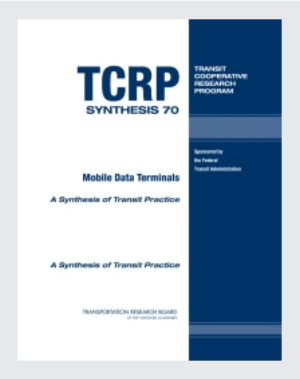

Mobile Data Terminals

DETAILS

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TRANSIT COOPERATIVE RESEARCH PROGRAM

TCRP SYNTHESIS 70

Mobile Data Terminals

A Synthesis of Transit Practice

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SUBJECT AREAS
Public Transit

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TRANSPORTATION RESEARCH BOARD

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TRANSIT COOPERATIVE RESEARCH PROGRAM

The nation's growth and the need to meet mobility, environmental, and energy objectives place demands on public transit systems. Current systems, some of which are old and in need of upgrading, must expand service area, increase service frequency, and improve efficiency to serve these demands. Research is necessary to solve operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the transit industry. The Transit Cooperative Research Program (TCRP) serves as one of the principal means by which the transit industry can develop innovative near-term solutions to meet demands placed on it.

The need for TCRP was originally identified in *TRB Special Report 213—Research for Public Transit: New Directions,* published in 1987 and based on a study sponsored by the Federal Transit Administration (FTA). A report by the American Public Transportation Association (APTA), *Transportation 2000*, also recognized the need for local, problem-solving research. TCRP, modeled after the longstanding and successful National Cooperative Highway Research Program, undertakes research and other technical activities in response to the needs of transit service providers. The scope of TCRP includes a variety of transit research fields including planning, service configuration, equipment, facilities, operations, human resources, maintenance, policy, and administrative practices.

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The TCRP provides a forum where transit agencies can cooperatively address common operational problems. The TCRP results support and complement other ongoing transit research and training programs.

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FOREWORD

By Staff
Transportation
Research Board

Transit administrators, engineers, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and unevaluated. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

There is information on nearly every subject of concern to the transit industry. Much of it derives from research or from the work of practitioners faced with problems in their day-to-day work. To provide a systematic means for assembling and evaluating such useful information and to make it available to the entire transit community, the Transit Cooperative Research Program Oversight and Project Selection (TOPS) Committee authorized the Transportation Research Board to undertake a continuing study. This study, TCRP Project J-7, "Synthesis of Information Related to Transit Problems," searches out and synthesizes useful knowledge from all available sources and prepares concise, documented reports on specific topics. Reports from this endeavor constitute a TCRP report series, *Synthesis of Transit Practice*.

This synthesis series reports on current knowledge and practice, in a compact format, without the detailed directions usually found in handbooks or design manuals. Each report in the series provides a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems.

PREFACE

This synthesis reflects state-of-the-practice information from selected transit agencies surveyed across the United States, as well as very specific information on the capability of mobile data computers offered by technology vendors to the industry. The report also contains information about the rapidly changing wireless communications infrastructure that supports mobile data terminal (MDT) deployment in transit. This topic will be of interest to transit planners and managers, information technology staff, and others who work with them in the deployment of MDTs in transit. The topic panel charge to the consultant dealt with educating the transit industry in how to address the technology marketplace as an informed buyer.

A large amount of technical information about MDTs was acquired from 119 different respondents by five different means—short survey form, long survey form, e-mail responses, fax responses, and telephone responses. This information plus survey design and case studies is presented in the various synthesis chapters, with voluminous survey database information included in the appendixes.

Lawrence J. Harman and Uma Shama, Harman Consulting, Boston, Massachusetts, collected and synthesized the information and wrote the paper, under the guidance of a panel of experts in the subject area. The members of the Topic Panel are acknowledged on the preceding page. This synthesis is an immediately useful document that records the practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As progress in research and practice continues, new knowledge will be added to that now at hand.

CONTENTS

MOBILE DATA TERMINALS

SUMMARY

The essence of transit is the movement of people through space and time. However, many transit agencies appear to concentrate on the movement of the transit vehicle that contains the passenger and overlook the information needs of the transit consumer. Defense-based technologists have always understood the information needs of the consumer in the movement of people and equipment. Military-oriented technologies have developed rugged and effective mobile computers, secure and resilient communications systems, and a host of web-based information services that are helping change the way transit service is delivered and designed.

A marker of the military technological revolution is the development of the mobile data terminal (MDT). Although on its own an MDT is simply a rugged version of a pager with some flexible functionality, when viewed in the context of technology development in the transit industry, it can help attain new paradigms of service for the transit consumer and new levels of public accountability for the transit manager. The MDT and the supporting communications infrastructure can offer the transit industry the opportunity to change its business in response to consumer demand. This synthesis explores that concept in documenting the current state of the practice for MDTs in transit.

Selected survey responses were received from 119 varied transit agencies and industry suppliers throughout the continental United States. Specific information is presented on the capability of mobile data computers offered by the technology vendors to the industry, as well as related information on the hardware and software provided in support of MDTs. Importantly, this synthesis study explored the rapidly changing wireless communications infrastructure that supports MDT deployment in transit. Survey respondents were asked to provide detailed information on the MDT functions that they have designed into their fixed-route and paratransit systems. They also provided information on operational and management applications made with MDT-collected data. To the extent practical, the transit professionals attempted to estimate unit costs for purchasing, installing, and maintaining MDTs. Survey participants provided insight useful to policymakers about scarce transit resources and corporate researchers attempting to create products and services to meet the needs of the transit industry. All participants were asked to address their future needs and future plans for technology deployment.

The survey results reported a rapidly changing MDT marketplace, largely driven by forces external to the transit industry. Several MDT manufacturers and intelligent transportation system (ITS) suppliers have existed for 25 years or more. There has however been considerable shake-out in the transit ITS business. There is also a significant presence from manufacturers and suppliers of European products and services. The European vendors provide a very different approach to designing and marketing their MDTs, reflecting a different service paradigm when compared with traditional U.S. transit technology approaches.

Wireless communications, from the rapidly expanding transmission capacity by franchised cellular carriers to emerging municipal wireless local area networks (WLAN or WiFi), is changing rapidly. Again, the economic forces for this development are external to the

transit industry, but are changing the outcome of life-cycle cost calculations used to determine the build or lease option for transit communications systems. Interestingly, as in business innovation, the smaller systems (see, e.g., the case study for Tyler, Texas) may be the harbingers of change. Small operators can enter the MDT business with a low-cost, data-only $10 per month cell phone plan and a $100 integrated global positioning system cell phone per vehicle. This may also be a way to get larger systems that are resource-constrained and necessarily cautious to establish a migratory path to fully featured transit advanced technology at a later date.

As with computing systems in general, there are marked advancements in MDT hardware and supporting software at every level. The synthesis survey shows an industry that attempts to upgrade when and where it can within the resources available. The survey also reveals the impact of technology companies that make one sale and go out of business. The wisest course for large systems may be exemplified by Portland's Tri-County Metropolitan Transportation District of Oregon (see case study), which invests in its own staff to take charge of the technology and find the better business solution rather than the narrow transit solution.

The trend is clear, more functionality in the MDT at lower unit cost, lower installation cost, and lower maintenance and repair costs. This synthesis study revealed a growing marketplace of technically superior MDT products and ITS services for the transit provider. The transit industry needs to become educated in how to address the technology marketplace as an informed buyer.

CHAPTER ONE

PROBLEM AND APPROACH

BACKGROUND

Since the end of World War II, public transit has required more and more public investment. With the use of public assets in transit comes public accountability. In law and regulation, public managers have sought to receive assurances from operators of public transit that these services are being provided in an efficient and effective manner. Also, the public scrutiny has gone beyond measures of productivity to include social issues of equity, nondiscrimination, environmental quality, and energy conservation. Increasingly, as national formulas were developed for the distribution of federal financial assistance to state and local governments, operational statistics were required from local transit properties in an accurate and timely manner. In addition to measures of service performance as an input to funding formulas, the U.S. Congress initiated a triennial review process for all recipients of federal transit assistance—a quality assurance/quality control (QA/QC) approach to transit management. As a public enterprise with substantial on-board data collection requirements, use of technology to facilitate the efficient, effective, and accurate collection of operational statistics has become an increasing priority for local transit operators and their state and federal government partners. Of late, transit professionals have focused on a mechanism for collecting and transmitting operational data—the mobile data terminal (MDT). TCRP addresses this development in this synthesis, *Mobile Data Terminals*.

SCOPE OF SYNTHESIS

In recent years, the number of transit agencies using MDTs on buses and paratransit vehicles has increased. The MDT is the underlying data processing and transporting facility. Applications such as automatic vehicle location (AVL), sensors, data communications, and security use the MDTs for communication. MDTs communicate pertinent information between vehicles in the same region and with dispatchers or central information systems. In paratransit, this greatly facilitates the communication of driving directions, schedule changes, and other information. Fixed-route systems are using MDTs to communicate detour information, available overtime work, and urgent messages.

The purpose of this synthesis is to survey selected transit agencies throughout the United States that use MDTs, document their successes and failures, and summarize other information about the following:

- Types and brand of equipment used.
- What applications and built-in functionalities are supported by MDTs.
- How these applications are integrated.
- Types of information communicated to MDTs versus other means.
- Costs to install and maintain MDTs.
- Staffing requirements to maintain the equipment and utilize the data.
- Staffing acceptance.
- Operational and technical problems encountered and solutions.
- MDT uses desired beyond the capabilities of the existing equipment.
- Future applications and technologies.
- Information technology and communications infrastructure supporting MDT.
- Types of communication [e.g., WiFi, cellular, multi-hop, or RF (radio frequency)].
- Security and resilience of communications (after disruption).

The synthesis will cover the use of MDTs in both urban and rural and small urban areas, will include both fixed-route and paratransit applications, and will identify reasons for their successes and failures, as well as lessons learned.

A review of the relevant literature in the field is combined with surveys of selected U.S. transit agencies and suppliers to report on the current state of the practice. Based on survey results, several case studies were developed to profile innovative and successful practices, as well as lessons learned and gaps in information.

DEFINITION OF TERMS

North Carolina's Institute for Transportation Research and Education (ITRE), in its landmark study of the application of technology in rural and small urban transit, provided the most useful discussion of MDTs found in the literature review.

Mobile Data Terminals display short written dispatch messages. They replace voice radio communication between the

> driver and the dispatcher except in emergencies or other exceptional cases. MDTs serve as the communication hub between the vehicle and computers at the control center. They automatically send vehicle location, passenger counts, engine performance, mileage, and other information. Some information like passenger boardings and deboardings may be sent when the passengers' "swipe" their smart cards as they enter or depart the vehicle or when the driver pushes function keys on the MDT. The driver can use other function keys to send pre-recorded digital messages regarding vehicle and passenger status or in response to questions or prompts displayed on the MDT screen. Thus, the MDT can virtually replace note taking and written manifests. It becomes the entry point for data to perform system-wide passenger accounting and vehicle performance analysis (Stone et al. 1999).

The TCRP synthesis topic panel was mindful that implicit in the study of MDTs as data collection instruments was the means used to communicate these data back to the operations center and other entities, including consumers. The changes in computer technology and communications technology are seen as dramatic and on-going. Therefore, the panel directed that a methodology be designed that could be useful for longitudinal studies measuring changes well beyond the shelf-life of a typical synthesis of current practice. To the extent possible, the survey includes emerging technology and approaches to on-board data collection that might not be currently in practice but are likely to be evident in the near future. Lastly, the topic panel wanted to include European and Asian MDT manufacturers and intelligent transportation system (ITS) suppliers in recognition of the global market for these goods and services.

For the purpose of this study, "mobile data terminal" is defined as a multifunctional data collection device on board transit vehicles that performs two-way data communication and, increasingly, has the ability to locate itself in real time. This definition excludes single-purpose electronic fareboxes, automatic passenger counters, stop enunciators, and personal data assistants from the scope of the study. It also permits a focus on products integrating locational technology that is crucial to the evaluation of transit performance and the provision of real-time customer information. Lastly, it recognizes that with the rapid evolution of wireless communication driven by business and consumer markets, real-time data communication between transit vehicles and operations is evolving as well.

ISSUES DELINEATED

This synthesis study takes place in an era of rapid international technology deployment. This deployment is raising issues that are being addressed in the deployment of MDT technologies.

- Location technology diffusion. Global positioning systems (GPS) have evolved from a military technology to a mass market product found in luxury cars and, increasingly, in cell phones. Today, few transit professionals remember that AVL was accomplished in transit by dead reckoning (Dublin, Ireland) and by "signpost" location (Norfolk, Virginia). Whereas Europe and others are launching new GPS systems, cell phone manufacturers are devising their own versions of location technology in response to regulators, consumers, and businesses seeking new ways of finding customers. This wave of innovation, with its capability to provide instant feedback from transit operations in very precise measures of space and time, is a boon to those interested in providing timely and reliable information to transit customers.
- Communication technology change. Transit operators, particularly large urban fixed-route transit operators covering large geographic areas, were slow to adopt voice radio systems until significant capital assistance became available in the mid-1970s. Outside of those with railroad signal systems, the only option of large transit operators was to build expensive private radio networks that had to compete for radio frequencies with other public safety and private businesses. For rural transit operations covering very large multicounty areas, it precluded any technology deployment requiring communication. The design and deployment of ITS in both urban and rural areas in the mid-1990s brought the issue of communication in transit to center stage. For most transit systems the answer was and still is building a separate private radio system (for voice and/or data) to communicate information to and from transit vehicles. Concerns on making more of the radio spectrum available for public purposes (a process called re-farming) continues to be a significant societal issue.

  However, dramatic changes are occurring in wireless networks for public use, called public data networks. Cellular carriers have evolved rapidly in response to market demand for services that include web access and video streaming. Competing cellular companies are responding with massive investment in communications infrastructure to provide broadband access to cell phone users, now popularly called wide area networks. Coincident with this development, WLAN or WiFi (for wireless fidelity standards), with their extraordinary throughput, are developing antennas and powerful radios integrated into computers that have evolved from ranges measured in feet to miles. Indeed, outdoor WiFi has attracted political leaders concerned with "the digital divide" occurring in their low income and minority communities to call for open WiFi cities (e.g., Boston, Philadelphia, and Seattle). As transit runs significant service in these communities, WiFi is being considered as a transit communication system in a few federal demonstrations (Bridgewater, Massachusetts; Cedar Rapids, Iowa; and Seattle, Washington). At least one computer hardware manufacturer promotes transit outdoor WiFi systems in its marketing materials. Although it is not known how wide area networks, WiFi, (or the emerging WiMAX) developments will turn out, the

immediate impact, in those communities that have these services, is inexpensive (in some cases free), two-way data communications for MDTs.

- Manufacturer/supplier volatility. In reviewing the literature and reflecting on the consultant's personal experience in deploying transit technology in the past decade, what stands out is the short life span of transit technology providers. The ITRE study of rural and small urban providers of MDTs and associated computer-assisted dispatching software is revealing; only one firm manufacturing MDTs in the 1999 study exists today. Also, only one ITS supplier in the ITRE survey remains in business today. The consultant's experience in large urban ITS applications is similar. When looking at the 1997 list of national ITS suppliers serving the U.S. metropolitan market developed for a request for proposal for the Cape Cod Transit ITS technology deployment, only one is still in the transit ITS business. Although it is not within the scope of this synthesis study to review the underlying business reasons for this volatility, it became important to create a very accurate baseline of MDT manufacturers and ITS suppliers if this study is to be useful to researchers who may want to build on this synthesis effort.
- Technology deployment in the transit environment. Issues arising out of the deployment of technology in transit have been receiving some notice in studies relating to the rural and small urban environment. Recently, similar concerns were raised by general managers of large urban transit systems at a technology summit of the 2005 APTA General Manager's Conference and the 2006 TransITech Conference. TCRP's Project J-09 Task 12 researchers are addressing these problems and issues in their work in progress, "New and Emerging Information Technologies for Public Transportation." This synthesis project has also revealed that there are significant differences in transit technology deployment in Europe when compared with North America. An interesting finding of this MDT report was that ITS suppliers from Europe and other overseas regions are entering the U.S. transit technology market with very sophisticated and proven products.

ORGANIZATION OF SYNTHESIS

This synthesis will discuss the database development for this study and future MDT research in the transit industry in chapter two. Chapter three presents the results from the on-line survey, including both the short- and long-form questionnaires; chapter four presents the case studies of MDT deployments; and chapter five provides the conclusions on the state of the practice of MDT deployment in the transit industry at this point in time.

METHODOLOGY

The scope of work provided clear direction on the questions that needed to be asked of the industry. Initial efforts focused on developing an up-to-date database on the universe of MDT products available to the transit industry from a global perspective. The aforementioned issue of industry volatility became apparent. It also became clear that MDT manufacturers may be "hidden" behind the branding of third-party ITS service vendors. It was very possible that the respondents to the survey in the transit industry would not know the manufacturer and model specification details. Fortunately for this study, four major industry conferences were being held during the term of this contract: the ITS World Congress (San Francisco, California); the International Taxi, Livery, and Paratransit Conference (Boston, Massachusetts); the Annual Meeting of the Transportation Research Board (Washington, D.C.); and the TransITech Conference (Las Vegas, Nevada). All of these conferences drew an international audience and had excellent vendor expositions. A timely, comprehensive, and detailed database of MDT manufacturers and MDT models, as well as ITS suppliers, products, and services was created. Subsequently, these data were incorporated into the survey instrument as drop down menus where transit industry respondents could chose an MDT manufacturer and model number and ITS supplier. In addition, a picture of each model in the database was made available to the survey taker for positive confirmation of the MDT make and model.

Particular efforts were taken to create a survey universe that would have some standardization for replication over time. After some experimentation, the National Transit Database (NTD)—composed entirely of transit operators receiving federal operating assistance—was the best database to establish the survey universe. An added benefit of the coordination of the MDT study with the NTD database is the opportunity to analyze the benefits of technology deployment using the statistically validated NTD financial and performance data. This provides the transit industry with an opportunity to readily calculate technology return on investment over time

Two survey instruments were developed for this synthesis. A short-form survey was developed to acquire essential MDT deployment data from the largest group of industry respondents. A long-form survey was developed for those transit properties that wanted to fully share their experience with industry colleagues and transit researchers and wanted to be considered for case study treatment. The survey instruments were installed on a web server. The on-line survey instructions were sent to the chief executive officer (CEO) and NTD contact person with instructions to forward them to the appropriate technology person. Response to the survey was immediate and exceeded expectations based on recent technology surveys of the transit industry.

CHAPTER TWO

SURVEY DESIGN

The evolution of MDTs has been driven by private businesses depending on the efficient provision of goods and services and the global competitiveness of technology products serving transportation suppliers. Transit ITS is a beneficiary of these larger economic forces fostering what has been variously described as "e-commerce," "l-commerce," and "m-commerce." Even greater change is taking place in wireless communications in Europe, Asia, and the United States—responding to the demands of business and consumers for faster and faster transmission speeds in the developed countries of the world. These factors are largely external to the transit industry; however, their impact is felt in the technology products, particularly MDTs, being offered for sale.

It became apparent early on in this synthesis study that rapid changes were taking place in the MDT marketplace that required thorough review at the beginning of the study. Many of these bellwether changes were taking place outside of the traditional transit and public transit experience and outside of the United States; however, they could affect transit technology in the near future. Also, the MDTs available in the global marketplace were widely diverse in capability and characteristics. The degree of specificity required to analyze these offerings was beyond a reasonable expectation of knowledge or experience at the small and mid-sized transit properties. Furthermore, the specifications offered by MDT manufacturers and ITS suppliers varied greatly, making it difficult to compare and contrast products. In response, this synthesis committed to creating a detailed database of MDT products and capabilities as a part of the survey design process. With this approach, if the survey respondent could identify the MDT (from a drop down list of model names or by identifying a picture of the product from a line-up), the database could be referenced (using relational database queries) for a full technical description. The objective was to improve the quality of the data product from this synthesis study and to enhance future research by industry technical staff, consultants, or university staff using these data.

Recognizing that the evolution of MDT technology and wireless communications was going to accelerate, particular efforts were made to implement popular and easy-to-use database management software and web services so that the baseline efforts established by this synthesis of practice could be efficiently and effectively updated and accessed by the transit industry in the future. Very reliable queries by size of urbanized area, mode of transport, size of fleet, and many other attributes can be devised to address issues of the best technological fit for a particular MDT deployment. It may also provide the transit industry with an instant user group by MDT manufacturer, MDT model, and ITS supplier. This approach may exceed the typical synthesis of practice; however, the foundation review required by this synthesis provided the opportunity to set up continued research in this very significant but difficult area of transit technology.

MOBILE DATA TERMINAL SURVEY DATABASE DESIGN

A relational database was designed to provide for the storage, retrieval, and manipulation of data collected for this MDT synthesis using Microsoft Access 2003. The flow chart, "Mobile Data Terminal Relational Database Structure," can be found in Appendix A1, Section A1-4, and can be downloaded from www.e-transit.org (GeoGraphic Laboratory Internet Mapping Application Projects—MDT-ITS RDBMS4.pdf). There are six data tables within the relational database described here:

- An MDT manufacturer contacts table providing mailing addresses, telephone numbers, e-mail, website, and related contact information.
- An ITS supplier contacts table providing mailing addresses, telephone numbers, e-mail, website, and related contact information.
- An MDT specifications table providing information on specific MDT makes and models including description (dimensions, weight, enclosure material), computer processor (type, speed, operating system), display (type of display, resolution, color quality), input devices, interfaces, memory features (base, expansion), GPS characteristics, communications (public and private networks), power supply information, and operating environment.
- An ITS product and services database with general descriptions of the product or service provided by the vendor.
- A transit agency contact table derived from the published 2003 FTA NTD and updated with January 2006 NTD records for this study.
- A transit agency survey table(s) including responses from the long form and short form of the on-line survey for this synthesis study (imported from survey software in .XML format).

MS Access 2003 was used to perform relational database functionality: design of database tables, creation of input forms, creation of Structured Query Language (SQL) queries, and creation of standard reports. It is important to note that this information is all that was known to the consultant at the time this synthesis was prepared; any omission is unintentional. In addition, TCRP and its sponsoring organizations do not endorse specific products and services.

MOBILE DATA TERMINAL MANUFACTURERS CONTACTS DATABASE

The development of the MDT manufacturers contact database came from the personal experience of the consultant over the past decade, the personal experience of the synthesis topic panel, a review of trade periodicals at the Massachusetts State Transportation Library, use of several on-line search engines, and attendance at four international transportation research and technology conferences that occurred during the course of this project. On-line searches went beyond the traditional transit technology applications to address fleet management in other industries with similar data collection requirements of transit and paratransit services. Because some MDT vendors and ITS suppliers were no longer in operation and new vendors were entering the marketplace, a write-in capability included in the on-line survey provided additional opportunities to populate this data table. A list of the MDT contact information gathered for this synthesis study can be found at www.e-transit.org. Periodically, and at the conclusion of this synthesis, the MDT database will be updated.

MOBILE DATA TERMINAL MODEL (SPECIFICATIONS) DATABASE

The heart of this synthesis is the MDT specifications table, which lists the features of the MDT by manufacturer's model number based on manufacturer-provided information. Some manufacturers had detailed specifications available for download on their websites; others had specifications available in handouts at the aforementioned conferences.

For the purposes of this study, several features were considered critical for comparison of MDT technology deployment in fixed-route and paratransit services now and in the future:

- Processing power (chip manufacturer, processing speed).
- Operating system (OS): mass market OS, open systems, proprietary OS, etc.
- Display: type and quality of display of MDT by mode may be significant over time.
- Interfaces: type, number, and variety may be significant in averting early obsolescence.
- Memory: base and expandability are lessons learned from the deployment of laptops into society that extend the life of a computing product in the field.
- GPS is changing with more channels providing faster locational fixes. Assisted-GPS for cell phones and variations of differential-GPS provide better geographic accuracy and, in some cases, dramatic improvements in time-to-first-fix that can be helpful in paratransit operations.
- Communications, as mentioned previously, is changing so rapidly that the web and periodical literature proved the only way to keep up with the changes. The situation is made more difficult by the marketing of competing national cell phone providers who can create confusion with their use of terminology (e.g., "broadband access" from cell phones vs. outdoor WiFi systems). However, it became clear that any review of an MDT model had to address the issue of its built-in communications capability. The MDT database (and the survey) attempted to address communications from legacy systems, evolving systems, and systems about to be deployed—*as they were found in the current marketplace evidenced by manufacturer specifications.*

The contents of the MDT specifications used at the time of this survey are described in an Adobe .pdf file and can be found at www.e-transit.org. The file will be periodically updated and will be available for download.

MOBILE DATA TERMINAL IMAGE FILE

In developing the MDT database, it became clear that MDT manufacturers approach the naming of their products in a wide variety of ways; some are very straightforward, others show the influence of creative marketing. As an aid to survey takers who may not know the nomenclature, but who do know what the MDT looks like, a picture file (jpeg images) was developed with the synthesis database number and the manufacturers MDT model number. The intent was to build some ease of use into the survey without losing the accuracy of the model identification. As was noted in the previous section, the MDT specifications add a significant dimension to the analysis of technology deployment in the industry without adding an overwhelming requirement for technical information for the transit industry respondent. The image files were downloaded from manufacturer's websites and vary in image quality. The image file "proof sheet" used in this synthesis study can be found at www.e-transit.org.

INTELLIGENT TRANSPORTATION SYSTEM SUPPLIER CONTACT DATABASE

In a manner similar to the development of the MDT manufacturers' database, an effort was made to include a wide representation of ITS suppliers from North America, Europe,

and Asia. Trade publications, on-line searches, and the four previously mentioned international conferences were used to identify suppliers and collect current contact information to populate the ITS supplier contact database. A periodically updated list of the contact information for ITS suppliers used in this synthesis study can be found as an Adobe .pdf file on the project website www.e-transit.org.

INTELLIGENT TRANSPORTATION SYSTEM PRODUCT AND SERVICES DATABASE

Although it was important to keep the narrow focus of the synthesis to MDT functionality and associated communications capability, it could not be completely separated from the ITS context at the transit property or the ITS vendor that supplied and installed the MDT on the transit vehicles. Furthermore, it was very possible that the survey respondent did not know who manufactured the MDT, but did know who provided the overall transit ITS system. As information was collected for the MDT database effort, it was also collected on ITS suppliers. A global search was attempted using international trade publications, international conferences, and the World Wide Web. As was found in collecting specific data on MDT products, published information on ITS products and services varies considerably depending on the marketing resources of the vendor. More importantly, descriptions of the products and services in transit ITS was market-driven, not science-driven. It was beyond the scope of this MDT synthesis to separate fact from fiction in ITS vendor publications. However, a generic classification scheme was created for the various products that the survey respondent could select from a pull-down menu. This ITS product/services database is available as an Adobe .pdf file and available for download at website www.e-transit.org.

NATIONAL TRANSIT DATABASE CONTACTS DATABASE

At the outset of this synthesis effort, it was assumed that there was a relatively small number of transit properties deploying MDTs, and that developing the survey universe would be a straightforward task. Although this may have been true, it also became apparent that the MDT deployment in the transit industry could have much more significance as a marker of the spread of transit technology deployment over time. Thus, establishing a valid and reliable baseline for longitudinal studies became an important consideration of this process. The NTD transit agency contact list, published by FTA, established a baseline of every transit operator receiving federal transit operating assistance. The transit agency database for this synthesis was developed using the latest published NTD database (2003) available in Excel.xls format and Adobe .pdf. In transit, some agencies consolidate, new agencies are formed, and (although rare) some agencies cease to exist. The annual NTD survey accurately monitors these changes in the transit operators in urban areas.

The primary key field for all database tables relating to transit agencies in this synthesis MDT database is the FTA primary key for transit agencies reporting to the NTD (Trs_ID). This is the linking field between the MDT relational database and the FTA NTD relational database.

NATIONAL TRANSIT DATABASE RELATIONSHIPS AND PERFORMANCE MEASUREMENT

The structural relationship between the MDT relational database and the relational database created by products from the NTD can be seen in the figure, “2004 National Transit Database Relational Database Management System,” in the Appendix A1, Section A1-5. Tables taken directly from FTA downloads are imported into this Microsoft Access 2003 relational database providing tables entitled “Agency_Info,” “Service” (modified to provide only rows of annual totals), and “Operating_Expenses.” Using the linking field, Trs_ID, data on technology deployment can be directly related to transit agency performance by year and by mode. Over time, transit agency personnel can relatively easily document return on investment and increase in ridership from the deployment of transit technology.

MOBILE DATA TERMINAL SURVEY RESULTS AND NATIONAL TRANSIT DATABASE TABLES AS TOOLS FOR PEER GROUP TECHNOLOGY IMPACT ANALYSIS

NTD has been used as a tool for peer group analysis for more than two decades. Combining the MDT survey with the NTD reporting process also provides the capability for grouping interested transit agency peers by mode, size of area, fleet size, and expenditures into peer groups to assess the impact of different technology deployments. In this way, some mistakes or misapplications of technology in one peer group may be avoided by others in the group. In some cases, the statistics may speak for themselves. In others, the transit agency professional can easily contact colleagues from the database contacts table. In the community of geographic information system (GIS) users, free and spirited communication among users is encouraged by GIS suppliers and has greatly assisted in a world-wide deployment of a difficult-to-use and sophisticated tool in transit planning and operations. A similar phenomenon could be encouraged in the transit industry around the issue of deploying mobile data collection equipment in transit and paratransit vehicles.

CHAPTER THREE

SURVEY FINDINGS

Chapter three presents a summary of the survey responses and a synthesis of the survey findings. It also provides references to supportive information and database reports in the appendices.

RESPONSES TO SURVEY

The cover memo to transit agencies noted the potential for a national baseline for technology deployment in the transit agencies. Transit agencies not deploying MDTs in a particular property this year and not to be deployed next year, were asked to reply in the negative. Therefore, a significant number of respondents answered in the negative through the survey, e-mails, or telephone calls. The value of the survey data in the future will be enhanced by this conscientious effort by the NTD respondents and CEOs. A summary of responses is presented in Table 1.

SURVEY APPROACH AND TOPICS

The information identified for collection by the synthesis topic panel was both extensive and detailed (see chapter one). In an attempt to attract a broad national response to the survey, yet also provide for some depth in understanding deployment of MDTs within the industry, a two-track option was provided to respondents. The short-form "standard" response provided an abbreviated survey instrument with eight topic areas. The long form provided questions on the entire range of inquiry with 14 topic areas. An on-line survey map provided a flowchart for survey respondents to decide which of these options to take. Copies of each survey instrument were also sent to each respondent to assist them in making this choice, as well as to draft the answers to the questions before they took the on-line survey. (The on-line survey map, as well as the long form and short form survey instruments, can be found in the Appendix A1, Section A1-1.) The topics included in the short and long forms are included in Table 2.

OVERALL SURVEY RESPONSES

In February 2006, surveys were distributed by e-mail to the 640 transit systems included in the 2006 NTD database. The e-mail message was hyperlinked to the on-line survey on the Bridgewater State College GeoGraphics Laboratory web server. By April 2006, 119 transit agencies had responded, a response rate of 18.6%. Of these 119, 40 indicated that they currently had deployed 9,070 MDTs. Thirty agencies indicated that they would be deploying 1,623 MDTs within the next year. This constituted an 18% increase in MDT terminals nationwide from 2006 to 2007.

Forty-six agencies reported that they did not have MDTs deployed and would not be deploying them next year. Nine agencies reported that they would be deploying MDTs in the future.

A database report of transit agency respondent information can be found in Appendix A2, Report A2-A1, "2006 MDT Survey Respondents." A report on the number of currently installed MDTs and those that will be installed within the next year can be found in the Appendix A2, Report A2-C1, "Installed Mobile Data Terminal Totals," sorted by state and transit property.

MODAL RESPONSE

Survey invitations were sent to all FTA NTD reporters, including all modes of public transportation. Overwhelmingly, the positive responders checked the "motor bus," "demand responsive," or both. As of March 2006, six transit properties reported deploying MDTs in motor bus operations, nine reported MDTs in demand-responsive service, and ten reported MDTs in both motor bus and demand-responsive modes. Five properties did not register a mode of transit from the drop down menu. Of those reporting the current or future deployment of MDTs, no other modes were indicated outside of the motor bus and demand-responsive NTD modes. Several respondents that operated modes that have wayside data collection (e.g., heavy rail and ferry boats) reported that they did not have MDTs. Responses to the survey on mode using MDTs from a drop down list and MDT in use in other modes are presented in Appendix A2, Report A2-B1, "Modal Use of MDT."

MOBILE DATA TERMINAL MANUFACTURERS AND MODELS

Survey respondents were asked to provide the manufacturer and model number of the MDTs from a drop down list or add their response to a text field. In most cases, the MDT make and model were chosen from the drop down list. The

TABLE 1
MDT SURVEY RESPONSES AS OF APRIL 2006

Responses	Total	No. Using MDTs	No. Deploying MDT Next Year
Short	75	19	23
Long	22	21	6
E-mail	19	0	1
Fax	1	0	0
Phone	2	0	0
Total	119	40	30

consolidated results are presented in Table 3, listing the number of transit agencies reporting by MDT make and model, aggregated by mode choice and the number of MDTs reported currently deployed and those expected to be deployed within the year.

A report from the MDT database presenting the number of MDT models installed at transit agencies, sorted by MDT manufacturer and model, can be found in Appendix A2, Report A2-C2, "Manufacturer and Model."

INTELLIGENT TRANSPORTATION SYSTEM SUPPLIERS

Most respondents who indicated that they had deployed MDTs also identified an ITS supplier and their product or service from the drop down list. The results of the survey are presented in the frequency distribution table and a chart showing the percentage of transit agencies responding is presented in Table 4.

A wide range of ITS suppliers were reported by those agencies that had deployed MDTs. Reports were generated from the MDT survey sorting transit agency responses to the ITS services by ITS supplier and again by state. In each

TABLE 2
MDT SURVEY TOPICS

Survey Topic	Long Form	Short Form
TA respondent information	√	√
Transit service (mode) using MDTs	√	√
MDT types and brands of equipment used	√	√
ITS supplier information	√	√
MDT functionality	√	
Communications infrastructure supporting MDT	√	√
Information technology supporting MDT	√	
Applications of MDT-collected data	√	√
Installation, maintenance, and data analysis costs	√	
MDT acceptance by staff	√	
MDT problems and solutions	√	
Security and resilience of communications	√	
MDT capabilities desired in future	√	√
Future ITS applications at TA	√	√

NOTE: TA = transit agency.

TABLE 3
MDT MANUFACTURER AND DEPLOYMENT BY MANUFACTURER

MDT Manufacturer	MDT Model	No. of Agencies	MDT Totals
Digital Dispatch Systems	Vector 530	1	140
GMSI	2101ROZ	1	321
Greyhawk Technologies	CEHawk MDT	1	0
Greyhawk Technologies	Fixed-route MDT	1	68
Greyhawk Technologies	Fixed-route MDT and paratransit MDT	1	25
Greyhawk Technologies	Paratransit MDT	3	281
Innovations in Transportation, Inc.	COPILOTsoftkey	3	385
Mentor Engineering, Inc.	MDC	5	195
Mentor Engineering, Inc.	MDC and Ranger	1	12
Mentor Engineering, Inc.	Ranger	3	413
Mentor Engineering, Inc.	Stryder	1	52
METS	METS	1	1,300
Micronet, Ltd	Net 960	1	44
Mobile Knowledge	Series 6000 MDT	1	47
Motorola	MW20	1	150
Motorola/Nextel	Motorola i58	1	44
Orbital TMS	SmartMDT	4	2,298
QSI Corporation	QTERM-R55	1	900
Radio Satellite Integrators	Version 2.0 4 X 40	1	65
Siemens VDO	MDT	10	2,239

TABLE 4
FREQUENCY DISTRIBUTION OF ITS SUPPLIERS

ITS Supplier	No. of Responses
EnGraph	1
Fleet Management Solutions, Inc.	1
HBSS	1
Innovations in Transportation, Inc.	3
Laidlaw Transit Services	1
Mentor Engineering Inc.; the Checker Group	1
Motorola	1
Nextbus	1
Orbital TMS	4
Orbital TMS, Actsoft, Inc.	1
RouteMatch Software	1
Siemens VDO	8
TAXiTRONiC (Verifone),	1
Trapeze Group	14
Trapeze Group, Siemens VDO	1
Trapeze Group, ITS	3

case, the number of MDT installations was added to provide the reader with a sense of the scale of the deployment at the transit property. These reports are in the Appendix A2, as Report A2-D1, "ITS Supplier—Service by Supplier" and Report A2-D2, "ITS Supplier—Service by State."

MOBILE DATA TERMINAL FUNCTIONALITY

Survey respondents reported on MDT functions for both fixed-route and paratransit operations.

Fixed-Route Service

Eleven of 17 respondents reported that the MDTs were used to download the driver manifests. All 17 reported using the MDT to collect data on driver actions such as sign-on, sign-off, start run, and end run. The individual agency responses can be found in Appendix A2, Report A2-E1, "Functions—Fixed Route—General."

Thirteen transit agencies reported counting passengers through their MDTs, with seven of those reporting using electronic beams to count both boarding and alighting automatically. Three of the respondents used the MDTs to manually count the boarding and alighting of passengers. Three other agencies reported a mix of manual and automatic counting. The report, by agency, can be found in Appendix A2, Report A2-E2, "Functions—Fixed Route—Counting."

Six agencies reported using the MDTs to count the use of mobility aids by passengers. Two others used the MDT to count the loading of bicycles. This report can be found in Appendix A2, Report A2-E3, "Functions—Fixed Route—Other Counting."

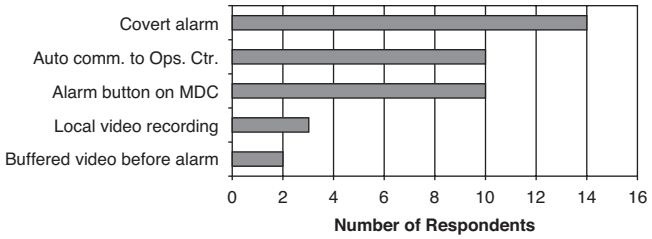

FIGURE 1 Fixed-route emergency functions.

Five agencies reported that their MDTs were equipped with fare technology; four used magnetic strip readers and one used smart card fare technology (see Appendix A2, Report A2-E4, "Functions—Fixed Route—Fares").

Twenty-four respondents reported that the MDT functioned as an emergency alarm, with 14 of the alarms covert trigger mechanisms and 10 buttons on the mobile data computer (MDC) itself. Ten reported automatic communication with the operating center upon setting off the alarm. Security video was reported by six agencies, including two that had the capability of buffering video frames that could be saved before the alarm was triggered. The disaggregated data sorted by state is found in Appendix A2, Report A2-E5, "Functions—Fixed Route—Emergency" (Figure 1).

The survey participants responding to the functions built into the MDC were asked if the data collected by the MDT was stamped with space and time references. They were asked to pick one or more of the following: (1) GPS latitude/longitude and date/time stamp or (2) digital odometer reading. Forty-six percent used both referencing capabilities, 47% used GPS only, and 7% used odometer readings. The database report can be found in Appendix A2, Report A2-E6, "Functions—Fixed Route—Space/Time Features" (Figure 2).

Other fixed-route functions written in by the survey respondents were:

- Covert microphone for one-way audio monitor;
- Bus, operator, route, run, direction, adherence, GPS validity;
- Digital messaging; and
- Map, suggested routing, predicted and actual on-time performance, and automatic recognition of bus stops.

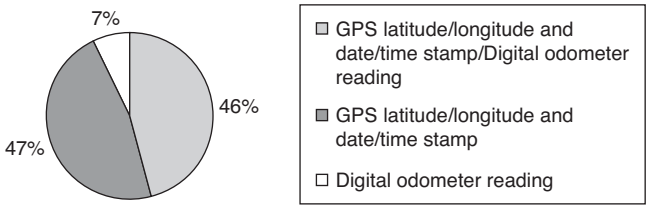

FIGURE 2 Fixed-route functions—Space–time referencing.

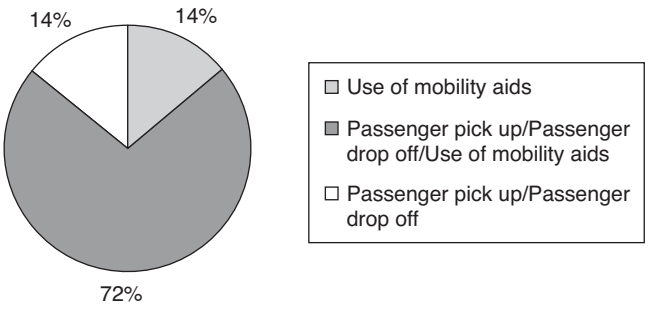

FIGURE 3 Demand-response functionality—Counting.

Demand-Response Service

Fifteen of the 16 respondents reporting on using MDTs for paratransit service noted that they used the MDTs to download the drivers' manifest to the vehicle, and that schedule changes were automatically updated to and from the MDT. Operational actions by the driver (e.g., sign-on and start run) were reported on the MDTs according to all survey participants. This shows a confidence in the technology by the operations staff that was not evident in the early days of MDT deployment in paratransit.

In demand-response service, MDTs were reportedly used for counting passenger pick up and drop off in 12 of 14 instances. Most of the 12 used the MDTs to count mobility aids as well. Figure 3 converts the survey responses to percentages in a pie chart.

Other functionality reported in demand-response use of MDTs included actual fare collected, messaging between dispatch and vehicle, covert emergency alarm, attendants, and companions.

COMMUNICATIONS INFRASTRUCTURE

Both the long-form and short-form survey questionnaires addressed the issue of the communications infrastructure supporting MDT deployment. Every respondent knew their communications infrastructure, even if they did not yet have MDTs or could not identify their ITS suppliers. Several respondents listed more than one means of communications. Most chose private radio network, listed as "conventional radio" (e.g., 450 MHz) on the drop down menu. A variety of communication infrastructures is evident as presented in Table 5.

As new markets develop for cellular carriers investing in higher-capacity infrastructure and open WiFi and WiMAX cities become a reality, this synthesis database will be positioned to track any changes among transit operators over time. Clearly, private radio networks dominate the communications at this time; however, public data networks (cellular telephone carriers) collectively make up a significant share. Even WiFi is making a presence at this early date, although it may be for downloading data at the maintenance facility, rather than an outdoor WiFi city scheme.

The survey addressed the types of information communicated to and from the MDTs. A number of reports generated from the MDT survey database are listed here and can be found in the Appendix A2:

- Report A2-F1, "MDT Communications by Type"
- Report A2-F2, "MDT Communications by State"
- Report A2-F3, "GPS Refresh Rates by Number of MDTs"
- Report A2-F4, "Communication of Data and Video"
- Report A2-F5, "Communication of Canned Text Messages"
- Report A2-F6, "MDT Communication of Free Form Text"
- Report A2-F7, "MDT Communication Types—Other"
- Report A2-F8, "Two-Way Voice Radio Communication."

The rate of refreshing information on the location of vehicles is generally related to the fleet size and transmission capacity of the communications infrastructure. If the data are transmitted over public data networks, cost may be an issue in polling the fleet for AVL, especially if the cellular carrier is charging by the call for data transmission. Recently, some cellular vendors began promoting unlimited data plans, fundamentally changing the economic analysis of MDT

TABLE 5
FREQUENCY DISTRIBUTION OF RESPONSES BY COMMUNICATIONS TYPE

Communications	No. of Responses
802.11b/g (2.4 GHz unrestricted)	1
Cellular—Cingular	7
Cellular—Cingular/802.11b/g (2.4 GHz unrestricted)	1
Cellular—Sprint/Nextel	2
Cellular—Verizon Wireless	6
Conventional radio (e.g., 450 MHz)	25
Conventional radio (e.g., 450 MHz)/802.11b/g (2.4 GHz unrestricted)	3
Conventional radio (e.g., 450 MHz)/802.11b/g (2.4 GHz unrestricted)/802.11a (5.0 GHz unrestricted)	1
Conventional radio (e.g., 450 MHz)/Cellular—Cingular	1

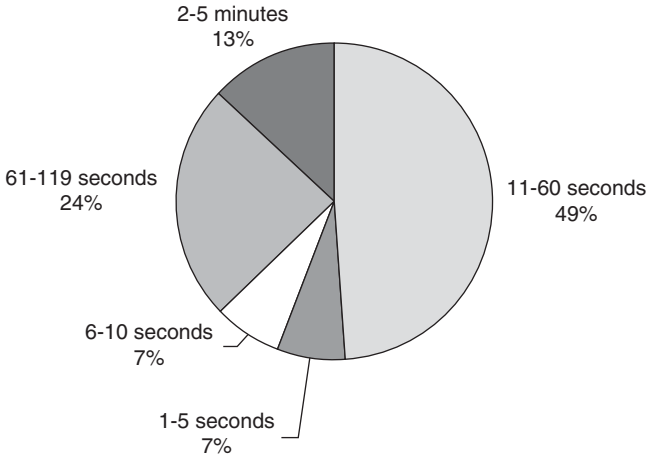

FIGURE 4 GPS and AVL refresh rates.

communications. Polling rates of 60 s and less, as indicated in Figure 4, are well suited to predicting arrival time for customer information systems. The majority of respondents reported refresh rates of 60 s or less.

When those respondents were asked if two-way mobile voice communication was also available to the driver, 86 of the 96 respondents to the survey (90%) answered affirmatively. Only 40 of those transit agencies currently had MDTs deployed and another 30 planned to deploy MDTs this year. If communications is the reason for not deploying MDTs, all of them could have MDTs if they used the approach developed by Cal Poly–San Louis Obispo under the California Department of Transportation (Caltrans) cooperative research program (CRP). Cal Poly has developed a public domain MDT that can use conventional 450 MHz simultaneously for voice and data at San Luis Obispo Transit. The project is well-documented by Cal Poly and has been approved by Caltrans for further development in the current state fiscal year CRP program.

APPLICATIONS OF MOBILE DATA TERMINAL-COLLECTED DATA

The transit agencies were asked to select current applications of MDT-collected data from an extensive list of potential applications arranged in ten topic areas. Responses were received from both short-form and long-form survey respondents. A tabular presentation of the results is presented in Table 6.

Deploying an MDT equipped with GPS provides for monitoring on-time performance for fixed-route and paratransit

TABLE 6
APPLICATIONS OF MDT-COLLECTED DATA

Applications of MDT-Collected Data	No. of Responses
Driver time keeping	28
Route and schedule adherence	
Fixed-route service on-time performance	30
Paratransit on-time performance	37
Fraud prevention and detection	
Time fraud by staff or contractors	11
Fare fraud by staff or contractors	7
Third-party payment fraud by human service clients	2
Real-time web mapping of AVL data	35
Dynamic calculation of estimated time of arrival (ETA) by vehicle	
At bus terminals	20
At bus stops	17
On board the bus	15
Display of ETA on web	11
QA/QC of service	
Fixed-route service	17
Paratransit service	25
Alarming for preventive maintenance scheduling	10
Verification of performance of scheduled maintenance and repair	7
Aggregation of fueling and consumable supplies by vehicle and driver	7
Calculation of periodic performance measures based on MDT data	
Passengers carried	30
Revenue received	18
Passenger miles	25
Revenue miles	26
Passengers per vehicle-mile	19
Passengers per revenue-mile	20
Passengers per vehicle-hour	21
Mean time between failures	1
Mean miles between failures	1
Other	1

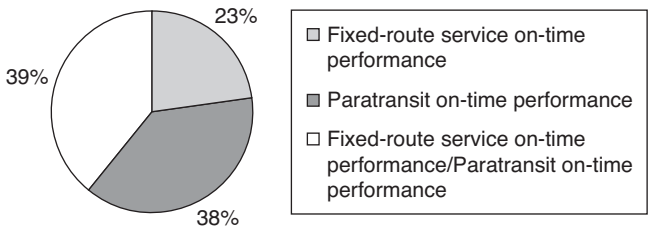

FIGURE 5 MDTs for route and schedule adherence.

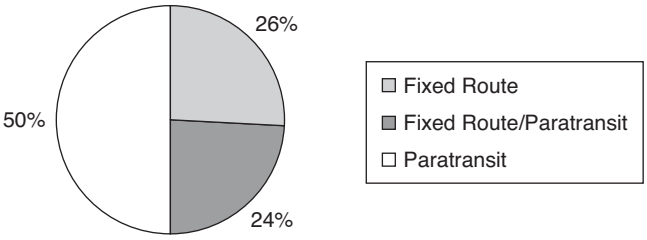

FIGURE 7 Percentage using MDTs for QA/QC by mode.

services. The survey indicated that 39% of the respondents use MDTs to measure on-time performance in both fixed-route and paratransit service configurations. A similar percentage uses the MDTs for measuring schedule adherence in paratransit (see Figure 5).

MDTs equipped with GPS can be used to calculate the estimated time of arrival (ETA) at a bus stop or terminal. Survey respondents were asked where these ETA calculations would be displayed: (1) at bus terminals, (2) at bus stops, (3) on board the bus, and (4) a display of ETA on the web. The results are presented in Figure 6.

MDTs equipped with GPS can be excellent tools for ensuring quality transit and paratransit service and detecting fraud and abuse relating to hours of operation, misuse of vehicle assets, and false reporting. The responses indicate a high percentage using MDTs for QA/QC for paratransit. This study indicated that it may be related to the need for contractor control for purchased transportation of demand-responsive service by transit agencies (see Figure 7).

Using the MDTs as a basis for the efficient and effective collection of performance measures is of interest to the FTA's NTD program managers. There was a high rate of return for respondents using the MDT to collect ridership data and other industry standard productivity indicators (see Figure 8).

Disaggregated Applications of Mobile Data Terminal-Collected Data

Early in the preparation of this synthesis there was a the comment that the applications of MDTs in the aggregate as described in Table 6 was important in providing support to those in the industry seeking to implement similar applications at their transit agency. However, it was equally important to these would-be innovators to be able to contact the early innovators directly. The disaggregated survey responses on applications of MDT-collected data are provided in the Appendix A2 in the following reports.

- Report A2-H1, "Applications—Timekeeping and Web–AVL"
- Report A2-H2, "Route and Schedule Adherence from MDTs"
- Report A2-H3, "MDT Applications to Prevent/Detect Fraud"
- Report A2-H4, "Applications—MDT-Based ETA and Display"
- Report A2-H5, "Applications—Quality Assurance/Quality Control from MDTs"
- Report A2-H6, "Applications—Maintenance Data from MDT"
- Report A2-H7, "Applications—Fueling and Consumables"
- Report A2-H8, "MDT-Based Performance Measurement"
- Report A2-H9, "Integration of Spatial Data Applications."

MOBILE DATA TERMINAL USES DESIRED BEYOND CAPABILITIES OF EXISTING EQUIPMENT

Survey respondents were asked to identify additional functionality that they desired, beyond the current capabilities of their MDTs. The purpose of this question was to anticipate the design of new MDT functionality based on customer preferences. These comments indicated the functions desired by new entrants into the MDT marketplace. The oft-stated need for integration between MDT-collected data and electronic fare collection devices may indicate a desire for an open system of data interchange—the antithesis of propri-

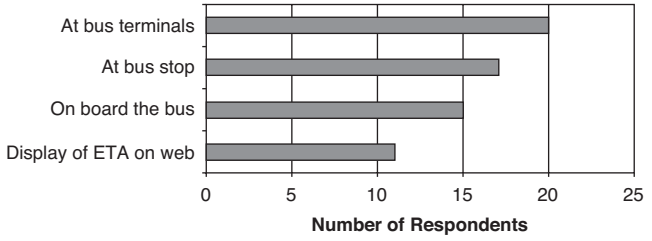

FIGURE 6 Display of ETA calculation by vehicle.

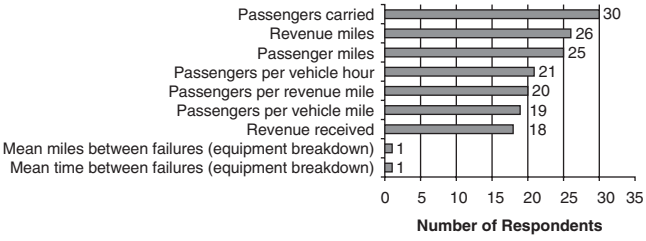

FIGURE 8 MDT-based performance measurement.

etary data collection and data manipulation sometimes found in the transit industry. A number of experienced providers called for better displays on MDTs, especially when mapping and AVL systems were integrated on the MDT. The comments on desires beyond the capabilities of existing equipment have been presented in a database report in the Appendix A2, Report A2-M1, "Desired Functionality."

FUTURE APPLICATIONS AND TECHNOLOGIES

Survey respondents were asked to identify technology applications that they were planning to employ. This question raised the issue of new and associated MDT technologies that might be planned beyond the short deployment period raised in the MDT synthesis of current practice. Many recipients used the opportunity to document future technology in the near term and beyond. Again, respondents who reported that they did not have MDTs currently nor did they expect to deploy them within the year used this opportunity to reveal their plans. As in the previous questions the responses followed a list of transit ITS components that are understandable in the context of the individual respondent. What stands out is that the most advanced technology deployments are also the most customer-oriented transit agencies. There is also some interest in WiFi technology and web-based video for security purposes that may relate to transit's heightened concern for passenger safety and security. The individual comments can be found in Appendix A2, Report A2-N1, "Planned Future Technology."

CHAPTER FOUR

CASE STUDIES

At the outset, the MDT case studies were expected to come from the experiences of the synthesis topic panel, the consultant, or professional presentations. During the conduct of the survey, it soon became apparent that a significant number of respondents were going to considerable effort to respond to the broad topical areas that were posed by the MDT synthesis topic panel. To the extent practicable, this synthesis attempts to address both avenues. All responses to the long form survey are summarized and presented in this synthesis. In addition, several transit properties are highlighted as they relate to specific technology deployments or modal environments arising out of the research. Table 7 provides a listing of those transit agencies that responded to the long form survey.

The topic areas that were addressed in the long form survey were:

- Information Technology Supporting MDT Deployment
- Installation, Maintenance, and Data Analysis Costs
- MDT Acceptance by Staff
- MDT Problems and Solutions
- Security and Resilience of Communications.

INFORMATION TECHNOLOGY SUPPORTING MOBILE DATA TERMINAL DEPLOYMENT

MDT long form survey respondents were asked to identify the operating system server software where the database resides that stores, manipulates, and retrieves data collected from the MDT. Several respondents identified more than one operating system. The responses can be found in Figure 9. Microsoft was the dominant operating system manufacturer and the responses indicated that the latest versions of this system were deployed in the field. However, older systems such as Windows NT and MS DOS were also reported, indicating that operating systems were in need of updating to protect the system from security breaches and improve system reliability. Other operating systems of note were Sun OS and UNIX. No respondent reported an open source operating system. Report A2-G1, "Operating Systems Supporting MDT Databases" provides the individual responses sorted by operating system and can be found in Appendix A2.

The long form survey respondents were asked to identify the database technology supporting the deployment. Again, Microsoft dominated the survey as the manufacturer of its SQL Server software. One respondent had upgraded to the 2005 version of SQL Server, although most reported using SQL Server 2000, and a significant number reported using SQL Server 7, which is no longer supported by Microsoft. The responses are presented in Figure 10. A significant portion (5 of the 23 respondents) reported using Oracle, another popular database. The individual responses to the question on database support can be viewed in the context of the MDT deployment and sorted by software in Report A2-G2, "Database Software for MDT Support" in Appendix A2.

INSTALLATION, MAINTENANCE, AND DATA ANALYSIS COSTS

The long form survey inquired about the cost of the individual MDT, the cost of installing and maintaining the MDT, and the labor expended in installation and maintenance. The respondents were diligent in their efforts to provide these data; however, there are clear limitations to this approach. First, the purchase and deployment of these MDTs were not contemporaneous; some were very recent, whereas others were among the first MDTs deployed in the nation. Furthermore, differing procurement approaches included installation and maintenance by the contractor or subcontractor. Also, the volume of the MDT purchase may have some affect on individual price (see Appendix A2, Report A2-C1, "Installed Mobile Data Terminal Totals," for the total number of MDTs installed by transit agencies to review the range of MDTs deployed by property). Most importantly, the MDT itself is simply a display unit in some manufacturer's configurations, whereas in others they are fully functional computer systems. Lastly, no one knows the current cost of a piece of equipment without conducting a procurement process to determine the market price at a particular time for a specific set of MDT capabilities. With these caveats, the results of the survey are presented here for planning purposes.

The long form survey asked participants to estimate the unit cost of the MDT for their most recent deployment. Many respondents were particularly uncomfortable with this question in systems where the MDT was simply a display for a separate computer and were clear in pointing this out in their individual responses. Others wanted to be clear that their latest deployment was not recent. However, Figure 11 indicates that the majority of the estimates are within the range of $1,000 to $4,000—not that much different from a laptop computer (see Appendix A2, Report A2-I1, "Unit Cost of Mobile Data Terminals," for agency responses).

TABLE 7
PARTICIPANTS IN CASE STUDY LONG FORM OF MDT SURVEY

Transit Agency	City	State
King County Department of Transportation—Metro Transit Division	Seattle	WA
Spokane Transit Authority	Spokane	WA
Tri-County Metropolitan Transportation District	Portland	OR
Kitsap Transit	Bremerton	WA
Clark County Public Transportation Benefit Area	Vancouver	WA
Potomac and Rappahannock Transportation Commission	Woodbridge	VA
Delaware Transit Corporation	Dover	DE
Research Triangle Regional Public Transportation Authority	Research Triangle Park	NC
Metro Regional Transit Authority	Akron	OH
Central Ohio Transit Authority	Columbus	OH
Metro Transit	Minneapolis	MN
Pace—Suburban Bus Division	Arlington Heights	IL
City of Tyler	Tyler	TX
St. Joseph Transit	St. Joseph	MO
Regional Transportation Commission of Washoe County	Reno	NV
San Mateo County Transit District	San Carlos	CA
San Joaquin Regional Transit District	Stockton	CA
Fresno Area Express	Fresno	CA
City of Phoenix Public Transit Department	Phoenix	AZ
Antelope Valley Transit Authority	Lancaster	CA
Eastern Contra Costa Transit Authority	Antioch	CA

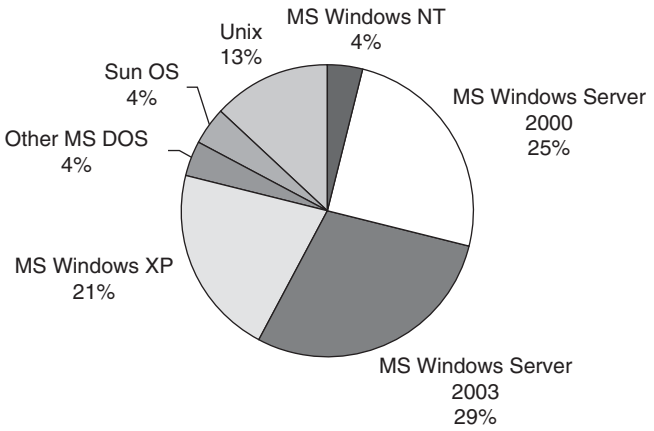

FIGURE 9 Operating support for MDT database software.

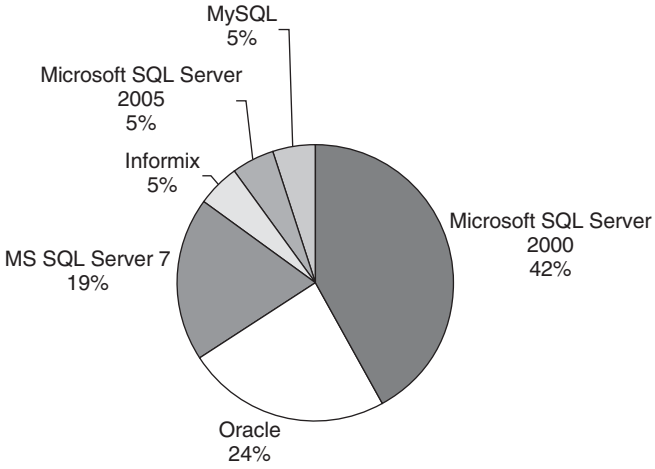

FIGURE 10 Database software supporting MDT deployment.

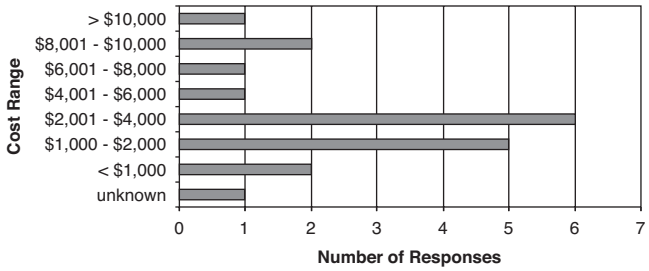

FIGURE 11 Unit cost of MDT.

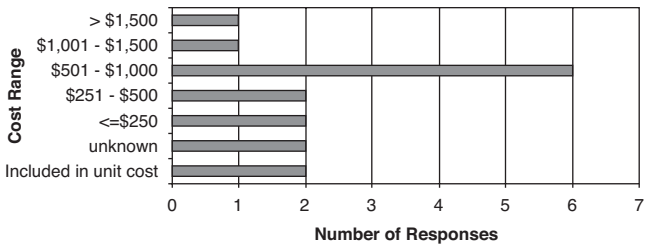

FIGURE 12 Unit cost of MDT installation.

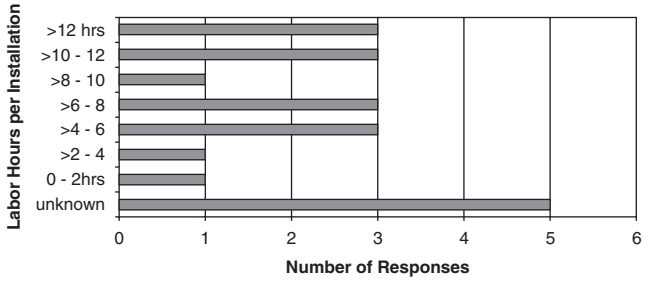

FIGURE 13 MDT installation labor-hours.

The survey asked "What was the unit cost of installation of the MDT for your most recent deployment?" In two cases, the installation cost was included in the unit cost. The distribution of the responses (Figure 12) revealed that the most frequent response was in the $501–$1,000 range. Again the configuration of the individual system as well as the complexity is relevant (e.g., number of functions performed by the MDT unit). The report for this question can be found in Appendix A2, Report A2-I2, "MDT Installation Costs."

In response to the survey question, "How many labor hours were expended to install an individual MDT for your most recent deployment?," the respondents had a wide variety of answers (see Figure 13). Most simply did not know because the installation was done by a subcontractor to the ITS vendor and was not known by the transit agency owing to the nature of the procurement. The installations were not trivial matters, however, as the estimates ranged widely from one-half a day per installation to two days per vehicle. It should also be noted that the participants in the long form survey were particularly complex ITS installations. Again, the best approach may not be a summary but a scan of the individual comments in Appendix A2, Report A2-I3, "Labor Hours per MDT Installation."

The long form survey asked the respondents, "What is the average annual unit cost to maintain/repair an individual MDT for your most recent deployment?" Many of the respondents did not know the answer to this question. For some, the deployment was too new to determine average cost of maintenance and repair. For others, it was covered by the original or extended warranties. Several made a good faith effort at estimation, and the average was clearly under $200 per unit per year. Figure 14 is the summary chart of ranges of responses. The full report by transit agencies can be found in Appendix A2, Report A2-I4, "MDT Maintenance/ Repair Cost."

Long form survey participants were asked to respond to the question "What are the average annual labor hours to maintain/repair an individual MDT for your deployment?" There were some difficulties responding to this question and participants used the free-form text to provide formulas and written responses to their concerns. The responses of those who were able to estimate the annual labor hour per unit for

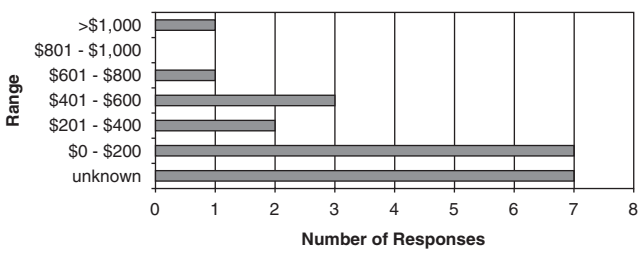

FIGURE 14 Annual cost of MDT maintenance and repair.

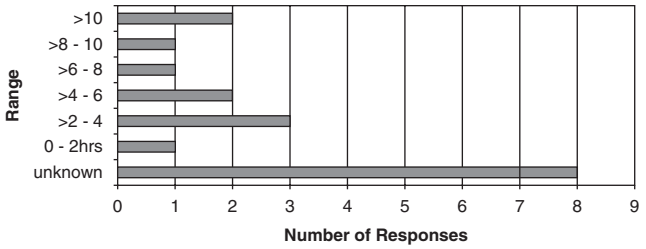

FIGURE 15 Labor-hours for maintenance and repair per unit.

maintenance and repair varied considerably. When compared with the number of hours expended for maintaining radios, cell phones, and laptop computers in an office setting, they may appear high. However, when attempting to operate electronic equipment in the difficult transit environment, the resulting numbers may appear quite low. The ranges of labor-hours are presented in Figure 15. The individual responses by transit property may be found in Appendix A2, Report A2-I5, "Labor Hours per MDT Maintenance and Repair."

The synthesis topic panel was interested in the investment that transit agencies deploying MDTs made in supporting information technology and communications. The survey asked for a yes or no response to the question, "Does the transit agency provide the information technology and communications infrastructure for the MDT deployment?" "If yes, what is the annual personnel cost dedicated to IT and communications?" "If no, how is the IT and communications provided." Where the respondent indicated "no," the communications infrastructure was provided by a wireless communications carrier and the IT support was provided by the ITS supplier or a city department. Where the IT or communications infrastructure was provided by the transit agency, the answers varied widely. Some responded with a number (or fraction) of full-time equivalent (FTE) staff (and some did not provide the base annual salary). Others responded with annual salaries (presumably unburdened by benefits and overhead costs) as presented in Figure 16. The range was from a low of $20,000 per year to a high of $1,125,000. The individual responses can be found in Appendix A2, Report A2-I6, "IT and Communications Support for MDTs."

There was also interest in how the transit agency accomplished data analysis and reporting on the information being generated by the MDTs. The long form asked participants if there were "transit staff dedicated to the analysis

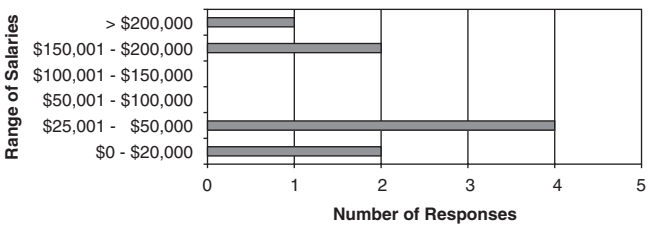

FIGURE 16 Annual transit agency personnel costs for IT and communications.

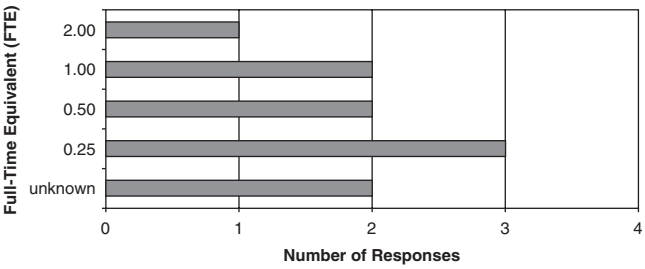

FIGURE 17 Dedicated staff to MDT analysis.

TABLE 8
RATING ACCEPTANCE OF MDTs BY EMPLOYEE CATEGORY TYPE

Staff Category	No Answer	1	2	3	4	5
Executive staff	0	0	0	3	10	9
Administrative/clerical staff	0	0	0	4	9	9
Operations supervisory staff	1	0	1	2	7	11
Drivers	1	1	1	2	10	7
Maintenance staff	1	0	4	5	8	4

NOTES: Range—Where 1 is least acceptance and 5 is greatest acceptance.

and reporting of data collected by the MDTs?" If the answer was "yes," the respondent was asked to estimate the annual costs and annual labor hours incurred by the transit agency for this activity. If the answer was "no," the respondent was asked to explain how this analysis and reporting was accomplished. Four respondents answered that they did not have dedicated staff, but that analysis and reporting were accomplished through existing personnel or contractor staff without specific delineation of duties. The remaining ten respondents made an attempt to estimate a level of effort for analysis and reporting of MDT-generated data. The results are summarized by the frequency distribution table presenting the FTE of an annual (professional) salary for this activity (see Figure 17). The individual responses are available in Appendix A2, Report A2-I7, "TA Support for MDT Data Analysis."

STAFFING ACCEPTANCE

The respondents to the long form were asked to rate the acceptance of MDTs by certain categories of staff from the agency's executives through the drivers and maintenance staff. In deploying technology into a transit culture, it is understandable that some employees would find the automatic collection of data from a transit vehicle more desirable than others. Although the 22 respondents are significant in that their responses are breaking new analytical ground from an industry perspective, it is important to note that it is the perspective of one person at a transit property. It is also important to note that this respondent has, at this point in the survey, proven proficient in responding to very technical questions on the MDT deployment at a property that has deployed MDTs for a year or more. In some cases, these respondents were very experienced in MDT technology deployment. The frequency distribution of ratings by staff categories is presented in Table 8.

Clearly, the overall acceptance of transit agency staff to the deployment of MDTs is positive. The ratings in the highest range (4 and 5) dominate all categories of employees. Respondents classified very few in the low range. To their credit, however, several respondents attempted to convey problem areas in the driver and maintenance category. The "no answer" category was noted when a respondent left one question blank while filling in all other responses in this series of questions. Although MDTs are often planned and installed as labor-saving devices for vehicle operators, they require training and raise operational questions that are not always appreciated. Similarly, MDTs are additional pieces of equipment on vehicles that require maintenance and repair by transit agency staff. Individual agency responses to these questions are presented in Appendix A2, Report A2-J1, "Staff Acceptance of MDT Rating by Type."

MOBILE DATA TERMINAL PROBLEMS AND SOLUTIONS

Deploying innovative technology is not for the risk averse. Nearly every respondent reporting on their experiences deploying MDT technology reported encountering at least one problem, and most reported multiple problems. Eighty-two problems were identified by the 22 respondents to the long form survey. The frequencies of response to the types of problems in deploying MDTs are displayed in Figure 18.

The manufacturers of the MDTs were criticized by survey respondents in problems reported as "MDT equipment design flaws" (9) and "MDT equipment manufacturing defects" (11), "MDT reliability in operating environment" (9), and "MDT installation problems" (14). One survey identified "MDT manufacturer/vendor warranty compliance" as a problem. Assuming that these agencies had a good warranty agreement, these categories of problems have a path to resolution. The human side of the technology deployment was particularly evident in the responses to "MDT driver training problems" (11), "MDT installer/maintainer training problems" (11), and "MDT sabotage" (7). The survey report presenting the problems encountered by individual agencies is particularly instructive and can be found in Appendix A2,

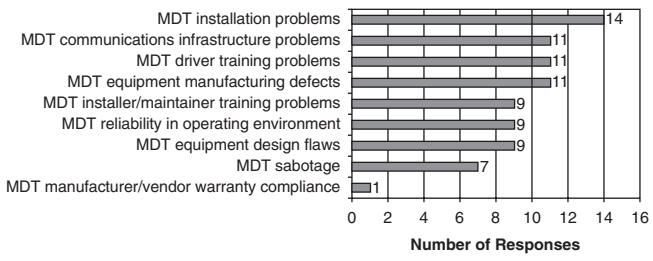

FIGURE 18 Frequency distribution of operational and technical problems.

Report A2-K1, "Operational/Technical Problems Encountered." These problems can be related to the manufacturer and size of MDT deployment by consulting Report A2-C2, "Manufacturer and Model" also in Appendix A2.

The respondents reporting problems encountered in their MDT deployment were prompted to identify solutions to those problems. Although this survey technique does not lend itself to easy synthesis, several observations are clear. These early transit innovators are straightforward in their assessment of problems and prompt in addressing these issues. Most were not shy about sending faulty equipment back to the manufacturer and insisting on a resolution to their problems. Some had many years of working with their equipment manufacturer and ITS vendor and had worked out a satisfactory relationship in resolving difficult problems and issues of deploying innovative technology in a difficult operational environment. In some cases, the manufacturer and vendor went out of business or the communications infrastructure was changed by corporate merger or failure. Some problems were identified as unresolved at this time. Again, the individual technical responses were forthright and deserving of review within the context of the specific setting. These responses can be found in Appendix A2, Report A2-K2, "Operational/Technical Solutions."

SECURITY AND RESILIENCE OF COMMUNICATIONS

At the onset of the 21st century, two disasters—one man-made and one natural—have impressed on civil servants the necessity for secure and resilient communications systems. As the twin towers of the World Trade Center fell on September 11, 2001, so did the communications towers for many of the private and public radio systems in lower Manhattan. As Hurricane Katrina ravaged the Mississippi and Louisiana coastline in August 2005, the mega-storm destroyed public and private data and voice networks throughout the region. Although the military response to both disasters included completely functional and self-contained communications systems, civilian agencies, including transit agencies, were not in a similar position. Some lessons learned from the military approach to protecting communications were clearly in evidence from the responses to questions about security and resilience of communications after a disruption.

In the long form survey, transit agencies were asked, "Do you have security measures in place for the communications systems supporting the MDT?" Figure 19 shows that nearly all respondents reported a secure base (radio) station, and most had addressed the issues of secure storage of mobile equipment when not in service (15) and secure auxiliary power generation for base stations and radio towers (14). Encryption and decryption of data radio transmission was reported by some respondents; however, the security of civilian transit data transmitted by MDTs may not be as vulnerable to threats as military data transmissions in a transit operational context.

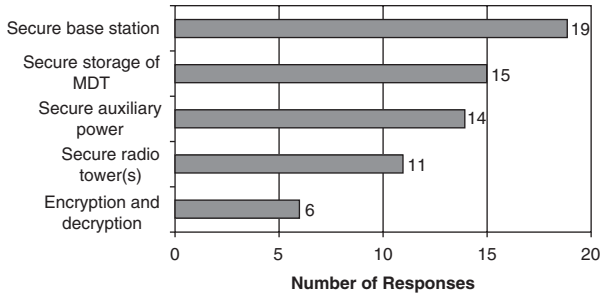

FIGURE 19 Security measures for MDT communications.

In assessing the issue of resilience, long form respondents were asked, "Do you have resilience built into the design of the communications system?" Each was asked to choose from several approaches designed to provide continuity of data radio communications after a disruption. Nine respondents indicated that they could continue mobile-to-mobile transmission when the base station and/or the central tower is/are down (see Figure 20). Four transit agencies reported that they had self-healing autonomous mesh networks for radio communications (e.g., multi-hop transmission and Internet communications protocols). Two systems reported that they had cooperative agreements with surrounding jurisdictions with duplicate communications systems in place that could temporarily replace central dispatch functionality.

The issues of security and resilience have been initially posed as problems that must be addressed by individual transit organizations. They are inherently costly to design and very expensive to deploy as a single public entity. As homeland security evolves at the regional level throughout the United States, transit communications becomes integrated with first responder communications at the local and regional level. Furthermore, as regional cellular providers compete to provide ever-increasing capacity for broadband access, they are vastly increasing the capacity and resilience of their multi-hop, self-healing mesh networks. As transit opts to use these public data networks for MDT data communications in the future, they have the built-in security and resilience of these regulated communications carriers. The individual responses to these questions on

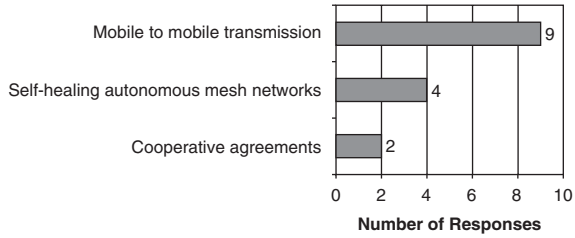

FIGURE 20 Resilience of MDT communications.

communications security and resilience can be found in Appendix A2, Report A2-L1, "Security and Resilience of Communications."

CASE STUDY HIGHLIGHTS FROM LONG FORM SURVEY

Nearly two dozen transit agencies responded to the long form survey and devoted considerable effort to sharing their experiences in deploying MDTs with the industry. At the conclusion of this synthesis, the survey results will be shared in a web-based database that can be queried by numerous variables that will provide comparable transit properties with these experiences. As an example of the kinds of information that is available when combining information from this MDT survey with other data available from the NTD, three very different properties are highlighted as a part of this case study section: (1) the Tri-County Metropolitan Transit District of Oregon (TriMet), (2) the Delaware Transit Corporation (DTC), and (3) the city of Tyler, Texas. The highlight will use the general outline of the survey topics and present information provided by the survey respondent and supplementary information from the 2004 NTD (the latest published data set available from FTA). Although the print media can show a few of these examples to present the diversity of the respondents, a database relating the similarities of service characteristics of transit agencies may be more advantageous for assisting those agencies considering technology deployment. The information here is derived from the long form, or case study, database for each transit agency and is presented sequentially using the major topic headings of the survey for reference.

Transit Agency Highlight No. 1: Tri-County Metropolitan Transit District of Oregon

TriMet has a large metropolitan transit agency staff that can set the technology agenda for the MDT manufacturer and ITS supplier. It went outside the transit industry vendor circles for the MDT, but chose one of the better known transit technology suppliers for integration. The functionality and applications are fully developed as the TriMet staff has deployed one of the largest MDT installations in the United States. It exhibits a clear recognition of the problems encountered and can articulate the resolution. The respondent has been able to state what it needs to continue their applications of technology in the future and how it is going to get there. More than any other respondent, TriMet understands that the data produced by these mobile collection instruments need to be analyzed and used in decision making by policy and operational staff. They have clearly identified the level of effort that it takes to support such a transit technology-rich enterprise.

- Transit agency information. TriMet is centered on the Portland, Oregon, urbanized area. It serves a population of 1,253,502 within a service area of 574 square miles. TriMet operates 235 paratransit vehicles in maximum service and provides 958,230 annual unlinked trips. The agency uses 614 buses in maximum service to provide 65,938,456 annual unlinked trips. It operates 105 light-rail vehicles in maximum service to provide 31,516,208 unlinked trips (National Transit Database 2004).
- MDT deployment. TriMet reports that it has deployed 900 MDTs from a nontraditional transit MDT manufacturer with a large non-transit business base. They use the traditional transit ITS supplier, Orbital TMS, with their ITS service TSL CAD/AVL.
- MDT functionality. TriMet reports fixed-route MDT functionality as follows: download manifest to vehicle, driver sign-on/sign-off, driver start run/end run (revenue service), automatic boarding/alighting—electronic beam, counting the use of mobility aids, covert alarm, automatic communications to operations center. MDT-collected data are accompanied by GPS latitude/longitude and GPS date/time stamp.
- Communications infrastructure. TriMet uses conventional radio or private radio network for MDT communications. The communication of data files from scheduling software to individual vehicles is provided by the communications infrastructure. There is a refresh rate of GPS data from vehicles to the central dispatch in the 2–5 min range. Communication of canned text messages is available from dispatch to vehicle and from vehicle to dispatch. The communication of free-formed text messages is possible from dispatch to vehicle.
- Information technology supporting MDT deployment. TriMet uses the Sun OS operating system and Oracle relational database to support the MDT deployment.
- Applications of MDT-collected data. TriMet uses its MDT-collected data for driver time keeping. It reports that MDTs are used for fixed-route service on-time performance and paratransit on-time performance. The MDTs are used to prevent or detect time fraud by staff or contractors. TriMet reports that it uses the MDT data for real-time web AVL and for ETA at bus terminals, bus stops, on board the bus, and on the web. MDT-collected data are used for QA/QC for both fixed-route and paratransit modes. TriMet reports that the following performance measures are based on MDT data collection: passengers carried, passenger-miles, revenue-miles, passengers per vehicle-mile, passengers per revenue-mile, passengers per vehicle-hour, and passengers per revenue-hour. TriMet reports that it uses the hardware on the vehicle (e.g., GPS temporal and spatial stamp sent with data record) to integrate MDT-based applications.
- Installation, maintenance, and data analysis costs. TriMet estimates the cost for MDTs at $4,200 per unit and an installation cost ranging from $500 to $1,000 per unit. Factory installations of MDTs were estimated at 4 labor-hours. TriMet estimated that its in-house MDT

retrofit took twice the factory labor-hours (8 h). MDT maintenance/repair cost was estimated at $111 per unit per year. Labor-hours per MDT maintenance and repair were estimated at 1.5 FTE for 900 units per year. The agency provides the information technology and the communications infrastructure for the MDT deployment at an estimated annual personnel cost of $1,125,000 (15 FTEs at $75,000 per FTE). TriMet reports that transit staff dedicated to the analysis and reporting of data collected by the MDT is equal to two FTEs at $75,000 per FTE or $150,000 per annum.

- Staff acceptance. TriMet reports the highest acceptance rate by the operations and supervisory staff and the lowest acceptance rate by maintenance staff. The ratings for TriMet were as follows: executive staff—4, administrative/clerical staff—4, operations/supervisory staff—5, drivers—4, and maintenance staff—2.
- Operational/technical problems encountered and solutions. TriMet reported that the following problems were encountered in deploying MDTs: equipment problems, installation problems, driver training problems, installer and maintainer training problems, and communications infrastructure problems. The solutions it reported are listed here:
  - MDT equipment manufacturing defects—DC to DC converters faulty; replaced under warranty.
  - MDT installation problems—checked each vehicle; covered by warranty.
  - MDT driver training problems—had to re-train owing to unanticipated changes in equipment.
- Security and resilience of communications (after disruption). TriMet reports the following security measures in place: secure base station, secure radio tower(s), secure auxiliary power generation, and secure storage of mobile equipment, when not in service. Mobile-to-mobile transmission is possible when base station and/or central tower is/are down to provide a resiliency to the communications system design.
- MDT capabilities desired in the future. TriMet reported the following additional MDT functions as desirable:
  - Decision support tools;
  - More effective way to prioritize information received by dispatchers;
  - Electronic manifest (paratransit);
  - Wireless data transfer;
  - Faster response between mobile and central (not necessarily faster data transfer);
  - Real-time traffic conditions for paratransit drivers; and
  - Digital maps, directions, address display, and route-finding/optimization for paratransit.
- Future ITS applications at transit agency. TriMet reports additional technology applications for planned deployment as follows:
  - 802.11 for data transfer to/from vehicle,
  - Real-time or near real-time video (will require faster data transfer), and
  - Deployment of MDTs to field supervisors.

Transit Agency Highlight No. 2: Delaware Transit Corporation

With a large service area on the edge of the megalopolis of the United States (Boston to Washington urbanized area), it is natural for the DTC to turn to technology for managing a statewide demand-response and fixed-route bus service. DTC has used a major transit technology industry company with functionalities for both paratransit and fixed-route services in its hardware and software. To its credit, DTC uses the MDT and associated GPS capability to deploy a full set of data collection capabilities on both modes to enhance operational control of both modes. Again, as with TriMet, DTC has focused on the potential of the MDT to provide timely and accurate performance measurement data at the vehicle and passenger level for full accountability and system productivity. Delaware provides the only statewide deployment of MDTs in the national survey. With such a significant accomplishment in large-scale deployment, it is noteworthy that DTC is reluctant to predict future technology initiatives.

- Transit agency information. DTC is a unit of state government serving a population of 817,491 within 1,954 square miles in the state of Delaware. It operates 177 demand-responsive vehicles in maximum service and provides 648,696 unlinked trips in paratransit service. It operates 166 buses in its maximum-peak fixed-route bus service and provides 7,792,571 annual unlinked trips (2004 National Transit Database).
- MDT deployment. DTC reports that it has deployed 415 SmartMDTs using SmartTrack software from Orbital TMS.
- MDT functionality. DTC reports using MDTs in both fixed-route bus and paratransit services.
  - Fixed route. In fixed-route bus service the MDT is used to download the manifest to vehicle, for driver sign-on and sign-off, and to indicate start run/end run for revenue bus service. An electric beam is used for counting boarding and alighting through the SmartMDT. A full set of MDT emergency features include covert alarm, automatic communications to operations, local recording of video feed, and buffered video frames before the alarm is activated.
  - Demand response. DTC uses the MDT to download the manifest to the paratransit vehicle and to automatically update schedule changes. The paratransit MDT will accommodate driver sign-on and sign-off and passenger pick up and drop off.
- Communications infrastructure. DTC reports communications infrastructure using three parts of the radio spectrum: conventional radio (e.g., 450 MHz), and two bands of unrestricted wireless local area network (WLAN or WiFi) at 2.4 GHz (IEEE standard 802.11b/g) and 5.0 GHz (IEEE standards 802.11a). Delaware reports communication of data files from scheduling software to individual vehicles. It uses a

GPS refresh rate of 2–5 min from transit and paratransit vehicles. DTC can communicate canned text messages for the dispatch to the vehicle, from vehicle to dispatch, and from vehicle to vehicle in the DTC fleet. Free form text messages are possible from dispatch to vehicle.
- Information technology supporting MDT deployment. DTC uses the UNIX operating system and Oracle relational database to support the MDT deployment.
- Applications of MDT-collected data. Delaware uses the MDT to collect data to determine fixed-route and paratransit service on-time performance. DTC reports that it uses web mapping of AVL data and calculated ETA at bus terminals and bus stops. MDT-collected data are used to calculate passengers carried, passenger-miles, revenue-miles, passengers per vehicle-mile, passengers per revenue-mile, passengers per vehicle-hour, and passengers per revenue-mile.
- Installation, maintenance, and data analysis costs. There was no response to his section.
- Staff acceptance. DTC had a variety of responses to the survey question on staff acceptance. The ratings were as follows: executive staff—4, administrative/clerical staff—5, operations/supervisory staff—2, drivers—1, maintenance—2.
- Operational/technical problems encountered and solutions. DTC reported a number of problems in its MDT deployment including equipment problems, reliability in operating environment, driver training problems, installer/maintainer training problems, and communications infrastructure problems. It did not respond to the survey question on solutions.
- Security and resilience of communications (after disruption). DTC reported secure auxiliary power generation for (base station and radio towers) and secure storage of mobile equipment, when not in service.
- MDT uses desired beyond the capabilities of the existing equipment. DTC respondent did not answer this section.
- Future applications and technologies. There was no response to this section by DTC.

Transit Agency Highlight No. 3: City Of Tyler, Texas

Tyler, Texas, proves that you do not have to be a major metropolitan agency or a state agency to get the benefits of technology deployed in a transit system. Tyler chose one of the most experienced of the MDT manufacturers and one of the nation's largest wireless carriers to deploy MDTs in its small fixed-route and paratransit fleets. It uses both the taxi-type inexpensive liquid crystal display MDT and the newer high-resolution graphics-capable MDT. Despite its small agency size, it has the most up-to-date database software of any of the respondents to the MDT survey. The responses show a clear capacity to exploit the MDT data for all its management and operational information without in-house information technology staff. The significance of the city of Tyler response is that, within the context of a small multi-modal municipal transit service, it gets the same results from the technology as the two very large systems. In particular, it shares the approach of Portland's TriMet and DTC in their obsession with using technology to provide the transit consumer with information and services to improve their transit experience.

- Transit agency information. Tyler Municipal Transit (TMT) is the owner and operator of transit services in the city of Tyler, Texas. TMT has a service area population of 101,494 and a service area of 53 square miles. TMT operates four demand-responsive vehicles and four buses for fixed-route bus service (2004 National Transit Database).
- MDT deployment. In its response to the 2006 MDT survey, Tyler indicated that it uses two different models of MDT. It has seven of the veteran lower-cost MDC with an 8 line by 40 column text display lower-cost unit, and five of the newer full-featured Rangers, with color video screens, a total of 12 deployed units.
- MDT functionality. TMT uses MDTs in both fixed-route and paratransit service.
  - Fixed route. TMT used the MDT in fixed-route service to download the manifest to the bus, driver sign-on and sign-off, and start run/end run for revenue service. It also uses the MDT to manually enter passenger boarding and the emergency button for a panic alarm. All data entries from the MDT were accompanied by a GPS latitude/longitude and GPS date/time stamp as well as a digital odometer reading.
  - Demand response. Tyler uses the MDT to download the paratransit manifest to the vehicle and it automatically updates schedule changes to and from the MDT. It provides for driver sign-on and sign-off, and records passenger pick up and passenger drop off and the use of mobility aids through the MDT.
- Communications infrastructure. The city of Tyler uses a cellular carrier for communicating with the MDTs. It communicates data files from the scheduling software to each vehicle using this public data network. Tyler reports that it refreshes the GPS data for AVL of the vehicles at a range of two to five minutes. It can communicate canned text messages in both directions from the dispatch to the vehicle and from the vehicle to the dispatch. It can only communicate free-formed text messages from dispatch to the vehicle.
- Information technology supporting MDT deployment. TMT reports that it uses the MS Windows Server 2000 operating systems and Microsoft SQL Server 2005 as the database supporting the MDT deployment.
- Applications of MDT-collected data. The city of Tyler uses the MDT-collected data for paratransit on-time performance and paratransit QA/QC. It reported that the use of MDTs to calculate the following

performance measures: passengers carried, revenue received, passenger-miles, revenue-miles, passengers per vehicle-mile, passengers per revenue-mile, passengers per vehicle-hour, and passengers per revenue-mile. TMT integrates data files through its relational database on a central server [e.g., data integrated through linking key fields Vehicle IDentification (VID), latitude and longitude, and GPS date and time].

- Installation, maintenance, and data analysis costs. Tyler reported an MDT unit cost of $3,500, with an installation cost of $125. It reported an MDT maintenance and repair cost of $125 per unit, with 2.5 h of labor devoted to this task each year. The city of Tyler's computer department supports the information technology requirements of the MDT deployment. The communications infrastructure is provided and supported by the cellular carrier. TMT reported 0.5 FTE transit staff dedicated to the analysis and reporting of data collected by the MDT at a rate of $8.85 per hour.
- Staff acceptance. TMT respondents rated the acceptance of the MDT deployment by staff as uniformly high, with executive and operations/supervisory staff rating the highest. The ratings were as follows: executive staff—5, administrative/clerical staff—4, operations/supervisory staff—5, drivers—4, and maintenance staff—4.
- Operational/technical problems encountered and solution. TMT reported that it encountered installation, driver training, and communications infrastructure problems in the deployment of MDTs. The solutions were reported as follows:

> Installation problems related to antenna attachment; installation company just added addition sealant. Training problems have been related [to] a few drivers that had problems with technology, some related to seeing the LCD [liquid crystal display] screen and some in just remembering to push the arrive or depart button, so busy talking to clients they just forget. Communications has been a real challenge, the [communications] network has been good, but communication between the two servers requires attention on a weekly basis; resets of the communication software occur at least once a week (on average).

- Security and resilience of communications (after disruption). TMT reported attention to security issues, including a secure base station, encryption, and decryption of data radio transmission, and secure storage of mobile equipment when not in service.
- MDT capabilities desired in the future. TMT reported one additional function beyond its current MDT capabilities—a web portal for clients to see real-time bus locations and trip data.
- Future ITS applications at transit agency. In identifying additional technology planned for deployment, the city of Tyler provided the following list:
  - Cameras with [snapshot] capability, sending real-time photographs by means of MDT to office, plus on board recording;
  - Passenger counters;
  - On-board proximity card readers for fare payment through MDC (or magnetic strip readers);
  - Bus stop emergency phones, probably secure cell phone-type system;
  - Next bus utilizing real-time GPS data from vehicle; and
  - Web portal for clients to view trip schedules on demand response, request trips, and view real-time location of fixed-route buses.

Considering the 12 MDTs that Tyler has deployed in a small fixed-route and paratransit system, this ambitious future applications list covers the latest technology in safety and security, passenger counting, fare payment, and customer information.

CHAPTER FIVE

CONCLUSIONS

The response from the transit industry to the mobile data terminal (MDT) survey was geographically widespread and diverse in agency size. The survey indicated a magnitude of MDT deployment (more than 10,000 units reported) in both fixed-route and paratransit that was larger than anticipated. In both demand-response and motor bus modes, the functionality deployed and the applications reported indicate an industry that is using MDT technology to monitor and enhance performance on the street, provide better information to customers, and prevent fraud and abuse by contractors and staff. The use of MDT-collected data for performance measurement and productivity is very sophisticated.

- There was a range in MDT manufacturers that showed some long-term suppliers surviving in a volatile marketplace, as well as new vendors entering a global marketplace. There were products and services that featured integration of modes and strong consumer orientation. New vendors were active in marketing and competing for transit and paratransit business at transit trade conferences. As anticipated by the synthesis topic panel, the MDTs deployed in the transit industry are found in the bus and demand-responsive modes; however, evidence indicates interest in nontraditional markets such as ferries and light rail, as well.
- For those survey participants who took the time to address the issues of cost, deployment problems and solutions, technology support, and acceptance of MDTs in a transit context, the responses were heartening. The transit industry has become a significant buyer of technology. It is practical and effective in dealing with the inevitable problems of changing culture in the workforce. The industry is helped by the favorable economic forces of lower cost and higher value of all technology products and the increasing dissemination of technology throughout society.
- Responses to questions concerning communications type indicate a dominance of the traditional private radio network (conventional radio) among respondents. However, when cellular carriers are aggregated as a public data network category, their presence in the deployment of MDTs is significant. The increases in the transmission capacity of wireless broadband currently being developed as cellular carriers compete for the new smart phone customers may provide transit with a cheap and reliable infrastructure for MDT and customer information deployment. Nontraditional radio spectrum, such as wireless local area network or WiFi (IEEE 802.11a/b/g), is also in evidence as cities strive to bridge the digital divide for their residents and savvy information technologists in the transit industry see the advantages of wireless downloads to MDTs in transit vehicles.
- Higher than expected global positioning system (GPS) rates were reported. In transit agencies using public data networks, this may reflect the difference between the transmission rates of first generation cellular communications and current 2.5 and third generation telecommunications infrastructure being rolled out nationwide. The higher refresh rates are particularly important for those agencies using the web to communicate the locations of their vehicles and for estimated time-of-arrival predictions. The availability of assisted GPS on GPS-integrated cell phones indicates very fast time-to-first-fix, GPS refresh rates of 1–2 s, and location calculation within buildings and urban canyons. If this technology becomes widespread and deployed in transit, new and different applications for automatic vehicle location data will emerge—such as incident and accident reconstruction, emergency evacuation management, and other safety and security applications.
- Some respondents were looking to acquire real-time video as future technology. The market competitiveness of wireless cellular companies with cable companies over broadband capacity for video download may provide some future cost-effective opportunities for transit. For example, in South Korea the communication infrastructure is in place that allows consumers to view television shows on their cell phones. If one can view television shows on a cell phone, there is enough bandwidth to transmit one frame per second video from an Internet camera on a bus to the operations center. The U.S. consumer will eventually decide if they want this capacity, but the technology is available. Transit should be alert to taking advantage of these emerging capabilities as a safety and security initiative.

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APPENDIX A1

Survey Instrument and Associated Database Documentation

SECTION A1-1
Transit Use of Mobile Data Terminals Survey Instrument Worksheet

Long Form—Case Study

A. Transit Agency (TA) Respondent Information

1. National Transit Database (NTD) ID (a.k.a. Trs_ID) [entering ID number fills in name below].
2. Name of the agency: [If Trs_ID is unknown; pick NTD reporting entity by state, city, sort].
   a. Acronym, if applicable from NTD: [filled in by file]
   b. Address of agency:
      i. City: [filled in by file]
      ii. State/province: [filled in by file]
      iii. State/province code: [filled in by file]
      iv. Country: [filled in by file]
      v. Country code: [filled in by file]
      vi. Zip/postal code: [filled in by file]
   c. Respondent:
      i. Contact name: _____
      ii. Contact title: _____
      iii. Contact phone: _____
      iv. Contact e-mail address: _____

B. Transit Service Using MDTs [Choose NTD Mode Code, as applicable:]

1. Motor bus (MB): Y/N?
2. Demand response (DR): Y/N?
3. Heavy rail (HR): Y/N?
4. Light rail (LR): Y/N?
5. Commuter rail (CR): Y/N?
6. Other(s): _____

C. Types and Brand of Equipment Used

1. Manufacturer name: [Choose from list of MDT manufacturers].
   a. Other: _____
2. Model name: [Choose from MDT model list. *See Mobile Data Terminal Specifications File Structure and graphics of models for example*].
3. If other (1.a above), address of MDT manufacturer:
   a. Address 1: _____
   b. Address 2: _____
   c. City: _____
   d. State/province: _____
   e. State/province code: _____
   f. Country: _____
   g. Country code: _____
   h. Zip/postal code: _____
   i. Contact name: _____
   j. Contact phone: _____
   k. Contact e-mail address: _____
   l. Web address: _____

4. How many MDT units are currently installed? _____
5. How many MDT units will be installed within one year? _____

D. ITS Supplier Information

1. ITS supplier name [Choose from list of ITS suppliers].
   a. Other: _____
2. If other (1.a above), address of ITS supplier.
   a. Address 1: _____
   b. Address 2: _____
   c. City: _____
   d. State/province: _____
   e. State/province code: _____
   f. Country: _____

g. Country code: _____
h. Zip/postal code: _____
i. Contact name: _____
j. Contact phone: _____
k. Contact e-mail address: _____
l. Web address: _____

E. What Applications/Built-In Functionalities Are Supported by MDTs

1. MDT functions used (list below from assumes GPS integration and real-time communications):
   a. Fixed-route service:
      i. Down load manifest to vehicle: Y/N?
      ii. Driver sign-on: Y/N?
         1. GPS date/time, latitude/longitude: Y/N?
         2. Digital odometer reading: Y/N?
      iii. Start run (revenue service): Y/N?
         1. GPS date/time, latitude/longitude: Y/N?
         2. Digital odometer reading: Y/N?
      iv. End run (revenue service): Y/N?
         1. GPS date/time, latitude/longitude: Y/N?
         2. Digital odometer reading: Y/N?
      v. Driver sign-off
         1. GPS date/time, latitude/longitude: Y/N?
         2. Digital odometer reading: Y/N?
      vi. Fixed-route passenger counting
         1. GPS date/time, latitude/longitude: Y/N?
         2. Digital odometer reading: Y/N?
         3. Passenger boarding
            a. Automatic: Y/N? If yes,
               i. Mechanical treadle: Y/N?
               ii. Break electronic beam: Y/N?
            b. If manual MDT entry of passengers:
               i. Single entry (1 per pax)
               ii. Multiple rider value (e.g., number of riders boarding at stop)
         4. Passenger alighting
            a. Automatic: Y/N? If yes,
               i. Mechanical treadle: Y/N?
               ii. Break electronic beam: Y/N?
            b. Manual MDT entry: Y/N?
               i. Single entry (1 per pax)
               ii. Multiple rider value (number of riders boarding at stop)
         5. Use of mobility aids: Y/N? If yes,
            a. GPS date/time, latitude/longitude: Y/N?
            b. Digital odometer reading: Y/N?
         6. Loading bicycle on rack: Y/N? If yes,
            a. GPS date/time, latitude/longitude: Y/N?
            b. Digital odometer reading: Y/N?
         7. Fixed-route fare collection:
            a. Automatic: Y/N? If yes,
               i. Magnetic stripe: Y/N?
               ii. Smart card: Y/N?
               iii. RF Proximity card: Y/N?
               iv. Combination of RF/stored value on card: Y/N?
               v. Other:_____
         8. Fixed-route emergency alarm: Y/N? If yes,
            a. GPS date/time, latitude/longitude: Y/N?
            b. Digital odometer reading: Y/N?
            c. Function key on MDC: Y/N?
            d. Covert alarm (e.g., foot treadle): Y/N?
            e. Communicates immediately to Transit Ops Center dispatch: Y/N?
            f. Communicates directly to local public safety: Y/N?
            g. Initiates video feed to:
               i. Transit operations center
               ii. Local public safety
               iii. Other: _____
            h. Video feed sends buffered images prior to alarm: Y/N?

b. Paratransit service:
   i. Download daily manifest to vehicle: Y/N?
   ii. Updates schedule changes to/from MDT automatically:
      1. Cancelled trips: Y/N?
      2. No shows: Y/N?
   iii. Paratransit passenger counting
      1. Passenger pick up:
         a. GPS date/time, latitude/longitude: Y/N?
         b. Digital odometer reading: Y/N?
      2. Passenger drop off:
         a. GPS date/time, latitude/longitude GPS date/time, latitude/longitude: Y/N?
         b. Digital odometer reading: Y/N?
      3. Driver sign-on
         a. GPS date/time, latitude/longitude: Y/N?
         b. Digital odometer reading: Y/N?
      4. Start run (revenue service)
         a. GPS date/time, latitude/longitude: Y/N?
         b. Digital odometer reading: Y/N?
      5. End run (revenue service)
         a. GPS date/time, latitude/longitude: Y/N?
         b. Digital odometer reading: Y/N?
      6. Driver sign-off
         a. GPS date/time, latitude/longitude: Y/N?
         b. Digital odometer reading: Y/N?
      7. Use of mobility aids:
         a. GPS date/time, latitude/longitude: Y/N?
         b. Digital odometer reading: Y/N?
         c. Wheel chair: Y/N?
         d. Walker: Y/N?
         e. Service animal: Y/N?
         f. Other: _____

F. Communications Infrastructure

1. How does the MDT communicate with the Operations Center?
   a. Conventional Private Radio Network: (e.g., 450 MHz)
   b. Public Data Networks (e.g., cellular)
      i. Verizon Wireless: Y/N?
      ii. Cingular (GSM/GPRS): Y/N?
      iii. Sprint/Nextel (iDEN): Y/N?
      iv. T-Mobile: Y/N?
      v. Other: _____
   c. WiFi or Wireless Local Area Network (IEEE 802.11 a/b/g)
      i. 2.4 GHz unrestricted (IEEE 802.11 b/g): Y/N?
      ii. 5.0 GHz unrestricted (IEEE 802.11 a): Y/N?
      iii. 5.0 GHz restricted public safety (4.9) or ITS DSRC (5.9): Y/N?
   d. WiMAX (IEEE 802.20): Y/N?
   e. Integrated WiFi and WiMAX: Y/N?

2. Types of information communicated to MDTs versus other means?
   a. Communication of data files from scheduling software to individual vehicles: Y/N?
   b. Polling of GPS data (NMEA GPS string) from individual vehicles: Y/N? If yes, refresh rate of (choose one)
      i. 1–5 seconds
      ii. 6–10 seconds
      iii. 10–60 seconds
      iv. 60–120 seconds
      v. 2–5 minutes
      vi. 6 or more minutes
   c. Communication of video to or from vehicle, through MDT: Y/N?
   d. Communication of canned text messages from dispatch to vehicle: Y/N?
   e. Communication of canned text messages from vehicle to dispatch: Y/N?
   f. Communication of canned text messages from vehicle to vehicle in fleet: Y/N?
   g. Communication of free formed text messages from dispatch to vehicle: Y/N?
   h. Communication of free formed text messages from vehicle to dispatch: Y/N?

i. Communication of free formed text messages from vehicle to vehicle in fleet: Y/N?
j. Is two-way mobile radio voice communications also available to the driver: Y/N?
k. Other communication?

G. Information Technology Supporting the MDT

1. What operating system is being run where the MDT database resides?
   a. MSDOS
   b. MS Windows Server 2000
   c. MS Windows Server 2003
   d. MS Windows XP
   e. MS Windows XP Professional
   f. Apple OS
   g. Linux
   h. Unix
   i. Sun SPARC OS
   j. Other

2. What database technology is supporting the MDT deployment?
   a. Microsoft SQL Server 2000
   b. Microsoft SQL Server 2003
   c. Microsoft SQL Server 2005
   d. Oracle RDBMS
   e. MS Access
   f. MS Excel
   g. Other _____

H. Applications of MDT-Collected Data

1. What are current applications of MDT-collected data?
   a. Driver time keeping
   b. Route and schedule adherence
      i. Fixed-route service on-time performance: Y/N?
      ii. Paratransit on-time performance: Y/N?
   c. Fraud prevention and detection
      i. Time fraud by staff or contractors: Y/N?
      ii. Fare fraud by staff or contractors: Y/N?
      iii. Third-party payment fraud by human service clients: Y/N?
   d. Real-time web mapping of automatic vehicle location data: Y/N?
   e. Dynamic calculation of estimated time of arrival (ETA) by vehicle
      i. At bus terminals: Y/N?
      ii. At bus stops: Y/N?
      iii. On-board the bus: Y/N?
      iv. Display of ETA on web: Y/N?
   f. Quality assurance/quality control (QA/QC) of service [verification of approved service configuration/fraud prevention]
      i. Fixed-route service: Y/N?
      ii. Paratransit service: Y/N?
   g. Alarming for preventive maintenance scheduling based on automatic odometer reading: Y/N?
   h. Verification of performance of scheduled maintenance and repair: Y/N?
   i. Aggregation of fueling and consumable supplies by vehicle and driver to verify operations performance and detect fraud and abuse: Y/N?
   j. Calculation of periodic performance measures based on MDT data collection:
      i. Passengers carried: Y/N?
      ii. Revenue received: Y/N?
      iii. Passenger miles: Y/N?
      iv. Revenue miles: Y/N?
      v. Passengers per vehicle mile: Y/N?
      vi. Passengers per revenue mile: Y/N?
      vii. Passengers per vehicle hour: Y/N?
      viii. Passengers per revenue mile: Y/N?
      ix. Mean time between failures (equipment breakdown): Y/N?
      x. Mean miles between failures (equipment breakdown): Y/N?
      xi. Other: _____

2. How are these applications integrated?
    a. Integrated data collection device (hardware) on vehicle: Y/N? (e.g., GPS temporal and spatial stamp sent with data record).
    b. Integrated data files through relational database on central server (software): Y/N? [e.g., data integrated through linking key fields—VID, latitude/longitude, GPS date/time]
    c. Manually integrated through spreadsheet analysis: Y/N?
    d. Not integrated: Y/N?

I. Installation, Maintenance, and Data Analysis Costs

1. Costs to install and maintain MDTs
    a. What was the unit cost of the MDT for your most recent deployment? _____
    b. What was the unit cost of installation of the MDT for your most recent deployment? _____
    c. How many labor hours were expended to install an individual MDT for your most recent deployment? _____
    d. What is the average annual unit cost to maintain/repair an individual MDT for your deployment? _____
    e. What are the average annual labor hours to maintain/repair an individual MDT for your deployment? _____

2. Staffing requirements to maintain the equipment and utilize the data
    a. Does the TA provide the information technology and communications infrastructure for the MDT deployment: Y/N?
        i. If yes, what is the annual personnel cost dedicated to IT and communications? _____
        ii. If no, how is the IT and communications provided? _____
    b. Are there transit staff dedicated to the analysis and reporting of data collected by the MDTs: Y/N?
        iii. If yes, what is the annual personnel cost for analysis and reporting? _____
        iv. If yes, what are the annual labor hours for analysis and reporting? _____
        v. If no, how is analysis and reporting accomplished? _____ _____

J. Staffing Acceptance

1. How would you rate the acceptance of staff to the deployment of MDTs (choose range 1–5, where 5 is greatest acceptance)?
    a. Executive staff: 1 2 3 4 5
    b. Administrative/clerical staff: 1 2 3 4 5
    c. Operations supervisory staff: 1 2 3 4 5
    d. Drivers: 1 2 3 4 5
    e. Maintenance staff: 1 2 3 4 5

K. Operational/Technical Problems Encountered and Solutions

1. What types of problems were encountered:
    a. MDT equipment design flaws: Y/N?
    b. MDT equipment manufacturing defects: Y/N?
    c. MDT installation problems: Y/N?
    d. MDT reliability in operating environment: Y/N?
    e. MDT driver training problems: Y/N?
    f. MDT installer/maintainer training problems: Y/N?
    g. MDT manufacturer/vendor warranty compliance: Y/N?
    h. MDT communications infrastructure problems: Y/N?
    i. MDT sabotage: Y/N?
    j. Other: _____

2. If yes to above, what solutions were developed to the above problems?
    a. MDT equipment design flaws _____ _____
    b. MDT equipment manufacturing defects_____ _____
    c. MDT installation problems_____ _____
    d. MDT reliability in operating environment_____ _____

e. MDT driver training problems_____
_____
f. MDT installer/maintainer training problems _____
_____
g. MDT manufacturer/vendor warranty compliance_____
_____
h. MDT communications infrastructure problems_____
_____
i. MDT sabotage_____
_____
j. Other: _____
_____

L. Security and Resilience of Communications (after disruption)

1. Do you have security measures in place for the communications system supporting the MDT?
   a. Secure base station: Y/N?
   b. Secure radio tower(s): Y/N?
   c. Secure auxiliary power generation for a and b above: Y/N?
   d. Encryption and decryption of data radio transmission: Y/N?
   e. Secure storage of mobile equipment, when not in service: Y/N?
2. Do you have resilience built into the design of the communication system?
   a. Mobile to mobile transmission when base station and/or central tower is/are down: Y/N?
   b. Self-healing autonomous mesh networks for radio communications (e.g., multi-hop transmission and Internet communications protocols): Y/N?
   c. Cooperative agreements with surrounding jurisdictions with duplicate communications systems in-place that can temporarily replace central dispatch functionality: Y/N?

M. MDT Uses Desired Beyond the Capabilities of the Existing Equipment

1. What additional functions are desired beyond current capabilities?

_____
_____
_____
_____
_____

N. Future Applications and Technologies

1. What additional technology applications are you planning to deploy?

_____
_____
_____
_____
_____

SECTION A1-2
Transit Use of Mobile Data Terminals Survey Instrument Worksheet

Short Form—Standard

A. Transit Agency (TA) Respondent Information

1. National Transit Database (NTD) ID (a.k.a Trs_ID) [entering ID number fills in name below].
2. Name of the agency: [If Trs_ID is unknown, pick NTD reporting entity by state, city, sort].
   a. Acronym, if available from NTD: [filled in by file]
   b. Address of agency:
      i. City [filled in by file]
      ii. State/province code: [filled in by file]
      iii. Country: [filled in by file]
      iv. Country code: [filled in by file]
      v. Zip/postal code: [filled in by file]
   c. Respondent
      i. Contact name: _____
      ii. Contact title: _____
      iii. Contact phone: _____
      iv. Contact e-mail address: _____

B. Transit Service Using MDTs [Choose NTD Mode Code, as applicable:]

1. Motor bus (MB): Y/N?
2. Demand response (DR): Y/N?
3. Heavy rail (HR): Y/N?
4. Light rail (LR): Y/N?
5. Commuter rail (CR): Y/N?
6. Other(s): _____

C. Types and Brand of Equipment Used

1. Manufacturer name: [Choose from list of MDT manufacturers].
   a. Other _____
2. Model name: [Choose from MDT Model list. *See Mobile Data Terminal Specifications File Structure and graphics of models for example*].
3. If other (1.a above), address of MDT manufacturer:
   a. Address 1: _____
   b. Address 2: _____
   c. City: _____
   d. State/province: _____
   e. State/province code: _____
   f. Country: _____
   g. Country code: _____
   h. Zip/postal code: _____
   i. Contact name: _____
   j. Contact phone: _____
   k. Contact e-mail address: _____
   l. Web address: _____

4. How many MDT units are currently installed? _____
5. How many MDT units will be installed within one year? _____

D. ITS Supplier Information

1. ITS supplier name [Choose from list of ITS suppliers].
   a. Other: _____
2. If other (1.a above), address of ITS supplier.
   a. Address 1: _____
   b. Address 2: _____
   c. City: _____
   d. State/province: _____
   e. State/province code: _____
   f. Country: _____

g. Country code: _____
h. Zip/postal code: _____
i. Contact name: _____
j. Contact phone: _____
k. Contact e-mail address: _____
l. Web address: _____

F. Communications Infrastructure

1. How does the MDT communicate with the Operations Center?
   a. Conventional Private Radio Network: (e.g., 450 MHz)
   b. Public Data Networks (e.g., cellular)
      i. Verizon Wireless: Y/N?
      ii. Cingular (GSM/GPRS): Y/N?
      iii. Sprint/Nextel (iDEN): Y/N?
      iv. T-Mobile: Y/N?
      v. Other: _____
   c. WiFi or Wireless Local Area Network (IEEE 802.11 a/b/g)
      i. 2.4 GHz unrestricted (IEEE 802.11 b/g): Y/N?
      ii. 5.0 GHz unrestricted (IEEE 802.11 a): Y/N?
      iii. 5.0 GHz restricted public safety (4.9) or ITS DSRC (5.9): Y/N?
   d. WiMAX (IEEE 802.20): Y/N?
   e. Integrated WiFi and WiMAX: Y/N?

2. Types of information communicated to MDTs versus other means?
   a. Communication of data files from scheduling software to individual vehicles: Y/N?
   b. Polling of GPS data (NMEA GPS string) from individual vehicles: Y/N? If yes, refresh rate of (chose one)
      i. 1–5 seconds
      ii. 6–10 seconds
      iii. 11–60 seconds
      iv. 61–120 seconds
      v. 2–5 minutes
      vi. 6 or more minutes
   c. Communication of video to or from vehicle, through MDT: Y/N?
   d. Communication of canned text messages from dispatch to vehicle: Y/N?
   e. Communication of canned text messages from vehicle to dispatch: Y/N?
   f. Communication of canned text messages from vehicle to vehicle in fleet: Y/N?
   g. Communication of free formed text messages from dispatch to vehicle: Y/N?
   h. Communication of free formed text messages from vehicle to dispatch: Y/N?
   i. Communication of free formed text messages from vehicle to vehicle in fleet: Y/N?
   j. Is two-way mobile radio voice communications also available to the driver: Y/N?
   k. Other communication?

H. Applications of MDT-Collected Data

1. What are current applications of MDT-collected data?
   a. Driver time keeping
   b. Route and schedule adherence
      i. Fixed-route service on-time performance: Y/N?
      ii. Paratransit on-time performance: Y/N?
   c. Fraud prevention and detection
      i. Time fraud by staff or contractors: Y/N?
      ii. Fare fraud by staff or contractors: Y/N?
      iii. Third-party payment fraud by human service clients: Y/N?
   d. Real-time web mapping of automatic vehicle location data: Y/N?
   e. Dynamic calculation of estimated time of arrival (ETA) by vehicle
      i. At bus terminals: Y/N?
      ii. At bus stops: Y/N?
      iii. On-board the bus: Y/N?
      iv. Display of ETA on web: Y/N?
   f. Quality assurance/quality control (QA/QC) of service [verification of approved service configuration/fraud prevention]
      i. Fixed-route service: Y/N?
      ii. Paratransit service: Y/N?
   g. Alarming for preventive maintenance scheduling based on automatic odometer reading: Y/N?

h. Verification of performance of scheduled maintenance and repair: Y/N?
i. Aggregation of fueling and consumable supplies by vehicle and driver to verify operations performance and detect fraud and abuse: Y/N?
j. Calculation of periodic performance measures based on MDT data collection:
   i. Passengers carried: Y/N?
   ii. Revenue received: Y/N?
   iii. Passenger miles: Y/N?
   iv. Revenue miles: Y/N?
   v. Passengers per vehicle mile: Y/N?
   vi. Passengers per revenue mile: Y/N?
   vii. Passengers per vehicle hour: Y/N?
   viii. Passengers per revenue mile: Y/N?
   ix. Mean time between failures (equipment breakdown): Y/N?
   x. Mean miles between failures (equipment breakdown): Y/N?
   xi. Other: _____

M. MDT Uses Desired Beyond the Capabilities of the Existing Equipment

1. What additional functions are desired beyond current capabilities?

_____
_____
_____
_____

N. Future Applications and Technologies

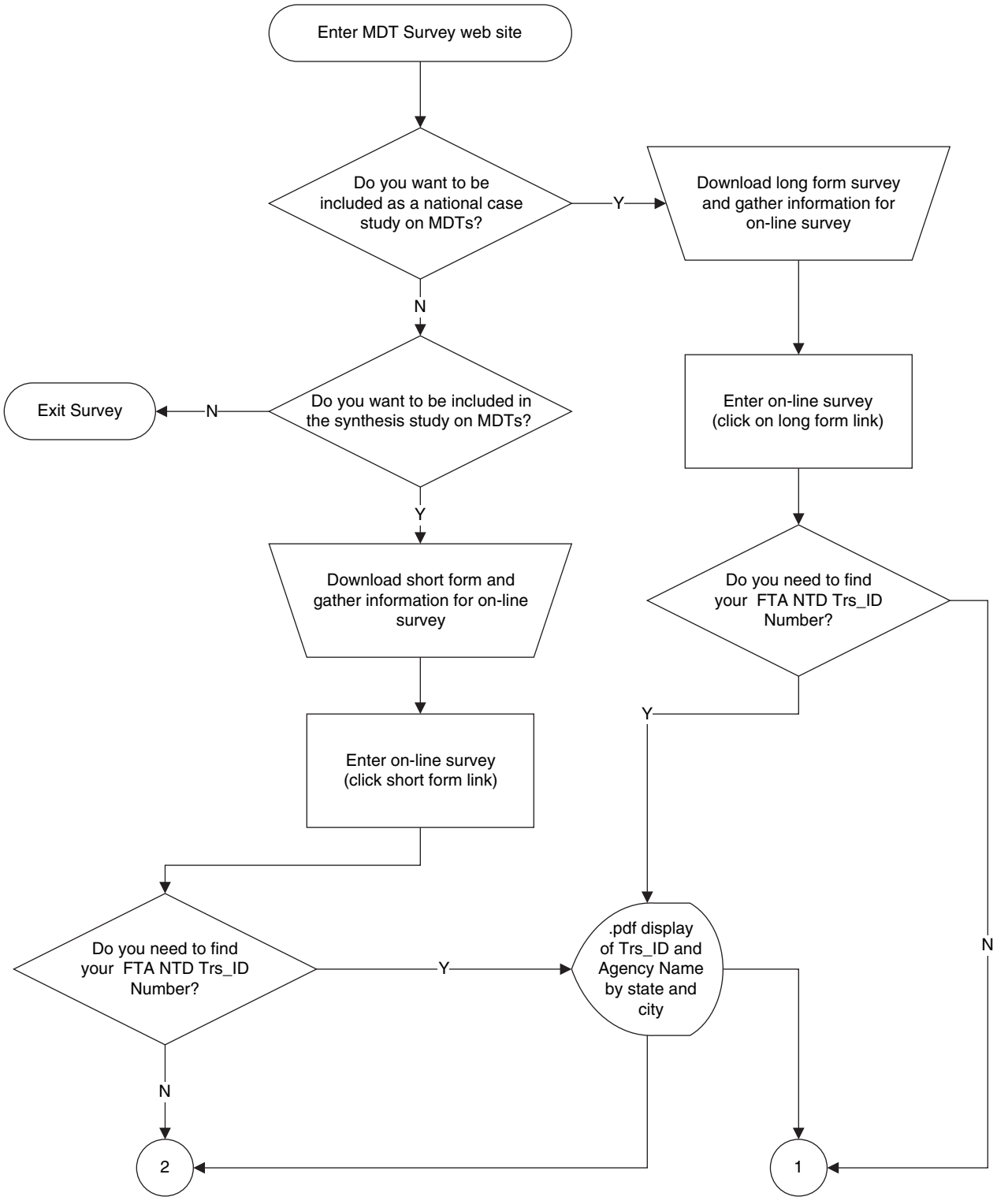
1. What additional technology applications are you planning to deploy?

_____
_____
_____
_____

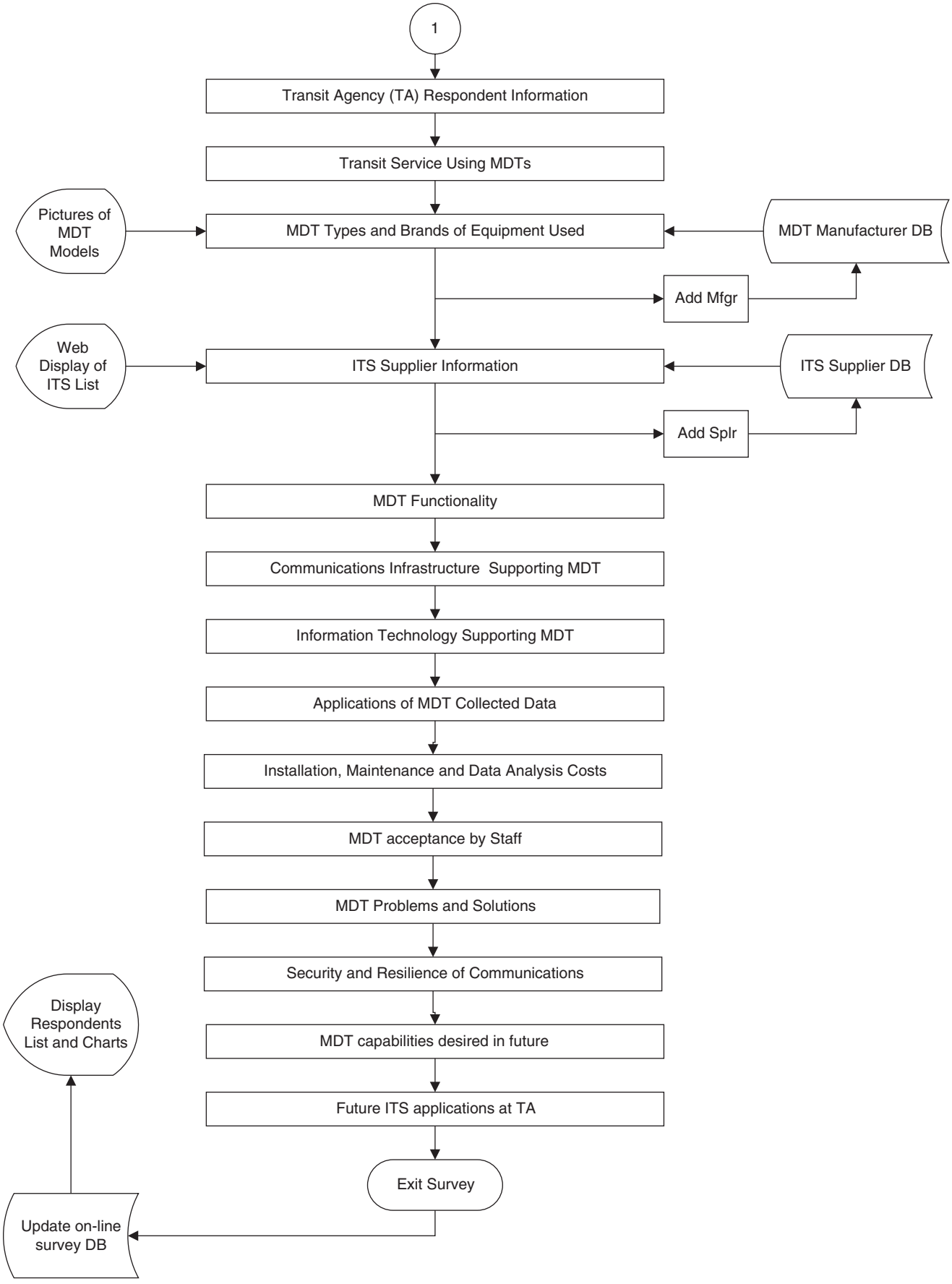
SECTION A1-3

Mobile Data Terminals Synthesis Study On-Line Survey Maps

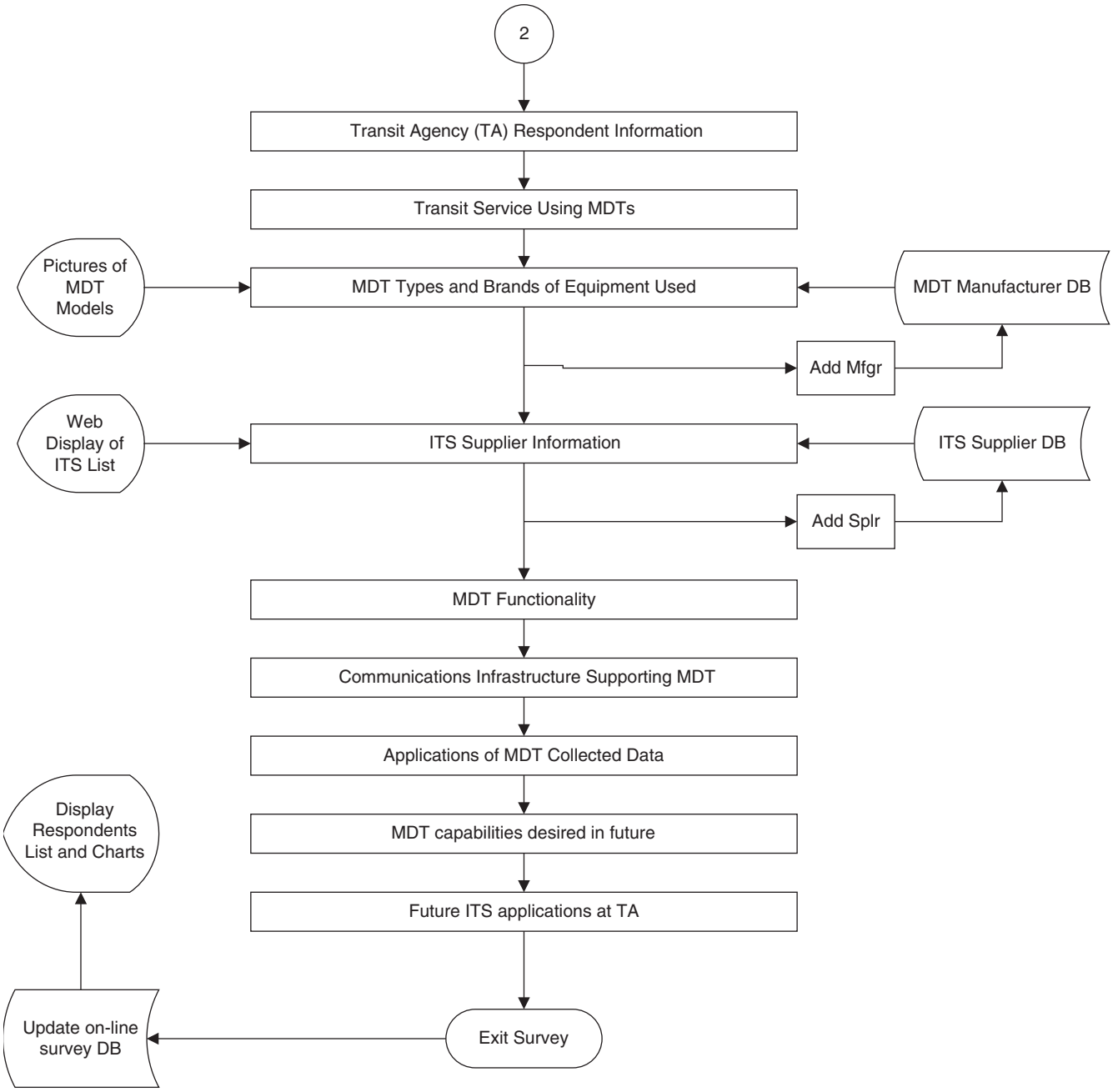
TCRP J-7 SC-08 Mobile Data Terminals Synthesis Study
On-Line Survey Map



TCRP J-7 SC-08 Mobile Data Terminals Synthesis Study
On-Line Survey Map – Case Study (long form) Option

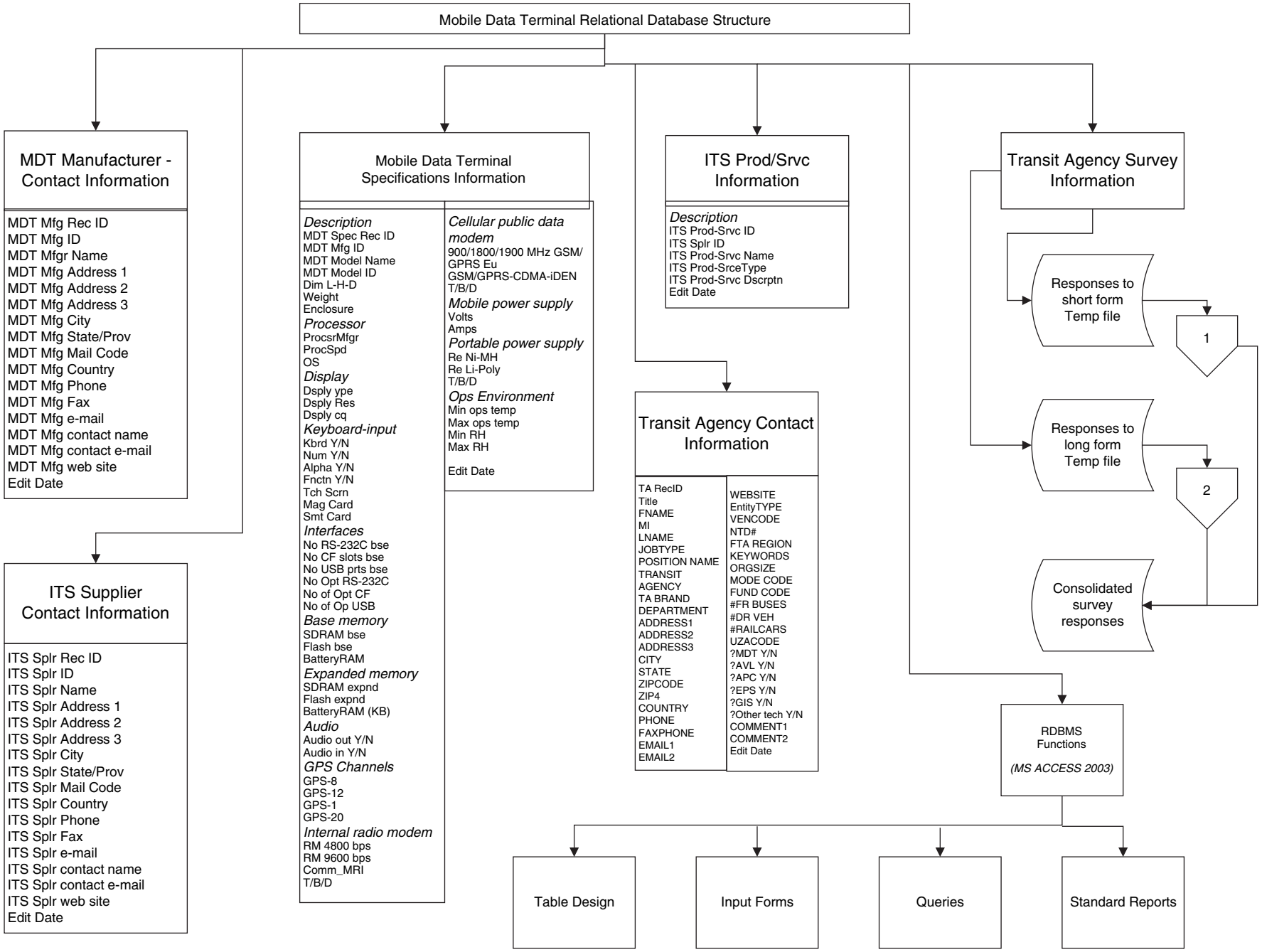


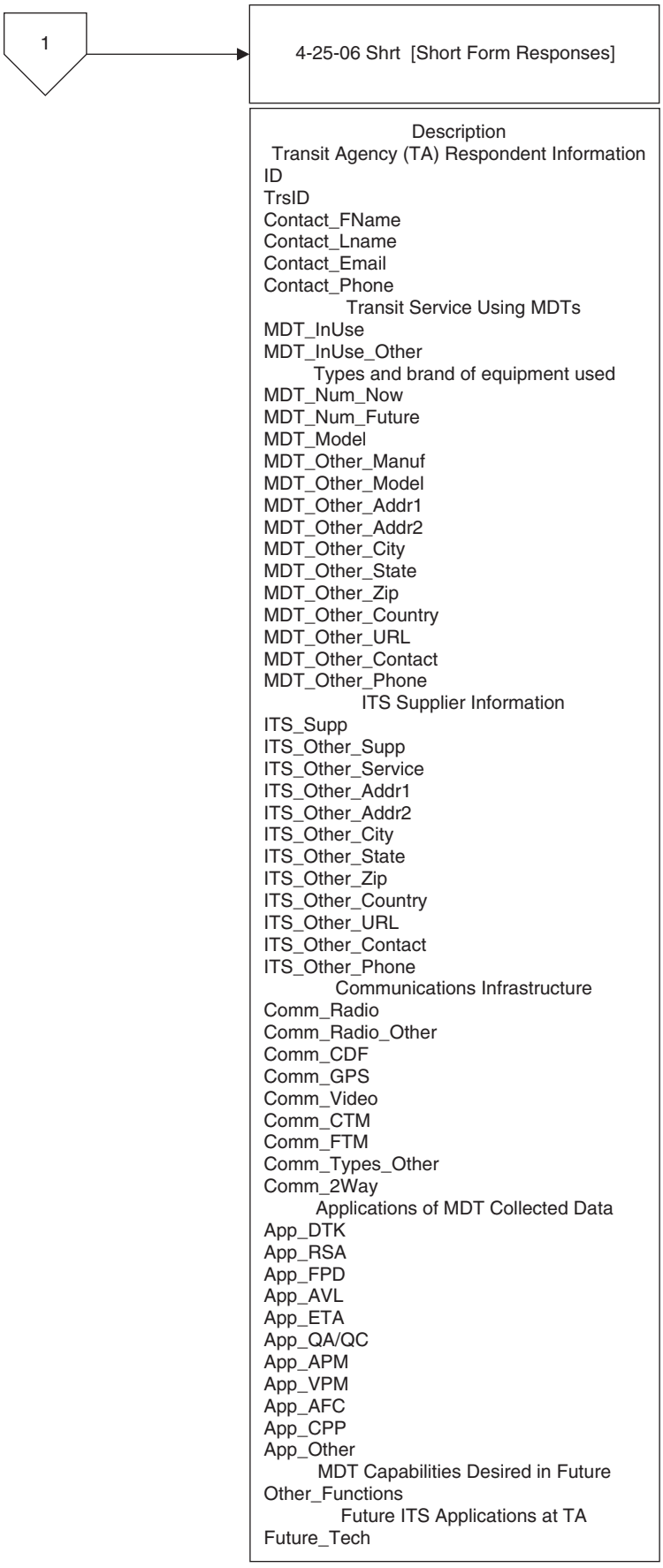
TCRP J-7 SC-08 Mobile Data Terminals Synthesis Study
On-Line Survey Map – Standard (short form) Option

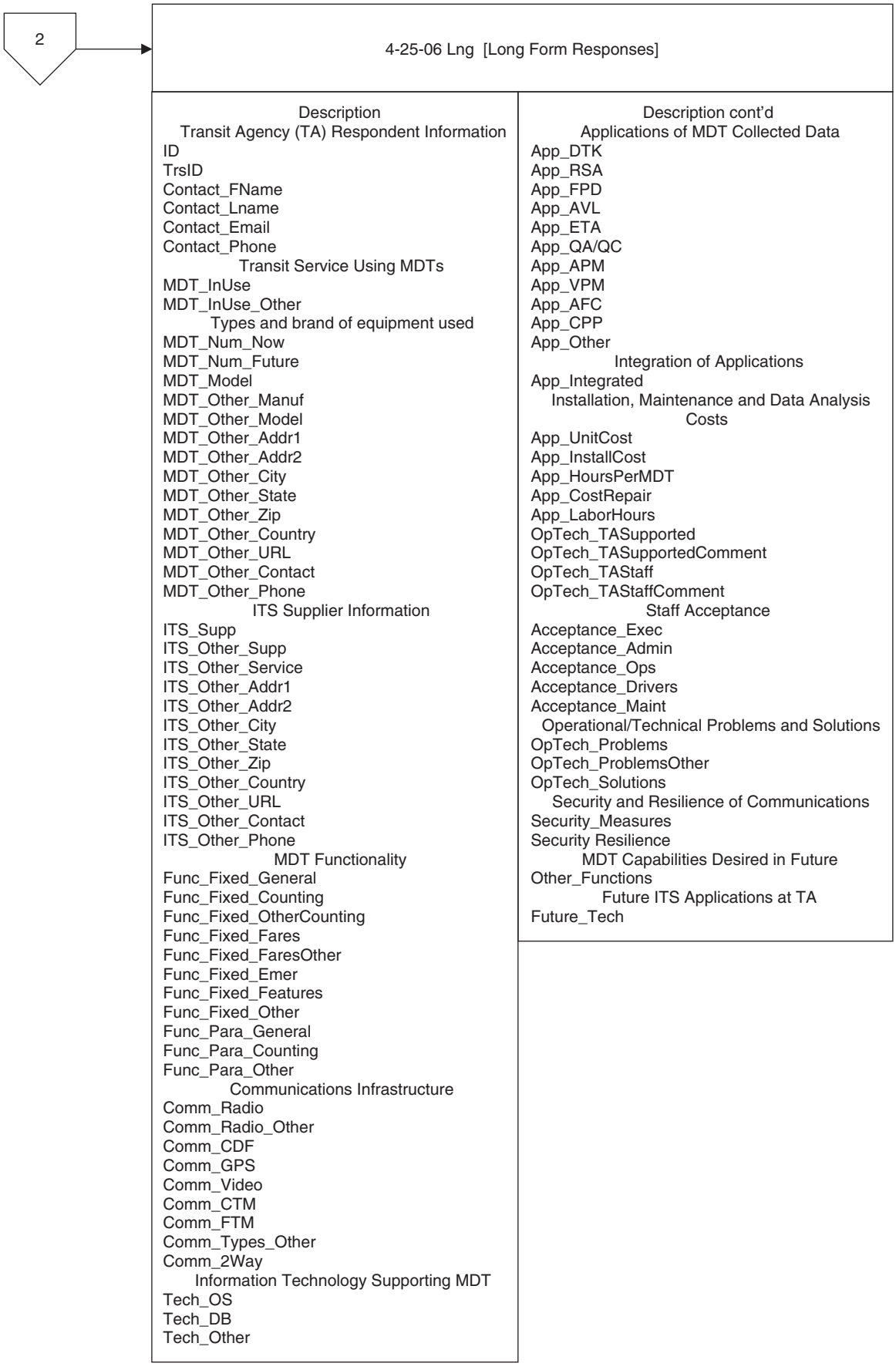


SECTION A1-4

Mobile Data Terminal Relationship Database Structure

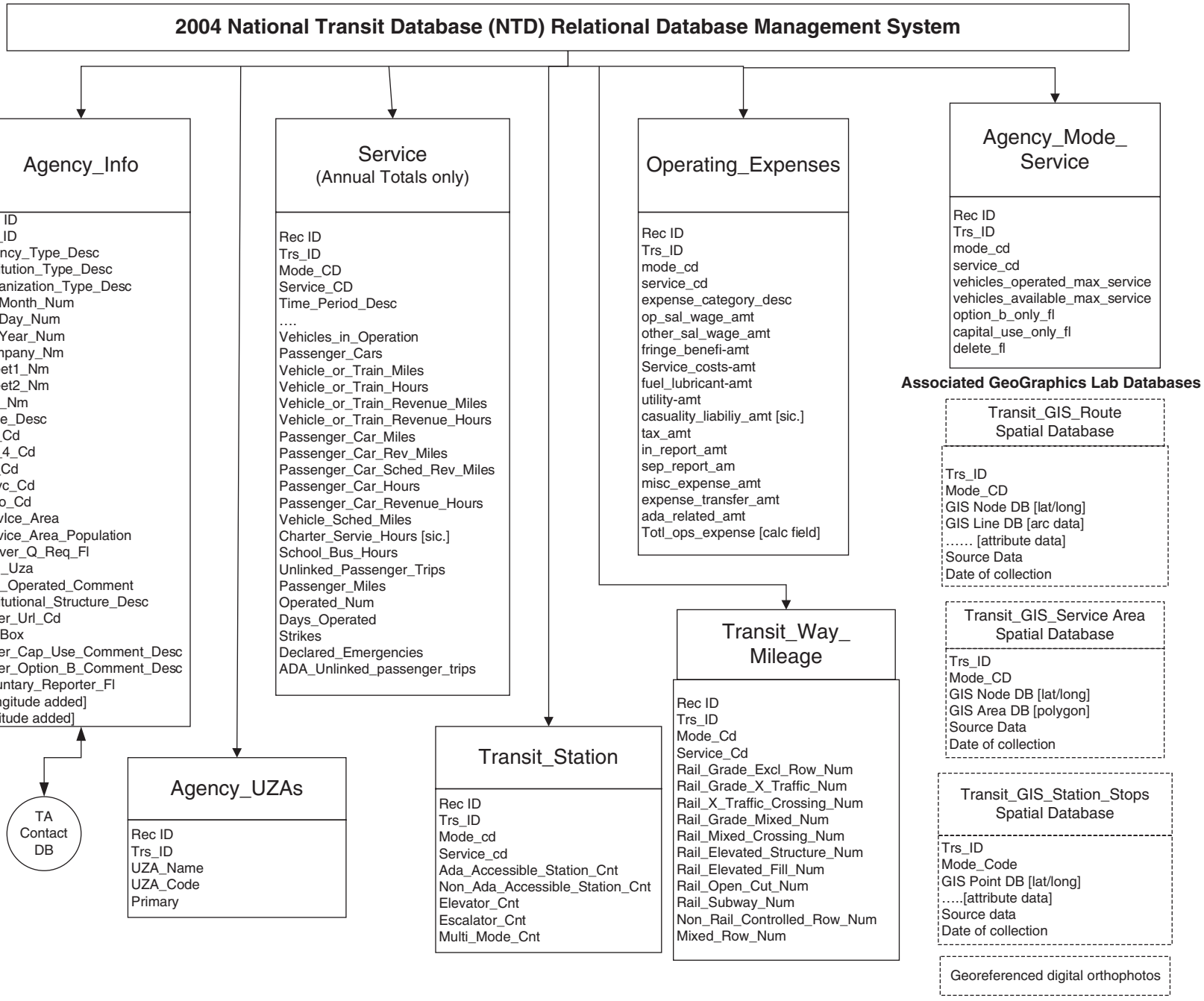






SECTION A1-5

2004 National Transit Database Relational Database Management System



APPENDIX A2

Reports from the Mobile Data Terminal Survey Database

A. Transit Agency Respondent Information
- Report A2-A1. 2006 MDT Survey Respondents

B. Transit Service Using MDTs
- Report A2-B1. Modal Use of MDT

C. Types and Brand of Equipment Used
- Report A2-C1. Installed Mobile Data Terminal Totals
- Report A2-C2. Manufacturer and Model

D. ITS Supplier Information
- Report A2-D1. ITS Supplier—Service by Supplier
- Report A2-D2. ITS Supplier—Service by State

E. What Applications/built-in Functionalities Are Supported by MDTs
- Report A2-E1. Functions—Fixed Route—General
- Report A2-E2. Functions—Fixed Route—Counting
- Report A2-E3. Functions—Fixed Route—Other Counting
- Report A2-E4. Functions—Fixed Route—Fares
- Report A2-E5. Functions—Fixed Route—Emergency
- Report A2-E6. Functions—Fixed Route—Space/Time Features
- Report A2-E7. Functions—Fixed Route—Other
- Report A2-E8. Functions—Demand Response—General
- Report A2-E9. Functions—Demand Response—Counting
- Report A2-E10. Functions—Demand Response—Other

F. Communications Infrastructure
- Report A2-F1. MDT Communications by Type
- Report A2-F2. MDT Communications by State
- Report A2-F3. GPS Refresh Rates by Number of MDTs
- Report A2-F4. Communication of Data and Video
- Report A2-F5. Communication of Canned Text Messages
- Report A2-F6. MDT Communication of Free Form Text
- Report A2-F7. MDT Communication Types—Other
- Report A2-F8. Two-Way Voice Radio Communication

G. Information Technology Supporting the MDT
- Report A2-G1. Operating Systems Supporting MDT Databases
- Report A2-G2. Database Software for MDT Support

H. Applications of MDT-Collected Data
- Report A2-H1. Applications—Timekeeping and Web–AVL
- Report A2-H2. Route and Schedule Adherence from MDTs
- Report A2-H3. MDT Applications to Prevent/Detect Fraud
- Report A2-H4. Applications—MDT-Based ETA and Display
- Report A2-H5. Applications—Quality Assurance/Quality Control from MDTs
- Report A2-H6. Applications—Maintenance Data from MDT
- Report A2-H7. Applications—Fueling and Consumables
- Report A2-H8. MDT-Based Performance Measurement
- Report A2-H9. Integration of Spatial Data Applications

I. Installation, Maintenance, and Data Analysis Costs
- Report A2-I1. Unit Cost of Mobile Data Terminals
- Report A2-I2. MDT Installation Costs
- Report A2-I3. Labor Hours per MDT Installation
- Report A2-I4. MDT Maintenance/Repair Cost
- Report A2-I5. Labor Hours per MDT Maintenance and Repair
- Report A2-I6. IT and Communications Support for MDTs
- Report A2-I7. TA Support for MDT Data Analysis

J. Staff Acceptance
- Report A2-J1. Staff Acceptance of MDT Rating by Type

K. Operational/Technical Problems Encountered and Solutions
- Report A2-K1. Operational/Technical Problems Encountered
- Report A2-K2. Operational/Technical Solutions

L. Security and Resilience of Communications
- Report A2-L1. Security and Resilience of Communications

M. MDT Uses Desired Beyond the Capabilities of the Existing Equipment
- Report A2-M1. Desired Functionality

N. Future Applications and Technologies
- Report A2-N1. Planned Future Technology

2006 MDT Survey Respondents

Report A2-A1

TRS_ID	Respondent Name		E-mail	Transit Agency	City	Zip
AL						
4044	Tim	Omick	tomick@montgomerytransit.com	Montgomery Area Transit System	Montgomery	36101
AZ						
9033	John	Zukas	john.zukas@tucsonaz.gov	City of Tucson	Tucson	85726
9034	Kevin	Link	klink@glendaleaz.com	City of Glendale Transit	Glendale	85301
9032	Tri	Trinh	tri.trinh@phoenix.gov	City of Phoenix Public Transit Department	Phoenix	85003
9135	Peter	Davis	pdavis37@cox.net	Sun Cities Area Transit System, Inc.	Sun City	85372
9137	Dave	Golder	david.golder@surpriseaz.com	Surprise Dial-A-Ride Transit System	Surprise	85374
CA						
9050	Chuck	Perkins	cperkins@simivalley.org	Simi Valley Transit	Simi Valley	93063
9012	Jennifer	Brown	jbrown@sanjoaquinrtd.com	San Joaquin Regional Transit District	Stockton	95205
9144	Greg	Love	glove@lavta.org	Livermore/Amador Valley Transit Authority	Livermore	94551
9019	Doug	Vanderkar	dvanderkar@sacrt.com	Sacramento Regional Transit District	Sacramento	95812
9091	Monty	Cox	transit@ci.visalia.ca.us	City of Visalia — Visalia City Coach	Visalia	93291
9121	Randy	Floyd	rfloyd@avta.com	Antelope Valley Transit Authority	Lancaster	93534
9027	Noel	Villaverde	noel.villaverde@fresno.gov	Fresno Area Express	Fresno	93706
9061	Keith	Martin	keith_martin@sbcglobal.net	Yuba–Sutter Transit Authority	Marysville	95901
9009	Frank	Burton	burtonf@samtrans.com	San Mateo County Transit District	San Carlos	94070
9029	Doug	Stanley	doug.stanley@omnitrans.org	Omnitrans	San Bernardino	92411
9162	Steve	Pontes	ponte@eccta.org	Eastern Contra Costa Transit Authority	Antioch	94509
CO						
8025	Marcy	Abreoa	breom@ci.loveland.co.us	City of Loveland Transit	Loveland	80537
DE						
3075	James	Braxton	jim.braxton@state.de.us	Delaware Transit Corporation	Dover	19901

TRS_ID	Respondent Name		E-mail	Transit Agency	City	Zip
FL						
4035	William	Hearndon	bhearndon@golynx.com	Central Florida Regional Transportation Authority	Orlando	32801
4038	Robert	Mahan	rob_mahan@co.escambia.fl.us	Escambia County Area Transit	Pensacola	32501
4074	Thelma	Williams	twilliams@ridepcpt.com	Pasco County Public Transportation	New Port Richey	34654
4032	James	Dorsten	jdorsten@co.volusia.us	County of Volusia (VOTRAN)	South Daytona	32119
4035	Edward L.	Johnson	ejohnson@golynx.com	Central Florida Regional Transportation Authority	Orlando	32801
4041	Justin	Begley	begleyj@hartline.org	Hillsborough Area Regional Transit Authority	Tampa	33605
IA						
7008	Brian	Bowers	b.bowers@cedar-rapids.org	Five Seasons Transportation and Parking	Cedar Rapids	52405
IL						
5058	Paula	Hughes	phughes@rmtd.org	Rockford Mass Transit District	Rockford	61101
5047	Gary	Gwin	g.gwin2@verizon.net	Bloomington–Normal Public Transit System	Bloomington	61701
5113	Randy	Heinemann	randy.heinemann@pacebus.com	Pace — Suburban Bus Division	Arlington Heights	60005
5113	John	Braband	john.braband@pacebus.com	Pace — Suburban Bus Division	Arlington Heights	60005
IN						
5041	Carol	Anderson	canderson@cityofanderson.com	City of Anderson Transportation System	Anderson	46016
5054	Kevin	Barton	kbarton@mitsbus.org	Muncie Indiana Transit System	Muncie	47302
5042	Ruby	Powell	rflowers@eastchicago.com	East Chicago Transit	East Chicago	46312
5098	Monique	Cook	moniquec@emichigancity.com	Michigan City Municipal Coach	Michigan City	46360
LA						
6025	Patrick	Leaumont	Pat.Leaumont@cityofalex.com	City of Alexandria	Alexandria	71309
6024	Vicki	Claunch	vicki.claunch@ci.shreveport.la.us	Shreveport Area Transit System	Shreveport	71137
MA						
1061	E.	Falk	efalk@mrta.us	Montachusett Regional Transit Authority	Fitchburg	01420
1004	Kathy	Riddell	kriddell@ridebat.com	Brockton Area Transit Authority	Brockton	02301

TRS_ID	Respondent Name		E-mail	Transit Agency	City	Zip
MD						
3040	Danielle	Matland	matlandd@annapolis.gov	Annapolis Department of Transportation	Annapolis	21401
3074	Michael	Hannan	mthannan@harfordcountymd.gov	Harford Transit	Bel Air	21014
ME						
1088	Roki	Horr	rokih@cascobaylines.com	Casco Bay Island Transit District	Portland	04112
1069	Cindy	Gilson	cgilson@rtprides.org	The Regional Transportation Program, Inc.	Portland	04102
MI						
5148	Dave	Frasier	dpf001bwt@aol.com	Blue Water Area Transportation Commission	Port Huron	48060
MN						
5025	Karin	Caine	caine@duluthtransit.com	Duluth Transit Authority	Duluth	55806
5027	Gary	Nyberg	gary.nyberg@metc.state.mn.us	Metro Transit	Minneapolis	55411
MO						
7032	Kurt	Janicek	transit_kjanicek@ci.st-joseph.mo.us	St. Joseph Transit	St. Joseph	64501
NC						
4011	Angela	Wynes	angela.wynes@highpointnc.gov	High Point Transit	High Point	27262
4108	Ramond	Robinson	rrobinson@ridetta.org	Research Triangle Regional Public Transportation Authority	Research Triangle Park	27709
NE						
7001	Glenn	Knust	gknust@lincoln.ne.gov	StarTran	Lincoln	68508
NH						
1087	Sheila	ORiordan	oriordans@ci.nashua.nh.us	Nashua Transit System	Nashua	03061
NJ						
2075	Dave	Fullerton	ddfullerton@drpa.org	Port Authority Transit Corporation	Lindenwold	08021
NM						
6077	Elizabeth	Carter	emcarter@cybermesa.com	Santa Fe Trails — City of Santa Fe	Santa Fe	87507
NV						
9001	Tina	Wu	wu@rtcwashoe.com	Regional Transportation Commission of Washoe County	Reno	89520

TRS_ID	Respondent Name		E-mail	Transit Agency	City	Zip
NY						
2089	Kenneth	Sohlman	svdpw@optonline.net	Village of Spring Valley Bus	Spring Valley	10977
2078	Jane	Seidenberg	seidenberg@mnr.org	Metro–North Commuter Railroad Company (MTA Metro–North)	New York	10017
2147	Hughes	Lawrence	hughes@cal.berkeley.edu	GTJC	Jamaica	11434
2072	Christopher	Chatterton	cchatterton@suffolkcountyny.gov	Suffolk County Department of Public Works — Transportation	Yaphank	11980
2099	Gregory	Wone	gregory.wone@nyct.com	Staten Island Rapid Transit Operating Authority (MTA Staten Island)	Brooklyn	11201
2096	Henry	Rosen	hrosen@panynj.gov	Putnam County Transit	Carmel	10512
OH						
5010	Dean	Harris	dean.harris@akronemtro.org	Metro Regional Transit Authority	Akron	44301
5166	Mike	Salamone	msalamone@co.clermont.oh.us	Clermont Transportation Connection	Batavia	45103
5010	P. T.	Liggett	paul.liggett@akronmetro.org	Metro Regional Transit Authority	Akron	44301
5138	Helen	Hall	hhall@newarkohio.net	City of Newark Transit Operations	Newark	43055
5016	Mark	Lemont	lemontma@cota.com	Central Ohio Transit Authority	Columbus	43222
OK						
6017	Wayne	Simpson	wayne.simpson@okc.gov	Central Oklahoma Transportation and Parking Authority	Oklahoma City	73109
OR						
0008	David	Crout	croutd@trimet.org	Tri-County Metropolitan Transportation District of Oregon	Portland	97202
PA						
3019	Richard	Krajewski	Rkrajewski@septa.org	Southeastern Pennsylvania Transportation Authority	Philadelphia	19107
3067	Ervin	Roszner	eroszner@accesstransys.com	Access Transportation Systems, Inc.	Pittsburgh	15222
3015	Stanley	Strelish	sstrelish@epix.net	Luzerne County Transportation Authority	Kingston	18704
3012	Karen	Seymore	kseymore@atlanticbbn.net	Cambria County Transit Authority	Johnstown	15902
PR						
4117	Magaly	Maldonado	ddec@coqui.net	Municipality of Vega Baja	Vega Baja	00694
TN						
4057	Johnny	Gullett	jgullett@ridejta.com	Jackson Transit Authority	Jackson	38302
4054	Donna	Bridwell	jct.dbridwell@earthlink.net	Johnson City Transit System	Johnson City	37604

TRS_ID	Respondent Name		E-mail	Transit Agency	City	Zip
TX						
6059	Barry	Bulen	IT Manager	Brazos Transit District	Bryan	77803
6008	Fred	Franks	ff02@ridemetro.org	Metropolitan Transit Authority of Harris County, Texas	Houston	77208
6091	Terry	Reeves	treeves@takethehop.com	Hill Country Transit District	San Saba	76877
6056	Norma	Zapata	zapata@dart.org	Dallas Area Rapid Transit	Dallas	75202
6048	Jane	Schroter	jane.schroter@capmetro.org	Capital Metropolitan Transportation Authority	Austin	78702
6040	Bobby	Sharpe	robert.sharpe@abilenetx.com	Abilene Transit System	Abilene	79602
6089	Norman	Schenck	schenck@tylertexas.com	City of Tyler	Tyler	75710
6097	Kenneth	Smithson	smithson@netwest.com	Midland–Odessa Urban Transit District	Odessa	79765
VA						
3070	Eric	Marx	emarx@omniride.com	Potomac and Rappahannock Transportation Commission	Woodbridge	22192
3071	Al	Himes	al.himes@alexandriava.gov	City of Alexandria — Alexandria Transit Company	Alexandria	22314
WA						
0024	David	Daily	Davidd@c-tran.org	Clark County Public Transportation Benefit Area Authority	Vancover	98668
0002	Denise	Marchioro	dmarchioro@spokanetransit.com	Spokane Transit Authority	Spokane	99201
0020	Steve	Womble	Stevew@kitsaptransit.com	Kitsap Transit	Bremerton	98312
0029	Zohreh	Zandi	zzandi@commtrans.org	Snohomish County Transportation Benefit Area Corporation	Everett	98203
0044	Roger	Janes	rjanes@skat.org	Skagit Transit	Burlington	98233
0001	Kevin	Desmond	kevin.desmond@metrokc.gov	King County Department of Transportation — Metro Transit Div.	Seattle	98104
WI						
5099	Chuck	Reineke	Chuck.Reineke@ci.eau-claire.wi.us	Eau Claire Transit	Eau Claire	54701
5096	Brian	Engelking	bengelki@ci.waukesha.wi.us	City of Waukesha Transit Commission	Waukesha	53188
5108	Michael	Gensler	genslerm@ci.janesville.wi.us	Janesville Transit System	Janesville	53545
5171	Laura	Korff	korff@ci.fond-du-lac.wi.us	Fond du Lac Area Transit	Fond du Lac	54935
5001	Susan	Kappell	susan.kappell@appleton.org	City of Appleton — Valley Transit	Appleton	54914
WY						
8013	Marge	Colem	arge@casperareatransportation.com	City of Casper	Casper	82601

2006 MDT Survey: Modal Use of MDT

Report A2-B1

State/Transit Agency	City	Mode Using MDTs (from list)	MDT in Use in Other Mode
AZ			
Sun Cities Area Transit System, Inc.	Sun City	Demand Response (DR)	
Surprise Dial-A-Ride Transit System	Surprise	Demand Response (DR)	
City of Tucson	Tucson	Motor Bus (MB)/Demand Response (DR)	
City of Phoenix Public Transit Department	Phoenix	Motor Bus (MB)/Demand Response (DR)	
City of Glendale Transit	Glendale	Demand Response (DR)	
CA			
City of Visalia—Visalia City Coach	Visalia	Motor Bus (MB)/Demand Response (DR)	
San Joaquin Regional Transit District	Stockton	Motor Bus (MB)/Demand Response (DR)	
Eastern Contra Costa Transit Authority	Antioch	Demand Response (DR)	
San Mateo County Transit District	San Carlos	Motor Bus (MB)	
Livermore/Amador Valley Transit Authority	Livermore	Motor Bus (MB)	
Fresno Area Express	Fresno	Motor Bus (MB)/Demand Response (DR)	
Antelope Valley Transit Authority	Lancaster	Motor Bus (MB)/Demand Response (DR)	
Sacramento Regional Transit District	Sacramento	Motor Bus (MB)	
Omnitrans	San Bernardino	Motor Bus (MB)/Demand Response (DR)	
DE			
Delaware Transit Corporation	Dover	Motor Bus (MB)/Demand Response (DR)	
FL			
County of Volusia (VOTRAN)	South Daytona	Motor Bus (MB)/Demand Response (DR)	
Central Florida Regional Transportation Authority	Orlando	Motor Bus (MB)/Demand Response (DR)	VP
Central Florida Regional Transportation Authority	Orlando	Demand Response (DR)	
IA			
Five Seasons Transportation and Parking	Cedar Rapids	Motor Bus (MB)	
IL			
Pace — Suburban Bus Division	Arlington Heights	Motor Bus (MB)	
Pace — Suburban Bus Division	Arlington Heights	Demand Response (DR)	

State/Transit Agency	City	Mode Using MDTs (from list)	MDT in Use in Other Mode
IN			
Muncie Indiana Transit System	Muncie	Motor Bus (MB)/Demand Response (DR)	
City of Anderson Transportation System	Anderson	Motor Bus (MB)/Demand Response (DR)	
MA			
Montachusett Regional Transit Authority	Fitchburg	Demand Response (DR)	
MD			
Annapolis Department of Transportation	Annapolis	Motor Bus (MB)	
ME			
Casco Bay Island Transit District	Portland	Other	Ferryboat
The Regional Transportation Program, Inc.	Portland	Demand Response (DR)	
MI			
Blue Water Area Transportation Commission	Port Huron	Motor Bus (MB)/Demand Response (DR)	
MN			
Metro Transit	Minneapolis	Motor Bus (MB)	
Duluth Transit Authority	Duluth	Motor Bus (MB)/Demand Response (DR)	
MO			
St. Joseph Transit	St. Joseph	Motor Bus (MB)	
NC			
Research Triangle Regional Public Transportation Authority	Research Triangle Park	Motor Bus (MB)	
NM			
Santa Fe Trails—City of Santa Fe	Santa Fe	Demand Response (DR)	
NV			
Regional Transportation Commission of Washoe County	Reno	Motor Bus (MB)/Demand Response (DR)	
NY			
Staten Island Rapid Transit Operating Authority (MTA Staten Island)	Brooklyn	Heavy Rail (HR)	
Village of Spring Valley Bus	Spring Valley	Motor Bus (MB)	
Putnam County Transit	Carmel	Heavy Rail (HR)	
OH			
City of Newark Transit Operations	Newark	Demand Response (DR)	
Central Ohio Transit Authority	Columbus	Motor Bus (MB)/Demand Response (DR)	
Metro Regional Transit Authority	Akron	Demand Response (DR)	
Metro Regional Transit Authority	Akron	Motor Bus (MB)/Demand Response (DR)	

State/Transit Agency	City	Mode Using MDTs (from list)	MDT in Use in Other Mode
OR			
Tri-County Metropolitan Transportation District of Oregon	Portland	Motor Bus (MB)/Demand Response (DR)/Light Rail	
PA			
Luzerne County Transportation Authority	Kingston	Other	
Southeastern Pennsylvania Transportation Authority	Philadelphia	Demand Response (DR)	
TX			
Brazos Transit District	Bryan	Demand Response (DR)	
City of Tyler	Tyler	Motor Bus (MB)/Demand Response (DR)	
Dallas Area Rapid Transit	Dallas	Demand Response (DR)	
Metropolitan Transit Authority of Harris County, Texas	Houston	Other	Police/street supervisor vehicles
VA			
City of Alexandria—Alexandria Transit Company	Alexandria	Motor Bus (MB)	
Potomac and Rappahannock Transportation Commission	Woodbridge	Other	Flex-route
WA			
Clark County Public Transportation Benefit Area Authority	Vancouver	Motor Bus (MB)/Demand Response (DR)	
Kitsap Transit	Bremerton	Demand Response (DR)	
King County Department of Transportation — Metro Transit Division	Seattle	Motor Bus (MB)	Note: DR—Paratransit only
Spokane Transit Authority	Spokane	Demand Response (DR)	
WI			
City of Waukesha Transit Commission	Waukesha	Motor Bus (MB)/Demand Response (DR)	

2006 MDT Survey: Installed Mobile Data Terminal Totals

Report A2-C1

State	City	TRS_ID	Transit Agency	No. MDT Installed Now	No. Next Year	MDT Total
AL	Montgomery	4044	Montgomery Area Transit System	0	0	0
AZ	Glendale	9034	City of Glendale Transit	28	5	33
AZ	Phoenix	9032	City of Phoenix Public Transit Department	1,000	0	1,000
AZ	Sun City	9135	Sun Cities Area Transit System, Inc.	0	0	0
AZ	Surprise	9137	Surprise Dial-A-Ride Transit System	0	10	10
AZ	Tucson	9033	City of Tucson	311	119	430
CA	Antioch	9162	Eastern Contra Costa Transit Authority	20	0	20
CA	Fresno	9027	Fresno Area Express	150	13	163
CA	Lancaster	9121	Antelope Valley Transit Authority	75	3	78
CA	Livermore	9144	Livermore/Amador Valley Transit Authority	93	0	93
CA	Marysville	9061	Yuba–Sutter Transit Authority	0	0	0
CA	Sacramento	9019	Sacramento Regional Transit District	17	3	20
CA	San Bernardino	9029	Omnitrans	152	168	320
CA	San Carlos	9009	San Mateo County Transit District	428	0	428
CA	Simi Valley	9050	Simi Valley Transit	0	0	0
CA	Stockton	9012	San Joaquin Regional Transit District	160	50	210
CA	Visalia	9091	City of Visalia–Visalia City Coach	40	7	47
CO	Loveland	8025	City of Loveland Transit	0	0	0
DE	Dover	3075	Delaware Transit Corporation	406	9	415
FL	New Port Richey	4074	Pasco County Public Transportation	0	0	0
FL	Orlando	4035	Central Florida Regional Transportation Authority	0	135	135
FL	Orlando	4035	Central Florida Regional Transportation Authority	0	10	10
FL	Pensacola	4038	Escambia County Area Transit	0	0	0
FL	South Daytona	4032	County of Volusia (VOTRAN)	0	140	140

State	City	TRS_ID	Transit Agency	No. MDT Installed Now	No. Next Year	MDT Total
FL	Tampa	4041	Hillsborough Area Regional Transit Authority	0	308	308
IA	Cedar Rapids	7008	Five Seasons Transportation and Parking	40	12	52
IL	Arlington Heights	5113	Pace—Suburban Bus Division	650	60	710
IL	Arlington Heights	5113	Pace—Suburban Bus Division	210	0	210
IL	Bloomington	5047	Bloomington–Normal Public Transit System	0	0	0
IL	Rockford	5058	Rockford Mass Transit District	0	26	26
IN	Anderson	5041	City of Anderson Transportation System	0	0	0
IN	East Chicago	5042	East Chicago Transit	0	0	0
IN	Michigan City	5098	Michigan City Municipal Coach	0	0	0
IN	Muncie	5054	Muncie Indiana Transit System	44	0	44
LA	Alexandria	6025	City of Alexandria	0	0	0
LA	Shreveport	6024	Shreveport Area Transit System	0	0	0
MA	Brockton	1004	Brockton Area Transit Authority	0	0	0
MA	Fitchburg	1061	Montachusett Regional Transit Authority	35	40	75
MD	Annapolis	3040	Annapolis Department of Transportation	0	0	0
MD	Bel Air	3074	Harford Transit	0	0	0
ME	Portland	1069	The Regional Transportation Program, Inc.	0	0	0
ME	Portland	1088	Casco Bay Island Transit District	0	0	0
MI	Port Huron	5148	Blue Water Area Transportation Commission	0	52	52
MN	Duluth	5025	Duluth Transit Authority	83	10	93
MN	Minneapolis	5027	Metro Transit	948	0	948
MO	St. Joseph	7032	St. Joseph Transit	20	0	20
NC	High Point	4011	High Point Transit	0	0	0
NC	Research Triangle Park	4108	Research Triangle Regional Public Transportation Authority	65	0	65
NE	Lincoln	7001	StarTran	0	69	69
NH	Nashua	1087	Nashua Transit System	0	0	0
NJ	Lindenwold	2075	Port Authority Transit Corporation	0	0	0

State	City	TRS_ID	Transit Agency	No. MDT Installed Now	No. Next Year	MDT Total
NM	Santa Fe	6077	Santa Fe Trails—City of Santa Fe	30	14	44
NV	Reno	9001	Regional Transportation Commission of Washoe County	135	8	143
NY	Brooklyn	2099	Staten Island Rapid Transit Operating Authority: MTA Staten	0	0	0
NY	Carmel	2096	Putnam County Transit	0	0	0
NY	Jamaica	2147	GTJC	0	0	0
NY	New York	2078	Metro–North Commuter Railroad Company (MTA Metro–North)	0	0	0
NY	Spring Valley	2089	Village of Spring Valley Bus	0	0	0
NY	Yaphank	2072	Suffolk County Department of Public Works—Transportation Division	0	0	0
OH	Akron	5010	Metro Regional Transit Authority	146	0	146
OH	Akron	5010	Metro Regional Transit Authority	79	0	79
OH	Batavia	5166	Clermont Transportation Connection	0	0	0
OH	Columbus	5016	Central Ohio Transit Authority	455	0	455
OH	Newark	5138	City of Newark Transit Operations	0	0	0
OK	Oklahoma City	6017	Central Oklahoma Transportation and Parking Authority	0	0	0
OR	Portland	0008	Tri-County Metropolitan Transportation District of Oregon	900	0	900
PA	Johnstown	3012	Cambria County Transit Authority	0	0	0
PA	Kingston	3015	Luzerne County Transportation Authority	0	0	0
PA	Philadelphia	3019	Southeastern Pennsylvania Transportation Authority	321	0	321
PA	Pittsburgh	3067	Access Transportation Systems, Inc.	0	0	0
PR	Vega Baja	4117	Municipality of Vega Baja	0	0	0
TN	Jackson	4057	Jackson Transit Authority	0	0	0
TN	Johnson City	4054	Johnson City Transit System	0	0	0
TX	Abilene	6040	Abilene Transit System	0	0	0
TX	Austin	6048	Capital Metropolitan Transportation Authority	0	200	200
TX	Bryan	6059	Brazos Transit District	45	23	68
TX	Dallas	6056	Dallas Area Rapid Transit	196	0	196
TX	Houston	6008	Metropolitan Transit Authority of Harris County, Texas	97	53	150

State	City	TRS_ID	Transit Agency	No. MDT Installed Now	No. Next Year	MDT Total
TX	Odessa	6097	Midland–Odessa Urban Transit District	0	0	0
TX	San Saba	6091	Hill Country Transit District	0	0	0
TX	Tyler	6089	City of Tyler	7	5	12
VA	Alexandria	3071	City of Alexandria—Alexandria Transit Company	12	0	12
VA	Woodbridge	3070	Potomac and Rappahannock Transportation Commission	21	4	25
WA	Bremerton	0020	Kitsap Transit	68	0	68
WA	Burlington	0044	Skagit Transit	0	0	0
WA	Everett	0029	Snohomish County Transportation Benefit Area Corporation	0	53	53
WA	Seattle	0001	King County Department of Transportation—Metro Transit Division	0	0	0
WA	Seattle	0001	King County Department of Transportation—Metro Transit Division	1,300	0	1,300
WA	Spokane	0002	Spokane Transit Authority	102	0	102
WA	Vancover	0024	Clark County Public Transportation Benefit Area Authority	160	0	160
WI	Appleton	5001	City of Appleton—Valley Transit	0	0	0
WI	Eau Claire	5099	Eau Claire Transit	0	0	0
WI	Fond du Lac	5171	Fond du Lac Area Transit	0	0	0
WI	Janesville	5108	Janesville Transit System	0	0	0
WI	Waukesha	5096	City of Waukesha Transit Commission	21	4	25
WY	Casper	8013	City of Casper	0	0	0

2006 MDT Survey: Manufacturer and Model

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Manufacture/Model	Transit Agency	State	MDT Totals
Digital Dispatch Systems			
Vector 530	County of Volusia (VOTRAN)	FL	140
GMSI			
2101ROZ	Southeastern Pennsylvania Transportation Authority	PA	321
Greyhawk Technologies			
CEHawk Mobile Data Terminal	King County Department of Transportation—Metro Transit Division	WA	0
Fixed-Route MDT	Kitsap Transit	WA	68
Fixed-Route MDT and Paratransit MDT	Potomac and Rappahannock Transportation Commission	VA	25
Paratransit MDT	Dallas Area Rapid Transit	TX	196
Paratransit MDT	Montachusett Regional Transit Authority	MA	75
Paratransit MDT	Surprise Dial-A-Ride Transit System	AZ	10
Innovations in Transportation, Inc.			
COPILOTsoftkey	Metro Regional Transit Authority	OH	146
COPILOTsoftkey	Clark County Public Transportation Benefit Area Authority	WA	160
COPILOTsoftkey	Metro Regional Transit Authority	OH	79
Mentor Engineering, Inc.			
MDC	Eastern Contra Costa Transit Authority	CA	20
MDC	Spokane Transit Authority	WA	102
MDC	City of Glendale Transit	AZ	33
MDC	Sacramento Regional Transit District	CA	20
MDC	St. Joseph Transit	MO	20
MDC and Ranger	City of Tyler	TX	12
Ranger	Pace—Suburban Bus Division	IL	210
Ranger	Central Florida Regional Transportation Authority	FL	135
Ranger	Brazos Transit District	TX	68

Manufacture/Model	Transit Agency	State	MDT Totals
Stryder	Blue Water Area Transportation Commission	MI	52
METS			
METS	King County Department of Transportation—Metro Transit Division	WA	1,300
Micronet, Ltd			
Net 960	Muncie Indiana Transit System	IN	44
Mobile Knowledge			
Series 6000 MDTC	City of Visalia—Visalia City Coach	CA	47
Motorola			
MW20	Metropolitan Transit Authority of Harris County, Texas	TX	150
Motorola/Nextel			
Motorola i58	Santa Fe Trails—City of Santa Fe	NM	44
Orbital TMS			
SmartMDT	Delaware Transit Corporation	DE	415
SmartMDT	San Mateo County Transit District	CA	428
SmartMDT	Central Ohio Transit Authority	OH	455
SmartMDT	City of Phoenix Public Transit Department	AZ	1,000
QSI Corporation			
QTERM-R55	Tri-County Metropolitan Transportation District of Oregon	OR	900
Radio Satellite Integrators			
Version 2.0 4 X 40	Research Triangle Regional Public Transportation Authority	NC	65
Siemens VDO			
Mobile Data Terminal (MDT)	Livermore/Amador Valley Transit Authority	CA	93
Mobile Data Terminal (MDT)	City of Waukesha Transit Commission	WI	25
Mobile Data Terminal (MDT)	Pace—Suburban Bus Division	IL	710
Mobile Data Terminal (MDT)	Fresno Area Express	CA	163
Mobile Data Terminal (MDT)	Five Seasons Transportation and Parking	IA	52
Mobile Data Terminal (MDT)	City of Tucson	AZ	430
Mobile Data Terminal (MDT)	Omnitrans	CA	320
Mobile Data Terminal (MDT)	Regional Transportation Commission of Washoe County	NV	143
Mobile Data Terminal (MDT)	Duluth Transit Authority	MN	93
Mobile Data Terminal (MDT)	San Joaquin Regional Transit District	CA	210

2006 MDT Survey: ITS Supplier—Service by Supplier

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ITS Supplier/Transit Agency	State	MDT Totals	ITS Service(s)
EnGraph			
City of Loveland Transit	CO	0	ParaPlan Pro
Fleet Management Solutions, Inc.			
City of Visalia—Visalia City Coach	CA	47	GPS AVL, Wireless comm
HBSS			
Montachusett Regional Transit Authority	MA	75	ITMS
Innovations in Transportation, Inc.			
Metro Regional Transit Authority	OH	79	Mobile-CAD/AVL, Mobile-PARAnet
Metro Regional Transit Authority	OH	146	Mobile-CAD/AVL
Clark County Public Transportation Benefit Area Authority	WA	160	Mobile-CAD/AVL
Laidlaw Transit Services			
King County Department of Transportation—Metro Transit Division	WA	0	(contracted call center)
Mentor Engineering, Inc.; the Checker Group			
City of Tyler	TX	12	IntelliFleet, Routematch
Motorola			
Metropolitan Transit Authority of Harris County, Texas	TX	150	
Nextbus			
City of Alexandria—Alexandria Transit Company	VA	12	Nextbus
Orbital TMS			
Tri-County Metropolitan Transportation District of Oregon	OR	900	TSL CAD/AVL
San Mateo County Transit District	CA	428	OrbCAD
Delaware Transit Corporation	DE	415	SmartTrack
City of Phoenix Public Transit Department	AZ	1,000	OrbCAD
Orbital TMS, Actsoft, Inc.			
Santa Fe Trails—City of Santa Fe	NM	44	SmartStop, Comet Tracker
RouteMatch Software			
Blue Water Area Transportation Commission	MI	52	RouteMatch

ITS Supplier/Transit Agency	State	MDT Totals	ITS Service(s)
Siemens VDO			
Regional Transportation Commission of Washoe County	NV	143	
City of Tucson	AZ	430	
Pace—Suburban Bus Division	IL	710	
Fresno Area Express	CA	163	
Metro Transit	MN	948	TransitMaster
City of Waukesha Transit Commission	WI	25	
Omnitrans	CA	320	
Duluth Transit Authority	MN	93	
TAXiTRONiC (Verifone)			
Capital Metropolitan Transportation Authority	TX	200	eFleet
Trapeze Group			
Spokane Transit Authority	WA	102	intelligent transit systems
City of Glendale Transit	AZ	33	intelligent transit systems
Muncie Indiana Transit System	IN	44	intelligent transit systems
Sacramento Regional Transit District	CA	20	intelligent transit systems
Southeastern Pennsylvania Transportation Authority	PA	321	PASS-Dos
County of Volusia (VOTRAN)	FL	140	intelligent transit systems
Surprise Dial-A-Ride Transit System	AZ	10	intelligent transit systems
Central Florida Regional Transportation Authority	FL	135	intelligent transit systems
Kitsap Transit	WA	68	intelligent transit systems
San Joaquin Regional Transit District	CA	210	intelligent transit systems
St. Joseph Transit	MO	20	intelligent transit systems
Brazos Transit District	TX	68	intelligent transit systems
Dallas Area Rapid Transit	TX	196	intelligent transit systems
Pace—Suburban Bus Division	IL	210	PASS
Trapeze Group, Siemens VDO			
Livermore/Amador Valley Transit Authority	CA	93	intelligent transit systems
Trapeze Group, intelligent transit systems			
Potomac and Rappahannock Transportation Commission	VA	25	
Antelope Valley Transit Authority	CA	78	
Eastern Contra Costa Transit Authority	CA	20	intelligent transit systems

2006 MDT Survey: ITS Supplier–Service by State

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State	Transit Agency	MDT Totals	ITS Supplier	ITS Service
AZ				
	City of Phoenix Public Transit Department	1,000	Orbital TMS	OrbCAD
	Surprise Dial-A-Ride Transit System	10	Trapeze Group	intelligent transit systems
	City of Glendale Transit	33	Trapeze Group	intelligent transit systems
	City of Tucson	430	Siemens VDO	
CA				
	Fresno Area Express	163	Siemens VDO	
	Antelope Valley Transit Authority	78	Trapeze Group, intelligent transit systems	
	City of Visalia—Visalia City Coach	47	Fleet Management Solutions, Inc.	GPS AVL, Wireless communication
	San Mateo County Transit District	428	Orbital TMS	OrbCAD
	Omnitrans	320	Siemens VDO	
	San Joaquin Regional Transit District	210	Trapeze Group	intelligent transit systems
	Sacramento Regional Transit District	20	Trapeze Group	intelligent transit systems
	Eastern Contra Costa Transit Authority	20	Trapeze Group, intelligent transit systems	intelligent transit systems
	Livermore/Amador Valley Transit Authority	93	Trapeze Group, Siemens VDO	intelligent transit systems
CO				
	City of Loveland Transit	0	EnGraph	ParaPlan Pro
DE				
	Delaware Transit Corporation	415	Orbital TMS	SmartTrack
FL				
	County of Volusia (VOTRAN)	140	Trapeze Group	intelligent transit systems
	Central Florida Regional Transportation Authority	135	Trapeze Group	intelligent transit systems
IL				
	Pace—Suburban Bus Division	710	Siemens VDO	
	Pace—Suburban Bus Division	210	Trapeze Group	PASS
IN				
	Muncie Indiana Transit System	44	Trapeze Group	intelligent transit systems
MA				
	Montachusett Regional Transit Authority	75	HBSS	ITMS

State	Transit Agency	MDT Totals	ITS Supplier	ITS Service
MI				
	Blue Water Area Transportation Commission	52	RouteMatch Software	RouteMatch
MN				
	Duluth Transit Authority	93	Siemens VDO	
	Metro Transit	948	Siemens VDO	TransitMaster
MO				
	St. Joseph Transit	20	Trapeze Group	intelligent transit systems
NM				
	Santa Fe Trails—City of Santa Fe	44	Orbital TMS, Actsoft, Inc.	SmartStop, Comet Tracker
NV				
	Regional Transportation Commission of Washoe County	143	Siemens VDO	
OH				
	Metro Regional Transit Authority	79	Innovations in Transportation, Inc.	Mobile-CAD/AVL, Mobile-PARAnet
	Metro Regional Transit Authority	146	Innovations in Transportation, Inc.	Mobile-CAD/AVL
OR				
	Tri-County Metropolitan Transportation District of Oregon	900	Orbital TMS	TSL CAD/AVL
PA				
	Southeastern Pennsylvania Transportation Authority	321	Trapeze Group	PASS-Dos
TX				
	City of Tyler	12	Mentor Engineering, Inc.; the Checker	IntelliFleet, Routematch
	Metropolitan Transit Authority of Harris County, Texas	150	Motorola	
	Brazos Transit District	68	Trapeze Group	intelligent transit systems
	Capital Metropolitan Transportation Authority	200	TAXiTRONiC (Verifone)	eFleet
	Dallas Area Rapid Transit	196	Trapeze Group	intelligent transit systems
VA				
	Potomac and Rappahannock Transportation Commission	25	Trapeze Group, intelligent transit systems	
	City of Alexandria–Alexandria Transit Company	12	Nextbus	Nextbus
WA				
	Clark County Public Transportation Benefit Area Authority	160	Innovations in Transportation, Inc.	Mobile-CAD/AVL
	Spokane Transit Authority	102	Trapeze Group	intelligent transit systems
	Kitsap Transit	68	Trapeze Group	intelligent transit systems
	King County Department of Transportation — Metro Transit	0	Laidlaw Transit Services	(contracted call center)
WI				
	City of Waukesha Transit Commission	25	Siemens VDO	

2006 MDT Survey: Functions—Fixed Route—General

Report A2-E1

State	Transit Agency	General MDT Functionality
AZ		
	City of Phoenix Public Transit Department	Download manifest to vehicle/Driver sign-on/Driver sign-off/Start run (revenue service)/End run (revenue service)
CA		
	San Mateo County Transit District	Download manifest to vehicle/Driver sign-on/Driver sign-off/Start run (revenue service)/End run (revenue service)
	Fresno Area Express	Download manifest to vehicle/Driver sign-on/Driver sign-off/Start run (revenue service)/End run (revenue service)
	San Joaquin Regional Transit District	Download manifest to vehicle/Driver sign-on/Driver sign-off/Start run (revenue service)/End run (revenue service)
	Antelope Valley Transit Authority	Driver sign-on/Driver sign-off/Start run (revenue service)/End run (revenue service)
DE		
	Delaware Transit Corporation	Download manifest to vehicle/Driver sign-on/Driver sign-off/Start run (revenue service)/End run (revenue service)
IL		
	Pace—Suburban Bus Division	Driver sign-off
MN		
	Metro Transit	Download manifest to vehicle/Driver sign-on/Driver sign-off/Start run (revenue service)/End run (revenue service)
MO		
	St. Joseph Transit	Download manifest to vehicle/Driver sign-on/Driver sign-off/Start run (revenue service)/End run (revenue service)
NC		
	Research Triangle Regional Public Transportation Authority	Driver sign-on/Driver sign-off/Start run (revenue service)/End run (revenue service)
NV		
	Regional Transportation Commission of Washoe County	Driver sign-on/Driver sign-off/Start run (revenue service)/End run (revenue service)
OH		
	Central Ohio Transit Authority	Driver sign-on/Driver sign-off/Start run (revenue service)/End run (revenue service)
OR		
	Tri-County Metropolitan Transportation District of Oregon	Download manifest to vehicle/Driver sign-on/Driver sign-off/Start run (revenue service)/End run (revenue service)
TX		
	City of Tyler	Download manifest to vehicle/Driver sign-on/Driver sign-off/Start run (revenue service)/End run (revenue service)
VA		
	Potomac and Rappahannock Transportation Commission	Download manifest to vehicle/Driver sign-on/Driver sign-off/Start run (revenue service)/End run (revenue service)
WA		
	King County Dept. of Transportation—Metro Transit Div.	Driver sign-on
	Clark County Public Transportation Benefit Area Authority	Download manifest to vehicle/Driver sign-on/Driver sign-off/Start run (revenue service)/End run (revenue service)

2006 MDT Survey: Functions—Fixed Route—Counting

Report A2-E2

State/Transit Agency	Fixed-Route MDT Passenger Counting Functionality
AZ	
City of Phoenix Public Transit Department	Automatic boarding, electronic beam/Automatic alighting, electronic beam
CA	
Antelope Valley Transit Authority	Automatic boarding, electronic beam/Automatic alighting, electronic beam
Fresno Area Express	Automatic boarding, electronic beaml/Automatic alighting, electronic beam
San Mateo County Transit District	Automatic boarding, electronic beam/Manual boarding, individual entries/Automatic alighting, electronic beam
DE	
Delaware Transit Corporation	Automatic boarding, electronic beam/Automatic alighting, electronic beam
MN	
Metro Transit	Automatic boarding, electronic beam/Manual boarding, individual entries/Automatic alighting, electronic beam/ Manual alighting, individual entries
MO	
St. Joseph Transit	Manual boarding, individual entries/Manual alighting, individual entries
NV	
Regional Transportation Commission of Washoe County	Automatic boarding, electronic beam/Automatic alighting, electronic beam
OR	
Tri-County Metropolitan Transportation District of Oregon	Automatic boarding, electronic beam/Automatic alighting, electronic beam
TX	
City of Tyler	Manual boarding, individual entries
VA	
Potomac and Rappahannock Transportation Commission	Manual boarding, individual entries/Manual boarding, total entries/Manual alighting, individual entries/Manual alighting, total entries
WA	
King County Department of Transportation—Metro Transit Division	Automatic boarding, mechanical treadle/Automatic boarding, electronic beam/Automatic alighting, mechanical treadle/Automatic alighting, electronic beam
Clark County Public Transportation Benefit Area Authority	Automatic boarding, electronic beam/Automatic alighting, electronic beam

2006 MDT Survey: Functions—Fixed Route—Other Counting

Report A2-E3

State	City	Transit Agency	Other (MDT) Counting
AZ	Phoenix	City of Phoenix Public Transit Department	Use of mobility aids
CA	Lancaster	Antelope Valley Transit Authority	Use of mobility aids
MN	Minneapolis	Metro Transit	Loading of bicycles
NC	Research Triangle Park	Research Triangle Regional Public Transportation Authority	Loading of bicycles
NV	Reno	Regional Transportation Commission of Washoe County	Use of mobility aids
OR	Portland	Tri-County Metropolitan Transportation District of Oregon	Use of mobility aids
VA	Woodbridge	Potomac and Rappahannock Transportation Commission	Use of mobility aids
WA	Vancouver	Clark County Public Transportation Benefit Area Authority	Use of mobility aids

2006 MDT Survey: Functions—Fixed Route—Fares

Report A2-E4

State	City	Transit Agency	TRS_ID	Fare Technology
AZ	Phoenix	City of Phoenix Public Transit Department	9032	Magnetic strip
CA	Lancaster	Antelope Valley Transit Authority	9121	Magnetic strip
MN	Minneapolis	Metro Transit	5027	Smart card
NV	Reno	Regional Transportation Commission of Washoe County	9001	Magnetic strip
WA	Seattle	King County Department of Transportation—Metro Transit Division	0001	Magnetic strip

2006 MDT Survey: Functions—Fixed Route—Emergency

Report A2-E5

State/Transit Agency	MDT Safety and Security Functionality
AZ	
City of Phoenix Public Transit Department	Covert alarm/Automatic communications to operations center/Local recording of video feed
CA	
San Joaquin Regional Transit District	Covert alarm/Button on MDC for alarm/Automatic communications to operations center
San Mateo County Transit District	Covert alarm/Button on MDC for alarm
Fresno Area Express	Covert alarm/Automatic communications to operations center
Antelope Valley Transit Authority	Covert alarm/Button on MDC for alarm/Automatic communications to operations center
DE	
Delaware Transit Corporation	Covert alarm/Automatic communications to operations center/Local recording of video feed/Buffered video frames from before alarm
MN	
Metro Transit	Covert alarm/Button on MDC for alarm/Automatic communications to operations center
MO	
St. Joseph Transit	Button on MDC for alarm
NC	
Research Triangle Regional Public Transportation Authority	Button on MDC for alarm
NV	
Regional Transportation Commission of Washoe County	Covert alarm/Button on MDC for alarm/Automatic communications to operations center/Local recording of video feed/Buffered video frames from before alarm
OH	
Metro Regional Transit Authority	Covert alarm
Central Ohio Transit Authority	Covert alarm/Automatic communications to operations center
OR	
Tri-County Metropolitan Transportation District of Oregon	Covert alarm/Button on MDC for alarm/Automatic communications to operations center
TX	
City of Tyler	Button on MDC for alarm
VA	
Potomac and Rappahannock Transportation Commission	Covert alarm
WA	
King County Department of Transportation—Metro Transit Division	Covert alarm/Button on MDC for alarm/Automatic communications to operations center
Clark County Public Transportation Benefit Area Authority	Covert alarm

2006 MDT Survey: Functions—Fixed Route—Space/Time Features

Report A2-E6

State/Transit Agency	Spatial and Temporal Data on Operations Collected Through MDT
AZ	
City of Phoenix Public Transit Department	GPS latitude/longitude and date/time stamp
CA	
San Joaquin Regional Transit District	GPS latitude/longitude and date/time stamp
Antelope Valley Transit Authority	GPS latitude/longitude and date/time stamp/Digital odometer reading
Fresno Area Express	GPS latitude/longitude and date/time stamp/Digital odometer reading
San Mateo County Transit District	GPS latitude/longitude and date/time stamp
DE	
Delaware Transit Corporation	GPS latitude/longitude and date/time stamp
MN	
Metro Transit	GPS latitude/longitude and date/time stamp/Digital odometer reading
MO	
St. Joseph Transit	GPS latitude/longitude and date/time stamp/Digital odometer reading
NC	
Research Triangle Regional Public Transportation Authority	Digital odometer reading
NV	
Regional Transportation Commission of Washoe County	GPS latitude/longitude and date/time stamp/Digital odometer reading
OH	
Central Ohio Transit Authority	GPS latitude/longitude and date/time stamp
OR	
Tri-County Metropolitan Transportation District of Oregon	GPS latitude/longitude and date/time stamp
TX	
City of Tyler	GPS latitude/longitude and date/time stamp/Digital odometer reading
VA	
Potomac and Rappahannock Transportation Commission	GPS latitude/longitude and date/time stamp/Digital odometer reading
WA	
Clark County Public Transportation Benefit Area Authority	GPS latitude/longitude and date/time stamp

2006 MDT Survey: Functions—Fixed Route—Other

Report A2-E7

State/Transit Agency	Other Fixed-Route MDT Functions
CA	
Fresno Area Express	Covert microphone for one-way audio monitor
MN	
Metro Transit	Bus, operator, route, run, direction, adherence, GPS validity
OH	
Metro Regional Transit Authority	Digital messaging
VA	
Potomac and Rappahannock Transportation	Map, suggested routing, predicted and actual on-time performance, automatic recognition of bus stops

2006 MDT Survey: Functions—Demand Response—General

Report A2-E8

State/Transit Agency	General MDT Functionality
AZ	
City of Phoenix Public Transit Department	Download manifest to vehicle/Update schedule changes to/from MDT automatically/Driver sign-on/Driver sign-off/Start run (revenue service)/End run (revenue service)
CA	
Antelope Valley Transit Authority	Download manifest to vehicle/Update schedule changes to/from MDT automatically/Driver sign-on/Driver sign-off/Start run (revenue service)/End run (revenue service)
San Joaquin Regional Transit District	Download manifest to vehicle/Update schedule changes to/from MDT automatically/Driver sign-on/Driver sign-off/Start run (revenue service)/End run (revenue service)
San Mateo County Transit District	Download manifest to vehicle/Update schedule changes to/from MDT automatically/Driver sign-on/Driver sign-off/Start run (revenue service)/End run (revenue service)
Fresno Area Express	Download manifest to vehicle/Update schedule changes to/from MDT automatically/Driver sign-on/Driver sign-off/Start run (revenue service)/End run (revenue service)
Eastern Contra Costa Transit Authority	Download manifest to vehicle/Update schedule changes to/from MDT automatically/Driver sign-on/Driver sign-off/Start run (revenue service)/End run (revenue service)
DE	
Delaware Transit Corporation	Download manifest to vehicle/Update schedule changes to/from MDT automatically/Driver sign-on/Driver sign-off/Start run (revenue service)/End run (revenue service)
IL	
Pace—Suburban Bus Division	Download manifest to vehicle/Update schedule changes to/from MDT automatically/Driver sign-on/Driver sign-off/Start run (revenue service)/End run (revenue service)
NV	
Regional Transportation Commission of Washoe	Download manifest to vehicle/Update schedule changes to/from MDT automatically/Driver sign-on/Driver sign-off/Start run (revenue service)/End run (revenue service)
OH	
Metro Regional Transit Authority	Download manifest to vehicle/Update schedule changes to/from MDT automatically/Driver sign-on/Driver sign-off/Start run (revenue service)/End run (revenue service)
Central Ohio Transit Authority	Driver sign-on/Driver sign-off/Start run (revenue service)/End run (revenue service)

State/Transit Agency	General MDT Functionality
TX	
City of Tyler	Download manifest to vehicle/Update schedule changes to/from MDT automatically/Driver sign-on/Driver sign-off/Start run (revenue service)/End run (revenue service)
WA	
King County Department of Transportation—Metro Transit Division	Download manifest to vehicle/Update schedule changes to/from MDT automatically/Driver sign-on/Driver sign-off/Start run (revenue service)/End run (revenue service)
Spokane Transit Authority	Download manifest to vehicle/Update schedule changes to/from MDT automatically/Driver sign-on/Driver sign-off/Start run (revenue service)/End run (revenue service)
Kitsap Transit	Download manifest to vehicle/Update schedule changes to/from MDT automatically/Driver sign-on/Driver sign-off/Start run (revenue service)/End run (revenue service)
Clark County Public Transportation Benefit Area	Download manifest to vehicle/Update schedule changes to/from MDT automatically/Driver sign-off/Start run (revenue service)/End run (revenue service)

2006 MDT Survey: Functions—Demand Response—Counting

Report A2-E9

State	Transit Agency	Paratransit MDT Counting Functionality
AZ		
	City of Phoenix Public Transit Department	Passenger pick up/Passenger drop off/Use of mobility aids
CA		
	San Joaquin Regional Transit District	Passenger pick up/Passenger drop off
	Antelope Valley Transit Authority	Use of mobility aids
	San Mateo County Transit District	Passenger pick up/Passenger drop off
	Eastern Contra Costa Transit Authority	Passenger pick up/Passenger drop off/Use of mobility aid
DE		
	Delaware Transit Corporation	Passenger pick up/Passenger drop off
IL		
	Pace—Suburban Bus Division	Passenger pick up/Passenger drop off/Use of mobility aids
NV		
	Regional Transportation Commission of Washoe County	Passenger pick up/Passenger drop off/Use of mobility aids
OH		
	Metro Regional Transit Authority	Passenger pick up/Passenger drop off/Use of mobility aids
TX		
	City of Tyler	Passenger pick up/Passenger drop off/Use of mobility aids
WA		
	King County Department of Transportation—Metro Transit Division	Passenger pick up/Passenger drop off/Use of mobility aids
	Kitsap Transit	Passenger pick up/Passenger drop off/Use of mobility aids
	Spokane Transit Authority	Passenger pick up/Passenger drop off/Use of mobility aids
	Clark County Public Transportation Benefit Area Authority	Use of mobility aids

2006 MDT Survey: Functions—Demand Response—Other

Report A2-E10

State/Transit Agency	Other Paratransit MDT Functionality
IL	
Pace—Suburban Bus Division	Actual fare collected, messaging between dispatch and vehicle, covert emergency alarm
VA	
Potomac and Rappahannock Transportation Commission	Same as fixed route; our system is actually the flex-route version, which was not listed.
WA	
King County Department of Transportation—Metro Transit Div.	Fare payment, attendants, companions

2006 MDT Survey: MDT Communications by Type

Report A2-F1

MDT Communications	Transit Agency	City	State
802.11b/g (2.4 Ghz unrestricted)			
	City of Visalia—Visalia City Coach	Visalia	CA
Cellular—Cingular			
	Muncie Indiana Transit System	Muncie	IN
	Dallas Area Rapid Transit	Dallas	TX
	Potomac and Rappahannock Transportation Commission	Woodbridge	VA
	Brazos Transit District	Bryan	TX
	City of Tyler	Tyler	TX
	Kitsap Transit	Bremerton	WA
	Southeastern Pennsylvania Transportation Authority	Philadelphia	PA
Cellular—Cingular/802.11b/g (2.4 Ghz unrestricted)			
	Antelope Valley Transit Authority	Lancaster	CA
Cellular—Sprint/Nextel			
	Santa Fe Trails—City of Santa Fe	Santa Fe	NM
	Central Florida Regional Transportation Authority	Orlando	FL
Cellular—Verizon Wireless			
	Pace—Suburban Bus Division	Arlington Heights	IL
	Research Triangle Regional Public Transportation Authority	Research Triangle Park	NC
	Montachusett Regional Transit Authority	Fitchburg	MA
	City of Alexandria—Alexandria Transit Company	Alexandria	VA
	Sacramento Regional Transit District	Sacramento	CA
	Surprise Dial-A-Ride Transit System	Surprise	AZ
Conventional Radio (e.g., 450 Mhz)			
	Fresno Area Express	Fresno	CA
	City of Glendale Transit	Glendale	AZ
	County of Volusia (VOTRAN)	South Daytona	FL
	Spokane Transit Authority	Spokane	WA
	City of Waukesha Transit Commission	Waukesha	WI

MDT Communications	Transit Agency	City	State
	Central Ohio Transit Authority	Columbus	OH
	City of Tucson	Tucson	AZ
	City of Phoenix Public Transit Department	Phoenix	AZ
	San Mateo County Transit District	San Carlos	CA
	Clark County Public Transportation Benefit Area Authority	Vancouver	WA
	Metro Regional Transit Authority	Akron	OH
	Regional Transportation Commission of Washoe County	Reno	NV
	Eastern Contra Costa Transit Authority	Antioch	CA
	Pace—Suburban Bus Division	Arlington Heights	IL
	St. Joseph Transit	St. Joseph	MO
	Tri-County Metropolitan Transportation District of Oregon	Portland	OR
	Putnam County Transit	Carmel	NY
	King County Department of Transportation — Metro Transit Division	Seattle	WA
	Duluth Transit Authority	Duluth	MN
	Omnitrans	San Bernardino	CA
	Metro Regional Transit Authority	Akron	OH
	San Joaquin Regional Transit District	Stockton	CA
	Five Seasons Transportation and Parking	Cedar Rapids	IA
	Municipality of Vega Baja	Vega Baja	PR
	Blue Water Area Transportation Commission	Port Huron	MI
Conventional Radio (e.g., 450 MHz)/802.11b/g (2.4 GHz unrestricted)			
	Metropolitan Transit Authority of Harris County, Texas	Houston	TX
	Livermore/Amador Valley Transit Authority	Livermore	CA
	Metro Transit	Minneapolis	MN
Conventional Radio (e.g., 450 MHz)/802.11b/g (2.4 GHz unrestricted)/802.11a (5.0 GHz unrestricted)			
	Delaware Transit Corporation	Dover	DE
Conventional Radio (e.g., 450 MHz)/Cellular—Cingular			
	City of Loveland Transit	Loveland	CO

2006 MDT Survey: MDT Communications by State

Report A2-F2

State/Transit Agency	City	MDT Communications
AZ		
City of Phoenix Public Transit Department	Phoenix	Conventional radio (e.g., 450 MHz)
Surprise Dial-A-Ride Transit System	Surprise	Cellular—Verizon Wireless
City of Glendale Transit	Glendale	Conventional radio (e.g., 450 MHz)
City of Tucson	Tucson	Conventional radio (e.g., 450 MHz)
CA		
Fresno Area Express	Fresno	Conventional radio (e.g., 450 MHz)
Antelope Valley Transit Authority	Lancaster	Cellular — Cingular/802.11b/g (2.4 GHz unrestricted)
Livermore/Amador Valley Transit Authority	Livermore	Conventional radio (e.g., 450 MHz)/802.11b/g (2.4 GHz unrestricted)
City of Visalia—Visalia City Coach	Visalia	802.11b/g (2.4 GHz unrestricted)
San Mateo County Transit District	San Carlos	Conventional radio (e.g., 450 MHz)
Eastern Contra Costa Transit Authority	Antioch	Conventional radio (e.g., 450 MHz)
San Joaquin Regional Transit District	Stockton	Conventional radio (e.g., 450 MHz)
Sacramento Regional Transit District	Sacramento	Cellular—Verizon Wireless
Omnitrans	San Bernardino	Conventional radio (e.g., 450 MHz)
CO		
City of Loveland Transit	Loveland	Conventional radio (e.g., 450 MHz)/Cellular—Cingular
DE		
Delaware Transit Corporation	Dover	Conventional radio (e.g., 450 MHz)/802.11b/g (2.4 GHz unrestricted)/802.11a (5.0 GHz unrestricted)
FL		
County of Volusia (VOTRAN)	South Daytona	Conventional radio (e.g., 450 MHz)
Central Florida Regional Transportation Authority	Orlando	Cellular—Sprint/Nextel
IA		
Five Seasons Transportation and Parking	Cedar Rapids	Conventional radio (e.g., 450 MHz)
IL		
Pace—Suburban Bus Division	Arlington Heights	Cellular—Verizon Wireless
Pace—Suburban Bus Division	Arlington Heights	Conventional radio (e.g., 450 MHz)

State/Transit Agency	City	MDT Communications
IN		
Muncie Indiana Transit System	Muncie	Cellular—Cingular
MA		
Montachusett Regional Transit Authority	Fitchburg	Cellular—Verizon Wireless
MI		
Blue Water Area Transportation Commission	Port Huron	Conventional radio (e.g., 450 MHz)
MN		
Metro Transit	Minneapolis	Conventional radio (e.g., 450 MHz)/802.11b/g (2.4 GHz unrestricted)
Duluth Transit Authority	Duluth	Conventional radio (e.g., 450 MHz)
MO		
St. Joseph Transit	St. Joseph	Conventional radio (e.g., 450 MHz)
NC		
Research Triangle Regional Public Transportation	Research Triangle Park	Cellular—Verizon Wireless
NM		
Santa Fe Trails—City of Santa Fe	Santa Fe	Cellular—Sprint/Nextel
NV		
Regional Transportation Commission of Washoe	Reno	Conventional radio (e.g., 450 MHz)
NY		
Putnam County Transit	Carmel	Conventional radio (e.g., 450 MHz)
OH		
Central Ohio Transit Authority	Columbus	Conventional radio (e.g., 450 MHz)
Metro Regional Transit Authority	Akron	Conventional radio (e.g., 450 MHz)
OR		
Tri-County Metropolitan Transportation District of Oregon	Portland	Conventional radio (e.g., 450 MHz)
PA		
Southeastern Pennsylvania Transportation Authority	Philadelphia	Cellular—Cingular
PR		
Municipality of Vega Baja	Vega Baja	Conventional radio (e.g., 450 MHz)
TX		
Dallas Area Rapid Transit	Dallas	Cellular—Cingular
Brazos Transit District	Bryan	Cellular—Cingular

State/Transit Agency	City	MDT Communications
City of Tyler	Tyler	Cellular—Cingular
Metropolitan Transit Authority of Harris County	Houston	Conventional radio (e.g., 450 MHz)/802.11b/g (2.4 GHz unrestricted)
VA		
Potomac and Rappahannock Transportation	Woodbridge	Cellular—Cingular
City of Alexandria—Alexandria Transit Company	Alexandria	Cellular—Verizon Wireless
WA		
Spokane Transit Authority	Spokane	Conventional radio (e.g., 450 MHz)
Clark County Public Transportation Benefit Area	Vancouver	Conventional radio (e.g., 450 MHz)
King County Department of Transportation—Metro Transit Division	Seattle	Conventional radio (e.g., 450 MHz)
Kitsap Transit	Bremerton	Cellular—Cingular
WI		
City of Waukesha Transit Commission	Waukesha	Conventional radio (e.g., 450 MHz)

2006 MDT Survey: GPS Refresh Rates by Number of MDTs

Report A2-F3

MDT Totals	Transit Agency	City	State	GPS Refresh Rates
1,300	King County Department of Transportation—Metro Transit Division	Seattle	WA	61–119 s
1,000	City of Phoenix Public Transit Department	Phoenix	AZ	61–119 s
948	Metro Transit	Minneapolis	MN	11–60 s
900	Tri-County Metropolitan Transportation District of Oregon	Portland	OR	2–5 min
710	Pace—Suburban Bus Division	Arlington Heights	IL	61–119 s
455	Central Ohio Transit Authority	Columbus	OH	11–60 s
430	City of Tucson	Tucson	AZ	1–5 s
428	San Mateo County Transit District	San Carlos	CA	2–5 min
415	Delaware Transit Corporation	Dover	DE	2–5 min
320	Omnitrans	San Bernardino	CA	11–60 s
308	Hillsborough Area Regional Transit Authority	Tampaa	FL	11–60 s
210	San Joaquin Regional Transit District	Stockton	CA	61–119 s
210	Pace—Suburban Bus Division	Arlington Heights	IL	2–5 min
200	Capital Metropolitan Transportation Authority	Austin	TX	61–119 s
196	Dallas Area Rapid Transit	Dallas	TX	61–119 s
163	Fresno Area Express	Fresno	CA	11–60 s
160	Clark County Public Transportation Benefit Area Authority	Vancouver	WA	11–60 s
150	Metropolitan Transit Authority of Harris County, Texas	Houston	TX	6–10 s
146	Metro Regional Transit Authority	Akron	OH	11–60 s
143	Regional Transportation Commission of Washoe County	Reno	NV	11–60 s
140	County of Volusia (VOTRAN)	South Daytona	FL	61–119 s
135	Central Florida Regional Transportation Authority	Orlando	FL	11–60 s
102	Spokane Transit Authority	Spokane	WA	61–119 s
93	Duluth Transit Authority	Duluth	MN	11–60 s

MDT Totals	Transit Agency	City	State	GPS Refresh Rates
93	Livermore/Amador Valley Transit Authority	Livermore	CA	1–5 s
79	Metro Regional Transit Authority	Akron	OH	6–10 s
78	Antelope Valley Transit Authority	Lancaster	CA	11–60 s
75	Montachusett Regional Transit Authority	Fitchburg	MA	6–10 s
68	Brazos Transit District	Bryan	TX	11–60 s
68	Kitsap Transit	Bremerton	WA	11–60 s
65	Research Triangle Regional Public Transportation Authority	Research Triangle Park	NC	11–60 s
52	Five Seasons Transportation and Parking	Cedar Rapids	IA	11–60 s
52	Blue Water Area Transportation Commission	Port Huron	MI	1–5 s
47	City of Visalia—Visalia City Coach	Visalia	CA	11–60 s
44	Santa Fe Trails—City of Santa Fe	Santa Fe	NM	2–5 min
44	Muncie Indiana Transit System	Muncie	IN	11–60 s
33	City of Glendale Transit	Glendale	AZ	11–60 s
25	Potomac and Rappahannock Transportation Commission	Woodbridge	VA	11–60 s
25	City of Waukesha Transit Commission	Waukesha	WI	11–60 s
20	St. Joseph Transit	St. Joseph	MO	11–60 s
20	Sacramento Regional Transit District	Sacramento	CA	61–119 s
20	Eastern Contra Costa Transit Authority	Antioch	CA	11–60 s
12	City of Tyler	Tyler	TX	2–5 min
12	City of Alexandria—Alexandria Transit Company	Alexandria	VA	61–119 s
10	Surprise Dial-A-Ride Transit System	Surprise	AZ	11–60 s
0	King County Department of Transportation—Metro Transit Division	Seattle	WA	61–119 s

2006 MDT Survey: Communication of Data and Video

Report A2-F4

State/Transit Agency	City	Communicate Scheduling Data to Vehicle?	Communicate Video Through MDT?
AL			
Montgomery Area Transit System	Montgomery	No	No
AZ			
City of Tucson	Tucson	Yes	Yes
City of Glendale Transit	Glendale	Yes	No
City of Phoenix Public Transit Department	Phoenix	Yes	No
Sun Cities Area Transit System, Inc.	Sun City	No	No
Surprise Dial-A-Ride Transit System	Surprise	Yes	No
CA			
Simi Valley Transit	Simi Valley	No	No
San Joaquin Regional Transit District	Stockton	Yes	No
Livermore/Amador Valley Transit Authority	Livermore	Yes	No
Sacramento Regional Transit District	Sacramento	Yes	No
City of Visalia—Visalia City Coach	Visalia	Yes	No
Antelope Valley Transit Authority	Lancaster	Yes	No
Fresno Area Express	Fresno	Yes	No
Yuba–Sutter Transit Authority	Marysville	No	No
San Mateo County Transit District	San Carlos	Yes	No
Omnitrans	San Bernardino	Yes	No
Eastern Contra Costa Transit Authority	Antioch	Yes	No
CO			
City of Loveland Transit	Loveland	No	No
DE			
Delaware Transit Corporation	Dover	Yes	No
FL			
Central Florida Regional Transportation Authority	Orlando	Yes	No
Escambia County Area Transit	Pensacola	No	No
Pasco County Public Transportation	New Port Richey	No	No
County of Volusia (VOTRAN)	South Daytona	Yes	No
Central Florida Regional Transportation Authority	Orlando	No	No

State/Transit Agency	City	Communicate Scheduling Data to Vehicle?	Communicate Video Through MDT?
Hillsborough Area Regional Transit Authority	Tampa	Yes	No
IA			
Five Seasons Transportation and Parking	Cedar Rapids	Yes	No
IL			
Rockford Mass Transit District	Rockford	No	No
Bloomington–Normal Public Transit System	Bloomington	No	No
Pace—Suburban Bus Division	Arlington Heights	Yes	No
Pace—Suburban Bus Division	Arlington Heights	Yes	No
IN			
City of Anderson Transportation System	Anderson	No	No
Muncie Indiana Transit System	Muncie	Yes	No
East Chicago Transit	East Chicago	No	No
Michigan City Municipal Coach	Michigan City	No	No
LA			
City of Alexandria	Alexandria	No	No
Shreveport Area Transit System	Shreveport	No	No
MA			
Montachusett Regional Transit Authority	Fitchburg	Yes	No
Brockton Area Transit Authority	Brockton	No	No
MD			
Annapolis Department of Transportation	Annapolis	No	No
Harford Transit	Bel Air	No	No
ME			
Casco Bay Island Transit District	Portland	No	No
The Regional Transportation Program, Inc.	Portland	No	No
MI			
Blue Water Area Transportation Commission	Port Huron	Yes	No
MN			
Duluth Transit Authority	Duluth	Yes	No
Metro Transit	Minneapolis	Yes	No
MO			
St. Joseph Transit	St. Joseph	Yes	No

State/Transit Agency	City	Communicate Scheduling Data to Vehicle?	Communicate Video Through MDT?
NC			
High Point Transit	High Point	No	No
Research Triangle Regional Public Transportation Authority	Research Triangle Park	No	No
NE			
StarTran	Lincoln	No	No
NH			
Nashua Transit System	Nashua	No	No
NJ			
Port Authority Transit Corporation	Lindenwold	No	No
NM			
Santa Fe Trails—City of Santa Fe	Santa Fe	Yes	No
NV			
Regional Transportation Commission of Washoe County	Reno	Yes	No
NY			
Village of Spring Valley Bus	Spring Valley	No	No
Metro–North Commuter Railroad Company (MTA Metro–North)	New York	No	No
GTJC	Jamaica	No	No
Suffolk County Department of Public Works—Transportation	Yaphank	No	No
Staten Island Rapid Transit Operating Authority (MTA Staten Island)	Brooklyn	No	No
Putnam County Transit	Carmel	No	No
OH			
Metro Regional Transit Authority	Akron	Yes	No
Clermont Transportation Connection	Batavia	No	No
Metro Regional Transit Authority	Akron	Yes	No
City of Newark Transit Operations	Newark	No	No
Central Ohio Transit Authority	Columbus	Yes	No
OK			
Central Oklahoma Transportation and Parking Authority	Oklahoma City	No	No
OR			
Tri-County Metropolitan Transportation District of Oregon	Portland	Yes	No
PA			
Southeastern Pennsylvania Transportation Authority	Philadelphia	Yes	No
Access Transportation Systems, Inc.	Pittsburgh	No	No

State/Transit Agency	City	Communicate Scheduling Data to Vehicle?	Communicate Video Through MDT?
Luzerne County Transportation Authority	Kingston	No	No
Cambria County Transit Authority	Johnstown	No	No
PR			
Municipality of Vega Baja	Vega Baja	No	No
TN			
Jackson Transit Authority	Jackson	No	No
Johnson City Transit System	Johnson City	Yes	No
TX			
Brazos Transit District	Bryan	Yes	No
Metropolitan Transit Authority of Harris County, Texas	Houston	No	No
Hill Country Transit District	San Saba	No	No
Dallas Area Rapid Transit	Dallas	Yes	No
Capital Metropolitan Transportation Authority	Austin	Yes	No
Abilene Transit System	Abilene	No	No
City of Tyler	Tyler	Yes	No
Midland–Odessa Urban Transit District	Odessa	No	No
VA			
Potomac and Rappahannock Transportation Commission	Woodbridge	Yes	No
City of Alexandria—Alexandria Transit Company	Alexandria	No	No
WA			
Clark County Public Transportation Benefit Area Authority	Vancouver	Yes	No
Spokane Transit Authority	Spokane	Yes	No
Kitsap Transit	Bremerton	Yes	No
Snohomish County Transportation Benefit Area Corporation	Everett	No	No
Skagit Transit	Burlington	No	No
King County Department of Transportation—Metro Transit	Seattle	No	No
WI			
Eau Claire Transit	Eau Claire	No	No
City of Waukesha Transit Commission	Waukesha	Yes	No
Janesville Transit System	Janesville	No	No
Fond du Lac Area Transit	Fond du Lac	No	No
City of Appleton—Valley Transit	Appleton	No	No
WY			
City of Casper	Casper	No	No

2006 MDT Survey: Communication of Canned Text Messages

Report A2-F5

State/Transit Agency	City	Communication of Canned Text Messages Through MDT
AZ		
Surprise Dial-A-Ride Transit System	Surprise	From dispatch to vehicle/from vehicle to dispatch
City of Phoenix Public Transit Department	Phoenix	From dispatch to vehicle/from vehicle to dispatch
City of Tucson	Tucson	From dispatch to vehicle/from vehicle to dispatch
City of Glendale Transit	Glendale	From dispatch to vehicle/from vehicle to dispatch
CA		
San Joaquin Regional Transit District	Stockton	From dispatch to vehicle/from vehicle to dispatch/from vehicle to vehicle in fleet
Antelope Valley Transit Authority	Lancaster	From dispatch to vehicle/from vehicle to dispatch/from vehicle to vehicle in fleet
Eastern Contra Costa Transit Authority	Antioch	From dispatch to vehicle/from vehicle to dispatch
San Mateo County Transit District	San Carlos	From dispatch to vehicle/from vehicle to dispatch
Sacramento Regional Transit District	Sacramento	From dispatch to vehicle/from vehicle to dispatch
Fresno Area Express	Fresno	From dispatch to vehicle/from vehicle to dispatch
Omnitrans	San Bernardino	From dispatch to vehicle/from vehicle to dispatch
Livermore/Amador Valley Transit Authority	Livermore	From dispatch to vehicle
DE		
Delaware Transit Corporation	Dover	From dispatch to vehicle/from vehicle to dispatch/from vehicle to vehicle in fleet
FL		
County of Volusia (VOTRAN)	South Daytona	From dispatch to vehicle/from vehicle to dispatch
Central Florida Regional Transportation Authority	Orlando	From dispatch to vehicle/from vehicle to dispatch
IA		
Five Seasons Transportation and Parking	Cedar Rapids	From dispatch to vehicle/from vehicle to dispatch
IL		
Pace—Suburban Bus Division	Arlington Heights	From dispatch to vehicle/from vehicle to dispatch
Pace—Suburban Bus Division	Arlington Heights	From dispatch to vehicle/from vehicle to dispatch
IN		
Muncie Indiana Transit System	Muncie	From dispatch to vehicle
MA		
Montachusett Regional Transit Authority	Fitchburg	From dispatch to vehicle/from vehicle to dispatch
MI		
Blue Water Area Transportation Commission	Port Huron	From dispatch to vehicle/from vehicle to dispatch

State/Transit Agency	City	Communication of Canned Text Messages Through MDT
MN		
Duluth Transit Authority	Duluth	From dispatch to vehicle/from vehicle to dispatch
Metro Transit	Minneapolis	From dispatch to vehicle/from vehicle to dispatch
MO		
St. Joseph Transit	St. Joseph	From dispatch to vehicle/from vehicle to dispatch
NC		
Research Triangle Regional Public Transportation Authority	Research Triangle Park	From dispatch to vehicle/from vehicle to dispatch
NM		
Santa Fe Trails—City of Santa Fe	Santa Fe	From dispatch to vehicle/from vehicle to dispatch
NV		
Regional Transportation Commission of Washoe County	Reno	From dispatch to vehicle/from vehicle to dispatch/from vehicle to vehicle in fleet
OH		
Metro Regional Transit Authority	Akron	From dispatch to vehicle/from vehicle to dispatch
Central Ohio Transit Authority	Columbus	From dispatch to vehicle/from vehicle to dispatch
Metro Regional Transit Authority	Akron	From dispatch to vehicle/from vehicle to dispatch
OR		
Tri-County Metropolitan Transportation District of Oregon	Portland	From dispatch to vehicle/from vehicle to dispatch
PA		
Southeastern Pennsylvania Transportation Authority	Philadelphia	From dispatch to vehicle/from vehicle to dispatch
TX		
Dallas Area Rapid Transit	Dallas	From dispatch to vehicle/from vehicle to dispatch/from vehicle to vehicle in fleet
Metropolitan Transit Authority of Harris County, Texas	Houston	From dispatch to vehicle/from vehicle to dispatch/from vehicle to vehicle in fleet
City of Tyler	Tyler	From dispatch to vehicle/from vehicle to dispatch
Capital Metropolitan Transportation Authority	Austin	From dispatch to vehicle/from vehicle to dispatch
Brazos Transit District	Bryan	From dispatch to vehicle/from vehicle to dispatch
VA		
Potomac and Rappahannock Transportation Commission	Woodbridge	From dispatch to vehicle/from vehicle to dispatch
WA		
Spokane Transit Authority	Spokane	From dispatch to vehicle/from vehicle to dispatch
Kitsap Transit	Bremerton	From dispatch to vehicle/from vehicle to dispatch
Clark County Public Transportation Benefit Area Authority	Vancouver	From dispatch to vehicle/from vehicle to dispatch
King County Department of Transportation—Metro Transit Div.	Seattle	From dispatch to vehicle/from vehicle to dispatch
WI		
City of Waukesha Transit Commission	Waukesha	From dispatch to vehicle/from vehicle to dispatch

2006 MDT Survey: MDT Communication of Free Form Text

Report A2-F6

State/Transit Agency	City	MDT Communication of Free Form Text Messages
AZ		
Surprise Dial-A-Ride Transit System	Surprise	From dispatch to vehicle/from vehicle to dispatch
City of Phoenix Public Transit Department	Phoenix	From dispatch to vehicle
City of Tucson	Tucson	From dispatch to vehicle/from vehicle to dispatch
City of Glendale Transit	Glendale	From dispatch to vehicle
CA		
Eastern Contra Costa Transit Authority	Antioch	From dispatch to vehicle/from vehicle to dispatch
San Joaquin Regional Transit District	Stockton	From dispatch to vehicle
Antelope Valley Transit Authority	Lancaster	From dispatch to vehicle/from vehicle to dispatch/from vehicle to vehicle in fleet
Livermore/Amador Valley Transit Authority	Livermore	From dispatch to vehicle
San Mateo County Transit District	San Carlos	From dispatch to vehicle
Sacramento Regional Transit District	Sacramento	From dispatch to vehicle
Fresno Area Express	Fresno	From dispatch to vehicle
Omnitrans	San Bernardino	From dispatch to vehicle
DE		
Delaware Transit Corporation	Dover	From dispatch to vehicle
FL		
County of Volusia (VOTRAN)	South Daytona	From dispatch to vehicle
Central Florida Regional Transportation Authority	Orlando	From dispatch to vehicle/from vehicle to dispatch
IA		
Five Seasons Transportation and Parking	Cedar Rapids	From dispatch to vehicle/from vehicle to dispatch
IL		
Pace—Suburban Bus Division	Arlington Heights	From dispatch to vehicle
IN		
Muncie Indiana Transit System	Muncie	From dispatch to vehicle
MA		
Montachusett Regional Transit Authority	Fitchburg	From dispatch to vehicle/from vehicle to dispatch

State/Transit Agency	City	MDT Communication of Free Form Text Messages
MI		
Blue Water Area Transportation Commission	Port Huron	From dispatch to vehicle/from vehicle to dispatch
MN		
Duluth Transit Authority	Duluth	From dispatch to vehicle
Metro Transit	Minneapolis	From dispatch to vehicle
MO		
St. Joseph Transit	St. Joseph	From dispatch to vehicle
NC		
Research Triangle Regional Public Transportation Authority	Research Triangle Park	From dispatch to vehicle/from vehicle to dispatch
NM		
Santa Fe Trails—City of Santa Fe	Santa Fe	From dispatch to vehicle/from vehicle to dispatch
NV		
Regional Transportation Commission of Washoe County	Reno	From dispatch to vehicle
OH		
Metro Regional Transit Authority	Akron	From dispatch to vehicle
Central Ohio Transit Authority	Columbus	From dispatch to vehicle
OR		
Tri-County Metropolitan Transportation District of Oregon	Portland	From dispatch to vehicle
PA		
Southeastern Pennsylvania Transportation Authority	Philadelphia	From dispatch to vehicle
TX		
City of Tyler	Tyler	From dispatch to vehicle
Capital Metropolitan Transportation Authority	Austin	From dispatch to vehicle/from vehicle to dispatch
Brazos Transit District	Bryan	From dispatch to vehicle
Dallas Area Rapid Transit	Dallas	From dispatch to vehicle/from vehicle to dispatch/from vehicle to vehicle in fleet
Metropolitan Transit Authority of Harris County, Texas	Houston	From dispatch to vehicle/from vehicle to dispatch/from vehicle to vehicle in fleet
VA		
Potomac and Rappahannock Transportation Commission	Woodbridge	From dispatch to vehicle/from vehicle to dispatch

State/Transit Agency	City	MDT Communication of Free Form Text Messages
WA		
Spokane Transit Authority	Spokane	From dispatch to vehicle
Kitsap Transit	Bremerton	From dispatch to vehicle/from vehicle to dispatch
Clark County Public Transportation Benefit Area Authority	Vancouver	From dispatch to vehicle
King County Department of Transportation—Metro Transit	Seattle	From dispatch to vehicle/from vehicle to dispatch
WI		
City of Waukesha Transit Commission	Waukesha	From dispatch to vehicle

2006 MDT Survey: MDT Communication Types—Other

Report A2-F7

State/Transit Agency	City	Other Communication Using MDT
AZ		
Surprise Dial-A-Ride Transit System	Surprise	Color mapping
IN		
City of Anderson Transportation System	Anderson	We have no mobile data terminals
MN		
Metro Transit	Minneapolis	Transfer hold request functionality—operator can send a transfer hold request. System accepts/rejects request based on preset parameters, then forwards request to appropriate bus(es) if accepted. This is “controlled” vehicle to vehicle communication.
OH		
Metro Regional Transit Authority	Akron	Text messaging via fleet broadcast
VA		
Potomac and Rappahannock Transportation Commission	Woodbridge	On-time performance
WA		
King County Department of Transportation—Metro Transit	Seattle	Driver can initiate notification call to client. Driver can request update of WSDOT traffic map data to be displayed on MDT.

2006 MDT Survey: Two-Way Voice Radio Communication

Report A2-F8

State/Transit Agency	City	Is Two-Way Voice Communication Available to the Operator?
AL		
Montgomery Area Transit System	Montgomery	Yes
AZ		
City of Tucson	Tucson	Yes
City of Glendale Transit	Glendale	Yes
City of Phoenix Public Transit Department	Phoenix	Yes
Sun Cities Area Transit System, Inc.	Sun City	Yes
Surprise Dial-A-Ride Transit System	Surprise	Yes
CA		
Simi Valley Transit	Simi Valley	Yes
San Joaquin Regional Transit District	Stockton	Yes
Livermore/Amador Valley Transit Authority	Livermore	Yes
Sacramento Regional Transit District	Sacramento	Yes
City of Visalia—Visalia City Coach	Visalia	Yes
Antelope Valley Transit Authority	Lancaster	Yes
Fresno Area Express	Fresno	Yes
Yuba–Sutter Transit Authority	Marysville	No
San Mateo County Transit District	San Carlos	Yes
Omnitrans	San Bernardino	Yes
Eastern Contra Costa Transit Authority	Antioch	Yes
CO		
City of Loveland Transit	Loveland	Yes
DE		
Delaware Transit Corporation	Dover	Yes
FL		
Central Florida Regional Transportation Authority	Orlando	Yes
Escambia County Area Transit	Pensacola	Yes
Pasco County Public Transportation	New Port Richey	No

State/Transit Agency	City	Is Two-Way Voice Communication Available to the Operator?
County of Volusia (VOTRAN)	South Daytona	Yes
Central Florida Regional Transportation Authority	Orlando	No
Hillsborough Area Regional Transit Authority	Tampa	Yes
IA		
Five Seasons Transportation and Parking	Cedar Rapids	Yes
IL		
Rockford Mass Transit District	Rockford	Yes
Bloomington–Normal Public Transit System	Bloomington	Yes
Pace—Suburban Bus Division	Arlington Heights	Yes
IN		
City of Anderson Transportation System	Anderson	Yes
Muncie Indiana Transit System	Muncie	Yes
East Chicago Transit	East Chicago	Yes
Michigan City Municipal Coach	Michigan City	Yes
LA		
City of Alexandria	Alexandria	Yes
Shreveport Area Transit System	Shreveport	Yes
MA		
Montachusett Regional Transit Authority	Fitchburg	Yes
Brockton Area Transit Authority	Brockton	No
MD		
Annapolis Department of Transportation	Annapolis	No
Harford Transit	Bel Air	Yes
ME		
Casco Bay Island Transit District	Portland	Yes
The Regional Transportation Program, Inc.	Portland	Yes
MI		
Blue Water Area Transportation Commission	Port Huron	Yes

State/Transit Agency	City	Is Two-Way Voice Communication Available to the Operator?
MN		
Duluth Transit Authority	Duluth	Yes
Metro Transit	Minneapolis	Yes
MO		
St. Joseph Transit	St. Joseph	Yes
NC		
High Point Transit	High Point	Yes
Research Triangle Regional Public Transportation Authority	Research Triangle Park	Yes
NE		
StarTran	Lincoln	Yes
NH		
Nashua Transit System	Nashua	Yes
NJ		
Port Authority Transit Corporation	Lindenwold	Yes
NM		
Santa Fe Trails—City of Santa Fe	Santa Fe	Yes
NV		
Regional Transportation Commission of Washoe County	Reno	Yes
NY		
Village of Spring Valley Bus	Spring Valley	Yes
Metro–North Commuter Railroad Company (MTA Metro–North)	New York	No
GTJC	Jamaica	Yes
Suffolk County Department of Public Works—Transportation Division	Yaphank	Yes
Staten Island Rapid Transit Operating Authority (MTA Staten Is.)	Brooklyn	No
Putnam County Transit	Carmel	Yes
OH		
Metro Regional Transit Authority	Akron	Yes
Clermont Transportation Connection	Batavia	Yes
City of Newark Transit Operations	Newark	Yes
Central Ohio Transit Authority	Columbus	Yes

State/Transit Agency	City	Is Two-Way Voice Communication Available to the Operator?
OK		
Central Oklahoma Transportation and Parking Authority	Oklahoma City	Yes
OR		
Tri-County Metropolitan Transportation District of Oregon	Portland	Yes
PA		
Southeastern Pennsylvania Transportation Authority	Philadelphia	No
Access Transportation Systems, Inc.	Pittsburgh	Yes
Luzerne County Transportation Authority	Kingston	Yes
Cambria County Transit Authority	Johnstown	Yes
PR		
Municipality of Vega Baja	Vega Baja	Yes
TN		
Jackson Transit Authority	Jackson	Yes
Johnson City Transit System	Johnson City	Yes
TX		
Brazos Transit District	Bryan	Yes
Metropolitan Transit Authority of Harris County, Texas	Houston	Yes
Hill Country Transit District	San Saba	Yes
Dallas Area Rapid Transit	Dallas	Yes
Capital Metropolitan Transportation Authority	Austin	Yes
Abilene Transit System	Abilene	Yes
City of Tyler	Tyler	Yes
Midland–Odessa Urban Transit District	Odessa	Yes
VA		
Potomac and Rappahannock Transportation Commission	Woodbridge	Yes
City of Alexandria—Alexandria Transit Company	Alexandria	Yes
WA		
Clark County Public Transportation Benefit Area Authority	Vancouver	Yes
Spokane Transit Authority	Spokane	Yes
Kitsap Transit	Bremerton	Yes
Snohomish County Transportation Benefit Area Corporation	Everett	No
Skagit Transit	Burlington	Yes

State/Transit Agency	City	Is Two-Way Voice Communication Available to the Operator?
King County Department of Transportation—Metro Transit	Seattle	Yes
King County Department of Transportation—Metro Transit	Seattle	No
WI		
Eau Claire Transit	Eau Claire	Yes
City of Waukesha Transit Commission	Waukesha	Yes
Janesville Transit System	Janesville	Yes
Fond du Lac Area Transit	Fond du Lac	Yes
City of Appleton—Valley Transit	Appleton	Yes
WY		
City of Casper	Casper	Yes

2006 MDT Survey: Operating Systems Supporting MDT Databases

Report A2-G1

Operating System	State	City	Transit Agency	TRS_ID
MS Windows NT				
	CA	San Carlos	San Mateo County Transit District	9009
MS Windows Server 2000				
	NC	Research Triangle Park	Research Triangle Regional Public Transportation Authority	4108
	NV	Reno	Regional Transportation Commission of Washoe County	9001
	TX	Tyler	City of Tyler	6089
	VA	Woodbridge	Potomac and Rappahannock Transportation Commission	3070
	WA	Spokane	Spokane Transit Authority	0002
MS Windows Server 2000/MS Windows XP				
	CA	Fresno	Fresno Area Express	9027
MS Windows Server 2003				
	MN	Minneapolis	Metro Transit	5027
	MO	St. Joseph	St. Joseph Transit	7032
	OH	Akron	Metro Regional Transit Authority	5010
	WA	Bremerton	Kitsap Transit	0020
	WA	Seattle	King County Department of Transportation—Metro Transit Division	0001
	WA	Vancouver	Clark County Public Transportation Benefit Area Authority	0024
MS Windows Server 2003/MS Windows XP				
	IL	Arlington Heights	Pace—Suburban Bus Division	5113
MS Windows XP				
	CA	Antioch	Eastern Contra Costa Transit Authority	9162
	CA	Lancaster	Antelope Valley Transit Authority	9121
	CA	Stockton	San Joaquin Regional Transit District	9012
Other MS Windows/DOS				
	OH	Columbus	Central Ohio Transit Authority	5016
Sun OS				
	OR	Portland	Tri-County Metropolitan Transportation District of Oregon	0008

Operating System	State	City	Transit Agency	TRS_ID
Unix				
	AZ	Phoenix	City of Phoenix Public Transit Department	9032
	DE	Dover	Delaware Transit Corporation	3075
	WA	Seattle	King County Department of Transportation—Metro Transit Division	0001

2006 MDT Survey: Database Software for MDT Support

Report A2-G2

Database	State	City	Transit Agency	TRS_ID
Informix				
	WA	Seattle	King County Department of Transportation — Metro Transit Division	0001
Microsoft SQL Server 2000				
	CA	Antioch	Eastern Contra Costa Transit Authority	9162
	CA	Lancaster	Antelope Valley Transit Authority	9121
	CA	Stockton	San Joaquin Regional Transit District	9012
	MN	Minneapolis	Metro Transit	5027
	MO	St. Joseph	St. Joseph Transit	7032
	NV	Reno	Regional Transportation Commission of Washoe County	9001
	VA	Woodbridge	Potomac and Rappahannock Transportation Commission	3070
	WA	Seattle	King County Department of Transportation—Metro Transit Division	0001
	WA	Spokane	Spokane Transit Authority	0002
Microsoft SQL Server 2005				
	TX	Tyler	City of Tyler	6089
MS SQL Server 7				
	AZ	Phoenix	City of Phoenix Public Transit Department	9032
	CA	Fresno	Fresno Area Express	9027
	CA	San Carlos	San Mateo County Transit District	9009
	OH	Columbus	Central Ohio Transit Authority	5016
MySQL				
	NC	Research Triangle Park	Research Triangle Regional Public Transportation Authority	4108
Oracle				
	DE	Dover	Delaware Transit Corporation	3075
	IL	Arlington Heights	Pace—Suburban Bus Division	5113
	OH	Akron	Metro Regional Transit Authority	5010
	OR	Portland	Tri-County Metropolitan Transportation District of Oregon	0008
	WA	Vancouver	Clark County Public Transportation Benefit Area Authority	0024

2006 MDT Survey: Applications—Timekeeping and Web–AVL

Report A2-H1

State/City	Transit Agency	Driver Timekeeping?	Web AVL Mapping?
AL			
Montgomery	Montgomery Area Transit System	No	No
AZ			
Glendale	City of Glendale Transit	No	Yes
Phoenix	City of Phoenix Public Transit Department	Yes	No
Sun City	Sun Cities Area Transit System, Inc.	No	No
Surprise	Surprise Dial-A-Ride Transit System	Yes	Yes
Tucson	City of Tucson	Yes	Yes
CA			
Antioch	Eastern Contra Costa Transit Authority	No	Yes
Fresno	Fresno Area Express	No	Yes
Lancaster	Antelope Valley Transit Authority	Yes	Yes
Livermore	Livermore/Amador Valley Transit Authority	No	Yes
Marysville	Yuba–Sutter Transit Authority	No	No
Sacramento	Sacramento Regional Transit District	No	Yes
San Bernardino	Omnitrans	No	No
San Carlos	San Mateo County Transit District	Yes	Yes
Simi Valley	Simi Valley Transit	No	No
Stockton	San Joaquin Regional Transit District	Yes	Yes
Visalia	City of Visalia—Visalia City Coach	No	Yes
CO			
Loveland	City of Loveland Transit	No	No
DE			
Dover	Delaware Transit Corporation	No	Yes
FL			
New Port Richey	Pasco County Public Transportation	No	No
Orlando	Central Florida Regional Transportation Authority	Yes	Yes
Orlando	Central Florida Regional Transportation Authority	No	No

State/City	Transit Agency	Driver Timekeeping?	Web AVL Mapping?
Pensacola	Escambia County Area Transit	No	No
South Daytona	County of Volusia (VOTRAN)	No	Yes
Tampa	Hillsborough Area Regional Transit Authority	Yes	No
IA			
Cedar Rapids	Five Seasons Transportation and Parking	Yes	Yes
IL			
Arlington Heights	Pace—Suburban Bus Division	No	Yes
Bloomington	Bloomington–Normal Public Transit System	No	No
Rockford	Rockford Mass Transit District	No	No
IN			
Anderson	City of Anderson Transportation System	Yes	No
East Chicago	East Chicago Transit	Yes	No
Michigan City	Michigan City Municipal Coach	No	No
Muncie	Muncie Indiana Transit System	No	No
LA			
Alexandria	City of Alexandria	No	No
Shreveport	Shreveport Area Transit System	No	No
MA			
Brockton	Brockton Area Transit Authority	No	No
Fitchburg	Montachusett Regional Transit Authority	No	Yes
MD			
Annapolis	Annapolis Department of Transportation	No	No
Bel Air	Harford Transit	No	No
ME			
Portland	Casco Bay Island Transit District	No	No
Portland	The Regional Transportation Program, Inc.	No	No
MI			
Port Huron	Blue Water Area Transportation Commission	Yes	Yes
MN			
Duluth	Duluth Transit Authority	No	Yes
Minneapolis	Metro Transit	Yes	Yes

State/City	Transit Agency	Driver Timekeeping?	Web AVL Mapping?
MO			
St. Joseph	St. Joseph Transit	Yes	Yes
NC			
High Point	High Point Transit	No	No
Research Triangle Park	Research Triangle Regional Public Transportation Authority	Yes	Yes
NE			
Lincoln	StarTran	No	No
NH			
Nashua	Nashua Transit System	No	No
NJ			
Lindenwold	Port Authority Transit Corporation	No	No
NM			
Santa Fe	Santa Fe Trails—City of Santa Fe	Yes	No
NV			
Reno	Regional Transportation Commission of Washoe County	Yes	Yes
NY			
Brooklyn	Staten Island Rapid Transit Operating Authority (MTA Staten Island)	No	No
Carmel	Putnam County Transit	No	No
Jamaica	GTJC	No	No
New York	Metro–North Commuter Railroad Company (MTA Metro–North)	No	No
Spring Valley	Village of Spring Valley Bus	No	No
Yaphank	Suffolk County Department of Public Works—Transportation Division	No	No
OH			
Akron	Metro Regional Transit Authority	No	No
Akron	Metro Regional Transit Authority	Yes	No
Batavia	Clermont Transportation Connection	No	No
Columbus	Central Ohio Transit Authority	No	No
Newark	City of Newark Transit Operations	No	No
OK			
Oklahoma City	Central Oklahoma Transportation and Parking Authority	No	No
OR			
Portland	Tri-County Metropolitan Transportation District of Oregon	Yes	Yes

State/City	Transit Agency	Driver Timekeeping?	Web AVL Mapping?
PA			
Johnstown	Cambria County Transit Authority	No	No
Kingston	Luzerne County Transportation Authority	Yes	No
Philadelphia	Southeastern Pennsylvania Transportation Authority	Yes	No
Pittsburgh	Access Transportation Systems, Inc.	No	No
PR			
Vega Baja	Municipality of Vega Baja	No	No
TN			
Jackson	Jackson Transit Authority	No	No
Johnson City	Johnson City Transit System	No	Yes
TX			
Abilene	Abilene Transit System	No	No
Austin	Capital Metropolitan Transportation Authority	Yes	Yes
Bryan	Brazos Transit District	Yes	Yes
Dallas	Dallas Area Rapid Transit	No	No
Houston	Metropolitan Transit Authority of Harris County, Texas	No	Yes
Odessa	Midland–Odessa Urban Transit District	No	No
San Saba	Hill Country Transit District	No	No
Tyler	City of Tyler	No	Yes
VA			
Alexandria	City of Alexandria — Alexandria Transit Company	No	Yes
Woodbridge	Potomac and Rappahannock Transportation Commission	Yes	Yes
WA			
Bremerton	Kitsap Transit	Yes	No
Burlington	Skagit Transit	No	No
Everett	Snohomish County Transportation Benefit Area Corporation	Yes	No
Seattle	King County Department of Transportation—Metro Transit Division	Yes	Yes
Spokane	Spokane Transit Authority	No	No
Vancouver	Clark County Public Transportation Benefit Area Authority	No	Yes

State/City	Transit Agency	Driver Timekeeping?	Web AVL Mapping?
WI			
Appleton	City of Appleton—Valley Transit	No	No
Eau Claire	Eau Claire Transit	No	No
Fond du Lac	Fond du Lac Area Transit	No	No
Janesville	Janesville Transit System	No	No
Waukesha	City of Waukesha Transit Commission	Yes	No
WY			
Casper	City of Casper	No	No

2006 MDT Survey: Route and Schedule Adherence from MDTs

Report A2-H2

State/City	Transit Agency	Use of MDTs to Monitor On-Time Performance by Mode
AZ		
Glendale	City of Glendale Transit	Paratransit on-time performance
Phoenix	City of Phoenix Public Transit Department	Fixed-route service on-time performance/Paratransit on-time performance
Surprise	Surprise Dial-A-Ride Transit System	Paratransit on-time performance
Tucson	City of Tucson	Fixed-route service on-time performance/Paratransit on-time performance
CA		
Antioch	Eastern Contra Costa Transit Authority	Paratransit on-time performance
Fresno	Fresno Area Express	Fixed-route service on-time performance
Lancaster	Antelope Valley Transit Authority	Fixed-route service on-time performance/Paratransit on-time performance
Livermore	Livermore/Amador Valley Transit Authority	Fixed-route service on-time performance/Paratransit on-time performance
Sacramento	Sacramento Regional Transit District	Paratransit on-time performance
San Bernardino	Omnitrans	Fixed-route service on-time performance/Paratransit on-time performance
San Carlos	San Mateo County Transit District	Fixed-route service on-time performance/Paratransit on-time performance
Stockton	San Joaquin Regional Transit District	Fixed-route service on-time performance/Paratransit on-time performance
Visalia	City of Visalia—Visalia City Coach	Fixed-route service on-time performance/Paratransit on-time performance
CO		
Loveland	City of Loveland Transit	Paratransit on-time performance
DE		
Dover	Delaware Transit Corporation	Fixed-route service on-time performance/Paratransit on-time performance
FL		
Orlando	Central Florida Regional Transportation Authority	Paratransit on-time performance
South Daytona	County of Volusia (VOTRAN)	Fixed-route service on-time performance/Paratransit on-time performance
IA		
Cedar Rapids	Five Seasons Transportation and Parking	Fixed-route service on-time performance
IL		
Arlington Heights	Pace—Suburban Bus Division	Fixed-route service on-time performance
Arlington Heights	Pace—Suburban Bus Division	Paratransit on-time performance
IN		
Muncie	Muncie Indiana Transit System	Fixed-route service on-time performance/Paratransit on-time performance

State/City	Transit Agency	Use of MDTs to Monitor On-Time Performance by Mode
MA		
Fitchburg	Montachusett Regional Transit Authority	Paratransit on-time performance
MI		
Port Huron	Blue Water Area Transportation Commission	Fixed-route service on-time performance/Paratransit on-time performance
MN		
Duluth	Duluth Transit Authority	Fixed-route service on-time performance
Minneapolis	Metro Transit	Fixed-route service on-time performance
MO		
St. Joseph	St. Joseph Transit	Fixed-route service on-time performance
NC		
Research Triangle Park	Research Triangle Regional Public Transportation	Fixed-route service on-time performance
NM		
Santa Fe	Santa Fe Trails—City of Santa Fe	Paratransit on-time performance
NV		
Reno	Regional Transportation Commission of Washoe	Fixed-route service on-time performance/Paratransit on-time performance
OH		
Akron	Metro Regional Transit Authority	Paratransit on-time performance
Columbus	Central Ohio Transit Authority	Fixed-route service on-time performance/Paratransit on-time performance
OR		
Portland	Tri-County Metropolitan Transportation District of Oregon	Fixed-route service on-time performance/Paratransit on-time performance
PA		
Philadelphia	Southeastern Pennsylvania Transportation Authority	Paratransit on-time performance
TN		
Johnson City	Johnson City Transit System	Fixed-route service on-time performance/Paratransit on-time performance
TX		
Austin	Capital Metropolitan Transportation Authority	Fixed-route service on-time performance/Paratransit on-time performance
Bryan	Brazos Transit District	Paratransit on-time performance
Dallas	Dallas Area Rapid Transit	Paratransit on-time performance
Houston	Metropolitan Transit Authority of Harris County	Fixed-route service on-time performance
Tyler	City of Tyler	Paratransit on-time performance

State/City	Transit Agency	Use of MDTs to Monitor On-Time Performance by Mode
VA		
Alexandria	City of Alexandria—Alexandria Transit Company	Fixed-route service on-time performance
Woodbridge	Potomac and Rappahannock Transportation Commission	Fixed-route service on-time performance/Paratransit on-time performance
WA		
Bremerton	Kitsap Transit	Paratransit on-time performance
Seattle	King County Dept. of Transportation—Metro Transit Div.	Fixed-route service on-time performance
Seattle	King County Dept. of Transportation—Metro Transit Div.	Paratransit on-time performance
Spokane	Spokane Transit Authority	Paratransit on-time performance
Vancouver	Clark County Public Transportation Benefit Area	Fixed-route service on-time performance/Paratransit on-time performance
WI		
Waukesha	City of Waukesha Transit Commission	Fixed-route service on-time performance

2006 MDT Survey: MDT Applications to Prevent/Detect Fraud

Report A2-H3

Transit Agency	Use of MDTs for fraud prevention and detection
Antelope Valley Transit Authority	Time fraud by staff or contractors/Fare fraud by staff or contractors
Brazos Transit District	Time fraud by staff or contractors
Capital Metropolitan Transportation Authority	Time fraud by staff or contractors
Central Florida Regional Transportation Authority	Time fraud by staff or contractors/Fare fraud by staff or contractors
City of Glendale Transit	Fare fraud by staff or contractors/Third-party payment fraud by human service clients
City of Tucson	Time fraud by staff or contractors/Fare fraud by staff or contractors/Third-party payment fraud by human service clients
King County Department of Transportation—Metro Transit Division	Time fraud by staff or contractors
Pace—Suburban Bus Division	Time fraud by staff or contractors
Santa Fe Trails—City of Santa Fe	Time fraud by staff or contractors/Fare fraud by staff or contractors
Spokane Transit Authority	Time fraud by staff or contractors/Fare fraud by staff or contractors
Surprise Dial-A-Ride Transit System	Time fraud by staff or contractors/Fare fraud by staff or contractors
Tri-County Metropolitan Transportation District of Oregon	Time fraud by staff or contractors

2006 MDT Survey: Applications—MDT-Based ETA and Display

Report A2-H4

State/Transit Agency	Calculation of Estimated Time of Arrival from MDT and Display of Results at Various Locations
AZ	
City of Phoenix Public Transit Department	At bus terminals/at bus stops/on board the bus
City of Tucson	At bus terminals/at bus stops/on board the bus/display of ETA on web
CA	
Antelope Valley Transit Authority	At bus terminals/at bus stops/on board the bus
City of Visalia—Visalia City Coach	At bus terminals/display of ETA on web
Eastern Contra Costa Transit Authority	On board the bus
Fresno Area Express	At bus terminals/at bus stops/on board the bus
Livermore/Amador Valley Transit Authority	At bus terminals/on board the bus/display of ETA on web
San Joaquin Regional Transit District	At bus terminals/at bus stops/on board the bus/display of ETA on web
San Mateo County Transit District	At bus terminals/at bus stops
DE	
Delaware Transit Corporation	At bus terminals/at bus stops
FL	
County of Volusia (VOTRAN)	At bus terminals
IA	
Five Seasons Transportation and Parking	On board the bus
IL	
Pace—Suburban Bus Division	At bus terminals/on board the bus/display of ETA on web
MI	
Blue Water Area Transportation Commission	At bus stops/display of ETA on web
MN	
Duluth Transit Authority	At bus terminals/at bus stops/display of ETA on web
Metro Transit	At bus terminals/at bus stops/on board the bus/display of ETA on web
MO	
St. Joseph Transit	At bus terminals/at bus stops

State/Transit Agency	Calculation of Estimated Time of Arrival from MDT and Display of Results at Various Locations
NC	
Research Triangle Regional Public Transportation Authority	At bus stops
NV	
Regional Transportation Commission of Washoe County	At bus terminals/on board the bus
OR	
Tri-County Metropolitan Transportation District of Oregon	At bus terminals/at bus stops/on board the bus/display of ETA on web
TN	
Johnson City Transit System	At bus stops
TX	
Capital Metropolitan Transportation Authority	At bus terminals/at bus stops/display of ETA on web
VA	
City of Alexandria—Alexandria Transit Company	At bus terminals/at bus stops
Potomac and Rappahannock Transportation Commission	On board the bus
WA	
King County Department of Transportation—Metro Transit Division	At bus terminals/at bus stops/display of ETA on web
Kitsap Transit	On board the bus
Spokane Transit Authority	On board the bus
WI	
City of Waukesha Transit Commission	At bus terminals

2006 MDT Survey: Applications—Quality Assurance/Quality Control from MDTs

Report A2-H5

State/City	Transit Agency	Use of MDTs for Quality Assurance/ Quality Control by Mode
AZ		
Glendale	City of Glendale Transit	Paratransit
Surprise	Surprise Dial-A-Ride Transit System	Paratransit
Tucson	City of Tucson	Fixed route/Paratransit
CA		
Antioch	Eastern Contra Costa Transit Authority	Paratransit
Lancaster	Antelope Valley Transit Authority	Fixed route/Paratransit
San Carlos	San Mateo County Transit District	Fixed route
Visalia	City of Visalia—Visalia City Coach	Fixed route/Paratransit
FL		
Orlando	Central Florida Regional Transportation Authority	Paratransit
South Daytona	County of Volusia (VOTRAN)	Fixed route/Paratransit
IA		
Cedar Rapids	Five Seasons Transportation and Parking	Fixed route
IL		
Arlington Heights	Pace—Suburban Bus Division	Fixed route
Arlington Heights	Pace—Suburban Bus Division	Paratransit
MA		
Fitchburg	Montachusett Regional Transit Authority	Paratransit
MI		
Port Huron	Blue Water Area Transportation Commission	Fixed route/Paratransit
MN		
Minneapolis	Metro Transit	Fixed route
MO		
St. Joseph	St. Joseph Transit	Fixed route

State/City	Transit Agency	Use of MDTs for Quality Assurance/ Quality Control by Mode
NM		
Santa Fe	Santa Fe Trails—City of Santa Fe	Paratransit
NV		
Reno	Regional Transportation Commission of Washoe County	Fixed route/Paratransit
OH		
Akron	Metro Regional Transit Authority	Paratransit
Batavia	Clermont Transportation Connection	Paratransit
Columbus	Central Ohio Transit Authority	Fixed route
OR		
Portland	Tri-County Metropolitan Transportation District of Oregon	Fixed route/Paratransit
PA		
Philadelphia	Southeastern Pennsylvania Transportation Authority	Paratransit
TX		
Austin	Capital Metropolitan Transportation Authority	Fixed route/Paratransit
Bryan	Brazos Transit District	Paratransit
Dallas	Dallas Area Rapid Transit	Paratransit
Tyler	City of Tyler	Paratransit
VA		
Alexandria	City of Alexandria—Alexandria Transit Company	Fixed route
WA		
Bremerton	Kitsap Transit	Paratransit
Seattle	King County Department of Transportation—Metro Transit Division	Fixed route
Seattle	King County Department of Transportation—Metro Transit Division	Paratransit
Spokane	Spokane Transit Authority	Paratransit
Vancouver	Clark County Public Transportation Benefit Area Authority	Fixed route

2006 MDT Survey: Applications—Maintenance Data from MDT

Report A2-H6

State/City	Transit Agency	Alarm for Scheduled Maintenance?	Verify Performed Maintenance?
AZ			
Surprise	Surprise Dial-A-Ride Transit System	Yes	Yes
Tucson	City of Tucson	Yes	Yes
CA			
Fresno	Fresno Area Express	Yes	Yes
Lancaster	Antelope Valley Transit Authority	Yes	Yes
Livermore	Livermore/Amador Valley Transit Authority	Yes	No
FL			
Tampa	Hillsborough Area Regional Transit Authority	Yes	Yes
IL			
Arlington Heights	Pace—Suburban Bus Division	Yes	No
NV			
Reno	Regional Transportation Commission of Washoe County	Yes	Yes
TN			
Johnson City	Johnson City Transit System	Yes	Yes
WA			
Seattle	King County Department of Transportation—Metro Transit Division	Yes	No

2006 MDT Survey: Applications—Fueling and Consumables

Report A2-H7

State	Transit Agency	City	Identify Fueling and Consumable Supplies by Vehicle and Driver Through
AL			
	Montgomery Area Transit System	Montgomery	No
AZ			
	City of Tucson	Tucson	Yes
	City of Glendale Transit	Glendale	No
	City of Phoenix Public Transit Department	Phoenix	No
	Sun Cities Area Transit System, Inc.	Sun City	No
	Surprise Dial-A-Ride Transit System	Surprise	No
CA			
	Simi Valley Transit	Simi Valley	No
	San Joaquin Regional Transit District	Stockton	No
	Livermore/Amador Valley Transit Authority	Livermore	No
	Sacramento Regional Transit District	Sacramento	No
	City of Visalia—Visalia City Coach	Visalia	No
	Antelope Valley Transit Authority	Lancaster	Yes
	Fresno Area Express	Fresno	Yes
	Yuba–Sutter Transit Authority	Marysville	No
	San Mateo County Transit District	San Carlos	No
	Omnitrans	San Bernardino	No
	Eastern Contra Costa Transit Authority	Antioch	No
CO			
	City of Loveland Transit	Loveland	No
DE			
	Delaware Transit Corporation	Dover	No

State	Transit Agency	City	Identify Fueling and Consumable Supplies by Vehicle and Driver Through
FL			
	Central Florida Regional Transportation Authority	Orlando	No
	Escambia County Area Transit	Pensacola	No
	Pasco County Public Transportation	New Port Richey	No
	County of Volusia (VOTRAN)	South Daytona	No
	Central Florida Regional Transportation Authority	Orlando	No
	Hillsborough Area Regional Transit Authority	Tampa	No
IA			
	Five Seasons Transportation and Parking	Cedar Rapids	No
IL			
	Rockford Mass Transit District	Rockford	No
	Bloomington–Normal Public Transit System	Bloomington	No
	Pace—Suburban Bus Division	Arlington Heights	No
IN			
	City of Anderson Transportation System	Anderson	No
	Muncie Indiana Transit System	Muncie	No
	East Chicago Transit	East Chicago	Yes
	Michigan City Municipal Coach	Michigan City	No
LA			
	City of Alexandria	Alexandria	No
	Shreveport Area Transit System	Shreveport	No
MA			
	Montachusett Regional Transit Authority	Fitchburg	No
	Brockton Area Transit Authority	Brockton	No
MD			
	Annapolis Department of Transportation	Annapolis	No
	Harford Transit	Bel Air	No
ME			
	Casco Bay Island Transit District	Portland	No
	The Regional Transportation Program, Inc.	Portland	No

State	Transit Agency	City	Identify Fueling and Consumable Supplies by Vehicle and Driver Through
MI			
	Blue Water Area Transportation Commission	Port Huron	No
MN			
	Duluth Transit Authority	Duluth	No
	Metro Transit	Minneapolis	No
MO			
	St. Joseph Transit	St. Joseph	No
NC			
	High Point Transit	High Point	No
	Research Triangle Regional Public Transportation Authority	Research Triangle Park	No
NE			
	StarTran	Lincoln	No
NH			
	Nashua Transit System	Nashua	No
NJ			
	Port Authority Transit Corporation	Lindenwold	No
NM			
	Santa Fe Trails—City of Santa Fe	Santa Fe	No
NV			
	Regional Transportation Commission of Washoe County	Reno	No
NY			
	Village of Spring Valley Bus	Spring Valley	No
	Metro–North Commuter Railroad Company (MTA Metro–North)	New York	No
	GTJC	Jamaica	No
	Suffolk County Department of Public Works—Transportation	Yaphank	No
	Staten Island Rapid Transit Operating Authority (MTA Staten Is.)	Brooklyn	No
	Putnam County Transit	Carmel	No

State	Transit Agency	City	Identify Fueling and Consumable Supplies by Vehicle and Driver Through
OH			
	Metro Regional Transit Authority	Akron	No
	Clermont Transportation Connection	Batavia	Yes
	Metro Regional Transit Authority	Akron	No
	City of Newark Transit Operations	Newark	No
	Central Ohio Transit Authority	Columbus	No
OK			
	Central Oklahoma Transportation and Parking Authority	Oklahoma City	No
OR			
	Tri-County Metropolitan Transportation District of Oregon	Portland	No
PA			
	Southeastern Pennsylvania Transportation Authority	Philadelphia	No
	Access Transportation Systems, Inc.	Pittsburgh	No
	Luzerne County Transportation Authority	Kingston	Yes
	Cambria County Transit Authority	Johnstown	No
PR			
	Municipality of Vega Baja	Vega Baja	No
TN			
	Jackson Transit Authority	Jackson	No
	Johnson City Transit System	Johnson City	Yes
TX			
	Brazos Transit District	Bryan	No
	Metropolitan Transit Authority of Harris County, Texas	Houston	No
	Hill Country Transit District	San Saba	No
	Dallas Area Rapid Transit	Dallas	No
	Capital Metropolitan Transportation Authority	Austin	No
	Abilene Transit System	Abilene	No
	City of Tyler	Tyler	No
	Midland–Odessa Urban Transit District	Odessa	No

State	Transit Agency	City	Identify Fueling and Consumable Supplies by Vehicle and Driver Through
VA			
	Potomac and Rappahannock Transportation Commission	Woodbridge	No
	City of Alexandria—Alexandria Transit Company	Alexandria	No
WA			
	Clark County Public Transportation Benefit Area Authority	Vancouver	No
	Spokane Transit Authority	Spokane	No
	Kitsap Transit	Bremerton	No
	Snohomish County Transportation Benefit Area Corporation	Everett	No
	Skagit Transit	Burlington	No
	King County Department of Transportation—Metro Transit	Seattle	No
WI			
	Eau Claire Transit	Eau Claire	No
	City of Waukesha Transit Commission	Waukesha	No
	Janesville Transit System	Janesville	No
	Fond du Lac Area Transit	Fond du Lac	No
	City of Appleton—Valley Transit	Appleton	No
WY			
	City of Casper	Casper	No

2006 MDT Survey: MDT-Based Performance Measurement

Report A2-H8

Transit Agency	Calculation of Periodic Performance Measures Based on MDT Data Collection
Antelope Valley Transit Authority	Passengers carried/Revenue received/Passenger miles/Revenue miles/Passengers per vehicle-mile/Passengers per revenue-mile/Passengers per vehicle-hour/Passengers per revenue-mile/Mean time between failures (equipment breakdown)/Mean miles between failures
Blue Water Area Transportation Commission	Passengers carried/Revenue received/Passenger miles/Revenue miles/Passengers per vehicle-mile/Passengers per revenue-mile/Passengers per vehicle-hour/Passengers per revenue-mile
Brazos Transit District	Passengers carried/Revenue received/Passenger miles/Revenue miles/Passengers per vehicle-mile/Passengers per revenue-mile/Passengers per vehicle-hour/Passengers per revenue-mile
Central Florida Regional Transportation Authority	Passengers carried/Revenue received/Passenger miles/Revenue miles/Passengers per vehicle-mile/Passengers per revenue-mile/Passengers per vehicle-hour/Passengers per revenue-mile
City of Glendale Transit	Passengers carried/Passengers per revenue-mile
City of Phoenix Public Transit Department	Passengers carried/Revenue miles
City of Tucson	Passengers carried/Revenue received/Passenger miles/Revenue miles/Passengers per vehicle-mile/Passengers per revenue-mile/Passengers per vehicle-hour/Passengers per revenue-mile
City of Tyler	Passengers carried/Revenue received/Passenger miles/Revenue miles/Passengers per vehicle-mile/Passengers per revenue-mile/Passengers per vehicle-hour/Passengers per revenue-mile
City of Waukesha Transit Commission	Revenue miles
Clark County Public Transportation Benefit Area Authority	Passengers carried/Passenger miles/Revenue miles/Passengers per vehicle-mile/Passengers per revenue-mile/Passengers per vehicle-hour/Passengers per revenue-mile

Transit Agency	Calculation of Periodic Performance Measures Based on MDT Data Collection
County of Volusia (VOTRAN)	Passengers carried/Revenue received/Passenger miles/Revenue miles/Passengers per vehicle-mile/Passengers per revenue-mile/Passengers per vehicle-hour/Passengers per revenue-mile
Dallas Area Rapid Transit	Passenger miles/Revenue miles
Delaware Transit Corporation	Passengers carried/Passenger miles/Revenue miles/Passengers per vehicle-mile/Passengers per revenue-mile/Passengers per vehicle-hour/Passengers per revenue-mile
Eastern Contra Costa Transit Authority	Passengers carried/Passenger miles/Revenue miles
Five Seasons Transportation and Parking	Revenue miles
Fresno Area Express	Passengers carried/Revenue received/Passenger miles/Revenue miles/Mean miles between failures (equipment breakdown)
Johnson City Transit System	Passengers carried/Revenue received/Passenger miles/Revenue miles/Passengers per vehicle-mile/Passengers per revenue-mile/Passengers per vehicle-hour/Passengers per revenue-mile
King County Department of Transportation—Metro Transit	Passengers carried/Revenue received/Passenger miles/Revenue miles/Passengers per vehicle-mile/Passengers per revenue-mile/Passengers per vehicle-hour/Passengers per revenue-mile
Kitsap Transit	Passengers carried/Revenue received/Passenger miles/Revenue miles/Passengers per vehicle-mile/Passengers per revenue-mile/Passengers per vehicle-hour/Passengers per revenue-mile
Metro Regional Transit Authority	Passengers carried
Metro Transit	Passengers carried/Revenue received
Montachusett Regional Transit Authority	Passengers carried/Revenue received/Revenue miles/Passengers per vehicle-hour/Passengers per revenue-mile
Omnitrans	Passengers carried/Passenger miles/Revenue miles/Passengers per vehicle-mile/Passengers per revenue-mile/Passengers per vehicle-hour/Passengers per revenue-mile

Transit Agency	Calculation of Periodic Performance Measures Based on MDT Data Collection
Pace—Suburban Bus Division	Passengers carried/Revenue received/Revenue miles/Passengers per vehicle-hour
	Passengers carried/Passenger miles/Revenue miles/Passengers per vehicle-mile/Passengers per revenue-mile/Passengers per vehicle-hour/Passengers per revenue-mile
Potomac and Rappahannock Transportation Commission	Passengers carried/Passenger miles
Regional Transportation Commission of Washoe County	Passengers carried/Passenger miles/Revenue miles
Sacramento Regional Transit District	Passengers carried/Revenue received
San Mateo County Transit District	Passengers carried/Passenger miles/Revenue miles/Passengers per vehicle-mile/Passengers per revenue-mile/Passengers per vehicle-hour/Passengers per revenue-mile
Santa Fe Trails—City of Santa Fe	Passengers carried/Revenue received/Passenger miles/Passengers per vehicle-mile/Passengers per revenue-mile/Passengers per vehicle-hour/Passengers per revenue-mile
Southeastern Pennsylvania Transportation Authority	Passenger miles
Spokane Transit Authority	Passengers carried/Revenue received/Passenger miles/Revenue miles/Passengers per vehicle-mile/Passengers per revenue-mile/Passengers per vehicle-hour/Passengers per revenue-mile
Surprise Dial-A-Ride Transit System	Passengers carried/Revenue received/Passenger miles/Revenue miles/Passengers per vehicle-mile/Passengers per revenue-mile/Passengers per vehicle-hour/Passengers per revenue-mile
Tri-County Metropolitan Transportation District of Oregon	Passengers carried/Passenger miles/Revenue miles/Passengers per vehicle-mile/Passengers per revenue-mile/Passengers per vehicle-hour/Passengers per revenue-mile

2006 MDT Survey: Integration of Spatial Data Applications

Report A2-H9

Transit Agency	How Is Data Collected from MDT Integrated with Other Spatial Data Applications?
Antelope Valley Transit Authority	Integrated data files through relational database on central server (software) (e.g., data integrated though linking key fields VID, latitude/longitude, GPS date/time).
Central Ohio Transit Authority	Integrated data files through relational database on central server (software) (e.g., data integrated though linking key fields VID, latitude/longitude, GPS date/time).
City of Phoenix Public Transit Department	Integrated data files through relational database on central server (software) (e.g., data integrated though linking key fields VID, latitude/longitude, GPS date/time).
City of Tyler	Integrated data files through relational database on central server (software) (e.g., data integrated though linking key fields VID, latitude/longitude, GPS date/time).
Clark County Public Transportation Benefit Area Authority	Integrated data files through relational database on central server (software) (e.g., data integrated though linking key fields VID, latitude/longitude, GPS date/time).
Delaware Transit Corporation	Not integrated
Eastern Contra Costa Transit Authority	Integrated data files through relational database on central server (software) (e.g., data integrated though linking key fields VID, latitude/longitude, GPS date/time).
Fresno Area Express	Integrated data collection device (hardware) on vehicle (e.g., GPS temporal and spatial stamp sent with data record).
King County Department of Transportation—Metro Transit	Integrated data collection device (hardware) on vehicle (e.g., GPS temporal and spatial stamp sent with data record). Integrated data collection device (hardware) on vehicle (e.g., GPS temporal and spatial stamp sent with data record).
Kitsap Transit	Integrated data files through relational database on central server (software) (e.g., data integrated though linking key fields VID, latitude/longitude, GPS date/time).
Metro Regional Transit Authority	Integrated data files through relational database on central server (software) (e.g., data integrated though linking key fields VID, latitude/longitude, GPS date/time).
Metro Transit	Integrated data collection device (hardware) on vehicle (e.g., GPS temporal and spatial stamp sent with data record).

Transit Agency	How Is Data Collected from MDT Integrated with Other Spatial Data Applications?
Pace—Suburban Bus Division	Integrated data collection device (hardware) on vehicle (e.g., GPS temporal and spatial stamp sent with data record).
Potomac and Rappahannock Transportation Commission	Integrated data collection device (hardware) on vehicle (e.g., GPS temporal and spatial stamp sent with data record).
Regional Transportation Commission of Washoe Cyount	Integrated data files through relational database on central server (software) (e.g., data integrated though linking key fields VID, latitude/longitude, GPS date/time).
Research Triangle Regional Public Transportation Authority	Integrated data files through relational database on central server (software) (e.g., data integrated though linking key fields VID, latitude/longitude, GPS date/time).
San Joaquin Regional Transit District	Integrated data files through relational database on central server (software) (e.g., data integrated though linking key fields VID, latitude/longitude, GPS date/time).
San Mateo County Transit District	Integrated data files through relational database on central server (software) (e.g., data integrated though linking key fields VID, latitude/longitude, GPS date/time).
Spokane Transit Authority	Integrated data collection device (hardware) on vehicle (e.g., GPS temporal and spatial stamp sent with data record).
St. Joseph Transit	Not integrated
Tri-County Metropolitan Transportation District of Oregon	Integrated data collection device (hardware) on vehicle (e.g., GPS temporal and spatial stamp sent with data record).

2006 MDT Survey: Unit Cost of Mobile Data Terminals

Report A2-I1

State/Transit Agency	What Was the Unit Cost of the MDT for Your Most Recent Deployment?
AZ	
City of Phoenix Public Transit Department	$2,000
CA	
Eastern Contra Costa Transit Authority	Entire cost was $19,005 per bus. MTC only was $1,395
San Joaquin Regional Transit District	$22,000
San Mateo County Transit District	Approximate cost $6,500 per unit
Fresno Area Express	$2,000
IL	
Pace—Suburban Bus Division	$3,600 hardware; $525 associated hardware/training
MN	
Metro Transit	$982—Important to note that MDT is separate unit in the Siemens TransitMaster system. It is just a display unit and is connected to a separate onboard computer.
MO	
St. Joseph Transit	$9,880
NC	
Research Triangle Regional Public Transportation Authority	Initial cost of the MDT by unit was $895/per unit back in 2000.
NV	
Regional Transportation Commission of Washoe County	$2,000
OH	
Metro Regional Transit Authority	$3,000
Central Ohio Transit Authority	Unknown
OR	
Tri-County Metropolitan Transportation District of Oregon	$4,200 per unit
TX	
City of Tyler	$3,500

State/Transit Agency	What Was the Unit Cost of the MDT for Your Most Recent Deployment?
VA	
Potomac and Rappahannock Transportation Commission	$3,695
WA	
King County Department of Transportation—Metro Transit Division	Unit Cost $3,960 + tax
Spokane Transit Authority	$1,250
Kitsap Transit	$3,590
Clark County Public Transportation Benefit Area Authority	$10,000 per vehicle installation included

2006 MDT Survey: MDT Installation Costs

Report A2-I2

State/Transit Agency	What Was the Unit Cost of Installation of the MDT for Your Most Recent Deployment?
AZ	
City of Phoenix Public Transit Department	$640/unit
CA	
Eastern Contra Costa Transit Authority	See above
San Joaquin Regional Transit District	$1,000
San Mateo County Transit District	Installation at 6 hours per bus for communication system installation (Orbital). Estimate $125 per hour
Fresno Area Express	$13,000
IL	
Pace—Suburban Bus Division	Above costs included installation, training, and 1-year warranty.
MN	
Metro Transit	True per unit cost for installation needs to include on-board computer, wiring, antennas, and associated mounting hardware. This cost = $5,251. Passenger count functionality = $3,659. Data radio = ~$800
MO	
St. Joseph Transit	$533
NC	
Research Triangle Regional Public Transportation Authority	Initial cost of the MDT installation was $150 per unit back in 2000.
NV	
Regional Transportation Commission of Washoe County	$500
OH	
Metro Regional Transit Authority	$1,600
Central Ohio Transit Authority	Unknown
OR	
Tri-County Metropolitan Transportation District of Oregon	$500–$1,000 per unit
TX	
City of Tyler	$125

State/Transit Agency	What Was the Unit Cost of Installation of the MDT for Your Most Recent Deployment?
VA	
Potomac and Rappahannock Transportation Commission	$750
WA	
King County Department of Transportation—Metro Transit Division	$250
Spokane Transit Authority	N/A
Kitsap Transit	$275

2006 MDT Survey: Labor Hours per MDT Installation

Report A2-I3

State/Transit Agency	How Many Labor Hours Were Expended to Install an Individual MDT for Your Most Recent Deployment
AZ	
City of Phoenix Public Transit Department	8 h
CA	
Eastern Contra Costa Transit Authority	100 h
San Joaquin Regional Transit District	24 h
San Mateo County Transit District	6 h
Fresno Area Express	12 h
Antelope Valley Transit Authority	1.5 h
IL	
Pace—Suburban Bus Division	Unknown as Mentor provided installation via a subcontractor as part of the purchase contract.
MN	
Metro Transit	~20 man-hours per bus
MO	
St. Joseph Transit	10 h
NV	
Regional Transportation Commission of Washoe County	5 h
OH	
Metro Regional Transit Authority	8 h
Central Ohio Transit Authority	Unknown
OR	
Tri-County Metropolitan Transportation District of Oregon	Factory install = 4 h. In-house retrofit = 8 h
TX	
City of Tyler	Unknown

State/Transit Agency	How Many Labor Hours Were Expended to Install an Individual MDT for Your Most Recent Deployment
VA	
Potomac and Rappahannock Transportation Commission	Unknown
WA	
King County Department of Transportation—Metro Transit	Do not know, paid per unit.
Spokane Transit Authority	4 h
Clark County Public Transportation Benefit Area Authority	4 h per vehicle
Kitsap Transit	3 man-hours per vehicle

2006 MDT Survey: MDT Maintenance/Repair Cost

Report A2-I4

State/Transit Agency	What Is the Average Annual Unit Cost to Maintain/ Repair an Individual MDT for Your Deployment?
AZ	
City of Phoenix Public Transit Department	$200
CA	
Eastern Contra Costa Transit Authority	$100
San Joaquin Regional Transit District	$68,000
San Mateo County Transit District	$400 (cost equals $800 per unit for repairs * 50% of fleet needing repair)
Fresno Area Express	$700
IL	
Pace—Suburban Bus Division	Unknown. System acceptance has not yet occurred; therefore, Pace has no direct experience with maintenance and repair of the units.
MN	
Metro Transit	Unknown at time—currently under warranty—contact Siemens for details
MO	
St. Joseph Transit	$500
NV	
Regional Transportation Commission of Washoe County	$100
OH	
Metro Regional Transit Authority	$685
Central Ohio Transit Authority	Unknown
OR	
Tri-County Metropolitan Transportation District of Oregon	$111 per unit
TX	
City of Tyler	$125

State/Transit Agency	What Is the Average Annual Unit Cost to Maintain/ Repair an Individual MDT for Your Deployment?
VA	
Potomac and Rappahannock Transportation Commission	$500—Through maintenance agreement
WA	
King County Department of Transportation—Metro Transit	Do not know; contracted cost for extended warranty is $366/vehicle (first year)
Spokane Transit Authority	30 h
Clark County Public Transportation Benefit Area Authority	System is to new to identify this cost
Kitsap Transit	$104

2006 MDT Survey: Labor Hours for MDT Maintenance and Repair

Report A2-I5

State/Transit Agency	What Are the Average Annual Labor Hours to Maintain/Repair an Individual MDT for Your Deployment?
AZ	
City of Phoenix Public Transit Department	Currently under warranty. Usually 20 minutes for repairs.
CA	
Eastern Contra Costa Transit Authority	10 h
San Joaquin Regional Transit District	4,160 h
San Mateo County Transit District	4.71 [428 units * 1 full-time person (2020 h)]. Note that this person also repairs other system components in Orbital communication system. MDT equals approximately 50% of time.
Fresno Area Express	8 h
IL	
Pace—Suburban Bus Division	Unknown. See above.
MN	
Metro Transit	3 h x $72/h
MO	
St. Joseph Transit	5 h
NV	
Regional Transportation Commission of Washoe	2.5 h
OH	
Metro Regional Transit Authority	800 h
Central Ohio Transit Authority	Unknown
OR	
Tri-County Metropolitan Transportation District of Oregon	1.5 FTE for 900 units
TX	
City of Tyler	2.5 h

State/Transit Agency	What Are the Average Annual Labor Hours to Maintain/Repair an Individual MDT for Your Deployment?
VA	
Potomac and Rappahannock Transportation	Unknown
WA	
King County Department of Transportation—Metro Transit	Do not know (not past warranty yet)
Spokane Transit Authority	Estimated $5,000 per year
Clark County Public Transportation Benefit Area	System is too new to identify this number
Kitsap Transit	No data as yet

2006 MDT Survey: IT and Communications Support for MDTs

Report A2-I6

State/Transit Agency	Transit Agency Provide Infrastructure?	If Yes: What Is the Annual Personnel Cost? If No: How Provided?
AZ		
City of Phoenix Public Transit Department	Yes	Data not available
CA		
San Mateo County Transit District	Yes	$151,000 (2,020 h x $75.00 per h)
Fresno Area Express	Yes	$50,000
Antelope Valley Transit Authority	Yes	$55,000
Eastern Contra Costa Transit Authority	Yes	$25,000 contracted
IL		
Pace—Suburban Bus Division	Yes	Pace does not dedicate staff to maintain either the Trapeze or Mentor systems. Therefore, it is difficult to determine exact costs. From an FTE perspective, approximately 1/2 FTE paratransit staff and 1/2 FTE IT staff for the Trapeze and Mentor systems.
MN		
Metro Transit	Yes	Question is somewhat vague. System is currently under warranty. Agency provides IT support within the Transit Control Center (TCC) department via TCC Assistant Manager—Systems, System Administrator, Geo-Code Supervisor, and Electronics Repair Department.
NV		
Regional Transportation Commission of Washoe Co.	Yes	We did not have dedicated IT and communications infrastructure resources for the MDT deployment. Personnel are assigned duties in addition to their normal work load.
OH		
Metro Regional Transit Authority	Yes	$20,000
Central Ohio Transit Authority	Yes	2 FTEs
OR		
Tri-County Metropolitan Transportation District of Oregon	Yes	15 FTE @ $75,000 per FTE = $1,125,000
TX		
City of Tyler	No	IT support by city computer department. Communication support by Cingular.

State/Transit Agency	Transit Agency Provide Infrastructure?	If Yes: What Is the Annual Personnel Cost? If No: How Provided?
VA		
Potomac and Rappahannock Transportation Commission	Yes	~$200,000
WA		
King County Department of Transportation—Metro Transit	No	Communications provided through Cingular; IT through contracted call center.
Spokane Transit Authority	Yes	Approximately $32,000 per year
Kitsap Transit	No	We contract out our information technology on a four-year contract. They provide support for our internal network. Greyhawk technology has remote access to their database and provides the support for the MDT server and MDTS.
Clark County Public Transportation Benefit Area	Yes	$50,000
King County Department of Transportation—Metro Transit	Yes	2

2006 MDT Survey: TA Support for MDT Data Analysis

Report A2-I7

State/Transit Agency	Dedicated Analytical Staff?	What Are the Annual Costs and Hours for Data Analysis and Reporting?
AZ		
City of Phoenix Public Transit Department	Yes	Data not available
CA		
Antelope Valley Transit Authority	Yes	Cost/year: $65,000: 500 h/year
Fresno Area Express	Yes	$20,000.00
Eastern Contra Costa Transit Authority	No	Everybody does different jobs so there is no dedicated staff; everybody just helps out.
MN		
Metro Transit	Yes	Analysis and reporting for this system roughly equal 1 FTE on an annual basis. This cost is ~$65,000–$70,000 annually.
OH		
Central Ohio Transit Authority	Yes	0.25 FTE
OR		
Tri-County Metropolitan Transportation District of Oregon	Yes	2 FTE @ $75,000 per FTE = $150,000
TX		
City of Tyler	Yes	About 0.5 FTE. Rate of pay for current employee is $8.85 per hour
VA		
Potomac and Rappahannock Transportation Commission	No	We have staff, but they are not dedicated; analysis is sporadic.
WA		
King County Department of Transportation— Metro Transit Division	No	Analysis and reporting accomplished through contracted call center IT staff.
King County Department of Transportation—Metro Transit	Yes	1/2
Kitsap Transit	No	One of our staff runs monthly reports and presents that information to management monthly. This is a very small part of her job.
Spokane Transit Authority	Yes	Approximately 2,080 h/year
Clark County Public Transportation Benefit Area Authority	Yes	Included in above cost

2006 MDT Survey: Staff Acceptance of MDT Rating by Type

Report A2-J1

State/Transit Agency	Executive Staff	Admin./Clerical	Operations Supervisory	Drivers	Maintenance
AZ					
City of Phoenix Public Transit Department	4	4	4	4	4
CA					
Eastern Contra Costa Transit Authority	4	4	4	4	4
San Mateo County Transit District	4	3	4	5	3
Fresno Area Express	5	5	5	5	5
San Joaquin Regional Transit District	4	4	4	4	4
Antelope Valley Transit Authority	5	5	5	4	4
DE					
Delaware Transit Corporation	4	5	2	1	2
IL					
Pace—Suburban Bus Division	5	5	4	5	3
MN					
Metro Transit	3	5	5	4	3
MO					
St. Joseph Transit	5	5	5	5	5
NC					
Research Triangle Regional Public Transportation Authority	4	4	3	2	2
NV					
Regional Transportation Commission of Washoe County	5	4	4	4	4
OH					
Metro Regional Transit Authority	3	3	3	3	3
Central Ohio Transit Authority	4	3	3	3	2
OR					
Tri-County Metropolitan Transportation District of Oregon	4	4	5	4	2
TX					
City of Tyler	5	4	5	4	4

State/Transit Agency	Executive Staff	Admin./Clerical	Operations Supervisory	Drivers	Maintenance
VA					
Potomac and Rappahannock Transportation Commission	5	5	5	5	3
WA					
Spokane Transit Authority	3	3	5	5	3
King County Department of Transportation—Metro Transit Div.	4	4	4	4	4
Kitsap Transit	4	5	5	5	
Clark County Public Transportation Benefit Area Authority	5	4	5	4	4
King County Department of Transportation—Metro Transit Div.	5	5	5	5	5

2006 MDT Survey: Operational/Technical Problems Encountered

Report A2-K1

State/Transit Agency	What Types of Problems Were Encountered in the Deployment (choose from a list)?
AZ	
City of Phoenix Public Transit Department	MDT equipment manufacturing defects/MDT installation problems/MDT reliability in operating environment/MDT sabotage
CA	
Eastern Contra Costa Transit Authority	MDT installation problems/MDT driver training problems
San Mateo County Transit District	MDT equipment design flaws/MDT installation problems
Fresno Area Express	MDT equipment design flaws/MDT equipment manufacturing defects/MDT installation problems
San Joaquin Regional Transit District	MDT reliability in operating environment
DE	
Delaware Transit Corporation	MDT equipment design flaws/MDT equipment manufacturing defects/MDT reliability in operating environment/MDT driver training problems/MDT installer/maintainer training problems/MDT communications infrastructure problems
IL	
Pace—Suburban Bus Division	MDT equipment design flaws/MDT equipment manufacturing defects/MDT installation problems/MDT installer/maintainer training problems/MDT communications infrastructure problems
MN	
Metro Transit	MDT equipment design flaws/MDT equipment manufacturing defects/MDT installation problems/MDT reliability in operating environment/MDT driver training problems/MDT installer/maintainer training problems
MO	
St. Joseph Transit	MDT driver training problems/MDT communications infrastructure problems
NC	
Research Triangle Regional Public Transportation Authority	MDT equipment design flaws/MDT equipment manufacturing defects/MDT driver training problems
NV	
Regional Transportation Commission of Washoe County	MDT equipment manufacturing defects/MDT driver training problems/MDT installer/maintainer training problems/MDT sabotage

State/Transit Agency	What Types of Problems Were Encountered in the Deployment (choose from a list)?
OH	
Central Ohio Transit Authority	MDT equipment design flaws/MDT equipment manufacturing defects/MDT installation problems/MDT reliability in operating environment/MDT driver training problems/MDT installer/maintainer training problems/MDT manufacturer/vendor warranty compliance/MDT communication infrastructure problems
Metro Regional Transit Authority	MDT installation problems/MDT reliability in operating environment/MDT driver training problems/MDT installer/maintainer training problems/MDT communications infrastructure problems/MDT sabotage
OR	
Tri-County Metropolitan Transportation District of Oregon	MDT equipment manufacturing defects/MDT installation problems/MDT driver training problems/MDT installer/maintainer training problems/MDT communications infrastructure problems
TX	
City of Tyler	MDT installation problems/MDT driver training problems/MDT communications infrastructure problems
VA	
Potomac and Rappahannock Transportation Commission	MDT installation problems/MDT reliability in operating environment/MDT driver training problems/MDT communications infrastructure problems/MDT sabotage
WA	
Spokane Transit Authority	MDT equipment design flaws/MDT installation problems/MDT installer/maintainer training problems
King County Department of TransportationóMetro Transit	MDT equipment manufacturing defects/MDT installation problems/MDT reliability in operating environment/MDT driver training problems/MDT communications infrastructure problems/MDT sabotage
Kitsap Transit	MDT communications infrastructure problems
Clark County Public Transportation Benefit Area Authority	MDT installer/maintainer training problems/MDT communications infrastructure problems
King County Department of Transportation—Metro Transit Division	MDT equipment design flaws/MDT equipment manufacturing defects/MDT installation problems/MDT reliability in operating environment/MDT sabotage

2006 MDT Survey: Operational/Technical Solutions

Report A2-K2

State/Transit Agency	What Solutions Were Developed to Overcome Problems Previously Identified?
AZ	
City of Phoenix Public Transit Department	b. Covert mic failure. Replaced sound chip and installed in-line filter in all MDTs. c. Spotty, poor workmanship. Instituted 3 points QA check on all installs. d. Water leaks resulted in water intrusion into SMDTs. Phoenix fixed leaks, Orbital provided casketing. i. Still on-going at Mesa/RPTA. Thin narrow tool intrusion into SMDT with component damage to mother board.
CA	
San Mateo County Transit District	MDT equipment design flaws: MDTs had some internal problems with a chip program. The chips were replaced and everything seems to be working well. MDT installation problems: Major problem with Orbital system installation on vehicles.
San Joaquin Regional Transit District	We are still working on the solution.
Fresno Area Express	Software updates and patches/hardware updates and upgrades/supplied acceptance test procedures to subcontract
Eastern Contra Costa Transit Authority	Had problems installing the odometer readers. Also had trouble with the drivers' understanding of how to use the MDC.
IL	
Pace—Suburban Bus Division	Drivers who did not use the system on an ongoing basis were removed from service until retrained and using the system. Design flaws, equipment defects, installation problems have all been handled adequately by Mentor and/or Trapeze, as needed. Communications problems have and are being handled adequately by the combined efforts of Pace IT staff, Mentor, and Verizon Wireless.
MN	
Metro Transit	- equipment flaws example: onboard computer susceptible to water damage of electrical components. Vendor retrofitted buses experiencing problems to better protect computer. - manufacturing defects example: memory storage flashcards susceptible of getting corrupted during wireless downloads. Vendor had to replace all flashcards with a higher quality type. - installation problems: initial installation team was producing low-quality work not up to agency inspection standards. Vendor replaced installation firm with another. - reliability — MDTs were susceptible to locking up upon boot up. Took long time for vendor to isolate problem. Problem eventually isolated to software scripts being used by the mobile unit upon boot up. Change was made/sent to buses. Problem has now gone away. - driver training — long distance installation time makes it very difficult to train drivers. Drivers were trained, then install delays meant that some drivers did not see an installed bus until a long time after they were trained. Hence, there was difficulty for them to retain their training. Retraining sessions were needed. - installer/maintainer training — as noted above, a new install firm was brought in. This meant a learning curve for the new installers and caused some installation delay. On-site engineer was new to vendor at the start of the project. Again, learning curve needed. Only corrected by time as they gained more experience.
NC	
Research Triangle Regional Public Transportation	With equipment flaws we just send the units back to RSI and they correct the problems. With driver training, the retention of what is learned in training can sometimes overshadow remembering how to use the MDT.

State/Transit Agency	What Solutions Were Developed to Overcome Problems Previously Identified?
NV	
Regional Transportation Commission of Washoe County	Additional training; monitoring of driver conduct; manufacture provided remedy for MDT defects.
OH	
Metro Regional Transit Authority	Reliability: repaired and hardened. Driver training: retrain and advise as needed. Installer/maintainer training via experience. Radio infrastructure is inadequate for service area, awaiting funding for additional data repeaters. Sabotage is minimal; some
Central Ohio Transit Authority	internal feedback loops. Internal process improvements. Training. Vendor management.
OR	
Tri-County Metropolitan Transportation District of Oregon	MDT equipment manufacturing defects: DC to DC converters faulty; replaced under warranty. MDT installation problems: Checked each vehicle; covered by warranty. MDT driver training problems: Had to retrain due to unanticipated changes.
TX	
City of Tyler	Installation problems related to antenna attachment, installation company just added additional sealant. Training problems have been related to a few drivers that had problems with technology, some related to seeing the LCD screen, and some in just remembering to push the arrive or depart button, so busy talking to clients they just forget. Communications has been a real challenge, the network from Cingular has been good, but communication between the two servers, one for Mentor and one for RouteMatch, require attention on a weekly basis; resets of the communication software occur at least once a week (on average).
VA	
Potomac and Rappahannock Transportation Commission	We were a development site for the flex version of this system, both from the Greyhawk and Trapeze end. Actually, the Greyhawk system was the second go-around for us. We began the process in 1994. I have detailed descriptions of the program, trials and tribulations, timeline, etc., if you are interested.
WA	
King County Department of Transportation—Metro Transit Division	MDT equipment manufacturing defects; additional QA checks by MDT vendor. MDT installation problems—Vendor replaced installer; rechecked units. MDT reliability in operating environment, still working on: in process of upgrading processor OS, screen, MDT software, modem drivers. MDT sabotage — Increased supervision; made contractors financially responsible for intentional or accidental damage. MDT driver training problems — Originally planned classroom training was not feasible. Train-the-trainer and behind the wheel training were very successful. MDT manufacturer/vendor warranty compliance — not there yet. So far, vendor has tried to be responsive in addressing problems. MDT communications infrastructure problems — Switched to GPRS when CDPD discontinuation was announced. Added redundant Internet coverage to prevent internal Internet outages. No solution to occasional outages within Cingular.
Spokane Transit Authority	MDT equipment design flaws: Forced to limit trip comments to 30 characters. MDT installation problems: Difficulty connecting old model MDC with Ford 2006 vehicles. MDT installer/maintenance training problems: Due to maintenance work done on vehicles (disconnect battery) requiring reset on odometer calibration.
Kitsap Transit	Just before the installations of our MDT units AT&T and Cingular merged, which caused problems for our communications. We had unscheduled outages with no information for AT&T/Cingular. We are presently working with Greyhawk Technologies upgrading our MDT modems and firmware.
Clark County Public Transportation Benefit Area Authority	Replaced first installer group with another group that had a higher level of technical skills. For maintenance vendor provided additional training to staff at no additional cost. The location of old voice radio equipment was poor to support data communications. Solution was to move equipment to better tower location.

2006 MDT Survey: Security and Resilience of Communications

Report A2-L1

State/Transit Agency	Security Measures for MDT Communications	Resilience Built into Communications
AZ		
City of Phoenix Public Transit Department	Secure base station/secure auxiliary power generation for above/secure storage of mobile equipment, when not in service	Mobile to mobile transmission when base station and/or central tower is/are down/cooperative agreements with surrounding jurisdictions with duplicate communications systems in-place that can temporarily replace central dispatch functionality
CA		
Fresno Area Express	Secure base station/secure radio tower(s)/secure auxiliary power generation for above/encryption and decryption of data radio transmission/secure storage of mobile equipment, when not in service	Mobile to mobile transmission when base station and/or central tower is/are down/self-healing autonomous mesh networks for radio communications (e.g., multi-hop transmission and Internet communications protocols). Cooperative agreements with surrounding jurisdictions with duplicate communications systems in place that can temporarily replace central dispatch functionality.
San Mateo County Transit District	Secure radio tower(s)/secure auxiliary power generation for above	Mobile to mobile transmission when base station and/or central tower is/are down/self-healing autonomous mesh networks for radio communications (e.g., multi-hop transmission and Internet communications protocols)
MN		
Metro Transit	Secure base station/secure radio tower(s)/secure auxiliary power generation for above/secure storage of mobile equipment, when not in service	Mobile to mobile transmission when base station and/or central tower is/are down/self-healing autonomous mesh networks for radio communications (e.g., multi-hop transmission and Internet communications protocols)
MO		
St. Joseph Transit	Secure base station/secure radio tower(s)/secure auxiliary power generation for above/secure storage of mobile equipment, when not in service	Mobile to mobile transmission when base station and/or central tower is/are down
NV		
Regional Transportation Commission of Washoe County	Secure base station/secure radio tower(s)/secure auxiliary power generation for above/encryption and decryption of data radio transmission/secure storage of mobile equipment, when not in service	Self-healing autonomous mesh networks for radio communications (e.g., multi-hop transmission and Internet communications protocols)
OH		
Central Ohio Transit Authority	Secure base station/secure radio tower(s)/secure auxiliary power generation for above/encryption and decryption of data radio transmission/secure storage of mobile equipment, when not in service	Mobile to mobile transmission when base station and/or central tower is/are down

State/Transit Agency	Security Measures for MDT Communications	Resilience Built into Communications
OR		
Tri-County Metropolitan Transportation District of Oregon	Secure base station/secure radio tower(s)/secure auxiliary power generation for above/secure storage of mobile equipment, when not in service	Mobile to mobile transmission when base station and/or central tower is/are down
VA		
Potomac and Rappahannock Transportation Commission	Secure auxiliary power generation for above/secure storage of mobile equipment, when not in service	Mobile to mobile transmission when base station and/or central tower is/are down

2006 MDT Survey: Desired Functionality

Report A2-M1

Transit Agency — **Additional Functionality Desired Beyond Current Capabilities**

Abilene Transit System

Current capabilities are sufficient.

Annapolis Department of Transportation

We have no functions.

Antelope Valley Transit Authority

To provide navigational assistance to the drivers

Capital Metropolitan Transportation Authority

We are in the RFP stage of this technology and will start with basic capabilities and grow as we gain more expertise with the data and system.

Central Ohio Transit Authority

Track service and revenue miles and hours by GPS (fixed and paratransit). Display and process route manifest data on MDT (paratransit).

City of Casper

None

City of Phoenix Public Transit Department

Integration with new fare collection system (Scheidt & Bachman fare boxes) and Vehicle Maintenance Management System (SAP). Functions to be determined.

City of Tucson

Measurement of bus dwell time (this should be available with new release, TM02, real-time fare acknowledgement for paratransit)

City of Tyler

Web portal for clients to see real-time bus locations and trip data

City of Waukesha Transit Commission

1. Actual/average speed of vehicle; 2. Integration of demand response software with AVL/MDT technology; 3. Passenger counting/integration with farebox system

Duluth Transit Authority

Free text from vehicle to dispatch. Map on MDT screen with appropriate route

Fresno Area Express

We use our MDT for ADA and public relation announcements.

Johnson City Transit System

We do not have MDTs yet, but if we get them, we need the passenger data collected to be transferable to an Excel spreadsheet on a main computer at the transit center.

We would like the easiest possible way for our drivers to enter ridership data using the MDTs.

Transit Agency	Additional Functionality Desired Beyond Current Capabilities
King County Department of Transportation—Metro Division	Possibly integrated voice—data system; fare card reader built into MDT
Kitsap Transit	None at this time
Metro Regional Transit Authority	Vehicle to vehicle data messaging. Video. Mapping on MDT
Metro Transit	Current MDT display can be difficult to see. Better contrast and larger letters are needed to be seen in bright and bad lighting conditions. High desire in agency to display graphics on MDT. Example: display route maps, right/left turns, detours, alerts.
Metropolitan Transit Authority of Harris County	Daily reports, interface with records management
Montachusett Regional Transit Authority	NTD download data, onboard mapping
Montgomery Area Transit System	Automation is desired and we are currently researching several applications/vendors for the appropriate services.
Pace—Suburban Bus Division	Interface with revenue collection equipment Installation and integration of IVR with MDT to permit automatic call-out to riders as vehicle approaches.
Port Authority Transit Corporation	PATCO is considering the use of MDTs for track inspection. Also, MDTs originally specified for a new smart card fare collection system have been removed from the project.
Potomac and Rappahannock Transportation	Re: the previous page, I really do not know the technicalities of resilience.
Research Triangle Regional Public Transportation	If the MDT could be connected to the fare collection and/or the APC software to get an account of passengers by location or stop.
San Joaquin Regional Transit District	Passenger count and mileage count, voice announcements
San Mateo County Transit District	It would be good to have GIS mapping capability on the MDT for driver directions (paratransit operation)
Snohomish County Transportation Benefit Area	We are hiring a consultant to write specifications for CAD, AVL, APC, MDT, and IVR for our fixed routes and paratransit services.
Southeastern Pennsylvania Transportation Authority	Current system to be upgraded. Procurement underway.

Transit Agency	Additional Functionality Desired Beyond Current Capabilities
Spokane Transit Authority	Graphic display mapping; IVR call-outs
Sun Cities Area Transit System, Inc.	Funding for MDT systems
Tri-County Metropolitan Transportation District of Oregon	Decision support tools. More effective way to prioritize information received by dispatchers. Electronic manifest (paratransit). Wireless data transfer. Faster response between mobile and central (not necessarily faster data transfer). Real-time traffic conditions for paratransit drivers.

2006 MDT Survey: Planned Future Technology

Report A2-N1

State	Transit Agency	Additional Technology Applications Planned for Deployment
AL		
	Montgomery Area Transit System	We are looking to deploy an AVL system on our entire fleet, once we have researched our options.
AZ		
	City of Phoenix Public Transit Department	Integration with new fare collection system (Scheidt & Bachman fare boxes) and Vehicle Maintenance Management System (SAP).
	Sun Cities Area Transit System, Inc.	If funding available, dispatch to VDU in vehicles for routing.
	City of Glendale Transit	No additional applications planned at this time.
	City of Tucson	Passenger information signs at transit centers and stops, deploying digital microwave as a carrier
CA		
	City of Visalia—Visalia City Coach	Passenger counters
	San Joaquin Regional Transit District	Voice announcements by Ontaria Communications
	Livermore/Amador Valley Transit Authority	Real-time signage
	Antelope Valley Transit Authority	Smart cards, RF Proximity cards, Fleet maintenance software
	Fresno Area Express	We are planning to deploy web-based customer service using our MDT
	San Mateo County Transit District	Signal light prioritization, passenger information systems, fare box replacement and integration
CO		
	City of Loveland Transit	AVL system, digital video surveillance, electronic fare boxes
FL		
	Central Florida Regional Transportation Authority	IVR and web-based reservations, cancellations, and ETAs
	Hillsborough Area Regional Transit Authority	CAD/AVL, MDT/IVLU, 36% APC, CCTV, on-board cameras, AVAS, Wayside DMS, real-time predictions
IL		
	Rockford Mass Transit District	We are planning to buy 26 MDTs for our paratransit fleet that will include both GPS and AVL.
	Pace—Suburban Bus Division	Data backflow to scheduling system. IVR system for passenger information.
	Pace—Suburban Bus Division	IVR call-out, cancel/confirm. Integration of Trapeze's Complaint Module with PASS
IN		
	Michigan City Municipal Coach	We are a very small transit system; therefore, 2-way radios have been successful.
	Muncie Indiana Transit System	Next Bus Technology
	City of Anderson Transportation System	We just started using a dispatch software MOBILITAT makers of EASY RIDES; this has helped with those who are scheduling in the demand respond area only.

State	Transit Agency	Additional Technology Applications Planned for Deployment
MA		
	Montachusett Regional Transit Authority	Will be deploying technology into fixed-route vehicles in 2007.
MN		
	Metro Transit	Transit signal priority, real-time next arrival systems: IVR (via phone system), via agency web page, via signs at stops and transit centers, mobile supervisor application, transit police dispatch system interfaced to bus CAD and light rail control
	Duluth Transit Authority	None at this time
MO		
	St. Joseph Transit	Passenger count, web links to schedules, GPS-based ETAs on reader boards
NC		
	Research Triangle Regional Public Transportation	Automatic passenger counters, automatic voice annunciation, and electronic fare collection (new); just got last year
NM		
	Santa Fe Trails—City of Santa Fe	The city of Santa Fe has recently purchased Route Match's Fixed Route and Paratransit software, which will be used with 25 AVL units in the fixed-route buses and 14 Ranger MCDs from Mentor Engineering in the paratransit vans. These technologies are plann
NV		
	Regional Transportation Commission of Washoe Co.	Next bus notifications at bus stop, trip planning info
NY		
	Suffolk County Department of Public Works	AVL system, RFP issued. We will be investigating the use of MDTs.
OH		
	Central Ohio Transit Authority	Interface of MDT and scheduling (paratransit)
OR		
	Tri-County Metropolitan Transportation District of Oregon	802.11 for data transfer to/from vehicle. Real-time or near real-time video (will require faster data transfer). Deployment of MDTs to field supervisors.
PA		
	Access Transportation Systems, Inc.	We anticipate introducing MTD technology in our paratransit system in the next two to three years.
	Southeastern Pennsylvania Transportation Authority	New MDT, AVL, IVR, DRTS, voice radio, data radio
TX		
	Abilene Transit System	We want to begin use of MDT/AVLs within the next two years.
	Metropolitan Transit Authority of Harris County,	New additional Z-Client software, crime mobile application, new router to improve communications, broadband wireless card for web-based interface.

State	Transit Agency	Additional Technology Applications Planned for Deployment
	City of Tyler	1. Cameras with "snapshot" capability, sending real-time photo via MDT to office plus on-board recording; 2. passenger counters; 3. on-board proximity card readers for fare payment via MDC (or mag strip readers); 4. bus stop emergency phones, probably secure cell phone type system; 5. next bus utilizing real-time GPS data from vehicle; 6. web portal for clients, to view trip schedules on DR, request trips, view real-time location of FR buses.
	Hill Country Transit District	Within the next few years, HCTD plans to deploy ADP software and hardware, including MDTs and AVLs.
	Capital Metropolitan Transportation Authority	We would like to leverage the MDTs to collect non-cash fares for paratransit.
WA		
	Snohomish County Transportation Benefit Area	CAD, AVL, AAS, APC, MDT, and IVR
	Clark County Public Transportation Benefit Area	We are looking forward to deployment of ADA audio and visual announcements on all vehicles. Also using the data to provide next bus information via the web.
	Spokane Transit Authority	Web presence, web cam, wireless security
	Kitsap Transit	None at this time
	King County Department of Transportation—Metro Transit Division	Enhanced interactive voice response (dial out); smart cards (ìback officeî solution but no card readers to be used on paratransit fleet); web booking; interior/exterior cameras; interface between odometer and fueling data and maintenance software.
WI		
	City of Waukesha Transit Commission	MDT/AVL installed in new paratransit vehicles
WY		
	City of Casper	None

Abbreviations used without definitions in TRB publications:

AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	Air Transport Association
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation