Implementation Issues For Community Transit Technologies

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Introduction

The purpose of this report is to evaluate the potential role of technology in improving the efficiency of community based transportation (CBT) service. CBT is broadly defined as organizations that provide transportation services specifically to transportation disadvantaged individuals; that is, those who, due to disability, income, age-related, or other constraints cannot viably own or use automobiles. CBT providers receive funding from a wide variety of government or non-profit organizations whose area of service include one or more of the following:

- Non-emergency medical care
- Social services
- Job training/Employment assistance (“welfare-to-work”)
- General transit service (Americans with Disabilities Act requirements)
- Poverty relief
- Care for the elderly
- School and head start

Community Based Transportation providers have two core functions, to provide rides, and to track rides and costs, and bill and report to the appropriate sponsoring agencies accordingly. Opportunities for efficiency improvements correspond to these two core functions. The basic activities that providers undertake typically include some or all of the following:

- Providing rides
- Tracking and verifying vehicle activities
  - After the fact, for reporting purposes
  - “Live,” for real-time route changes
- Tracking who rides and why
  - Eligibility for third-party billing or use of special program funds
  - Reporting activities to funders
- Scheduling vehicles and drivers
  - Before the route start
  - Changes during the route
- Keeping records, generating reports, bills, etc. given that data is available.
Another aspect of improved efficiency has to do with providers working together ("coordination"). Thus efficiency improvements could be grouped into four categories:

- Improved operations working as an individual agency.
- Improved operations due to better coordination with other agencies.
- Better administration working individually.
- Better administration due to coordination with other agencies.

This report addresses information technologies that are available or emerging that could improve the performance of these functions. It is not intended to be a detailed or exhaustive evaluation. Rather, the intent is to provide a broad-brush review touching on larger policy and implementation issues. We focus especially on how technology can be used to facilitate coordination among providers, both in terms of vehicle operations and administration.

**Information Technologies**

There have been a number of recent comprehensive studies addressing intelligent transportation system (ITS) applications for demand-based paratransit operations. These studies primarily take the point of view of how individual providers can use technologies to enhance their own operations. Several reports and a website have been produced by the Institute for Transportation Research and Education at North Carolina State University (1, 2, 3, 4) as part of a project for the Transit Cooperative Research Program (TCRP). Multisystems, Inc. (5) has done another major comprehensive survey for the Federal Highway Administration (FHWA). Readers who are interested in understanding more detail about specific technologies and how to implement them should refer to these documents.

Here we take an approach that focuses less on the technical details and more on the implementation and policy implications of these technologies. We have organized technologies that can be applied to CBT operations into the following categories, ordered roughly from those that are aimed more at administration efficiency, to those that are more useful for enhancing vehicle operations. This also corresponds roughly to a ranking from simple to complex:

- General data management/accounting software
- Palmtop computers/Personal Data Assistants
- Electronic on-board payment systems
- Internet communications
- Scheduling software
- Mobile Data Terminals (MDT)
- Automatic Vehicle Locators (AVL)
- Communications (operations center to vehicle)

These technologies will be discussed in the following subsections. For each, an overview will be provided, followed by a summary of potential benefits relative to the core CBT provider functions of operations and administration, and relative to the potential to facilitate improved coordination among providers.
General Data Management/Accounting Software

Overview

This category is the most basic of those being reviewed. This type of system could be as simple as a custom database in Microsoft Access. The basic functions to be provided would include:

- Keep data on individual clients in terms of name, address, program coverage/eligibility, and special needs (such as wheelchair user, elderly eligible for specific programs, or other attributes of individual riders).
- Track and organize rides provided over given reporting periods according to funding source, organization served, general client category, or geographic area covered for general tracking of operations. With appropriate programming, bills and reporting forms could be generated automatically.
- Facilitate improved coordination between organizations through consistent data management and data systems that can be accessed (in agreed upon ways) by multiple organizations.

Using the program to enter data and generate reports is straightforward, given that an appropriate program has been set up in advance. Setting up this program, however, can be a non-trivial problem, especially for organizations with many funding sources and client and trip types. However, since many different organizations would want to do basically the same kinds of things, it is reasonable to think that a single sufficiently general program, written and distributed from a single centralized source, could meet the needs of a wide variety of users. This sort of functionality was the original heart of the CRRAFT program in New Mexico (6), which subsequently evolved to incorporate a number of other useful functions.

Summary of Potential Benefits

The primary benefit of data management/accounting software would be to help keep passenger eligibility, trip, and cost information organized for billing and reporting purposes; and to automatically generate appropriate bills and reports so that agencies don’t have to do this “by hand.” Another potential benefit of a centrally provided program would be to establish some degree of standardization among providers with regard to how records are kept; this could ultimately help to facilitate more interagency coordination. Central provision would also have cost advantages; hundreds of individual agencies, most of whom likely have little computer programming expertise, would not have to invest resources in developing a record-keeping program individually.

Palmtop computers/Personal Data Assistants (PDAs)

Overview

This general category of product is a small, handheld computer that can electronically reproduce driver manifests. It has emerged relatively recently as an option for community based transportation systems. Loaded with a day’s worth of route information, a driver picks up the palmtop computer and enters operating information as he/she proceeds. At the end of the day, the driver returns the unit to the operations center, where the actual operations data is downloaded into the scheduling and recordkeeping system (7). This type of system would serve the same
basic function as a mobile data terminal (MDT). The benefit is that these units would be significantly less expensive than MDTs, at approximately $250 per unit (1). The disadvantage is that there is no real-time data link for dispatching and/or AVL applications.

The TCRP Report 76 (1) suggests that “Palmtop Electronic Manifest Devices” should be considered for small and medium CBT operations, and are not applicable for large CBT operations.

Summary of Potential Benefits

This technology is primarily one that would help slightly with efficiency and accuracy of data tracking and billing. Rather than a driver handwriting notes which are then typed into a database by office support staff, the driver would create notes directly in an electronic form. However, the schedule data has to be uploaded to the unit at the beginning of the day, and the notes downloaded from the unit, and processed in some way, at the end. Thus the overall time savings could be minimal; data entry time is to some extent just shifted from office staff to the vehicle driver. This could be beneficial if drivers typically have down time during which they could do this. Any benefits of this type of approach would have to be weighed against the cost of the units themselves, the training of the drivers, and the potential for lost data if the unit is damaged or malfunctions during the day.

Electronic On-Board Payment Systems

Overview

This category refers to systems that allow travelers to pay for transportation as they board the vehicle through the use of Smart Cards, bar codes, and magnetic strip cards. The on-board scanner can also register information regarding each passenger (name, address, eligibility status, etc.) to assist with the overall trip/data tracking efforts on the part of the CBT provider.

Detailed cost information was not available for electronic payment systems in the literature reviewed for this report. However, the TCRP Report 76 (1) suggests that fare media such as Smart Cards and similar systems are not feasible for small (less than ten vehicles), but should be considered for medium (10-30 vehicles) and large (greater than 30 vehicles) providers.

Summary of Potential Benefits

The primary advantages of this type of system are as follows:

• More convenience and speed of access for passengers (quality of trip provision)
• Eliminates in-route payment handling requirements for drivers
• Eliminates in-route paperwork requirements for drivers and associated potential for error
• Allows entry of each trip immediately and efficiently into a provider’s overall data management system

In a more general sense, it appears that one of the greatest benefits associated with the electronic fare payment systems may be to keep data regarding riders, eligibility, and rides provided organized when there is group of organizations coordinating together. Data can go directly from the rider’s card to a central data system, rather than going through individual drivers and the various operations centers that they report to. As an example, the use of on-board...
electronic benefits cards is an important component of the Client Referral, Ridership, and Financial Tracking (CRAFFT) system in New Mexico, which involves coordination between a very broad range of organizations (6).

**Internet Communications**

**Overview**

Internet CBT web sites can allow multiple providers to use a centralized and coordinated system without having to incur the costs and other development requirements associated with implementing their own individual systems. Such web sites can provide some combination of the following services: a) track and compile rider eligibility/background and trips provided information (this is also a fundamental element of the CRAFFT system), b) provide coordinated trip booking and scheduling (generate manifests); and c) provide real-time trip dispatching during operational shifts (3, 5, 6). The last of these functions relies on the use of “superphones,” which are essentially small hand-held computers with two-way cellular phone capability and internet access. These systems use Cellular Digital Package Data (CDPD) through the TCP/IP protocol and can have electronic mail capability (7).

**Summary of Potential Benefits**

The use of centralized internet coordinating capabilities (e.g., CBT web pages) can enhance the performance of both the trip provision and data tracking/billing functions which CBT providers perform. The key benefit is that multiple systems can be linked together in a way that, in a broader sense, increases economy of scale in the overall operations. The potential gains must be weighed against a) system costs, b) overall electronic information system compatibility issues, and c) technology training requirements.

**Scheduling Software**

**Overview**

There are a number of products in this general category (sometimes referred to as Computer Aided Dispatching) with differing levels of capability and sophistication. The primary focus of this type of system is to automate the scheduling of individual trips and the design and scheduling of routes. Performing these activities manually can be very cumbersome, and the use of scheduling software is now relatively widespread, particularly among larger operations. Often these programs also have the ability to track individual trips provided and organize them according to funding source for billing purposes. Scheduling software systems also generally have Geographic Information System (GIS) capabilities to allow pickup and drop-off locations to be geo-coded. This is very useful for determining trip feasibility (scheduling), route assignment (dispatching), and distance-of-trip (billing) information.

The transportation department of the American Red Cross in St. Paul has a representative example of scheduling software. Under this system, which they have had since 1995, schedulers receive calls from clients directly. The clients request a ride for a certain time to a certain location. The scheduler can look up that individual on the scheduling system to determine address, program eligibility, mobility needs and history, and other types of information. The scheduler enters the desired trip into the program and the program rates the trip as green (no
scheduling problem), yellow (may cause scheduling problems), or red (probably not possible). Schedulers are instructed to book all “green” requests and get assistance from managers for others. Managers can use judgment to determine if non-green requests can be performed or not. Once all trips for a given shift have been booked, the scheduling program assigns them (based in part on criteria factored in by Red Cross staff) to individual routes/drivers. It also assigns pickup and drop-off times for each ride. At the beginning of each shift, drivers receive printouts that identify all of their assigned trips with corresponding pick-up and drop-off times. At the end of each payment period the program used by the Red Cross allows all trips to be compiled by funding source and by organization served for billing purposes.

Information regarding costs of scheduling software programs varies to a significant degree. Generally, however, purchase/installation costs for fully automated systems are in the range of $25,000 to $55,000, with annual software maintenance/upgrade costs of 15 to 25 percent of software costs per year (2). While this figure may be too high for small operations, the potential for productivity gains can be substantial. Transit Cooperative Research Program Report 76 (1) indicates that scheduling software is likely not economically viable for “small systems” (defined as less than ten vehicles), but should be considered for “medium” (10-30 vehicles) as well as “large” (more than 30 vehicles) systems. The manager of the St. Paul-based Red Cross Transportation Services (22 vehicles) indicated that their scheduling system is a critical component of their successful operations.

**Summary of Potential Benefits**

This type of system has substantial benefits that support both the trip provision and data tracking/billing functions of CBT providers. For paratransit operations of any significant size, these systems provide calculations regarding optimal allocation of rides to individual routes/drivers more quickly and efficiently than staff members working by hand. Most such systems also allow efficient tracking of rides by eligibility category and funding source for billing purposes.

Scheduling software could in principle also provide efficiency gains in situations where a number of small providers are trying to work together; trips could be efficiently allocated to the different vehicles rather than each provider individually scheduling their own. This would require, however, that the providers were willing to submit their vehicles to a central scheduling authority, at least to some extent.

**Mobile Data Terminals (MDT)**

**Overview**

Mobile data terminals are essentially on-board computers that provide a real-time digital data link between the dispatch center and individual vehicles. Drivers can receive communications and information through a message screen, and can quickly send information to the operations center through function keys with pre-programmed messages. In their most basic application, MDTs are used: a) to reduce the need for verbal radio communications between vehicles and operations centers, b) replace written manifests and the need for on-board note-taking (and associated potential for errors) by drivers; and c) supply real-time operating information to the operations center within an architecture which allows accurate and efficient operating data management (8).
Often, MDTs are used in conjunction with automatic vehicle location (AVL) systems and/or smart card systems. The MDT unit compiles the information taken in through these types of systems, and transmits it in real-time to the operations center. In the case of AVL, map information showing vehicle location relative to given routes and destination points can be provided to the driver on the display screen on more advanced models of MDT units.

Cost estimates for MDT systems are dependent upon assumed features of the technology and upon the amount of effort and cost required to integrate the MDT units into the overall information/software architecture of the provider. However, a general estimate of $3,000 per unit (including base station and communication software) was made in TCRP Report 76 (1). In addition, there would be ongoing software maintenance and upgrade costs. This report identifies MDTs as not being feasible for small (less than ten vehicles) or medium (10-30 vehicles) demand responsive transportation systems. According to this report, they should be considered for large (more than 30 vehicles) systems.

**Summary of Potential Benefits**

Used on their own (that is, without AVL or Smart Card components), the use of MDTs has the potential to improve the trip provision and data tracking/billing functions that CBT providers serve. MDTs allow communication between the operations center and individual drivers without the need to go through radio connections, and they represent “paperless manifest” systems. Drivers can document revisions to their routes/schedules directly into any central scheduling and/or data management system used by the provider. Additionally, MDT units facilitate the use of AVL systems and electronic on-board electric payment systems as discussed in the following subsections. The potential benefits must be weighed against the significant costs of these systems, and against the possibility that some of the benefits may be of limited practical value, or could be closely replicated through less expensive means.

**Automatic Vehicle Location (AVL) Systems**

**Overview**

Automatic vehicle location systems locate and track individual vehicles using Global Positioning Systems (GPS) and relay this information to the central operations center. The AVL system requires not only GPS receivers, but also some method to transmit the data to the operations center.

A consideration with AVL systems is that GPS relies on signals from the satellites reaching the receivers. Signals may get degraded under the following conditions:

- Areas with tall buildings, such as high-density downtown areas
- Heavily wooded areas
- Dense fog or cloud cover
- GPS does not work at all in tunnels.

As with MDT systems, cost estimates for AVL systems depend upon assumptions made about the capabilities procured and data/communications linkages. However, a range of $1,000 to $3,000 per vehicle was reported in TCRP Report 76 (1). This report identifies AVL systems as not being feasible for small (less than ten vehicles) or medium (10-30 vehicles) community
based transportation systems. According to this report, they should be considered for large (more than 30 vehicles) systems.

**Summary of Potential Benefits**

The primary benefit of AVL is the support it can provide for the efficient delivery of trips by large CBT providers such as Metro Mobility. As explained to by a representative of Metro Mobility (which currently has scheduling software but does not have MDTs or AVL) there would be two aspects of this scheduling benefit. First, detailed and precise vehicle movement/operational data generated over time would provide Metro Mobility with helpful information that they could use to more effectively route drivers. Route planners could clearly understand how long given certain links actually take, where and when there are bottlenecks in the system, and other operational aspects of the system, to optimize scheduling parameters and maximize the efficiency of daily manifests given to drivers. The second primary scheduling benefit from AVL would be the enhanced ability to schedule and re-schedule “on the fly.” Once drivers are sent out, occurrences such as trip cancellations or unanticipated traffic congestion take place that require deviation from the original schedule. Knowing precisely where all the vehicles are in a network in real-time through AVL/MDT linkage, would allow the central operations center to adjust to these circumstances in an efficient way.

Another operational benefit of AVL/MDT systems is that drivers can be provided with maps to help them locate given destinations. These maps can be shown on the screen of the MDT unit based upon GIS information through the AVL system.

It is important to be somewhat cautious regarding the potential benefits of AVL to CBT providers. When asked about the desirability of AVL/MDT systems for American Red Cross operations, a representative of the Red Cross Transportation indicated that they would view this approach as a nice “luxury,” but not something which would have significant enough operational or other benefits to justify the costs. They are quite satisfied with their demand responsive transit software scheduling system, and Hudson’s Street Guides which their drivers use are more than adequate to locate given addresses.

The representative of Metro Mobility indicated that he had conducted an extensive review of AVL/MDT systems for potential implementation in 2001. The outcome of that review was that there were too many uncertainties regarding the actual benefits that would be realized from such an approach to move ahead with implementation. This is significant for an operation of this size; 260 vehicles and over 1 million trips provided per year. The representative from Metro Mobility indicated that sometimes transportation organizations get enthusiastic about “cool” technical systems and lose perspective on whether these systems will provide real value in terms of enhancing operational and other types of organizational performance.

**Communications**

**Overview**

Communications refers here to wireless information flow between central operations centers and individual vehicles, as well as between different vehicles. Information can be audio (voice) and/or data. Communications can be through radio (leased air time from commercial services) or through cellular telephone services. The basic considerations regarding selection of a communications technology for CBT providers would be:
• Cost
• Consistent coverage and service throughout the operating area
• Data transmittal capabilities
• Compatibility with, or utilization of, any existing communication systems/capabilities
• Compatibility with systems used by other operators for coordination purposes

The widespread availability of relatively low cost cellular telephone services allows even small operators to have basic wireless communications between dispatch personnel and drivers. In addition, Cellular Digital Packet Data (CDPD) systems allow data files to be separated into a number of packets and sent through idle channels of existing voice networks.

Summary of Potential Benefits

Having a communications system that allows appropriate levels of communications between central dispatch and the individual drivers will facilitate efficient operations in the field. When trips are cancelled, new requests come in, or circumstances on the road change for other reasons, routes can be adjusted accordingly. A number of sources, including those interviewed for this report, stressed that the communications technology selected for a given CBT must be compatible with all information technology components of that organization’s operations.

Implementation Issues

In general, it seems reasonable to suppose that specialized transportation providers are doing the best they can in terms of technology, given the limitations that they face in terms of the scale of their operations and the technical expertise that they have available for implementing and operating particular technologies. Most technologies are aimed either at saving labor or simplifying complex tasks, but for the many small providers with simple operations, neither of these is likely to be enough of an issue to justify the often-considerable expense and effort involved in implementing new technologies.

There are, however, potential gains in the context of providers working together. In terms of increasing operational efficiency, there are possible improvements to be made by small providers coordinating to make better use of underutilized vehicle capacity. To accomplish this in a cost-effective way will require some technological innovations. For reducing administrative costs, improvements could potentially be achieved through the central development of software that could be used to streamline administrative activities such as tracking rides, matching rides to funding sources, and generating bills and reports. Such software, once developed, could be almost costlessly distributed to many agencies, to the benefit of all.

Potential Operational Improvements

To get the performance improvements associated with most technologies aimed at increasing operational efficiency, there must be a sufficient level or extent of operations to support the cost associated with that technology. Also, more sophisticated and expensive technologies may provide functions that simply do not have value for small operations. For example, AVL likely would not have great value for a provider that only has five or ten vehicles, which can be relatively easily tracked by a dispatcher in any given shift.
However, Metro Mobility, with its 260 vehicles, is also not convinced at this point that AVL would be a worthwhile investment. This raises another important point, which is that there may be fundamental limits on operational efficiency; the idea of using technology to fill excess vehicle capacity may be unrealistic. Increasing the number of passengers per vehicle can be hard for a variety of reasons:

- Demand is generally sparse. Increasing passengers requires having several people going from roughly the same origin to roughly the same destination (or points in between) at very nearly the same time. Empirically, in the absence of special events, this simply doesn’t happen that often. Metro Mobility, with its 260 coordinated vehicles, only averages about 1.8 passengers per vehicle-hour.
- Providers may be limited to certain types of passengers or types of trips. This limits the underlying rate of trip generation for a given provider.
- From the other side, passengers may need a certain type of vehicle; a provider may not be able to carry a given passenger because of this.
- More passengers means worse service, as those who are already on board are delayed by picking up or dropping off others. Ultimately, the common constraint that no passenger should be on board for more than one hour will limit the number of stops that can be made.

Another key point is that the gains from increased passenger loads may be limited by the fact that many of the costs of operating a vehicle are incurred regardless of how much it is driven. That is, it is expensive to have a vehicle and a driver, but once they are in place, it is not that expensive to actually use them. Having one van carry six passengers while five other vans and drivers sit idle would not save that much money.

In general, the more sophisticated and expensive technologies are aimed primarily at squeezing relatively small efficiency improvements out of big operations that are already efficient. This could very well be useful if these improvements make it possible to avoid purchasing additional vehicles and hiring more drivers. But from a broader system standpoint, the more significant issue is that many vehicles are not used at all for considerable amounts of time; many agencies may have a vehicle to serve their own clients, but only use it a few hours a week.

Underused vehicles are problematic from a system funding standpoint because many or even most of the costs of owning a vehicle are fixed; that is, they will be incurred at the same level regardless of how much the vehicle is driven. Supporting these high fixed costs for a large number of lightly used vehicles creates a drain on limited funds that could be used for other purposes that actually create value for clients. Using technology to facilitate and support a system that can bring unused vehicles and other resources into use could potentially have significant benefits both in terms of better service in the short term, and reduced costs in the longer term.

**Reducing Administrative Costs**

At a simpler level, all types of providers could hope to benefit from reduced administration costs. Most or all providers, to varying degrees, need to do the same kinds of things, for example:

- Tracking rides
- Eligibility checking
- Reports to funders
- Third party billing

All of these activities could be automated to a large extent; but this involves a large fixed cost; either in developing software to perform the needed functions, or in purchasing custom-developed software from an outside vendor. The alternative is keeping records using whatever ad hoc methods have arisen over the years, and figuring out a way to deal with non-routine events like reports to funders as they come. This latter method seems to be what most providers do, and they do in fact complain of the labor spent on producing different reports for different funders.

While it seems like a waste of resources to have dozens or hundreds of individual providers all expending significant effort to generate the same set of funding reports, it would be even more inefficient for all of them to invest in software to automate this and other functions. However, software, once developed, can be distributed more or less costlessly. This would be a public good. It wouldn’t make much sense for individual providers to use their own resources to develop this software, only to then give it away to others. However, it would make sense for it to be centrally developed and distributed, perhaps by a consortium of funders; as funders are the beneficiaries of improved efficiency, and at some level the original source of the problem of excessive paperwork.

The standardization of recordkeeping that would result from centrally developed administrative software would have the additional benefit of possibly making coordination between providers easier; they would not be held up by incompatible data systems.

**Some Implementation Ideas**

A relatively straightforward idea for implementing technological improvements would be for some centrally funded organization to develop record keeping and report generation software of the type just described. This sort of program was the original heart of the CRRAFT program in New Mexico referenced earlier. In that case, the program is implemented on a central server accessed through the internet; this is better in terms of updating the software and correcting errors. In the New Mexico case it also facilitated the expansion of the system to incorporate more sophisticated information sharing functions, such as checking eligibility for different programs. However, central administration is more technically difficult and more expensive; there would still be considerable value to be gained in the short term from stand-alone software distributed to providers from a central source.

A more difficult problem is using technology to facilitate interactions and coordination among providers. Probably the greatest potential improvement in the short term, as discussed earlier, would be to develop a system by which unused vehicle capacity (and/or trained driver availability) could be made available to other agencies needing rides for their clients.

Ultimately, achieving greater operational efficiency in the sense of utilizing currently underused vehicles is less limited by technology than it is by the fact that small providers have no institutional framework for working together to share resources. One obvious point is that they would need a legal and financial system in place for compensating each other for rides, or for defining an in-kind trading scheme.
But there are also significant technological issues. The most notable is the simple point that potential riders, who may be coming from a multitude of different agencies or even as individuals, have to be matched to providers with unused capacity, the appropriate type of vehicle, and an interest in providing the ride. There is a generally held belief, based on a fair amount of evidence, that providers will be reluctant, at least at first, to simply submit their vehicles and drivers to a central scheduling authority. A politically more feasible option would be a brokering system, in which ride requests are referred to providers with the potential capacity to handle them; the provider then decides whether to give the ride.

While this solves the political problem of allowing providers to maintain control over their own vehicles and drivers, it is a more complex system in that a given ride request can’t simply be assigned. First the opportunity must be offered to several providers; then there is a wait to see if one or more respond, then if there are multiple responses it must be assigned to one based on some criteria. To have a human executing this would be an expensive proposition; such a system would likely use up a substantial fraction of the gains achieved through greater vehicle utilization.

In principle, much of this function could be automated through creative use of email and a form-based website. However, some work would have to be done up front to determine if users and providers would be comfortable working with such a system, and to understand the details of how it would have to be implemented to gain general acceptance.

**Conclusion**

As has been frequently demonstrated in the literature, there are substantial inefficiencies associated with CBT services that have to do with the complex and fragmented nature of this “system.” There are many funding sources at various levels of government, many different client groups, and many different service providers. The overlapping and at times inconsistent agency requirements, client needs, and provider capabilities make streamlining and general improvement of CBT services a daunting task.

A basic finding of this report is that there are information technologies available that are helping CBT providers perform their core functions more efficiently and effectively; we have identified the primary categories of these technologies along with preliminary information regarding capabilities and cost/implementation issues. While CBT providers should receive support to continue to assess and implement these information technologies consistent with their existing programmatic and operational parameters, there do not appear to be technologies that would lead to “breakthrough” gains in service performance. It appears that CBT providers are generally aware of the information technologies that are available to them.

In a macro sense, the most potential for significant gains in the efficiency and effectiveness of CBT operations will be through improved coordination at the funding and provider levels. We believe that a key in assessing and implementing information technologies is the question of how they would help improve operational and data tracking coordination with other organizations and better allow multiple organizations to work together. All of the categories of information technologies reviewed in this report could help existing operations be improved from efficiency and effectiveness perspectives, but perhaps more importantly, could also facilitate increased coordination between CBT organizations.
References


ADDITIONAL SOURCES:

5. *Deployment of Technology for Paratransit: What are the Effects on Employees?*, Carol Schweiger and Judith McGrane.