry continues to be pressured to meet the critical societal goal of mobility for elderly and disabled citizens as well as the general public. The Americans with Disabilities Act of 1990 (ADA) requires fixed-route transit systems to provide complementary paratransit services for persons within ¾-mi of a transit route who are unable to board conventional transit vehicles. ADA also requires systems to respond to previous-day reservations and to strive for real-time response. It stipulates that passengers can be on board no longer than an hour.

Operational pressures also exist in the realm of human service transportation. Vehicles often operate at a capacity of 25 percent or lower. The subsidized cost of carrying passengers may be twice the fare of comparable taxi service—or more if state and federal capital subsidies are included in the cost calculation. APTS, however, offers hope for improving efficiency and lowering costs, given the willingness to commit to change and to invest in the future.

The operations process starts when passengers reserve trips; at that time their eligibility to receive service is verified. They may reserve one or more trips up to 14 days in advance. Often they overbook to ensure their seats but later cancel 25 percent or more of their reservations. Ideally, ride confirmation occurs at the time of request; however, cancellations complicate the picture, as does the need to have sufficient time to build a schedule. Thus, most rides are confirmed the night or morning before service. APTS is already improving the bookkeeping of reservations and cancellations, but immediate ride confirmation depends on improved automated scheduling and dispatch.

Once a trip reservation is taken it must be scheduled into a shared-ride sequence of other reservations and perhaps timed to meet a fixed-route transfer. The scheduling process is difficult in that passenger disabilities and vehicle capability must be matched, special passenger groups identified, the origins and destinations of passengers sequenced, and the vehicle route optimized. Thus, scheduling is a daunting technical and human problem. APTS technology has only recently had modest success in automating the process.

Closely associated with scheduling is dispatching. A previously scheduled, unmodified route is easy to dispatch (just hand a driver a trip sheet to follow), but real-time reservations and cancellations can change the schedule quickly. APTS technology, both hardware and software, must be applied more effectively so that it can accommodate requests for new or modified service immediately.

Such operations problems add to the already-difficult challenges that public transit operators face in retaining patronage and attracting new riders. APTS applications promise to aid transit operators in meeting these challenges while helping transit users access and pay for transit use.

In response to the important record keeping, reservations, scheduling, and dispatching needs for shared-ride paratransit operations, many new software and hardware products are appearing on the market. During late 1991 and early 1992 the authors surveyed the market and reported comparative features of different products. Since then many innovations have occurred. This paper updates earlier work (*1*). First, we develop computer dispatch issues relevant to shared-ride paratransit. We briefly explain technical concepts and discuss the rapid innovation that is occurring to meet the mobility requirements of the ADA. From interviews with software vendors and paratransit operators, comparative costs and features of selected software systems are given. We address the promise, as well as the problems, of automated dispatch and scheduling and give guidelines for selecting among different products. Related technical innovations are also mentioned, including geographic information systems (GISs) for displaying the schedule and route, mobile data terminals for communicating changes to schedules, smart cards and readers that can help record passenger data and fares, and automatic vehicle locators (AVLs) for tracking vehicles in order to dispatch them in real-time.

J. R. Stone, Department of Civil Engineering, Box 7908, North Carolina State University, Raleigh, N.C. 27695. A. Nalevanko and J. Tsai, Institute for Transportation Research and Education, Raleigh, N.C. 27619.

OPPORTUNITIES FOR NEW SERVICE

By improving how vehicles are dispatched and scheduled—particularly on a shared-ride, real-time basis—three benefits will result. One is that operators will provide better service by responding more quickly, using vehicles more efficiently, and billing passengers or sponsors while maintaining complete records automatically. Second, operators will expand their services to include dynamically dispatched route-deviation transit. Simply put, better scheduling and dispatching of vehicles will allow paratransit operators to reconsider the quality and variety of services that they can offer. Third, improved vehicle dispatching will dramatically change the relationship between the passenger and the operator. Traditionally, paratransit passengers have had to contact operators directly, obtain schedule and fare information, reserve a seat, and pay the driver for the trip. Soon, improved computer dispatching will allow a passenger to contact a central reservation system directly, much like passengers do for airline travel. One no longer needs to call each airline to learn of available seats and fares. Instead, travel agents have that information available for all airlines and can completely arrange and confirm air travel. Comparable capability in public transit has been slow to occur, but it is no less possible with the currently available APTS technology.

The process of rethinking transit service in light of improved scheduling and dispatching is evident in the FTA concept for the mobility manager (*2*). An organizational and technology innovation, the mobility manager is a central agent who can not only provide information on all local public transportation but also make real-time reservations for a person while on the phone. The mobility manager can even collect fares from the passenger and process payments to operators and invoices to agencies or companies that subsidize the trips.

It is against this backdrop that paratransit agencies are evaluating their services and their computerized reservations and scheduling systems. Depending on the number and type of passengers the agency transports and the service-level objectives, APTS technology offers a wide range of hardware and software options.

PARATRANSIT SCHEDULING AND DISPATCH

Central to the ability of APTS to enhance public transit service is the effectiveness of APTS in improving the process of dispatching and scheduling demand-responsive transportation. How vehicles and trips are matched directly affects passenger service levels and system productivity. If the promise of APTS is to be fully realized, computer technology must be effective in improving the efficiency of scheduling and dispatching shared-ride vehicles in real time.

Matching vehicles and trips is a formidable operations problem. It requires the operations staff to perform three functions: accept requests for trips, assign those trips in a logical manner to specific vehicles, and document the completion of the trip. Each of these functions is challenging. Accepting trip requests requires the operations staff to take trip data accurately, efficiently, and pleasantly. Documenting trips is challenging because agencies and companies that subsidize trips may require much record keeping. But it is the second function—matching trips to vehicles—that is the most intellectually formidable and that most severely affects system performance.

In general public and special paratransit systems, the matching of vehicles and trip requests is called scheduling. Scheduling paratransit trips is more complex than dispatching single-passenger taxis because of the shared-ride nature of the paratransit trips. The shared-ride scheduling problem, however, can be mitigated by preparing the routes and passenger pickup sequence in advance, typically the night before trips are needed.

The nonscheduling functions of paratransit operations were the first to be computerized: client certification, records, and agency billing. A variety of software vendors offer systems to handle these functions as well as scheduling.

Scheduling, however, is automated less easily. Most paratransit operators, particularly those of smaller systems, use manual scheduling procedures. But manual scheduling becomes an unbearable task for large systems. Depending on the degree of automation, the computer may provide a set of schedules for a fleet of vehicles given "batch" reservation data the night before service. Or the computer may keep an up-to-the-minute schedule prepared (or at least a skeleton schedule) as each reservation or cancellation is called in. A fully automated scheduling system can handle real-time trip requests and simultaneously update schedules while requesting a vehicle to deviate from the earlier schedule and pick up the new passenger. In each case a human scheduler has oversight authority on the schedule, which in contemporary software is displayed as a map on the computer screen. The location of each passenger origin and destination is available for display, as are the changing locations of the vehicles if AVL technology is used.

Figure 1 illustrates computerized scheduling including grouping, sequencing, and optimization (D. Young, personal communication, Jan. 1992). Incoming trip requests, which are answered by the call taker, may be reservations or cancellations for the next day or week, or they may be real-time taxi-like calls. The call taker enters the caller information into the host computer, and the caller's eligibility to use paratransit is verified. The scheduling function takes over next. Passengers, vehicles, and drivers are grouped according to special passenger characteristics and transportation services offered. General sequences of vehicle trips are identified depending on time of day, day of week, and location for which the transportation is needed. The vehicle path is optimized for minimum time or distance with respect to such schedule constraints as vehicle capacity and the ADA limit of 1 hr in the vehicle for any passenger. As additional requests come into the system, the path is reoptimized until a schedule of pickups and destinations is built.

At the beginning of a typical paratransit tour, a prearranged schedule (or trip sheet) is given to each driver. It lists the sequence, pickup times, addresses, and destinations of the passengers. It also gives directions for the minimum time or distance path to follow. To this point, the scheduling process parallels traditional manual paratransit scheduling. However, since the computer "remembers" the exact schedule and can predict the approximate location of the vehicle at any time during the schedule, in concept it can accommodate real-time trip requests as Figure 1 indicates. AVL technology may also be used to identify the precise location of the vehicle. Any new real-time request is inserted into the prearranged sched-

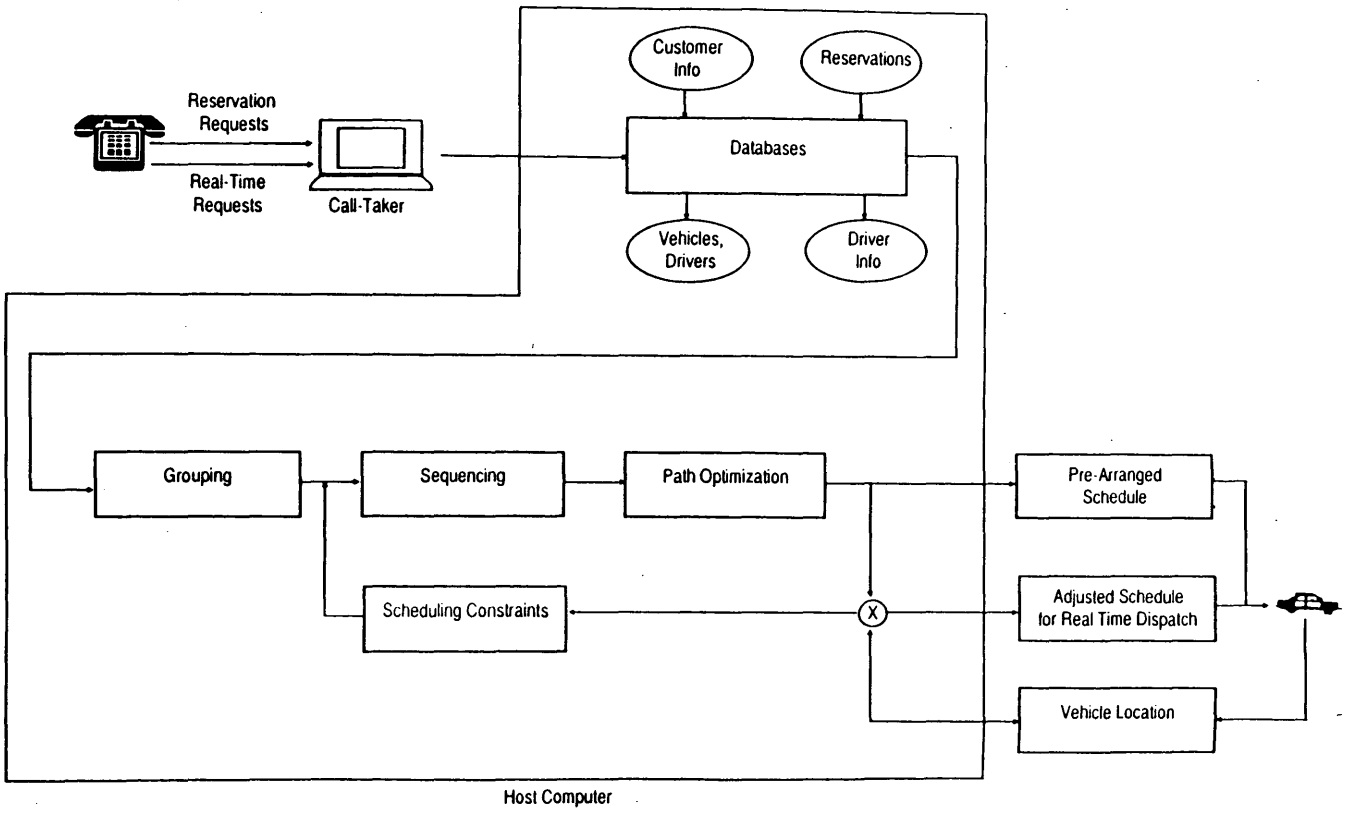

FIGURE 1 Paratransit computer scheduling.

ule at an appropriate point depending on the results of the grouping, sequencing, and optimizing functions. The new schedule is transmitted by voice or digital radio to the driver, who deviates from the scheduled route and picks up the new passenger. With appropriate in-vehicle display capabilities, the trip sheet can be replaced by digitally displayed information. Real-time, shared-ride scheduling and dispatching are not, however, a widespread operational reality for paratransit.

FEATURES OF AUTOMATED PARATRANSIT SOFTWARE

Several vendors provide software and hardware for paratransit management and service. Depending on the needs of the paratransit operator, various degrees of sophistication can be bought. For example, a small operator with 10 vehicles can buy a starter kit that includes one or more personal computers and a straightforward data base for reservations, record keeping, and billing. A larger system with 30 or more vehicles would most likely move up to a networked system of personal computers or workstations that call takers, schedulers, and dispatchers could access simultaneously. The functions of such a system would include not only automated reservations, record keeping, and billing, but also automated scheduling in at least batch mode. Larger systems, or those that have special service requirements such as timed transfers with fixed-route buses, would need options such as automated real-time dispatch, GIS route and map displays, mobile data terminals, smart card readers, and AVL devices. Tables 1 and 2 give the names of 13 major vendors, their software products, and various features. The table entries are not meant to be exhaustive. Other vendors need examination, including ATE-Ryder, Comsis (CTPS), Paratransit Systems International (Rides Unlimited), Navigation Data Systems (Fleet Track), Gandalf, State of the Art Systems, and KLD Associates (TransCad).

Paratransit software averages about $25,000, depending on available functions. Hardware costs depend on the products purchased and the number of vehicles and personnel locations that the items serve. Reduced personnel costs can often offset equipment and software costs in a year or two for the typical operator; so can improved system capacity and productivity. Nearly all the products claim demand-response scheduling, but there has been no wide independent verification of the acceptability of these products operating in an automatic scheduling or demand-response scheduling mode. In recognition of the growing importance of GIS, mobile data terminals, smart cards, and AVL, several vendors have incorporated these features into their products.

Tables 3 and 4 display comparative features for reservation, dispatch, and scheduling. Table 5 summarizes GIS features for the different software products.

SELECTION GUIDELINES

The selection of an automated paratransit management system must begin with a detailed definition of operational needs.

TABLE 1 Paratransit Software Vendor Information

Vendor Name	Software Name	Operating System	Hardware Requirement	Base Price (S) = single user (M) = multi-user	# Training Days (included in base cost)	Cost for Training
Aleph Computer Systems *	Aleph	Amos	Alpha Mini Computer	$80,000	-	-
Automated Business Solutions	PtMS	DOS Novell Windows	PC	(S) 8,400 (M) 16,500	3-4 days	N/A
Automated Dispatch Services	EMTRACK	Novell	PC	Approx $60,000	Yes	N/A
COMSIS	CTPS/CRSS	DOS Novell Banyon Unix	PC Alto Mini Computer	CTPS: (S) $9,995, (M)$14,995 CTPS/CRSS: (M) $19,995	3 days	N/A
Decision Sciences	Quick-Route	DOS PL/MOS	PC	(S) $12,000 (M) $12,000-$24,000	1 week	N/A
Easy Street	EasyTrips	DOS Lantastic	PC	(S) $25,000 (M) $25,000	1 week	N/A
Ketron*	PARMIS	Novell	PC	$25,000	0	$400 per day + expenses
Micro Dynamics	CADMOS	Novell	PC	1-5 users $7,500 >5 users $12,500	0	$360 per day + expenses
Mobile Computer Systems	PC-Dispatch/ Paratransit	DOS Novell	PC	$20,000	0	$500 per day + expenses
Modeling System	SCOOTER	VMS UNIX	Mini-computer PC	$6,400-24,000	0	$500 per day + expenses
Multisystem	GIRO/ACCESS	VMS UNIX Novell	Mini-computer PC	2-4 users $15,000 5-10 users $20,000 11+ $25,000	0	$700 per day + expenses
On-Line Data Products	PASS	DOS Novell	PC	(S) $24,500 $250 each add'l user	3 weeks	N/A
Paratransit Software, Inc.	PARRAS	DOS Novell	PC	(S) $7,000 - $11,000 (M) $10,000 - $18,000	4 days	N/A
Scandia Transport System	PLANET	VMS	Mini-computer	$500,000 +	2 months	N/A
UMA Engineering Ltd.	Quovadis	DOS Novell	PC	-	10 days	N/A

*: information from 1991, vendor did not reply
-: insufficient data, vendor did not supply

Some of these needs are shared by passengers, drivers, staff, and management. To select the best paratransit management information system, however, the focus must be on automating reservations and cancellations, scheduling and dispatching, and data collection and reporting. The following will define high-priority needs for each of these operational tasks. Given the needs as defined, technical specifications can be written to guide the procurement process.

Reservations and Cancellations

ADA Response

New software should accept 14-day advance reservations and be able to handle open returns with real-time dispatched shared-ride vans or taxis. The software should handle previous- and same-day reservations and prioritize service to eligible passengers on the basis of need, disability, and history of not showing. Real-time ride confirmation would reduce the heavy load of follow-up telephone calls for confirmation.

Matching Service to Special Passenger Needs

Passengers want to be able to book multiple trips in advance; request special drivers or vehicles; cancel trips as necessary; request immediate service; avoid unnecessary wait and travel time; travel with friends, spouses, guide dogs, aides, and groups; be made aware of alternative service by taxi and fixed-route bus; obtain service at the time requested; and have a reasonable response time. Passengers also want to be able to call the operator and quickly determine when a late vehicle will arrive.

Cancellations

New software must cancel a significant number of trip reservations efficiently and automatically, dispatch that information to drivers in real time, schedule new passengers into the open seats, and update trip sheets. The result would be more effective use of vehicle capacity, reduced dispatcher load, and a higher quality of service to passengers.

TABLE 2 Paratransit Software Features

Software Name	Client Registration	Demand-Response Scheduling	Batch Scheduling	GIS Interface	Fleet Maintenance	Reporting/ Billing	Integrate with Mobile Display Terminal	Smart-Card	Automatic Vehicle Location
Aleph	Y	Y	Y	N	Y	Y	Y	-	-
PtMS	Y	Y	Y	Y	Y	Y	Y	N	N
EMTRACK	Y	Y	Y	Y	Y	Y	Y	Y	N
Quick-Route	Y	Y	Y	Y	Y	Y	Y	N	N
CTPS/CRSS	Y	Y	Y	Y	Y	Y	N	N	N
EasyTrips	Y	Y	Y	Y	Y	Y	Y	N	N
PARMIS	Y	N	Y	Y	Y	Y	-	-	-
CADMOS	Y	Y	N	N	N	Y	N	N	N
PC-Dispatch	Y	Y	Y	Y	N	Y	Y	N	N
SCOOTER	Y	Y	Y	Y	Y	Y	Y	N	N
GIRO/ACCESS	Y	Y	N	N	N	Y	Y	Y	N
PASS	Y	Y	Y	Y	Y	Y	N	N	N
PARRAS	Y	N	Y	N	N	Y	N	N	N
PLANET	Y	Y	Y	N	N	Y	Y	Y	N
Quovadis	Y	Y	Y	Y	N	Y	N	N	N

-: insufficient data, vendor did not supply

Integrated System

In an integrated system, reservation clerks, schedulers, and dispatchers have access to the same information. If a passenger cancels a reservation, the clerk enters the information and the schedule is updated automatically and communicated immediately to the driver. Integrated systems would also be able to double-check passenger addresses from data bases and automatically identify the address from the passenger's name or identification number.

It should be noted that new software capabilities may redefine the roles of the operations staff. With the assistance of the computer and the results of automated scheduling, the telephone reservationists will have schedule information available. They will be able to answer calls from customers wondering where their rides are as well as calls for general information and trip reservations. They will have the schedules available, and the computer can slot in new calls so that rides can be confirmed immediately. In that sense, reservations clerks will take on some of the roles of schedulers and dispatchers. Automated scheduling also will allow the current schedulers to shift to a review role of automated schedules, taking on more of a strategic planning role rather than manually planning the schedules themselves.

Scheduling and Dispatching

Automated Scheduling

The highest priority for paratransit management (in a medium-sized to large operation) is a reliable, automated scheduling function. It may be on-line and schedule shared rides in real time, or it may schedule in batch mode. Either way it must allow the schedule to be adjusted manually to reduce deadheading and eliminate overlapping routes. Manual adjustment will be greatly facilitated by a GIS display of routes as they develop.

Mapping Capabilities

A GIS mapping display helps in finding optimal route paths automatically or manually; if the AVL feature is active, it helps locate vehicles so that the one closest to a demand-response call can be dispatched to it. It is highly desirable that the major elements of the street and highway network and the locations and destinations of clients be displayed during the reservation process.

Capacity

The new software and hardware must have the capacity to meet the current volume of trips and to grow with the demands of the system. A computer-based reservations and scheduling system must be able to handle a large volume of daily trips for several types of vehicles. New software must be able to use more fully the unused capacity of the vehicles, and it must accommodate unmet demand. New software cannot place trip limits on reservations; trip limits will have to be discontinued under ADA. Demand must be managed better by identifying riders who can use fixed-route transit and by monitoring and accommodating unmet demand.

Integrated System

Automated scheduling should be able to slot in another passenger who has a standby reservation or who has just called in. That new information should be displayed automatically to drivers and reservation clerks.

TABLE 3 Paratransit Software Reservation and Dispatch Component

Software	Aleph	CADMOS	CTPS/CRSS	EasyTrips	EMTRACK	GIRO/ACCESS	PARMIS
Follows ADA guidelines	Y	Y	Y	Y	Y	Y	Y
Integrate with fixed routes	-	N	Y	Y	Y	N	-
Policy help screen	-	N	Y	Y	Y	N	-
Utilize empty seats due to cancellation	-	Y	Y	Y	N	Y	-
Standby list	-	Y	Y	Y	Y	Y	-
Multi-window display	-	Y	Y	N	N	N	-
Reserve multiple trips	Y	Y	Y	Y	Y	Y	-
Reversal for round trip	Y	Y	Y	Y	Y	Y	Y
Quick key data entry	Y	Y	Y	Y	Y	Y	Y
Cancel trip by group	Y	Y	Y	Y	Y	Y	-
Cancel selected reservations	Y	Y	Y	Y	Y	Y	-
Multiple addresses	Y	Y	Y	Y	Y	Y	-
Code for landmark destination	Y	Y	Y	Y	Y	Y	Y

Software	PARRAS	PASS	PC-Dispatch	PLANET	PtMS	Quick-Route	SCOOTER	Quovadis
Follows ADA guidelines	Y	Y	Y	Y	Y	Y	Y	Y
Integrate with fixed routes	N	Y	Y	N	Y	N	Y	Y
Policy help screen	N	N	Y	N	N	Y	Y	Y
Utilize empty seats due to cancellation	N	Y	Y	Y	Y	Y	Y	Y
Standby list	N	N	Y	Y	Y	Y	Y	Y
Multi-window display	N	Y	N	Y	Y	Y	Y	Y
Reserve multiple trips	Y	Y	Y	Y	Y	Y	Y	Y
Reversal for round trip	Y	Y	Y	Y	Y	Y	Y	Y
Quick key data entry	Y	Y	Y	Y	Y	Y	Y	Y
Cancel trip by group	Y	N	Y	Y	Y	Y	Y	Y
Cancel selected reservations	Y	Y	Y	Y	Y	Y	Y	Y
Multiple addresses	Y	Y	Y	Y	Y	N	Y	Y
Code for landmark destination	Y	Y	Y	Y	Y	Y	Y	Y

-: insufficient data, vendor did not supply

Flexibility

As the system grows and moves toward real-time, taxi-like response, radio traffic will continue to grow and multiple voice radio frequencies are unlikely to be satisfactory for long—especially if paratransit service moves toward timed transfers with fixed-route buses in response to ADA guidelines. Mobile data terminals (MDTs) represent a successful approach to rapid, high-volume communications; any new paratransit operations system should be able to incorporate MDTs. Readers for magnetic fare and identification media are another type of device that the software should accommodate. A third type of device receiving much attention in paratransit operations is the AVL. A new operations system should be able to use an AVL.

TABLE 4 Paratransit Software Scheduling Component

Software	Aleph	CADMOS	CTPS/CRSS	EasyTrips	EMTRACK	GIRO/ACCESS	PARMIS
Demand-Response Scheduling	Y	Y	Y	Y	Y	Y	N
Batch Scheduling	Y	N	Y	Y	Y	N	Y
Vehicle/client needs match	Y	Y	Y	Y	Y	Y	Y
User - defined constraints	-	N	Y	Y	Y	N	-
User - weighted constraints	-	N	Y	Y	Y	N	-
Flag routes exceed constraints	N	N	Y	Y	-	Y	-
Callback list	-	N	Y	N	N	N	N
Manual route construction	-	Y	Y	Y	Y	Y	-
Freeze routes	-	Y	Y	N	Y	Y	-
Time calculation method	zone-to-zone	zone-to-zone	triangulation zone-to-zone	crow flight arterial	triangulation	zone-to-zone	-
Consider past cancellations/ no shows	-	N	N	N	Y	N	-
Perform simulation	-	N	Y	Y	Y	N	-

Software	PARRAS	PASS	PC-Dispatch	PLANET	PtMS	Quick-Route	SCOOTER	Quovadis
Demand-Response Scheduling	N	Y	Y	Y	Y	Y	Y	Y
Batch Scheduling	Y	Y	Y	Y	Y	Y	Y	Y
Vehicle/client needs match	Y	Y	Y	Y	Y	Y	Y	Y
User - defined constraints	Y	N	Y	Y	Y	Y	Y	Y
User - weighted constraints	N	N	N	Y	Y	Y	Y	Y
Flag routes exceed constraints	N	N	Y	Y	Y	N	N	Y
Callback list	N	N	Y	Y	Y	Y	Y	Y
Manual route construction	Y	Y	Y	Y	Y	Y	Y	Y
Freeze routes	Y	Y	Y	Y	Y	Y	Y	Y
Time calculation method	zone-to-zone	triangulatio	arterial	arterial	triangulatio	crow flight triangulation	arterial	crow flight, triangulation, arterial
Consider past cancellations/ no shows	N	N	N	N	N	N	N	N
Perform simulation	N	N	Y	Y	Y	Y	Y	Y

-: insufficient data, vendor did not supply

Data Collection and Reporting

Customized Reports

Operators desire customizable report formats so that they can easily design special reports on-line and readily retrieve selected data from the data base into the report format.

Automated Billing

Some operators do not need complicated invoicing and billing functions, but such options for future use should be considered when buying software.

The authors believe that any new software product must address most of these needs to ensure efficiency and quality

TABLE 5 Paratransit Software GIS Interface

Software	Aleph	CADMOS	CTPS/CRSS	EasyTrips	EMTRACK	GIRO/ACCESS	PARMIS
GIS Software	N/A	N/A	MapInfo	MapInfo	In-house	N/A	-
Import from DIME, TIGER files	N/A	N/A	Y	Y	Y	N/A	Y
GIS data maintenance utility	N/A	N/A	N	N	N	N/A	-
Multi-monitor display	N/A	N/A	Y	Y	Y	N/A	-
Manipulate screen display	N/A	N/A	Y	Y	Y	N/A	-
Display vehicle location	N/A	N/A	Y	Y	Y	N/A	-
Display driving path	N/A	N/A	Y	Y	Y	N/A	-
Display client location	N/A	N/A	Y	Y	Y	N/A	-

Software	PARRAS	PASS	PC-DISPATCH	PLANET	PtMS	Quick-Route	SCOOTER	Quovadis
GIS Software	N/A	MapInfo	MapInfo	N/A	MapInfo	In-house	DigiMap	In-house
Import from DIME, TIGER files	N/A	Y	Y	N/A	Y	Y	Y	Y
GIS data maintenance utility	N/A	N	N	N/A	N	N	N	Y*
Multi-monitor display	N/A	on one monitor	Y	N/A	on one monitor	on one monitor	Y	Y
Manipulate screen display	N/A	Y	Y	N/A	Y	Y	Y	Y
Display vehicle location	N/A	Y	Y	N/A	Y	N	Y	Y
Display driving path	N/A	Y	Y	N/A	Y	N	Y	Y
Display client location	N/A	Y	Y	N/A	Y	N	Y	Y

-: insufficient data, vendor did not supply

* Not a true GIS data maintenance utility.

of service to the operator and passengers alike. However, new software presents new opportunities, as discussed previously. New software is not an excuse for continuing old procedures. It is an opportunity to evaluate and change operating policies in order to reach new levels of service efficiency, passenger satisfaction, and community mobility.

FUTURE PROSPECTS

The current focus of the paratransit industry is on advanced technologies—APTS. The technologies include smart cards, AVLs, real-time dispatch and scheduling for shared rides, integrated reporting and billing, minimum time and distance routing for pickup and delivery of passengers, service confirmation, automatic caller identification and eligibility validation, GIS data base maintenance, graphic displays of service areas with relative passenger and vehicle locations, synthesized voice response, and other exciting items. Such micro-level improvements are vital to improving transportation to special groups. They will not in themselves, however, improve public mobility appreciably for the community, especially compared with the mobility provided by the private automobile.

Besides technical innovation, the service delivery system and community mobility require some creative thinking. New concepts such as the mobility manager are needed to affect the way people think about their transportation choices. Such concepts can then apply the new technology to affect people's travel behavior and give them alternatives to the single-occupant automobile. Thus, for example, the mobility manager must focus on the way transportation service information is acquired, processed, and made available before people choose their mode for a trip. APTS must be used not only to improve the efficiency and effectiveness of a particular mode, but to improve the choice of modes for a trip as well.

Automated computer dispatch for paratransit service is a precursor of the mobility manager. Already passengers can quickly call for rapidly responding, real-time service. Automated dispatch also has the capability for other major functions of the mobility manager, including brokering, fares, ride validation, passenger eligibility checks, billing and reporting, and magnetic fare media processing. However, the technology must also be extended to provide shared-ride, real-time dispatch and scheduling in order to become the "brain" of a mobility manager. When real-time, shared-ride scheduling is added to existing automated computer dispatch algorithms, advances must also be made in AVLs, the key to the next major improvement in response time. Fortunately, these improvements are on the verge of becoming reality.

The pace of technological change in the paratransit industry is rapid. Such change is exciting: new products and concepts for service delivery appear every month. Such rapid change also generates concern about the longevity of innovations and their integration as systems in concepts such as the mobility manager. Will better products come along? Will they all fit together when purchased? Crucial questions remain about such issues as common design specifications, physical connections, input and output formats, communications structures, and protocols. As many new products become available, there is concern in the industry about which products are best suited for operators' needs and whether the technology will greatly change within reasonable payback periods. Indeed, selecting new hardware and software can become a formidable problem.

The authors hope that this paper is valuable to those readers who plan to evaluate their needs and acquire an automated paratransit management system.

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