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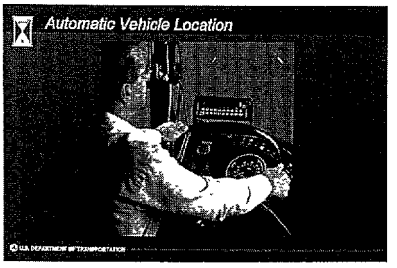


# Benefits Assessment of Advanced Public Transportation Systems

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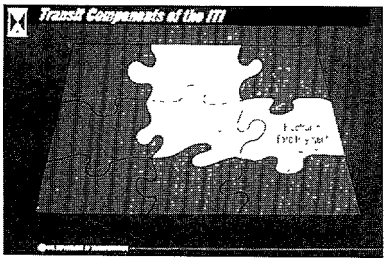


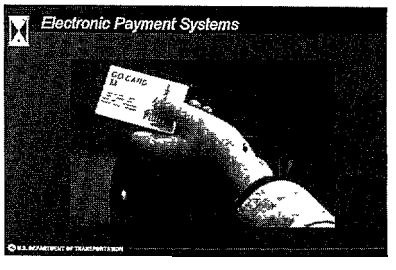


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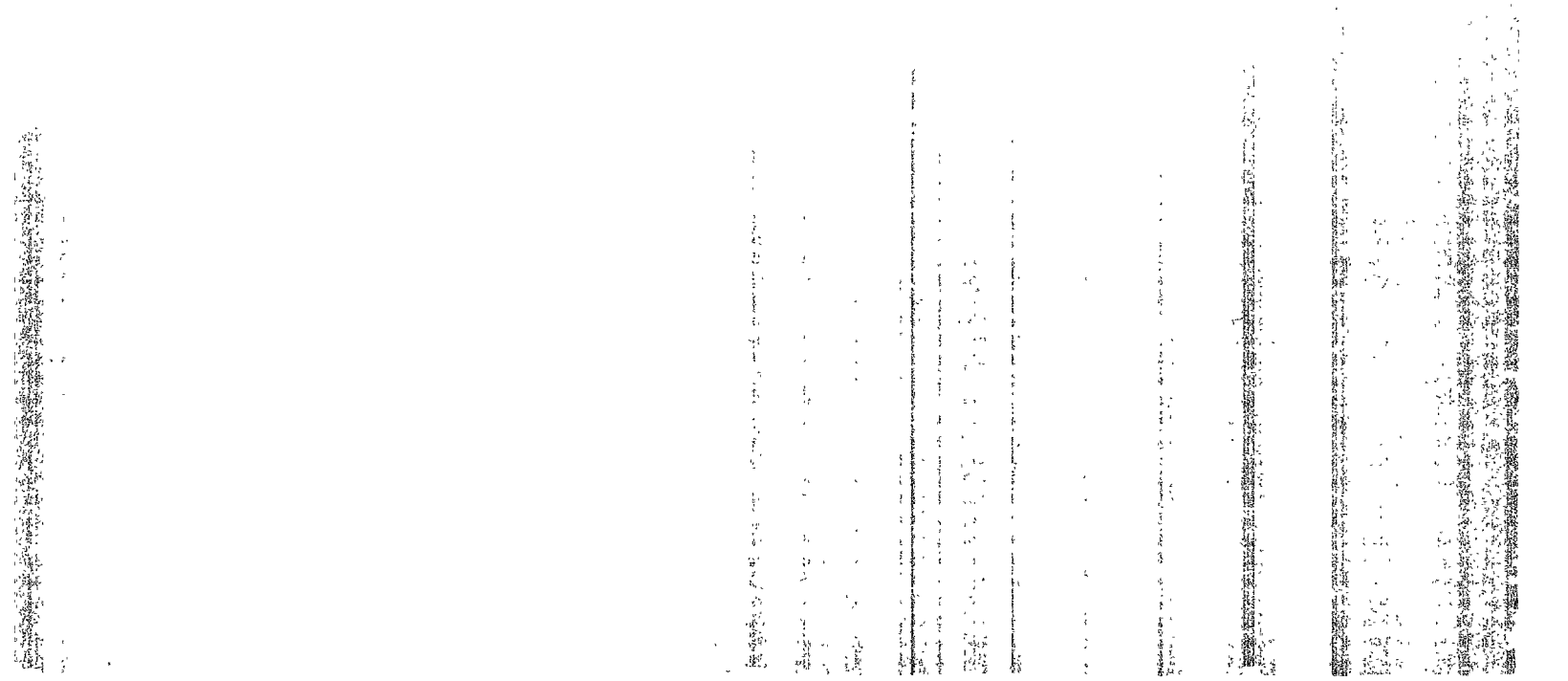

# Benefits Assessment of
# Advanced Public Transportation Systems (APTS)

July 30,1996

Prepared for:

Office of Mobility Innovation
Federal Transit Administration
U.S. Department of Transportation

Prepared by:

Office of Operations Engineering and Assessment
John A. Volpe National Transportation Systems Center
Research and Special Programs Administration
U.S. Department of Transportation

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This report documents work performed under FTA's Advanced Public Transportation Systems (APTS) Program, a program structured to undertake research and development of innovative applications of advanced navigation, information, and communication technologies that most benefit public transportation.

This report presents the results of an analysis conducted by the Volpe Center, for the FTA, to provide an "order-of-magnitude" estimate of the expected.benefits to the transit industry with the application of APTS technologies. Specifically, the study identified and quantified the major benefits derived from current applications of APTS technologies within the transit industry and projected current APTS benefits to a national level based on forecasts and reasonable assumptions on the potential future applications of such technologies within the transit industry.

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2

# LIST OF ACRONYMS AND ABBREVIATIONS USED IN THIS REPORT

| | |
|---|---|
| AATA | Ann Arbor Transportation Authority (Michigan) |
| AC Transit | Alameda-Contra Costa Transit (Oakland, California) |
| 'ADA | American with Disabilities Act |
| APC | Automatic Passenger Counters |
| APTS | Advanced Public Transportation Systems |
| ATIS | Automated Traveler Information Systems |
| AVL | Automatic Vehicle Location |
| AVM | Automatic Vehicle Monitoring |
| BART | Bay Area Rapid Transit District (Oakland, California) |
| CAD | Computer-Aided Dispatch |
| Caltrans | California Department of Transportation |
| DRT | Demand Responsive Transit |
| FTA | Federal Transit Administration |
| GPS | Global Positioning System |
| IC | Integrated Circuit |
| ITS | Intelligent Transportation Systems |
| JPO | Joint Project Office |
| KCATA | Kansas City Area Transportation Authority |
| LACMTA | Los Angeles County Metropolitan Transit Authority |
| MARTA | Metropolitan Atlanta Rapid Transit Authority |
| MTA | Mass Transit Administration (Maryland MTA) |
| MTA | Metropolitan Transportation Authority (New York City) |
| Muni | San Francisco Municipal Railway (Muni) |
| NJT | New Jersey Transit |
| NYCT | New York City Transit |
| OMB | Office of Management and Budget |
| PTI | Public Technology Inc. |
| RF | Radio Frequency |
| SOA | State-of-Art |
| SOV | Single Occupancy Vehicle |
| TRB | Transportation Research Board |
| Volpe Center | Volpe National Transportation Systems Center |
| WMATA | Washington Metropolitan Area Transit Authority |
| WSTA | Winston-Salem Transit Authority |

# EXECUTIVE SUMMARY

## Background

The Federal Transit Administration's (FTA) Advanced Public Transportation Systems (APTS) Program is a major element of the U.S. Department of Transportation's initiative in Intelligent Transportation Systems (ITS).

The APTS Program involves the application and integration of technologies in the following areas:

- Transit Management Systems
- Automated Traveler Information Systems (ATIS)
- Electronic Fare Pavement Systems
- Transportation Demand Management

## Study Objectives

This paper documents the results of an analysis conducted by the Volpe Center, for the Federal Transit Administration, to provide an 'order-of-magnitude' estimate of the expected benefits to the transit industry with the application of APTS technologies. Specifically, the following objectives were established for this study:

- Identify and quantify the major benefits derived from current applications of APTS technologies within the transit industry.
- Project current APTS benefits to a national level based on forecasts and reasonable assumptions on the potential future applications of such technologies within the transit industry.

## Study Scope and Approach

The study addressed four major APTS program areas with applications in the motorbus, demand responsive transit, and rail transit industries.

**APTS Program Areas Considered**

| APTS Program Areas | Motorbus | Demand Responsive | Rail |
|---|---|---|---|
| **Transit Management Systems** | ✔ | ✔ | not considered |
| **Automated Traveler Information Systems** | ✔ | ✔ | ✔ |
| **Electronic Fare Payment Systems** | ✔ | ✔ | ✔ |
| **Demand Responsive CAD *** | n/a | ✔ | n/a |
| * CAD is computer-aided dispatching. | | | |

The study was structured to address the current and projected deployments of APTS technologies, based on recent surveys and analyses conducted by the Volpe Center. A ten-year period (1996-2005) was chosen as the overall timeframe of the analysis with current and projected APTS applications characterized as being operational, under implementation (applications that are expected to be deployed in the transit industry over the next 2-3 years), or planned (applications that are expected to be deployed over the next 4-5 years).

The study considered the deployment of APTS technologies over a total of 200 motorbus, 212 demand-responsive transit, 16 light-rail and 14 heavy-rail transit systems. For each of these systems, data representing the current (1993) financial, operating, and performance characteristics (as reported by these transit systems under Section 15) was used to develop benefit estimating relationships of current and projected APTS deployments. Because of the nature of the reported benefits from current applications and the uncertainty in the quantification of these benefits, a range of estimates (low and high) was established on the projected level of benefits.

## Summary of Benefits

The study identified a total of 265 APTS system deployments that are currently operational, under implementation, or planned for implementation over the next 10 years.

The projected total benefits of these deployments are estimated to range from $3.8 billion (low estimate) to as high as $7.4 billion (high estimate). These benefits are expressed in current (1996) discounted, present-value dollars. On an annualized basis, the annual APTS system benefits, over the next 10 years, from these deployments are projected to range from $546.6 million (low estimate) to as high as $1 .1 million (high estimate). From the projected total APTS benefits, approximately 44% of the total benefits are accrued from transit management system deployments, 34% from electronic fare pavement system applications, 21% from automated traveler information system deployments, with the remaining 1% from DRT-CAD system applications.

**Total APTS System Benefits**

| | Transit Management Systems | Traveler Information Systems | Electronic Fare Payment Systems | Transit DRT- CAD Systems | Total |
|---|---|---|---|---|---|
| **APTS Deployments (considered)** | 73 | 72 | 43 | 77 | 265 |
| **Benefits (Low Estimate)** (in millions of discounted, present-value dollars) | | | | | |
| **Total Benefits** | **$1718** | **$796.0** | **$3,839.3** | **$44.7** | |
| Annualized | **$244.7** | **$113.3** | **$182.2** | **$6.4** | **$546.6** |
| **Benefits (High Estimate)** (in millions of discounted, present-value dollars) | | | | | |
| **Total Benefits** | $3,204.2 | $1,592.0 | $2 559.7 | $74.5 | $7 430.4 |
| **Annualized** | $456.2 | $226.7 | $364.4 | $10.6 | $1,057.9 |

## 1.0 Background

The Federal Transit Administration's Advanced Public Transportation Systems (APTS) Program is a major element of the U.S. Department of Transportation's initiative in Intelligent Transportation Systems (ITS). Through the APTS Program, the Federal Transit Administration is making substantial investments in the deployment and evaluation of advanced technologies to improve the convenience, reliability, and safety of public transportation services.

The APTS Program involves the application and integration of technologies in the following areas:

- Transit Management Systems - integrate fleet based communication, Automatic Passenger Counting (APC), vehicle monitoring/location, and Computer Aided Dispatching (CAD) and control technologies to improve the overall planning, scheduling, and operations of transit systems.
- ***Automated Traveler Information Systems (ATIS)*** - includes a broad range of advanced computer and communication technologies designed to provide transit riders real-time information to make better informed decisions regarding their mode of travel, planned routes, and travel times. ATIS systems include in-vehicle annunciators/displays, terminal or wayside based information centers, kiosks, telephone information systems, cable and interactive TV, and the Internet.
- ***Electronic Fare Pavement Systems*** - are those advanced fare collection and fare media technologies, designed to make fare payment more convenient for transit users and fare collection more efficient and more flexible for the transit provider. These systems include fare media, ranging from magnetic strip to smart cards, and their associated fare collection and processing systems.
- ***Transportation Demand Management-*** are those applications that would combine technologies and strategies to promote the use of existing transportation infrastructure to serve the increased demand for transit. These applications would include computerized demand responsive transit reservation and dispatching systems, strategies to promote ride sharing, and coordinated transportation services among transit and non-transit providers.

## 2.0 Study Objective

This paper documents the results of an analysis conducted by the Volpe Center, for the Federal Transit Administration, to provide an 'order-of-magnitude' estimate of the expected benefits to the transit industry with the application of Advanced Public Transportation System technologies. Specifically, the following objectives were established for this study:

- Identify and quantify the major benefits derived from current applications of APTS technologies within the transit industry.

- Project current APTS benefits to a national level based on forecasts and reasonable assumptions on the potential future applications of such technologies within the transit industry.

## 3.0 Study Scope and Approach

The study addressed four major APTS program areas, shown in Table 1, with applications in the motorbus, demand responsive transit, and rail transit industries.

**Table 1: APTS Program Areas Considered**

| APTS Program Areas | Motorbus | Demand Responsive | Rail |
|---|---|---|---|
| **Transit Management Systems** | ✔ | ✔ | not considered |
| **Automated Traveler Information Systems** | ✔ | ✔ | ✔ |
| **Electronic Fare Payment Systems** | ✔ | ✔ | ✔ |
| **Demand Responsive CAD *** | n/a | ✔ | n/a |

* CAD is computer-aided dispatching.

This study built upon prior work, performed by the Volpe Center and other agencies, for the Federal Transit Administration under the APTS program. The overall study approach, depicted in Figure 1, consisted of the following steps:

- Available studies and surveys of APTS technology applications were reviewed to identify the major deployments and benefits derived.
- In those areas where benefits were identified, cited benefits were correlated to the type and class of APTS application.
- Using the cited benefit areas, estimating relationships were developed to quantify APTS benefits based on available transit data. For this analysis, the most recent data (1993) on transit system characteristics, reported under the FTA's Section 15 program, was used.
- APTS benefits were projected to a national level based on a projection of future transit deployments of APTS technologies. Because of the nature of the reported benefits from current applications and the uncertainty in the quantification of these benefits, a range of estimates (low and high) was established on the projected level of benefits.

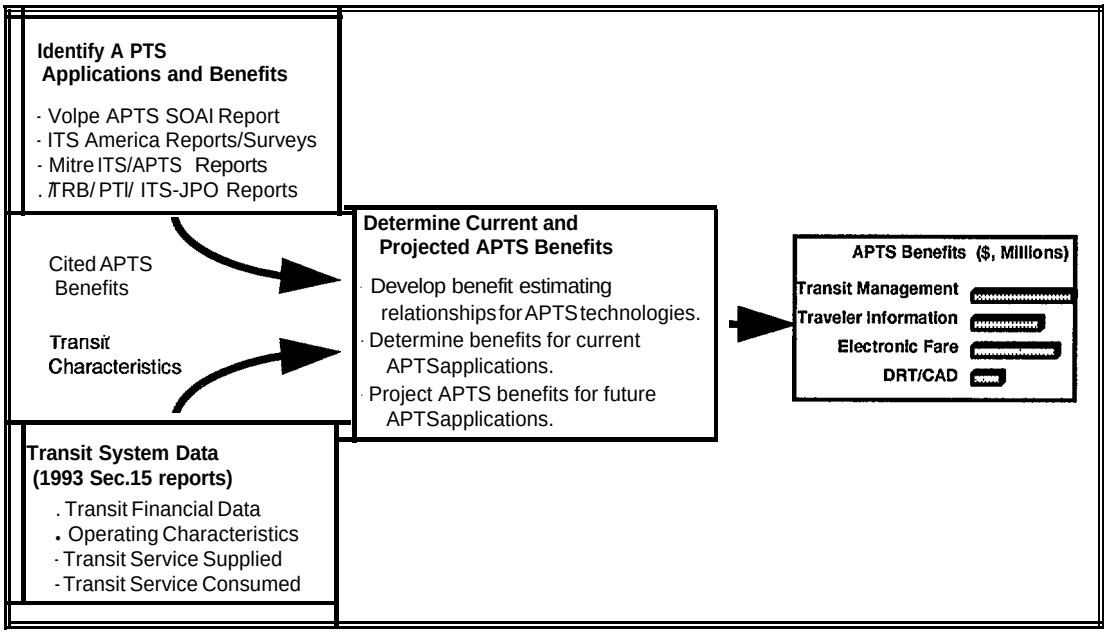


**Figure 1 Study Approach**

## 4.0 Analysis Data and Assumptions

The study was structured to address the current and projected deployments of APTS technologies, based on recent surveys and analyses,[1] conducted by the Volpe Center. A ten-year period (1996-2005) was chosen as the overall timeframe of the analysis, as shown in Figure 2, with current and projected APTS applications being characterized as falling within one of the three following timeframes:

- ***Operational APTS Systems*** - representing currently deployed APTS technologies within the transit industry, the benefits are accrued over the entire ten years of the analysis period.
- ***APTS Systems Under Implementation*** - representing APTS applications that are expected to be deployed in the transit industry over the next 2-3 years, the benefits are accrued over an 8 year period (1998-2005) under the analysis.
- ***Pfanned APTS Systems*** - representing those APTS applications that are expected to be deployed over the next 4-5 years, the benefits are accrued over a 6 year period (2000-2005) under the analysis.

1 'Advanced Public Transportation Systems: The State of the Art - Update '96' The Volpe Center, U.S. Department of Transportation; January, 1996.

'Advanced Public Transportation Systems: APTS Deployments in the U.S.' Preliminary Draft Report; The Volpe Center, U.S. Department of Transportation; January, 1996.

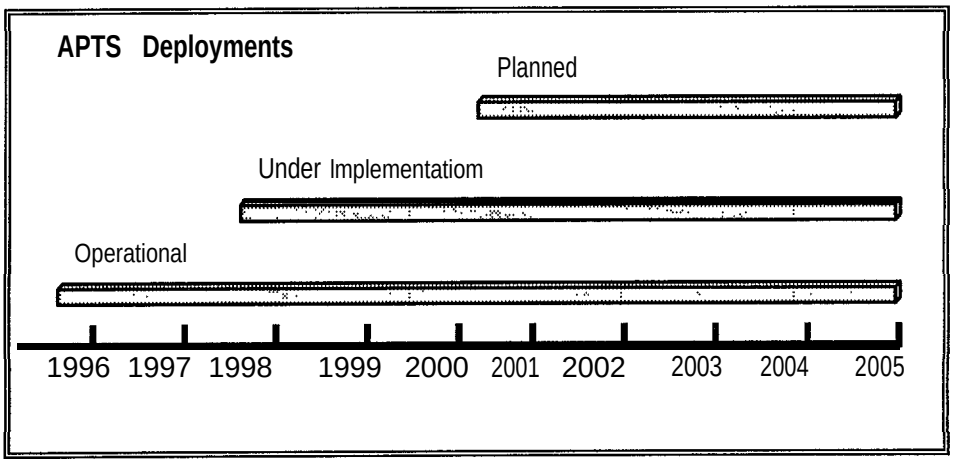


**Figure 2 Analysis Timeframe for APTS Deployments**

The study considered the deployment of APTS technologies over a total of 200 motorbus, 212 demand-responsive transit, 16 light-rail and 14 heavy-rail transit systems (see Table 2). As shown, this analysis considered 43% of total motorbus transit systems (89% of the total motorbus fleet) and over 48% of the demand-responsive transit systems (90% of the total demand-responsive fleet) of the transit industry.[2] All of the U.S. heavy-rail and light-rail transit systems were considered. Appendix A presents a listing of all the motorbus, demand responsive transit, and rail systems considered in the analysis.

**Table 2 Transit Systems Considered in Analysis**

| | Systems Considered in Analysis | | Total Transit industry | |
|---|---|---|---|---|
| | #Transit Systems | # Vehicles | # Transit Systems | # Vehicles |
| Motorbus | 200 | 39,334 | 470 | 44,041 |
| Demand Responsive | 212 | 10.16 | 438 | 11.262 |
| Heavy Rail | 14 | 8187 | 14 | 8187 |
| Light Rail | 16 | 770 | 16 | 770 |

For each of these systems, data representing the current (1993) financial, operating, and performance characteristics were established based on the information reported by these transit systems under Section 15. A summary of the types of information available and used in this analysis appears in Appendix B of this report.

The primary assumptions used in this analysis were:

- The analysis considered a ten-year time horizon (1996-2005) for the deployment of APTS system technologies.

2 'National Transit Database 1993 Section 15 Report Year;' Federal Transit Administration, U.S. Department of Transportation, May 1995. Table reflects the total count of motorbus, demand-responsive and rail transit systems reporting under the FTA 1993 Section 15 reporting system. The number of vehicles represents total vehicle fleet operated in maximum service.

- All benefits are calculated in current-year (1996) dollars and reported in total or annualized discounted present-value (1996) dollars.
- Office of Management and Budget (OMB) guidelines[3] and recommended discount rate of 7.0% were used in the calculation of all present-value dollar benefits.
- Transit ridership (as measured by unlinked passenger trips) was assumed to remain constant over the next ten years. Recent national trends[4] actually show a 5.0% decline in transit ridership over the past five years (or an average annual decline of 1 .0%) for all transit modes.
- Transit operating costs were assumed to increase at an average annual rate of 2.5%, over the next ten years. This reflects the national trend in transit operating costs (for motorbus, demand responsive, and rail) over the past five years [4]
- Transit fares were assumed to increase, over the next ten years, at an average annual rate of 3.5%, from a current 1996 base value of $0.85 per passenger trip. This is a conservative assumption, since transit data6 indicate that transit fares have actually increased by nearly 6.0% per year over the past ten years.
- Transit service provided, as measured by annual vehicle revenue miles, was assumed to increase at the same average annual rate as transit service has expanded over the past five years. National trends[5] indicate that annual revenue vehicle miles increased, over the past five years, at an average annual rate of 1 .0% for motorbus operations, 8.0% for demand responsive transit, and 0.5% for rail operations.
- Transit vehicle fleets, as measured by total number of vehicles available for maximum service, were assumed to increase at the same annual rate as has been experienced by transit properties over the past five years. This analysis assumed average annual increases in transit vehicle fleets of 0.5% for motorbus operations, 3.0% for demand responsive transit, and 0.3% for rail systems.

A summary of these assumptions, for motorbus, demand responsive transit, and rail operations is presented in Table 3.

3 'Guidelines and Discount Rates for Benefit-Cost Analyses of Federal Programs;' Office of Management and Budget: Circular No. A-94 (revised), Transmittal Memorandum No. 64; October 29, 1992.

4 Sources: 'National Transit Summaries and Trends;' Section 15 1993 Transit Reports; Federal Transit Administration; May 1995. 'Transit Fact Book, 1994-l 995;' American Public Transit Association; February 1995.

5 'National Transit Summaries and Trends;' Section 15 1993 Transit Reports; Federal Transit Administration; May 1995.

6 ibid.

7 ibid.

**Table 3 Summary of Analysis Assumptions**

| Analysis Assumptions [Average annual rates] | Motorbus | Demand Responsive | Rail |
|---|---|---|---|
| OMB recommended discount rate | 7.0% | 7.0% | 7.0% |
| Transit ridership | 0.0% | 0.0% | 0.0% |
| Transit operating costs | 2.5% | 2.5% | 2.5% |
| Transit fares | 3.5% | 3.5% | 3.5% |
| Transit vehicle revenue miles | 1.0% | 8.0% | 0.5% |
| Transit vehicle fleet | 0.5% | 3.0% | 0.3% |

## 5.0 Transit Management System Benefits

Transit management systems refer to a broad range of APTS technologies designed to improve the planning, scheduling of transit services and the operations of transit vehicle fleets. These technologies include:

- Advanced Vehicle and control center communication systems
- Automatic Vehicle Location and Monitoring (AVUAVM) systems
- Automated Passenger Counters (APC)
- Automated software systems for transit route planning, scheduling, and operations.

Over the past decade, there has been widespread application of these technologies in the United States and Canada. Most notable are those applications that involve the integration of advanced vehicle/control center communication systems with AVUAVM systems. Recent studies[8] indicate that there are nearly 75 transit systems in the U.S. and at least six Canadian transit authorities that have AVM/AVL systems operational, under installation, or under planned implementation. Over the past decade, many of these applications have utilized wayside signposts and vehicle based communications to determine and relay the location of transit vehicles to a central dispatch center. Currently, there are over 16 deployments of signpost/odometer-based AVM/AVL systems in the U.S. and Canada. Primary limitations most often associated with these systems are: decreased flexibility in changing transit route structures; restricted monitoring of transit fleets to only signpost equipped routes; and generally higher costs for signpost installation and maintenance. Most recent installations and generally all planned new implementations of AVM/AVL systems are using Global Positioning System (GPS) navigation technology for monitoring transit vehicle fleets. GPS-based AVM/AVL systems utilize signals transmitted from a network of 24 satellites, and onboard vehicle GPS receiver/communication units to determine the location of the vehicle and relay this information to central dispatch. Area coverage with GPS-based AVM/AVL systems is generally considered

8 'Advanced Public Transportation Systems: The State of the Art - Update '96' The Volpe Center, U.S. Department of Transportation; January, 1996.
'ITS Technologies in Public Transit: Deployment and Benefits;' ITS America; February 1995.

better than that provided by wayside signpost systems; however, in certain areas fleet coverage may be limited[9] due to impeded GPS signal reception.

As a basis for estimating current and projected APTS transit management system benefits, this analysis considered a total of 73 deployments of AVM/AVL systems that are currently operational, under implementation, or planned. These applications were identified based on a recent review[10] of APTS system deployments within the transit industry. Figure 3 presents the distribution of transit motorbus and demand-responsive AVM/AVL system applications considered to be operational, under implementation, or planned for implementation over the next ten years. As shown, 21 AVM/AVL system deployments, encompassing a total fleet of over 6,500 motorbuses (MB) and demand responsive transit (DRT) vehicles are considered to be operational. Another 28 AVM/AVL system applications, with a total fleet of over 8,220 motorbus and DRT vehicles are currently under installation. A total of 23 fleet management system deployments, with over 8,500 transit vehicles, are being planned over the next 5-6 years. A listing of the motorbus and demand responsive transit systems in each of these categories is presented in Appendix-C.

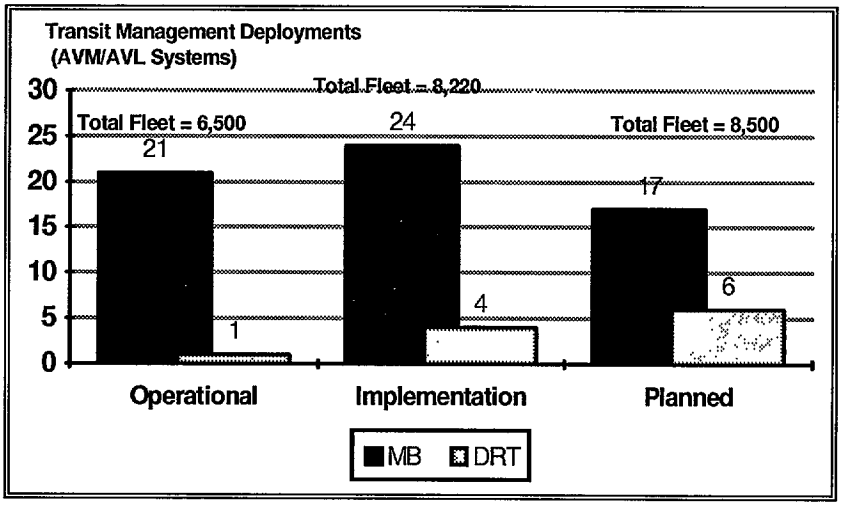


**Figure 3 Transit Management Deployments**

Major deployments of APTS transit management systems[11] are currently operational in Denver, CO; Seattle, WA; San Francisco, CA; Tampa, FL; San Antonio, TX; Louisville, KY; Albany, NY; Newark, NJ; Columbus, OH; Milwaukee, WI; and Norfolk, VA. Applications of APTS fleet management systems, that are currently under installation (or demonstration testing) include: Tucson, AZ; Kansas City, MO; Dallas, TX; Miami, FL; Atlanta, GA; Los Angeles, CA; Oakland, CA; Baltimore, MD; Cincinnati, OH; Detroit, MI; and Buffalo, NY.

[9] GPS satellite coverage area includes all of North America. GPS navigation coverage may be limited in those areas where the satellite signal may be impeded by tall buildings, tunnels, or other signal obstructions.

[10] 'Advanced Public Transportation Systems: The State of the Art - Update '96' The Volpe Center, U.S. Department of Transportation; January, 1996.
'Advanced Public Transportation Systems: APTS Deployments in the U.S.' Preliminary Draft Report; The Volpe Center, U.S. Department of Transportation; January, 1996.

[11] Fleet Management Systems includes AVM/AVL, advanced vehicle communications, and centralized fleet dispatch and control.

The primary benefits most often cited by transit agencies with the deployment of APTS transit management systems include:

- Increased transit safety and security for both drivers and transit users.
- Improved operating efficiency with potential reductions in fleet requirements and non-revenue vehicle miles (non-revenue vehicle hours).
- More uniform and reliable transit service that promote increased ridership.
- Improved response to transit service disruptions (i.e., route, traffic, and vehicle breakdown disruptions).
- Increased control of fleet and driver operations and fleet dispatch functions.
- Improved information for transit route planning and vehicle/driver scheduling systems.
- Increased information for integration with other transit APTS technologies (e.g., transit information systems, route/stop annunciators, and vehicle passenger counters).
- Increased information for integration into other ITS technologies (e.g., traffic signal preemption systems, traffic flow metering, etc.)

Specifically, some of the benefits reported by transit agencies (or other transportation literature sources) in these areas are summarized below.

- **Increased transit safety and security.** The integration of AVM and advanced vehicle communications technologies can significantly increase the safety and security of both transit drivers and riders. For many transit agencies, (i.e., Seattle, Toronto, Denver, and Baltimore), the issues of transit safety and security were primary factors in decisions to install AVM/AVL transit management systems. The monitoring of vehicle movements and ability to respond to silent alarms have increased the sense of transit security and improved the response to transit emergencies and incidents. Many transit agencies have reported[12] reductions in emergency response times of up to 40%.
- **Improved operating efficiency.** Another major benefit area associated with transit management systems is improved efficiency in the operations of transit vehicle fleets and drivers. Most transit agencies incorporate layover times at the end of each trip, with the objective of preventing delays that develop in one trip from carrying over into the next trip. On average, it is reported[13] that the time transit vehicles/drivers spend in layover can cause a vehicle to be in non-revenue service 20%-25% of the time. By knowing the precise location of its vehicle fleet, transit dispatch centers can monitor and control fleet movements, reduce headway dispersion and platooning of vehicles, and reduce vehicle layover and non-revenue

12 ' ITS Technologies in Public Transit: Deployments and Benefits;' ITS America; November 1995.

13 ' Vehicle Location/Driver Communication Technologies Combine to Increase Efficiency and Reduce Costs;' Mass Transit; November/December 1992.

deadhead times. Preliminary results from initial fleet management system deployments have provided reductions in overall transit fleet requirements and non-revenue service time and mileage. The Kansas City Area Transportation Authority (KCATA) reported[14] a 23% improvement in schedule adherence, that allowed KCATA to revise their current schedules and reduce the number of buses serving the routes by seven buses (out of a total of 200 vehicles) and reassign these vehicles to service other transit routes. Other transit agencies have reported[15] reductions in fleet requirements ranging from 2% to 5% as a result of efficiencies in fleet utilization.

- **Improved transit service.** Transit management systems provide transit agencies increased flexibility to monitor and control their transit fleets and ensure adherence to published transit schedules. Some recent deployments of AVM/AVL systems have demonstrated improvements in overall schedule adherence. The Maryland Mass Transit Administration (MTA) reported[16] a 23% improvement in on-time performance on its AVL-equipped buses; while in Milwaukee, preliminary results showed that its fleet on-time performance improved from 90% to 94%, even though its fleet management system is not fully operational. In Toronto, which has one of the largest AVM/AVL deployments,[17] reported that its AVL system has significantly improved the quality of its transit service and estimated[18] that these improvements would conservatively result in a 0.5% to 1.0% increase in ridership and revenues.
- **Improved transit information.** AVM/AVL system applications also provide benefits in the form of improved transit information and integration with other APTS technologies. Many transit agencies are implementing AVM/AVL systems to provide information for their transit route planning and scheduling functions and their transit information systems. In Denver, Baltimore, Kansas City, and Seattle, AVM/AVL deployments are being used to develop tighter, more efficient schedules and to reduce the time and costs associated with conducting route schedule adherence checks. Other transit systems are employing AVM/AVL systems to provide up-to-date schedule information to its transit riders through its transit information systems. Integration of transit fleet management data with public transit information systems have been demonstrated in Minneapolis, Seattle, and Toronto and are planned in deployments for Atlanta, Portland, OR; Newark, and New York. Plans are also underway in Atlanta, Portland, OR; Chicago, New York, and Houston to link AVM/AVL deployments with traffic signal pre-emption and freeway access control systems.

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14 'Kansas City Area Transportation Authority-Automatic Vehicle Locator System Feasibility Study:' prepared for the KCATA by Wornall Electronics and Dobies Associates; undated.

15 ' ITS Technologies in Public Transit: Deployments and Benefits:' ITS America: November 1995.

16 ' Smart Bus, Passenger and Driver Safety Ripen;' article published in Metro magazine; May/June 1994.

17 The Toronto Transit Commission (TTC) has one of the largest deployments (2300 vehicles) of a signpost AVL system in North America. The TTC AVL system was initiated prior to 1985 and the entire system has been operational since 1992.

18 ' Communication and Information System, Evaluation Update;' Toronto Transit Commission; June 1988.

This analysis estimated the benefits of APTS fleet management systems, based on low and high estimated assumptions on efficiencies in transit operations. Benefits derived by transit agencies are in the form of reduced (or avoided) capital costs of future vehicle fleet acquisitions and reduced costs for transit fleet operations. The following equations outline the form of derived benefits, based on transit data[19] and the analysis assumptions presented in Table 4:

**Table 4 Transit Management System Analysis Assumptions**

| | Motorbus | | Demand Responsive | |
|---|---|---|---|---|
| | Low Estimate | High Estimate | Low Estimate | High Estimate |
| · average cost[20] of vehicle ($ thousands) | $225.0 | $225.0 | $85.0 | $85.0 |
| · reduction in vehicle fleet requirements | 1% | 2% | 1% | 2% |
| · reduction in non-revenue vehicle miles | 5% | 8% | 5% | 8% |

**Reduced Transit Fleet Acquisition Costs:**

These benefits represent a one-time cost savings to a transit agency as a result of reduced or avoided costs for fleet acquisitions, following deployment of an APTS fleet management system.

**[Reduced Fleet Costs] = [ # vehicles] x [% reduction in fleet] x [capital cost per vehicle]**

where:

| | |
|---|---|
| [ # vehicles] | is the transit system's fleet requirements (number of vehicles for maximum service). For operational deployments, it reflects current fleet requirements. For deployments under implementation or planned, it reflects projected fleet requirements over the next 5 and 10 years, respectively. |
| [% reduction in fleet] | are the assumed low/high estimates of reductions in vehicle fleet requirements. |
| [capital cost per vehicle] | is the assumed capital cost of motorbus or demand responsive transit bus. |

**Reduced Transit Fleet Operating Costs:**

These benefits are derived based on a one-time reduction in fleet operating costs, following deployment of an APTS fleet management system, and annual recurring savings in fleet operating costs as a result of the assumed fleet efficiency savings.

**[Reduced Operating Costs] = [operating cost per vehicle-mile] x [total non-revenue vehicle miles] x [% reduction in fleet non-revenue miles].**

19 Benefit calculations were performed with respect to individual transit APTS transit management applications (operational, under implementation, or planned) and transit (Section 15) reporting data.

20 Capital cost of transit buses, based on data provided by the Federal Transit Administration. Motorbus costs reflect current average cost of 40' diesel motorcoach. Demand responsive vehicle cost represents average cost of an 8-10 passenger, projected 7-year average life, DRT vehicle.

where:

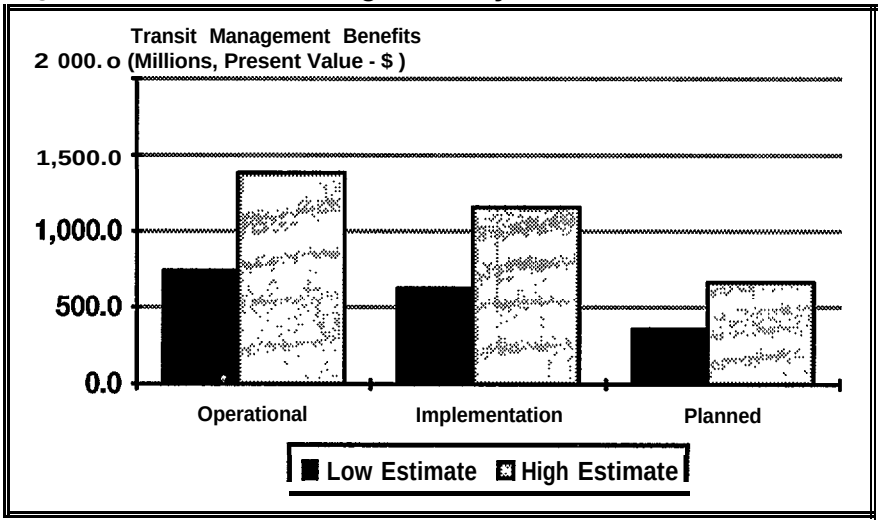
| | |
|---|---|
| [operating cost per vehicle-mile] | represents the transit system's operating cost per vehicle mile (includes only costs of fleet operations). For operational deployments, it reflects current fleet operating costs. For deployments under implementation or planned, it reflects projected fleet operating costs over the next five and 10 years, respectively. |
| [total non-revenue vehicle miles] | represents the transit system's annual non-revenue vehicle miles. For operational deployments, it reflects current fleet non-revenue miles. For deployments under implementation or planned, it reflects projected fleet non-revenue miles over the next five and 10 years, respectively. |
| [% reduction in fleet non-revenue miles] | are the assumed low/high estimates of reductions in non-revenue vehicle miles. |

Table 5 summarizes the total and annualized benefits (low and high estimates) projected for APTS fleet management system deployments over the next ten years. These benefits are expressed in discounted 1996 present-value dollars. The total benefits (low and high estimates) for the fleet management deployments (operational, under implementation, and planned) are depicted in Figure 4.

**Table 5 Transit Management System Benefits**

| System Deployments | Operational | Under Implementation | Planned | Total |
|---|---|---|---|---|
| # deployments - motorbus | **21** | **24** | **17** | **62** |
| # deployments DRT | 1 | **4** | **6** | 11 |
| **total** | **22** | **28** | **23** | **73** |
| **Benefits (Low Estimate)** (in thousands of discounted, present-value dollars) | | | | |
| Total Benefits | $738,518 | $624,191 | $356,135 | $1,718,844 |
| Annualized | $105,148. | $88,871. | $50,706. | $244,725. |
| **Benefits (High Estimate)** (in thousands of discounted present-value dollars) | | | | |
| Total Benefits | $1,318,590 | $1,158,789 | $664,154 | $3,204,203 |
| Annualized | $196,660. | $164,985 | $94,561 | $456,206 |

**Figure 4 Transit Management System Benefits**



As shown, the total APTS fleet management benefits (for the 73 deployments considered) is projected at $1.7 billion (low estimate) to as high as $3.2 billion (high estimate). On an annualized basis, the benefits derived from these deployments would range from an estimated value of $244.7 million (low estimate) to as high as $456.2 million (high estimate). Forty-three percent of the total benefits are derived as a result of currently operational fleet management deployments, 36% from deployments currently under implementation, and the remaining 21% come from the planned deployments.

## 6.0 APTS Traveler Information System Benefits

Advanced Traveler Information Systems (ATIS) are a key element of new technology applications in transportation to provide timely and accurate information to help travelers make decisions on modes of travel, routes, and travel times. This information generally includes: transit service areas and routes, scheduled vehicle departure times, information on transfers and other transportation services, as well as fares and other transit promotions.

The technologies used to deliver this information to the consumer are varied and include media such as: telephone information systems, terminal/wayside systems, cable and interactive TV, in-vehicle displays and annunciators, and the Internet. More recent deployments of transit information systems are now coupling existing scheduled transit service information with more dynamic, real-time information on projected bus arrival times, service disruptions and delays, accidents, and recommended alternative routes or services. This real-time information is generally made available through the integration of APTS traveler information systems with other APTS technologies such as AVUAVM systems, freeway access and traffic signal systems, and centralized transportation traffic management centers.

The recent study[21] of APTS technology applications have identified over 80 deployments of APTS traveler information systems in the United States that are currently operational, under implementation, or planned. This analysis considered a total of 72 of these deployments, that provide improved information for transit trip planning, multi-modal trip services, terminal and wayside information displays and interactive kiosks, and in-vehicle electronic signs and stop annunciators. Figure 5 presents the distribution of APTS traveler information system applications considered to be operational, under implementation, or planned for implementation over the next ten years. Also depicted in Figure 5 is the distribution of the type of traveler information system technology (trip planning, terminal/wayside, and in-vehicle systems) in these major deployment categories. Appendix C lists the APTS traveler information system deployments considered in this analysis to be operational, under implementation, and planned by the transit industry.

21 Advanced Public Transportation Systems: APTS Deployments in the U.S.' Preliminary Draft Report; The Volpe Center, U.S. Department of Transportation; January, 1996.

Most notable deployments of APTS traveler information systems are currently operational or under demonstration testing in Minneapolis, Los Angeles, Denver, Seattle, Portland, OR; and San Francisco Bay Area Rapid Transit (BART). Major deployments of APTS traveler information systems currently under installation (or planned for installation over the next ten years) would include applications in Chicago, Baltimore, Houston, San Francisco (Muni), Detroit, Newark, and New York City (NYCT) transit.

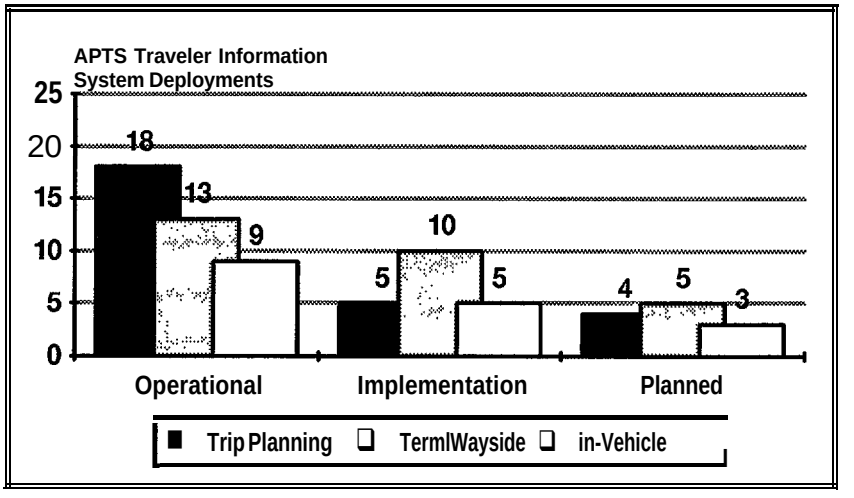



**Figure 5 Traveler Information System Deployments**

In Minneapolis, a federally funded demonstration project, Travlink, was initiated to improve the transit commute from the western suburbs of Minneapolis to the downtown area and to the University of Minnesota along a 11 -mile corridor of Interstate 394. Travlink employed a computer-aided dispatch/automatic vehicle location (CAD/AVL) system[22] to provide real-time vehicle location information to a transit dispatch center and to an advanced traveler information system (ATIS). This system allowed dispatchers to monitor the progress and movement of buses and provided transit commuters with updated transit arrival times on electronic signs, display monitors, information kiosks, and through video-text terminals in homes and businesses.[23] Results of the initial demonstration test, which was completed in December 1995, showed "that Travlink has been effective in its major objective, that of providing commuters with traveler information . . . and that despite unexpected complications in the transit service[24] - by the end of the test, bus ridership among Travlink participants was six percent greater than that among the control group[25]."

22 For this corridor operations, the Minneapolis MTC equipped 80 buses (of its 800 vehicle fleet) with a GPS based AVL system SmartTrackTM .

23 Sources: 'The Travlink Test' article published in Mass Transit; November/December 1994.
'Travlink: Getting Minneapolis to Work On Time'; article published in GPS World; Melanie Braun and Marilyn Remer , Minnesota Guidestar; October 1995.

24 Transit service was reduced during the test period and was compounded by a bus drivers' strike during the month of October 1995.

25 Source: "Travlink: An Intelligent Commute in Minneapolis;" Clayton, Candace Minnesota DOT; article submitted for publication in ITE Journal; undated. Also, discussions with Marilyn Remer, Project Manager Minnesota Guidestar Project, Minnesota DOT.

In Los Angeles, Caltrans is directing a Smart Traveler program[26] which provides free automated information services, such as up-to-the-minute freeway conditions and traffic speeds, customized transit route planning, and real-time ride matching, to commuters in Los Angeles County. The transit information component of this program involved the establishment of a I-800-COMMUTE telephone information service and deployment of 78 interactive kiosks, which allowed transit commuters access to Los Angeles County Metropolitan Transportation Authority's (LACMTA) bus and train schedules, route map, and fare structures. A preliminary evaluation on the commuters' use of this system showed a very positive response (80% to 85% found the system easy to use and would continue to use or encourage others to use the system).[27]

New Jersey Transit (NJT) has an extensive five-year plan to implement many APTS traveler information technologies, including an automated telephone information system, train information display systems, multimedia interactive kiosks, in-vehicle (bus and rail) displays, and terminal information displays. Results[28] from the deployment of its automated telephone information system[29] showed a significant increase (an increase of 40,000 monthly calls compared to prior year) in the volume of calls and reductions in waiting times (average call waiting time reduced from 85 to 27 seconds) of calls for transit services.

King County (Seattle) Metro, with the active participation of a non-profit organization, Overlake[30] has instituted a new electronic information system, called Riderlink. Riderlink is an on-line information resource available on the Internet that gives Seattle metropolitan area residents access to Metro routes, schedules, maps, and information on vanpool/ridematch services. Riderlink is planning expanded transit coverage by including Pierce Community Transit services along with Puget Sound ferry services. The overall objective of the program is to increase community awareness of public transportation options in the region and to reduce the number of single occupancy vehicles (SOV).[31]

The primary benefits most often cited by transit agencies with the deployment of APTS traveler information systems include:

- Increased transit ridership and revenues. Advanced traveler information systems have been found to be effective in promoting transit services to current and potential new transit patrons. The availability and ease of access to this information

26 Smart Traveler is public/private partnership directed by Caltrans in conjunction with the LACMTA, the Commuter Transportation Services, Inc., FHWA, FTA, the Health and Welfare Data Center, IBM, North Communications, and Pacific Bell.

27 'Los Angeles Smart Traveler Information Kiosks: A Preliminary Report;' paper by G. Giuliano and J. Golub; Transportation Research Record 1516, Transportation Research Board.

28 ' New Jersey Transit' s Customer Information Speeded Up by New System;' Passenger Transport; American Public Transportation Association; January 24, 1994.

29 Although the NJT automated telephone information system currently provides information rail transit schedules, NJT bus operations has also benefited by more calls to the agency on all transit services.

30 Overlake is a non-profit association of eight companies (Microsoft, Nintendo, Applied Microsystems, Allied Signal, Eddie Bauer, and others) dedicated to reducing traffic congestion in the Seattle-Puget Sound area.

31 ' Seattle' s Computerized Infosystem;' Mass Transit Journal; March/April 1995.

enhances the potential for keeping existing transit riders and attracting new users and transit revenues.

- ***Improved transit service and visibility within the community.*** The applications of advanced traveler information technologies are often used to demonstrate the full range of services and area coverage offered by public transportation in the community. This is especially true in larger metropolitan areas where extensive and more complex routes, fare structures, and multi-modal choices of transportation services often exist.
- ***Increased customer convenience***. Applications of advanced traveler information systems provide a more convenient and potentially lower cost alternative for disseminating traveler information to transit riders, as compared to published transit schedules and telephone information systems. The application of these systems, especially in high density travel areas of cities (i.e., transportation centers, major city attractions, malls, etc.) have proved to be very effective and convenient to transit riders.
- ***Enhanced compliance to Americans with Disabilities Act (ADA) requirements.*** Advanced traveler information systems, including electronic displays, annunciators, and terminal/information kiosks, are effective technologies to enhance transit services to the hearing and visually-impaired patrons and to promote an agency's compliance with ADA requirements.

This analysis assumed that the primary benefits associated with the deployment of APTS traveler information systems are accrued to transit agencies in the form of increased transit ridership and transit revenues from passenger fares. The following equation represents this relationship, based on assumed (low and high) estimates of expected increases in transit ridership with the deployment of advanced traveler information systems. Table 6 summarizes the assumptions used in the projection of these benefits.

**Table 6 Traveler Information System Analysis Assumptions**

| | Motorbus | | Demand Responsive | | Rail | |
|---|---|---|---|---|---|---|
| | Estimate | Estimate | Estimate | Estimate | Estimate | Estimate |
| - % increase in transit ridership | 1% | 3% | 1% | 3% | 1% | 3% |
| · average fare per passenger trip ($ 1996) | $0.85 | $0.85 | $0.85 | $0.85 | $0.85 | $0.85 |

**Transit Ridership Benefits (increased transit revenues):**

These benefits are direct recurring benefits to the transit agency, represented in the form of increased transit revenues from increased transit ridership and passenger fares.

[Increased transit revenues] = [(# annual transit passenger trips) x (assumed % increase in pax-trips) - (# annual transit passenger trips)] x [average fare per passenger trip].

where:

| | |
|---|---|
| [# annual transit passenger trips] | represents the transit system's total annual passenger trips. For operational TIS deployments, it reflects current annual passenger trips. For TIS deployments under implementation or planned, it reflects projected annual passenger trips for the next five and 10 years, respectively. |
| [assumed % increase in passenger trips] | are the assumed low/high estimates of the percentage increase in annual passenger trips that would result from deployment of advanced traveler/transit information systems. |
| [average fare per passenger trip] | represents the average transit fare within the transit industry. For operational deployments, it reflects current average transit fares. For deployments under implementation or planned, it reflects projected transit fares over the next five and 10 years, respectively. |

The total benefits (low and high estimates) for the 72 APTS traveler information system deployments (operational, under implementation, and planned) considered in this analysis are depicted in Figure 6. These represent total benefits, over 10 years (1996-2005), and are expressed in discounted 1996 present-value dollars.

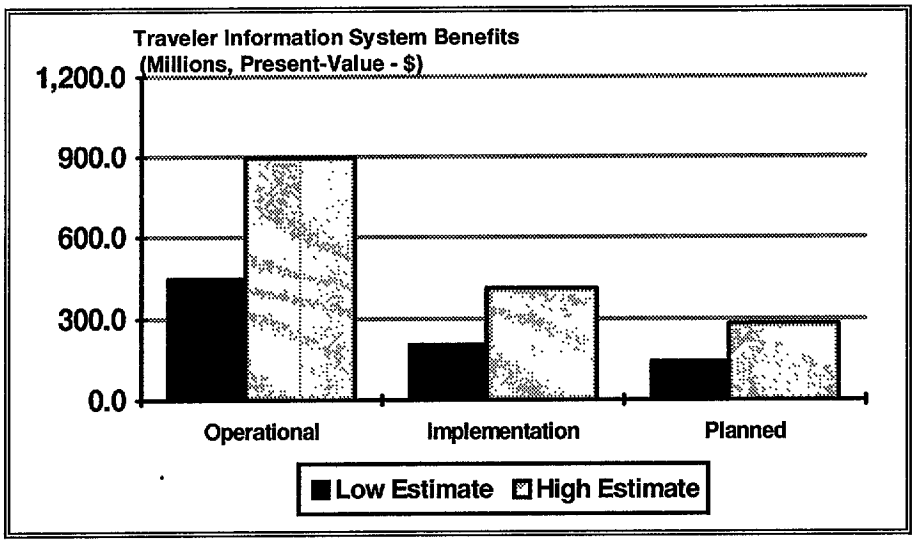



**Figure 6 Traveler Information System Benefits**

Table 7 summarizes the total and annualized benefits (low and high estimates) projected for the APTS transit information system deployments over the next 10 years.

**Table 7 Traveler Information System Benefits**

| System Deployments | Operational | Under Implementation | Planned | Total |
|---|---|---|---|---|
| # deployments - motorbus | **34** | 19 | 11 | **64** |
| # deployments DRT | **2** | **0** | 1 | **3** |
| # deployments - Rail : | **4** | 1 | **0** | **5** |
| **total** | **40** | **20** | **12** | **72** |
| **Benefits (Low Estimate)** (in thousands of discounted present-value dollars) | | | | |
| Total Beneflts | $447,902 | $205,971 | $142,143 | $796,016 |
| Annualized | $63.771 | $29.326 | $20.238 | $113,335 |
| **Benefits (High Estimate)** (in thousands of discounted, present-value dollars) | | | | |
| Total Benefit | $895,804 | $411,943 | $284,286 | $1,592,033 |
| Annualized | $127,542 | $58,651 | $40,476 | $226,669 |

The total APTS traveler information system benefits (for the 72 deployments considered) are projected to range from $796.0 million (low estimate) to as high as $1.6 billion (high estimate). On an annualized basis, the benefits derived from these deployments would be an estimated $113.3 million (low estimate) to as high as $226.7 million (high estimate). Of the total benefits, 56% are derived as a result of the 40 currently operational transit information deployments, 26% from 20 deployments under implementation, and the remaining 18% would come from the 12 deployments that are in the planning stage.

## 7.0 Electronic Fare Payment System Benefits

Electronic fare payment systems include a wide-range of automated fare collection system technologies and advanced fare media that make fare payment more convenient for the transit user and financial management of fare revenues more secure and efficient for the transportation provider. Electronic fare payment technologies are now capable of handling a variety of fare media including coins, bills, magnetic strip paper or plastic cards, and integrated circuit or radio frequency smart cards. Advances in fare media in recent years have been moving towards applications with stored value smart cards and credit cards issued by banks and other financial institutions.

Many transit agencies are looking at ways to improve their fare collection to meet a number of objectives. Primary among these are: eliminating cash and token handling to improve security of transit fares, introducing more innovative and equitable fare structures, providing increased convenience to transit riders in the purchase and payment of transit fares, and reducing overall transit costs of sorting, counting, and management of fare revenues.

Applications of advanced fare payment systems date back to the 1970s with initial applications of magnetic strip, stored value fare cards in rail transit systems in San Francisco-Oakland (BART) and Washington, DC (WMATA). Phoenix Transit was one the first bus transit systems to install magnetic card readers on electronic fare boxes in 1991. More recently, in May 1995, the authority has introduced a fare payment program using commercial credit cards, whereby fare payments are automatically debited from the transit user's credit card. Under this arrangement, the banks and financial institutions pay for the credit card media, Phoenix Transit pays the credit card companies one transaction fee per card paying passenger per month, and transit customers are billed once a month for their use of public transportation. From this program, Phoenix Transit claims[32] to have reduced fees paid to credit card companies to five cents per fare instead of 19 cents per fare transaction.

In New York City, the New York Metropolitan Transit Authority (MTA) has formed a subsidiary organization, MTA Card Company, to promote MetroCard. MetroCard is a magnetic stripe card, that will eventually be used in all NYCT subway stations. These cards would be sold in fixed denominations by the NYCT and at other outlets. Currently these cards are rechargeable and may be available for other non-transit uses, such as small purchases, telephone calls, etc.

The Washington Metropolitan Area Transit Authority (WMATA), which has implemented one of the more advanced paper magnetic strip systems (similar to that of BART in San Francisco) has recently received a one-year demonstration grant from the FTA to test a battery-powered, proximity reader/encoder smart card called the GoCard. Currently, the demonstration test includes installation of GoCard readers in 19 MetroRail stations, on 21 MetroBuses, and five park-ride lots. Long term plans call for the development of a totally integrated fare collection system that allows WMATA patrons to use one fare media on all transit systems in the Washington, DC metropolitan area.

A number of bus transit agencies are actively considering the use of Radio Frequency (RF) proximity smart cards and/or other advanced fare media for bus fares, parking fees, and inter-modal transportation services. The Ann Arbor Transportation Authority (AATA) has received a Federal Transit Administration grant to test the use of a RF proximity smart card for bus and transit parking. Applications of this smart card is tied to the University of Michigan M-Card. In California, as part of a joint effort by California Department of Transportation (Caltrans) and the FTA, eight transit authorities[33] in Ventura County are testing a proximity smart card that allows fare payment, based on a distance based fare structure, on all systems in the county. Cards can be purchased with a credit card.

32 'Bus Fare Payment with Credit Cards in Phoenix;' draft case study report, Schwenk, J.; Volpe Center, October, 1995.

33 The largest of these transit authorities is South Coast Area Transit, which provides fixed route transit service to Oxnard, Ventura, and Port Hueneme. Other transit systems involved in this demonstration include: Camarillo, Simi Valley, Moorpark, Thousand Oaks, Fillmore, Santa Paula, and Ojai.

In the Seattle Puget Sound area, a multi-modal integrated fare demonstration project is being proposed[34] for transit agencies and other transportation services[35] in King, Snohomish, Pierce, and Kitsap Counties. An operational test of smart fare cards is being proposed.

In Atlanta, the Metropolitan Atlanta Rapid Transit Authority (MARTA), in conjunction with VISA International and First Union Bank, are planning the introduction of a stored-value, Integrated Circuit (IC) contact-type card that can be used for transit and retail purchases. Actually, two types of cards are being proposed; one a stored-value card that is sold in fixed denominations and the other is a rechargeable card, having dollar values that can be increased and used for a wider range of purchases. Current plans are to have these cards available for use in time for the 1996 Olympics.

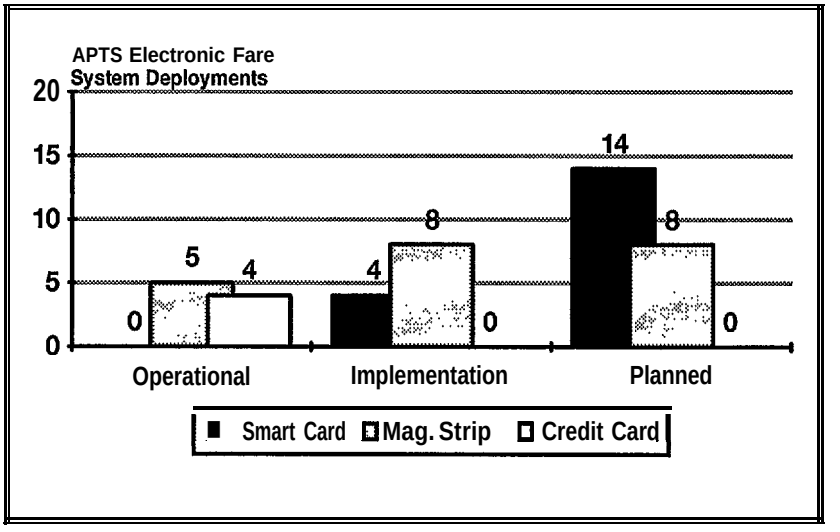



**Figure 7 Electronic Fare Payment System Deployments**

The recent study[36] of APTS technology applications have identified over 45 deployments of APTS electronic fare payment systems in the United States that are currently operational, under implementation, or planned. This analysis considered a total of 43 of these deployments. Figure 7 presents the distribution of APTS electronic fare payment system applications considered to be operational, under implementation, or planned for implementation over the next ten years. Also shown in this figure is the distribution of the type of automated fare system technology (magnetic strip, smart card, or credit card) in each of these major deployment categories. The APTS electronic fare payment system deployments considered in this analysis are presented in Appendix C.

The primary benefits cited by transit agencies with the deployment of APTS electronic fare payment systems include:

- ***Improved security of transit revenues.*** The introduction of advanced fare collection technologies and fare media reduces the amount of lost revenues due to fare evasion. Within the transit industry, estimates of lost revenues due to fare

34'Regional Fare and Technology Integration;' Feasibility Study - Draft Report: Central Puget Sound Transportation Agencies; July 19, 1995.

35This demonstration would include: Seattle King County Metro, Kitsap Transit, Pierce Transit, Everett Transit, Community Transit, the Regional Transportation Authority, and Washington State Ferry System.

36 Advanced Public Transportation Systems: APTS Deployments in the U.S.' Preliminary Draft Report; The Volpe Center, U.S. Department of Transportation; January, 1996.

evasions range from 4% to 8%.[37] New York City Transit which in 1993 installed a magnetic strip system received an additional revenue capture of $43 million and in 1994 an additional $54 million as a result of tightened revenue security measures and savings from reduced fare evasions. The reduction in fare evasions went from 4% to under 2%.[38]

- ***Customer convenience.*** Electronic fare payment systems improve customer convenience in the payment of transit fares and by providing a wider range of services. Electronic fare payment systems facilitate the integration of fares across regional transportation services (transit and non-transit), through a single payment media. The need for tokens, cash (exact change) and transfer slips is reduced, as well as the frequency of advanced purchases of transit fares. Electronic fare payment systems also encourage increased flexibility in fare policies (time and or distance based fares) to promote off-peak ridership or ridership by targeted market groups (e.g., employer subsidized fares for commuters, subsidized fares for the disadvantaged, etc.).
- ***Expanded base for transit revenue.*** Electronic fare payment systems provide a base of expanded revenue to transit agencies though increased marketing opportunities, interest or "float" earned on prepaid fares, transaction fees, and unused value on prepaid, stored value cards. From business case studies conducted for the New York City Transit, the MTA estimates[39] that their MetroCard system will generate increased revenues of $34.0 million from merchant fees and revenue float, $140.0 million from unused prepaid, stored value cards, and $49.0 million in revenues from new transit ridership as a result of expanded marketing opportunities.
- ***Reduced fare collection/processing costs***. Costs of handling cash and token fares are a major cost of a transit system's operating budget. Applications of electronic fare payment systems reduce agency costs in the counting and handling of cash, tokens, and transfers and, in some cases, enable these functions to be . borne by banks, credit card companies, or other financial management institutions. New Jersey Transit estimates cost savings of up to $2.7 million in reduced labor costs of handling cash and tokens.[40] Ventura County (FARETRANS) estimates that their smart card system will save the agency $9.5 million in reduced fare evasion, $5 million in reduced data collection costs, and $990,000 in reduced costs of handling fares and transfer slips.[41]
- ***More equitable, flexible fare structures.*** Advanced fare media allow transit agencies to adopt more flexible and equitable distance based fare structures, that facilitate coordinated transportation services and inter-modal transfers. These fare

37 ' Smart Cards for Transit: Multi-Use Remotely interrogated Stored-Data Cards for Fare and Toll Payment;' Final Report; The Volpe Center, U.S. DOT; April 1995.

38 ' Time to Get Smart;' article published in Mass Transit; November/December 1995.

39 ' Advanced Public Transportation System Benefits;' Federal Transit Administration; January, 1996.

40 ' ITS Technologies in Public Transit: Deployment and Benefits;' ITS America: February 1995.

41 ' Advanced Public Transportation System Benefits;' Federal Transit Administration; January, 1996.

structures would increase overall transit ridership and transit revenues. In the Los Angeles area, multi-operator fare agreements are increasing the use of mass transit, reducing traffic congestion, and increasing transit productivity. In 1993, the Los Angeles region began testing both smart card (chip embedded) and debit card (magnetic strip) technologies to integrate fare payment. As a result of increased service and fare coordination, inter-operator transfers, which accounted for less than 0.5% of all riders in 1988, had increased to at least 2% of total passengers, or 11 million boardings per year by 1994.[42]

This analysis assumed that the primary benefits associated with the deployment of APTS electronic fare payment systems are accrued to transit agencies in the form of increased transit ridership and recurring savings in passenger fare revenues. The following equation represents this relationship, based on assumed (low and high) estimates of expected savings in transit revenues and/or reductions in the costs of handling and processing transit fares. Table 8 summarizes the assumptions used in the projection of these benefits.

**Table 8 Electronic Fare Payment System Analysis Assumptions**

| | Motorbus | | Demand Responsive | | Rail | |
|---|---|---|---|---|---|---|
| | Low Estimate | High Estimate | Low Estimate | High Estimate | Low Estimate | High Estimate |
| percentage of passenger fares saved | 2 % | 4% | 2% | 4% | 2% | 4% |
| average fare per passenger trip ($, 1996) | $0.85 | $0.85 | $0.85 | $0.85 | $0.85 | $0.85 |

**Electronic Fare Payment System Revenue Savings:**

These benefits represent increased revenues to the transit agencies, based on an annual recurring savings in passenger fare revenues and/or reductions in the costs of handling and processing transit fares with the deployment of an APTS electronic fare payment system.

**[Transit fare revenue savings] = [# annual transit passenger trips] x [% passenger fares saved] x [average fare per passenger trip].**

where:

| | |
|---|---|
| [# annual transit passenger trips] | represents the transit system's total annual passenger trips. For operational deployments, it reflects current annual passenger trips. For APTS electronic fare system deployments under implementation or planned, it reflects projected annual passenger trips for the next five and 10 years, respectively. |
| [% passenger fares saved] | are the assumed low/high estimates of the percentage of current and projected passenger fares that would be saved through improved automated fare collection technologies and/or transit savings in the costs of handling and processing transit fares. |

42 ' A Joint Effort: Multi-Operator Fare Integration;' article published in Mass Transit; September/October 1994.

[average fare per passenger trip] represents the average transit fare within the transit industry. For operational deployments, it reflects current average transit fares. For deployments under implementation or planned, it reflects projected transit fares over the next five and 10 years, respectively.

Presented in Table 9 are the total and annualized benefits (low and high estimates) projected for APTS electronic fare payment system deployments over the next 10 years. These benefits are expressed in discounted 1996 present-value dollars. The total benefits (low and high estimates) for the electronic fare payment system deployments (operational, under implementation, and planned) are depicted in Figure 8.

**Table 9 Electronic Fare Payment System Benefits**

| System Deployments | Operational | Under Implementation | Planned | Total |
|---|---|---|---|---|
| # deployments - motorbus | 6 | 10 | 16 | 32 |
| # deployments DRT | 0 | 1 | 3 | 4 |
| # deployments Rail | 2 | 1 | 4 | 7 |
| **Total** | 8 | 12 | 23 | 43 |
| **Benefits (Low Estimate)** (in thousands of discounted present-value dollars) | | | | |
| Total Benefits | $94,770 | $565,353 | $619,713 | $1,279,836 |
| Annualized | $13,493 | $80,494 | $88,233 | $182,220 |
| **Benefits (High Estimate)** in thousands of discount&d present-value dollars) | | | | |
| **Total Benefits** | $189 540. | $1 130 706. | $1 239 426. | $2 559 672 |
| **Annualized** | **$26,986.** | **$160,987.** | $176,466. | $364,439. |

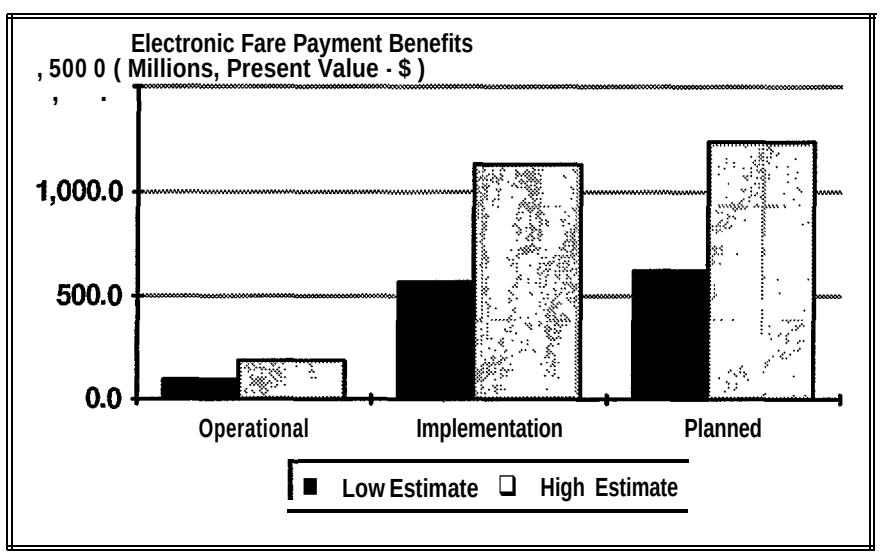



**Figure 8 Electronic Fare Payment System Benefits**

As shown, the total APTS electronic fare payment system benefits (for the 43 deployments considered) are projected to range from $1.3 billion (low estimate) to as high as $2.6 billion (high estimate). On an annualized basis, the benefits derived from these deployments is an estimated $182.2 million (low estimate) to as high as $364.4 million (high estimate). Of the total benefits, 8% are derived as a result of the eight currently operational automated fare system deployments, 44% from 12 deployments under implementation, and the remaining 48% would come from the 23 automated fare system deployments that are in the planning stage.

## 8.0 Demand Responsive Computer Aided Dispatch (CAD) System Benefits

The deployment of CAD systems for demand responsive transit and other ride-sharing services has existed in various forms over the past two decades. Early deployments of these systems have focused on vehicle dispatching as an outgrowth of automated dispatching services being implemented within the taxi industry. Within the transit industry, the applications of CAD services are directed to improve the operations of small urban and rural transit systems and to improve the services to many groups of citizens (e.g., the elderly and the disabled) that require specialized transportation services not readily available by fixed-route bus and rail systems.

The process of Demand Responsive Transit (DRT) scheduling is highly complex because of the shared-ride nature of the trips, the special needs (e.g., wheelchair accessible vehicles) of the passengers, and the constraints[43] under which transit agencies must comply to provide such services. DRT-CAD scheduling of transit services entails the recording and scheduling of incoming passenger reservations for on-demand, real-time trips or on advance reservations for trips to be taken the next day, week, or month. Passengers, vehicles and, in some cases, drivers are scheduled based upon the types of service required, time/day of week, and locale of trip origins and destinations. The vehicle routes and schedules are optimized by minimizing travel time or distance subject to the constraints of vehicle capacity and passenger desired pickup and drop-off times.

By improving how passenger ride requests are scheduled and how demand responsive vehicles are dispatched, significant benefits can be accrued by demand responsive transit systems in the following areas :

- ***Increased efficiency in transit operations.*** DRT-CAD systems can improve the efficiency of DRT operations through more efficient scheduling of vehicles/drivers to passenger trip requests, the validation of trip requests to provided transportation services, and the certification of pre-approved (subsidized) fare payments. DRT-CAD systems increase the utilization of vehicle fleets, reduce non-revenue vehicle miles (vehicle hours), reduce the costs of fleet dispatching and the recording and

43 Many of the constraints include compliance to meet the requirements of the Americans with Disabilities (ADA) Act, and with local, state, and Federal statutes dealing with the validation of passenger requirements for specialized transportation services and/or subsidized fares.

billing of services provided. In a recent evaluation[44] of computer-aided dispatching and scheduling services for the Winston-Salem Transit Authority (WSTA), showed that while total operating costs for their DRT operations[45] increased (because of increased service), the operating cost per vehicle-mile dropped by 8.5% to $1.93/vehicle-mile; their operating cost per vehicle-hour dropped by 8.6% ($2.33) to $24.70/vehicle-hour; and, their operating cost per passenger trip dropped by 2.4% to $564/passenger-trip.

- ***Improved transit service and customer convenience.*** DRT-CAD systems can provide improved transit service and convenience to customers in the form of improved response in placing DRT trip requests, through more accurate estimates of predicted pickup/drop-off times, increased flexibility in the scheduling of desired services, and reduced trip travel times.
- ***Increased compliance with transit ADA requirements.*** The Americans with Disabilities Act (ADA) of 1990 requires fixed-route transit systems to provide complementary demand-responsive transit services for passengers, who live/work within a three-quarter mile radius of a transit route, and who are unable to board a conventional transit vehicle. In addition, the ADA requirements stipulate that transit agencies are required to respond to previous-day reservations and that passengers cannot be on board the vehicle longer than one hour. DRT-CAD systems facilitate the scheduling and handling of specialized transportation requests, and ensure compliance with ADA requirements.[46]

As a basis for estimating current and projected benefits of demand responsive transit computer-aided dispatch systems, this analysis considered a total of 77 deployments of DRT-CAD systems that are currently operational, under implementation, or planned. These applications were identified based on recent review[47] of APTS system deployments within the transit industry. Figure 9 presents the distribution of DRT-CAD applications that were considered to be operational, under implementation, or planned for implementation over the next 10 years. A listing of the demand responsive transit systems in each of these categories is presented in Appendix-C.

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44 ' Winston-Salem Mobility Management: An Evaluation of Computer-Aided Dispatch and Scheduling;' Paper presented at Transportation Research Board 1996 Annual Meeting; by Stone, J. Ph.D., Department of Civil Engineering, North Carolina State University; August 1, 1995.

45 The Winston-Salem Transit Authority DRT operations is one of the demonstration sites of the Federal Transit Administration's APTS Program. This evaluation focused on the WSTA's DRT operations, called Trans-AID, a 17-vehicle system that provides demand-responsive transportation services to Medicare eligible handicapped persons, elderly citizens, social service agency clients, and senior/child day care passengers. The evaluation was conducted over a six-month period from September, 1994 to February, 1995.

46 Assessment of Computer Dispatch Technology in the Paratransit Industry;' Final Report for the Federal Transit Administration, by Stone, J., Gilbert G., and Nalevanko A., University of North Carolina Institute for Transportation Research and Education; March, 1992.

47 ' Advanced Public Transportation Systems: The State of the Art - Update ' 96' The Volpe Center, U.S. Department of Transportation; January, 1996.
'Advanced Public Transportation Systems: APTS Deployments in the U.S.' Preliminary Draft Report; The Volpe Center, U.S. Department of Transportation; January, 1996.

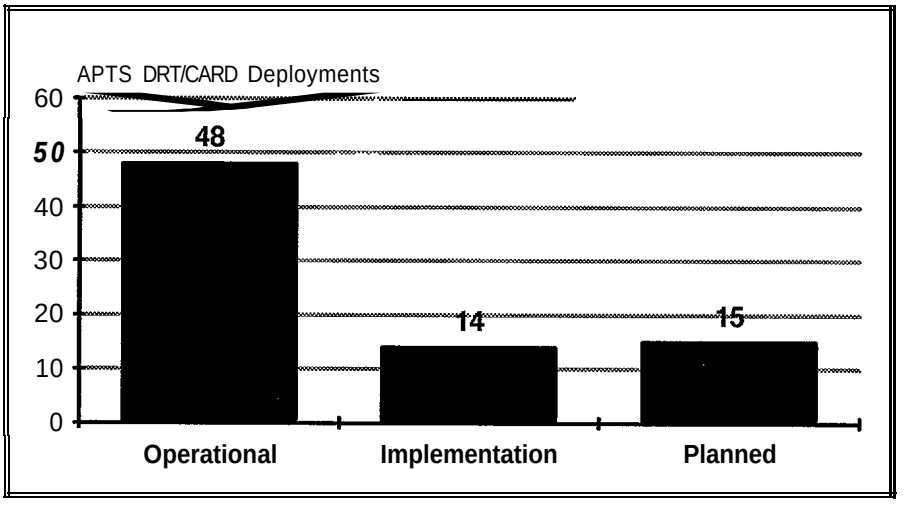


**Figure 9 DRT-CAD System Deployments**

This analysis estimated the benefits of APTS DRT-CAD deployments, based low and high estimated assumptions on efficiencies in demand responsive transit operations. Benefits derived by transit agencies would be in the form of improved DRT fleet operations and in improved scheduling of fleet resources to service scheduled passenger trips. The following equation outlines the form of derived DRT-CAD benefits, based on transit data[48] and the analysis assumptions presented in Table 10.

**Table 10 Demand Responsive Transit CAD Analysis Assumptions**

| | Demand Responsive | |
|---|---|---|
| | Low Estimate | High Estimate |
| • % reduction in total fleet vehicle miles | 3% | 5% |

**Reduced Transit Fleet Operating Costs:**

These benefits represent savings to the transit agency as a result of a recurring reduction in fleet operating costs, following deployment of an APTS DRT-CAD system, based on assumed efficiencies in the scheduling of DRT passengers and in the routing and dispatching of demand responsive vehicle trips.

**[Reduced Operating Costs] = [operating cost per vehicle-mile] x [total fleet vehicle miles] x ["/ reduction in total fleet vehicle miles].**

where:

[operating cost per vehicle-mile] is the transit system's operating cost per vehicle mile (includes only costs of fleet operations). For operational deployments, it reflects current fleet operating costs. For deployments under implementation or planned, it reflects projected fleet operating costs over the next five and 10 years, respectively.

48 Benefit calculations were performed with respect to individual transit APTS fleet management applications (operational, under implementation, or planned) and transit (Section 15) reporting data.

[total annual fleet vehicle miles] represents the transit system's total annual vehicle miles. For operational deployments, it reflects current fleet annual vehicle miles. For deployments under implementation or planned, it reflects projected fleet vehicle miles over the next five and 10 years, respectively.

[% reduction in fleet vehicle miles] are the assumed low/high estimates of percentage reductions in annual DRT vehicle miles, as result of DRT passenger scheduling and vehicle routing/dispatching.

Table 11 presents the total and annualized benefits (low and high estimates) projected for APTS demand responsive transit CAD system deployments over the next 10 years. These benefits are expressed in discounted 1996 present-value dollars. The total benefits (low and high estimates) for the DRT-CAD system deployments (operational, under implementation, and planned) are depicted in Figure 10.

**Table 11 Demand Responsive Transit CAD System Benefits**

| System Deployments | Operational | Under Implementation | Planned | Total |
|---|---|---|---|---|
| # deployments | **48** | **14** | **15** | **77** |
| **Benefits (Low Estimate)** in thousands of discounted, present-value dollars) | | | | |
| Total Benefits | $34,875 | $8,636 | $1,169 | $44,680 |
| **Annualized** | **$4,965.** | **$1,230.** | **$166.** | **$6,361.** |
| **Benefits (High Estimate)** (in thousands of discounted, present-value dollars) | | | | |
| **Total Benefits** | **$58,125.** | **$14,393.** | $1,948. | **$74,466.** |
| **Annualized** | **$8,276** | **$2,049** | $277. | $10,602 |

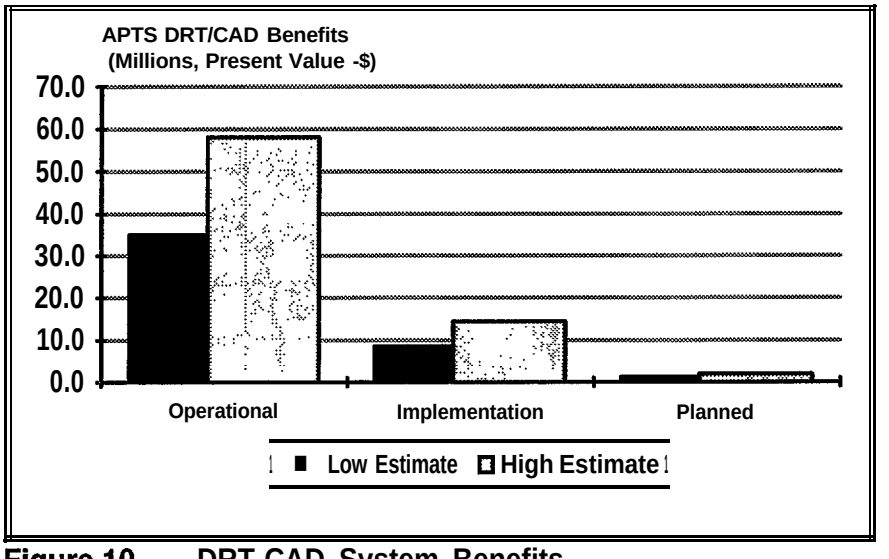


**Figure 10 DRT-CAD System Benefits**

The total APTS demand responsive transit CAD system benefits (for the 77 deployments considered) are projected to range from $44.6 million (low estimate) to as high as $74.5 million (high estimate). On an annualized basis, the benefits derived from these deployments are an estimated $6.4 million (low estimate) to as high as $10.6 million (high estimate). Seventy-eight percent of the total DRT-CAD benefits are derived as a result of the 48 currently operational DRT-CAD system applications, 20% from the 14 deployments under implementation, and the remaining 2% come from the 15 DRT-CAD system deployments that are in the planning stage.

## 9.0 Summary of Benefits

Table 12 summarizes the projected low and high estimated total benefits for the 265 APTS system deployments that are currently operational, under implementation, or planned for implementation over the next 10 years. These benefits are expressed in current (1996) discounted, present-value dollars. Also shown in the table are the projected (low and high estimate) annualized benefits that will be accrued, on an annual basis, over the next 10 years from these deployments.

**Table 12 Total APTS System Benefits**

| | Transit Management Systems | Traveler Information Systems | Electronic Fare Payment Systems | Transit DRT- CAD Systems | Total |
|---|---|---|---|---|---|
| **APTS Deployments (considered)** | **73** | **72** | **43** | **77** | **265** |
| **Benefits (Low Estimate)** (in millionsof discounted present-value dollars) | | | | | |
| **Total Benefits** | $1,718.8 | $796.0 | $1,279.8 | **$44.7** | **3,839.6** |
| **Annualized** | **$244.7** | **$113.3** | **$182.2** | **$6.4** | **$546.6** |
| **Benefits (High Estimate)** (in millions of discounted present-value dollars) | | | | | |
| **Total Benefits** | **$3,204.2** | **$1,592.0** | **$2,559.7** | **$74.5** | **$7,430.4** |
| **Annualized** | **$456.2** | **$226.7** | **$364.4** | **$10.6** | $1,057.9 |

As shown, this analysis projects the total benefits (over 10 years) from the 265 APTS system deployments would range from $3.8 billion (low estimate) to as high as $7.4 billion (high estimate). On an annualized basis, the annual APTS system benefits, over the next 10 years, from these deployments are projected to range from $546.6 million (low estimate) to as high as $1 .I million (high estimate). From the projected total APTS benefits, approximately 44% of the total benefits are accrued from fleet management system deployments, 34% from electronic fare payment system applications, 21% from traveler information system deployments, with the remaining 1% from DRT-CAD system applications. The projected total estimated (low and high) benefits for each of these APTS system deployments are depicted in Figure **II.**

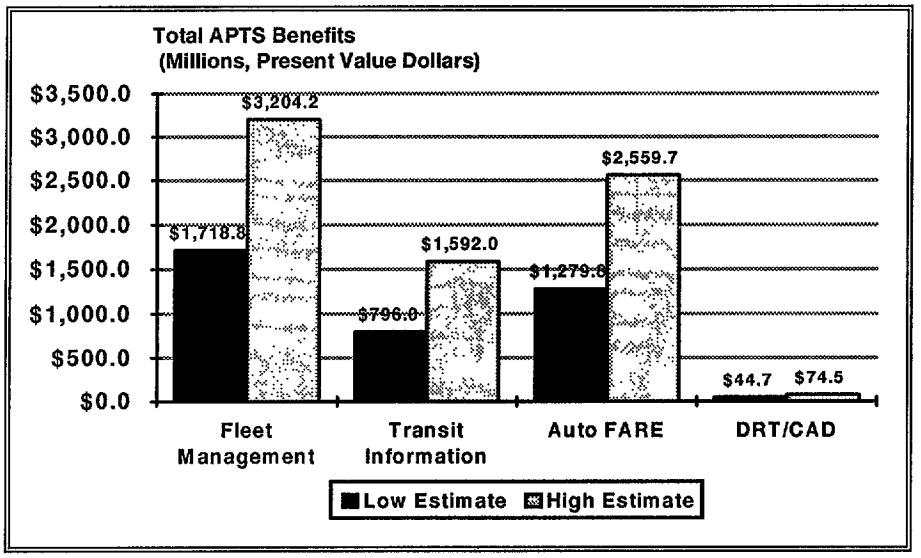


**Figure 11 Total APTS System Benefits**

# Appendix A
# Transit Systems Considered in Analysis

## Table A-1 Motorbus Systems Considered

| Motorbus | ST | Transit Agency | Total Vehicles Max. Service | | ST | Transit Agency | Total Vehicles Max. Service |
|---|---|---|---|---|---|---|---|
| 1 | AK | Municipality of Anchorage | 44 | 51 | DC | Washington-WMATA | 1,339 |
| 2 | AL | Birmingham-Max | 92 | 52 | DE | Wilmington-DART | 96 |
| 3 | AL | Mobile-MTA | 37 | 53 | FL | Bradenton-MCT | 9 |
| 4 | AR | Fayetteville-Springdale | 12 | 54 | FL | St. Petersburg-PSTA | 101 |
| 5 | AZ | Tucson-Sun Tran | 157 | 55 | FL | Ft. Myers-LeeTran | 26 |
| 6 | AZ | Phoenix-Phoenix TS/ATC | 282 | 56 | FL | Ft. Lauderdale-Bct | 184 |
| 7 | AZ | Phoenix-Mesa SunRunner | 9 | 57 | FL | Daytona Beach-VOTRAN | 34 |
| 8 | CA | Bakersfield-GET | 54 | 58 | FL | Miami-MDTA | 617 |
| 9 | CA | Santa Cruz-METRO | 66 | 59 | FL | Orlando-LYNX | 113 |
| 10 | CA | Modesto-MAX | 25 | 60 | FL | Tallahassee-TALTRAN | 41 |
| 11 | CA | LA-Santa Monica | 106 | 61 | FL | West Palm-CoTran | 57 |
| 12 | CA | SF-SamTrans | 249 | 62 | FL | Jacksonville-JTA | 135 |
| 13 | CA | LA-Torrance | 57 | 63 | FL | Tampa-Hartline | 133 |
| 14 | CA | Stockton-SMART | 55 | 64 | FL | Miami-Red Top | 171 |
| 15 | CA | San Jose-SCCTD | 412 | 65 | GA | Atlanta-MARTA | 561 |
| 16 | CA | Oakland-AC Transit | 614 | 66 | HI | Honolulu-DTS | 424 |
| 17 | CA | San Francisco-Muni | 386 | 67 | IA | Cedar Rapids-The Bus | 34 |
| 18 | CA | SF-Golden Gate | 247 | 68 | IA | Des Moines-Metro | 79 |
| 19 | CA | Sacramento-RT | 159 | 69 | IA | Sioux City-STC | 21 |
| 20 | CA | Santa Barbara-MTD | 59 | 70 | ID | Boise Urban Stages | 23 |
| 21 | CA | LA-LACMTA/SCRTD | 1,912 | 71 | IL | Rock Island-Metro Link | 50 |
| 22 | CA | LA-Long Beach Transit | 152 | 72 | IL | Champaign-Urbana-MTD | 60 |
| 23 | CA | San Diego Transit | 250 | 73 | IL | Chicago-RTA-CTA | 1,731 |
| 24 | CA | Fresno-FAX | 72 | 74 | IL | Chicago-RTA-Pace | 584 |
| 25 | CA | San Bernardino-OMNITRANS | 86 | 75 | IN | NW IN-Gary-GPTC | 29 |
| 26 | CA | San Diego-NCTD | 119 | 76 | IN | Indianapolis-Metro | 128 |
| 27 | CA | Riverside-RTA | 60 | 77 | IN | Lafayette-GLPTC | 34 |
| 28 | CA | Oxnard-SCAT | 29 | 78 | IN | South Bend-Transpo | 43 |
| 29 | CA | LA-OCTA | 410 | 79 | IN | Muncie-MITS | 18 |
| 30 | CA | LA-Culver City | 24 | 80 | KS | Wichita-MTA | 43 |
| 31 | CA | LA-Montebello | 36 | 81 | KY | Louisville-TARC | 248 |
| 32 | CA | LA-Gardena Bus Line | 38 | 82 | KY | Cincinnati-TANK | 83 |
| 33 | CA | Simi Valley Transit | 6 | 83 | LA | Shreveport-SparTran | 37 |
| 34 | CA | Yuba-Sutter | 7 | 84 | LA | New Orleans-RTA | 374 |
| 35 | CA | Oakland-County Connection | 100 | 85 | MA | Boston-MBTA | 841 |
| 36 | CA | Palm Springs-SunBus | 33 | 86 | MA | New Bedford-SERTA | 70 |
| 37 | CA | Santa Maria Area Transit | 6 | 87 | MA | Boston-CATA | 10 |
| 38 | CA | Napa-The V.I.N.E. | 13 | 88 | MA | Providence-GATRA | 28 |
| 39 | CA | Visalia City Coach | 10 | 89 | MD | Baltimore-Maryland-MTA | 722 |
| 40 | CA | Lancaster-AV Transit | 29 | 90 | MD | Maryland-Ride-On | 204 |
| 41 | CA | Merced | 10 | 91 | ME | Portland-METRO | 17 |
| 42 | CA | LA-Foothill Transit | 162 | 92 | MI | Bay City-Metro Transit | 25 |
| 43 | CA | Victorville-VVTSA | 33 | 93 | MI | Detroit-SMART | 233 |
| 44 | CO | Denver-RTD | 663 | 94 | MI | Flint-MTA | 137 |
| 45 | CO | Greeley-The Bus | 10 | 95 | MI | Grand Rapids-GRATA | 74 |
| 46 | CT | Hartford-CT Transit | 193 | 96 | MI | Jackson-JTA | 8 |
| 47 | CT | Greater Bridgeport TD | 38 | 97 | MI | Ann Arbor-AATA | 57 |
| 48 | CT | Danbury-HART | 15 | 98 | MI | Detroit-D-DOT | 412 |
| 49 | CT | New Haven-CT Transit | 86 | 99 | MN | Duluth-DTA | 71 |
| 50 | CT | Norwalk-Wheels | 17 | 100 | MN | Minneapolis-St. Paul-MTC | 855 |

## Table A-1 Motorbus Systems Considered (continued)

| Motorbus | ST | Transit Agency | Total Vehicles Max. Service | | ST | Transit Agency | Total Vehicles Max. Service |
|---|---|---|---|---|---|---|---|
| 101 | MO | Kansas City-KCATA | 208 | 151 | PA | Philadelphia-SEPTA | 1,131 |
| 102 | MO | St. Louis-Bi-State | 574 | 152 | PA | Pittsburgh-PAT | 735 |
| 103 | MO | Columbia-CATS | 10 | 153 | PA | Beaver County-BCTA | 13 |
| 104 | MO | St. Joseph Express | 10 | 154 | PA | Scranton-Colts | 30 |
| 105 | MT | Billings-MET | 16 | 155 | PA | Williamsport-City Bus | 14 |
| 106 | NC | Raleigh-CAT | 44 | 156 | PA | York-YCTA | 18 |
| 107 | NC | Charlotte-CTS | 135 | 157 | PA | Pittsburgh-Westmoreland | 12 |
| 108 | NC | Fayetteville-Fast | 12 | 158 | PA | State College-Centre Line | 26 |
| 109 | NC | Winston-Salem-WSTA | 41 | 159 | PR | San Juan-MBA | 160 |
| 110 | NC | Durham-Chapel Hill | 43 | 160 | RI | Providence-RIPTA | 183 |
| 111 | ND | Grand Forks-City Bus | 12 | 161 | SC | Greenville-GTA | 18 |
| 112 | NE | Omaha-TA | 126 | 162 | SD | Rapid City Transit System | 5 |
| 113 | NH | Nashua-City Bus | 4 | 163 | TN | Chattanooga-CARTA | 48 |
| 114 | NJ | New Jersey Transit | 1,656 | 164 | TN | Knoxville-K-Trans | 51 |
| 115 | NJ | NJ Transit (Contract) | 457 | 165 | TN | Memphis-MATA | 165 |
| 116 | NM | Albuquerque-Sun Tran | 108 | 166 | TN | Nashville-MTA | 96 |
| 117 | NV | Reno-Citifare | 53 | 167 | TN | Clarksville-CTS | 6 |
| 118 | NV | Las Vegas - Citizens | 218 | 168 | TX | Amarillo-ACT | 13 |
| 119 | NY | Albany-CDTA | 187 | 169 | TX | El Paso-Sun Metro | 118 |
| 120 | NY | Buffalo-NFTA | 307 | 170 | TX | Fort Worth-The T | 116 |
| 121 | NY | NY-MTA-Long Island Bus | 265 | 171 | TX | Houston-Metro | 1,016 |
| 122 | NY | NY-MTA-NYCTA | 3,064 | 172 | TX | Laredo-El Metro | 26 |
| 123 | NY | Syracuse-RTA-Centro | 137 | 173 | TX | San Antonio-VIA | 498 |
| 124 | NY | Utica-UTA | 32 | 174 | TX | Waco Transit System | 10 |
| 125 | NY | NYCDOT-Green Bus | 148 | 175 | TX | Brownsville-BUS | 12 |
| 126 | NY | NYCDOT-Jamaica Bus | 74 | 176 | TX | Austin-Capital Metro | 244 |
| 127 | NY | NYCDOT-Bus Tours | 100 | 177 | TX | Corpus Christi-The B | 54 |
| 128 | NY | NY-Hart | 10 | 178 | TX | Dallas-DART | 530 |
| 129 | NY | NYCDOT-Command Bus | 106 | 179 | TX | Dallas-DART/ATE | 209 |
| 130 | NY | NY-Westchester-BEE-LINE | 15 | 180 | UT | Salt Lake City-UTA | 420 |
| 131 | NY | NY-Westchester-Liberty | 241 | 181 | VA | Newport News-Pentran | 98 |
| 132 | NY | New York City DOT | 91 | 182 | VA | Norfolk-TRT | 124 |
| 133 | NY | Rochester-RTS | 178 | 183 | VA | Richmond-GRTC | 159 |
| 134 | NY | NYCDOT-Queens | 226 | 184 | VA | Fairfax Connector | 51 |
| 135 | NY | Ithaca-TOMTRAN | 30 | 185 | VT | Burlington-CT | 24 |
| 136 | OH | Akron-Metro | 134 | 186 | WA | Seattle-Metro | 906 |
| 137 | OH | Cincinnati-SORTA | 323 | 187 | WA | Spokane-STA | 115 |
| 138 | OH | Cleveland-RTA | 586 | 188 | WA | Tacoma-Pierce Transit | 147 |
| 139 | OH | Columbus-COTA | 252 | 189 | WA | Olympia-IT | 71 |
| 140 | OH | Dayton-RTA | 162 | 190 | WA | Bremerton-Kitsap Transit | 77 |
| 141 | OH | Toledo-TARTA | 161 | 191 | WA | Vancouver-C-Tran | 62 |
| 142 | OH | Youngstown-WRTA | 28 | 192 | WA | Seattle-Snohomish-Commun. | 150 |
| 143 | OK | Oklahoma City-COTPA | 65 | 193 | WI | Kenosha-KTC | 35 |
| 144 | OK | Tulsa-MTA | 66 | 194 | WI | LaCrosse Municipal | 14 |
| 145 | OR | Eugene-LTD | 65 | 195 | WI | Madison-MMT | 140 |
| 146 | OR | Portland-Tri-Met | 468 | 196 | WI | Milwaukee-County | 460 |
| 147 | OR | Medford-RVTD | 15 | 197 | WI | Sheboygan-ST | 29 |
| 148 | PA | Allentown-Lanta | 55 | 198 | WI | Milwaukee-Waukesha Metro | 45 |
| 149 | PA | Erie-EMTA | 52 | 199 | WV | Charleston-KRT | 43 |
| 150 | PA | Harrisburg-Cat | 52 | 200 | WV | Huntington-TTA | 20 |

## Table A-2 Demand Responsive Transit Systems Considered

| Demand Responsive Transit | ST | Transit Agency | Total Vehicles Max. Service | | ST | Transit Agency | Total Vehicles Max. Service |
|---|---|---|---|---|---|---|---|
| 1 | AK | Municipality of Anchorage | 10 | 54 | CT | Norwalk-Wheels | 13 |
| 2 | AL | Mobile-MTA | 19 | 55 | CT | Waterbury-GWTD | 7 |
| 3 | AL | Montgomery-Community | 26 | 56 | DE | Delaware-DAST | 47 |
| 4 | AL | NW Alabama COLG | 30 | 57 | FL | Bradenton-MCT | 18 |
| 5 | AL | Huntsville | 31 | 58 | FL | St. Petersburg-PSTA | 81 |
| 6 | AR | Fayetteville-Springdale | 2 | 59 | FL | Ft. Myers-LeeTran | 6 |
| 7 | AR | Fayetteville-CRG | 29 | 60 | FL | Ft. Lauderdale-Bct | 192 |
| 8 | AZ | Phoenix PTD | 61 | 61 | FL | Daytona Beach-VOTRAN | 4 |
| 9 | AZ | Tucson-Sun Tran | 48 | 62 | FL | Miami-MDTA | 27 |
| 10 | AZ | Phoenix-Glendale | 12 | 63 | FL | Orlando-LYNX | 70 |
| 11 | AZ | Phoenix-Mesa SunRunner | 22 | 64 | FL | Tallahassee-TALTRAN | 12 |
| 12 | AZ | Phoenix-Maricopa STS | 47 | 65 | FL | Jacksonville-JTA | 79 |
| 13 | AZ | Phoenix-Sun Cities-SCAT | 12 | 66 | FL | Tampa-Hartline | 86 |
| 14 | AZ | Peoria Transit | 4 | 67 | FL | Sarasota-SCTA | 21 |
| 15 | CA | Santa Cruz-METRO | 44 | 68 | FL | Brevard-SCAT | 50 |
| 16 | CA | Modesto-MAX | 10 | 69 | FL | Miami-MDTA/Comprehensive | 283 |
| 17 | CA | SF-SamTrans | 22 | 70 | FL | Okaloosa County | 30 |
| 18 | CA | LA-Torrance | 30 | 71 | FL | Panama City-Bay Council | 29 |
| 19 | CA | Stockton-SMART | 21 | 72 | HI | Aloha-State Tour & Transp | 86 |
| 20 | CA | San Jose-SCCTD | 15 | 73 | HI | Honolulu-HDOT-Mayflower | 135 |
| 21 | CA | San Francisco-Muni | 77 | 74 | IA | Cedar Rapids-The Bus | 4 |
| 22 | CA | Sacramento-RT | 52 | 75 | IA | Des Moines-Metro | 24 |
| 23 | CA | Santa Barbara-MTD | 8 | 76 | IA | Sioux City-STC | 16 |
| 24 | CA | LA-Long Beach Transit | 20 | 77 | IA | Waterloo-MET | 30 |
| 25 | CA | Fresno-FAX | 24 | 78 | ID | Boise Urban Stages | 3 |
| 26 | CA | San Bernardino-OMNITRANS | 65 | 79 | IL | Rock Island-Metro Link | 20 |
| 27 | CA | San Diego-NCTD | 26 | 80 | IL | Chicago-RTA-CTA | 695 |
| 28 | CA | Riverside-RTA | 10 | 81 | IL | Chicago-RTA-Pace | 313 |
| 29 | CA | LA-OCTA | 213 | 82 | IL | St. Louis-MCT | 30 |
| 30 | CA | LA-Montebello | 3 | 83 | IN | NW IN-Gary-GPTC | 2 |
| 31 | CA | LA-Gardena Bus Line | 7 | 84 | IN | NWIN-LCEOC, Inc. | 46 |
| 32 | CA | Simi Valley Transit | 2 | 85 | IN | NW IN-Trade Winds Rehab | 22 |
| 33 | CA | Salinas-Monterey | 21 | 86 | IN | Indianapolis-Metro | 24 |
| 34 | CA | Yuba-Sutter | 13 | 87 | IN | Lafayette-GLPTC | 3 |
| 35 | CA | LA-LACMTA METRO | 131 | 88 | IN | South Bend-Transpo | 5 |
| 36 | CA | Palm Springs-SunBus | 13 | 89 | IN | Muncie-MITS | 9 |
| 37 | CA | Santa Maria Area Transit | 5 | 90 | IN | Elkhart Heart-City Rider | 39 |
| 38 | CA | Visalia City Coach | 5 | 91 | IN | NW IN-Lake County | 52 |
| 39 | CA | San Diego-SANDAG | 43 | 92 | IN | City of Kokomo | 22 |
| 40 | CA | Lancaster-AV Transit | 13 | 93 | KS | Wichita-MTA | 7 |
| 41 | CA | Merced | 8 | 94 | KY | Louisville-TARC | 104 |
| 42 | CA | City of Los Angeles | 108 | 95 | LA | Shreveport-SparTran | 7 |
| 43 | CA | Victorville-VVTSA | 8 | 96 | LA | New Orleans-RTA | 50 |
| 44 | CA | Lompoc Transit | 9 | 97 | MA | Boston-MBTA | 125 |
| 45 | CO | Colorado Springs Transit | 46 | 98 | MA | Brockton-BAT | 33 |
| 46 | CO | Denver-RTD | 50 | 99 | MA | Lowell-LRTA | 22 |
| 47 | CO | Greeley-The Bus | 4 | 100 | MA | Pittsfield-BRTA | 53 |
| 48 | CO | Fort Collins-Transfort | 20 | 101 | MA | Springfield-PVTA | 54 |
| 49 | CO | Grand Junction-MesABILITY | 31 | 102 | MA | Worcester-WRTA | 107 |
| 50 | CT | Hartford-Metro | 85 | 103 | MA | Boston-CATA | 8 |
| 51 | CT | New Haven-Gr. New Haven | 11 | 104 | MA | Fitchburg-MART | 158 |
| 52 | CT | Greater Bridgeport TD | 14 | 105 | MA | Providence-GATRA | 60 |
| 53 | CT | Danbury-HART | 13 | 106 | MA | Hyannis-Cape Cod-CCRTA | 46 |

## Table A-2 Demand Responsive Transit Systems Considered (continued)

| Demand Responsive Transit | ST | Transit Agency | Total Vehicles Max. Service | | ST | Transit Agency | Total Vehicles Max. Service |
|---|---|---|---|---|---|---|---|
| 107 | MD | Baltimore-Maryland-MTA | 53 | 160 | PA | Reading-BARTA | 37 |
| 108 | ME | Portland-RTP | 14 | 161 | PA | Scranton-Colts | 10 |
| 109 | ME | Bangor-Eastern Transp. | 73 | 162 | PA | Williamsport-City Bus | 2 |
| 110 | ME | Lewiston-Western Maine | 15 | 163 | PA | York-YCTA | 8 |
| 111 | MI | Bay City-Metro Transit | 14 | 164 | PA | Pittsburgh-Westmoreland | 3 |
| 112 | MI | Detroit-SMART | 126 | 165 | PA | State College-Centre Line | 6 |
| 113 | MI | Flint-MTA | 59 | 166 | PA | Pittsburgh-PAT/ACCESS | 418 |
| 114 | MI | Grand Rapids-GRATA | 58 | 167 | SC | Greenville-GTA | 15 |
| 115 | MI | Jackson-JTA | 17 | 168 | SC | Florence-PDRTA | 86 |
| 116 | MI | Lansing-CATA | 50 | 169 | SC | Sumter-Santee Wateree | 45 |
| 117 | MI | Ann Arbor-AATA | 36 | 170 | SD | Sioux Falls-The Bus | 39 |
| 118 | MO | Kansas City-KCATA | 54 | 171 | SD | Rapid City Transit System | 5 |
| 119 | MO | St. Louis-Bi-State | 46 | 172 | TN | Chattanooga-CARTA | 7 |
| 120 | MO | St. Joseph Express | 20 | 173 | TN | Nashville-MTA | 34 |
| 121 | MT | Billings-MET | 10 | 174 | TN | Clarksville-CTS | 3 |
| 122 | NC | Raleigh-CAT | 7 | 175 | TX | Amarillo-ACT | 3 |
| 123 | NC | Charlotte-CTS | 37 | 176 | TX | El Paso-Sun Metro | 106 |
| 124 | NC | Winston-Salem-WSTA | 12 | 177 | TX | Fort Worth-The T | 20 |
| 125 | NC | Durham-Chapel Hill | 6 | 178 | TX | Houston-Metro | 208 |
| 126 | NC | Durham-DATA | 22 | 179 | TX | Laredo-El Metro | 7 |
| 127 | NC | Gastonia-Gaston | 24 | 180 | TX | San Antonio-VIA | 168 |
| 128 | ND | Grand Forks-City Bus | 9 | 181 | TX | Waco Transit System | 2 |
| 129 | ND | Bis-Man Transit | 20 | 182 | TX | Brownsville-BUS | 5 |
| 130 | NE | Lincoln- StarTRAN | 26 | 183 | TX | Dallas - Handitran | 10 |
| 131 | NH | Nashua-City Bus | 9 | 184 | TX | Austin-Capital Metro | 68 |
| 132 | NM | Albuquerque-Sun Tran | 44 | 185 | TX | Corpus Christi-The B | 22 |
| 133 | NM | Santa Fe-Sr. Citizens | 33 | 186 | TX | Dallas-DART | 312 |
| 134 | NV | Reno-Citifare | 29 | 187 | TX | Dallas-Grand Prairie | 5 |
| 135 | NV | Las Vegas-EOB | 23 | 188 | UT | Salt Lake City-UTA | 54 |
| 136 | NY | NY-MTA-NYCTA | 104 | 189 | VA | Newport News-Pentran | 21 |
| 137 | NY | Poughkeepsie-LOOP | 21 | 190 | VA | Norfolk-TRT | 59 |
| 138 | NY | Utica-UTA | 5 | 191 | VA | Richmond-GRTC | 24 |
| 139 | NY | NY-Hart | 4 | 192 | VA | Charlottesville-Jaunt | 42 |
| 140 | NY | NY-Westchester-BEE-LINE | 36 | 193 | VT | Burlington-CT | 8 |
| 141 | NY | New York City DOT | 92 | 194 | WA | Seattle-Metro | 174 |
| 142 | NY | Ithaca-TOMTRAN | 9 | 195 | WA | Spokane-STA | 68 |
| 143 | OH | Akron-Metro | 76 | 196 | WA | Tacoma-Pierce Transit | 106 |
| 144 | OH | Cincinnati-SORTA | 29 | 197 | WA | Richland-Ben Franklin | 41 |
| 145 | OH | Cleveland-RTA | 67 | 198 | WA | Bremerton-Kitsap Transit | 72 |
| 146 | OH | Dayton-RTA | 48 | 199 | WA | Bellingham-WTA | 20 |
| 147 | OH | Hamilton City Lines | 8 | 200 | WA | Seattle-Snohomish-Senior | 24 |
| 148 | OH | Youngstown-WRTA | 4 | 201 | WI | Appleton-Valley Transit | 25 |
| 149 | OH | Cleveland-LAKETRAN | 39 | 202 | WI | Green Bay-GBT | 60 |
| 150 | OH | Newark | 28 | 203 | WI | Kenosha-KTC | 2 |
| 151 | OK | Oklahoma City-COTPA | 40 | 204 | WI | Madison-MMT | 158 |
| 152 | OK | Tulsa-MTA | 38 | 205 | WI | Racine-Belle Urban System | 20 |
| 153 | OR | Portland-Tri-Met | 88 | 206 | WI | Sheboygan-ST | 5 |
| 154 | OR | Medford-RVTD | 5 | 207 | WI | Milwaukee-Waukesha Metro | 4 |
| 155 | PA | Allentown-Lanta | 55 | 208 | WI | Milwaukee-Paratransit | 295 |
| 156 | PA | Erie-EMTA | 24 | 209 | WV | Charleston-KRT | 8 |
| 157 | PA | Lancaster-RRTA | 70 | 210 | WV | Huntington-TTA | 4 |
| 158 | PA | Philadelphia-SEPTA | 246 | 211 | WY | City of Casper | 9 |
| 159 | PA | Beaver County-BCTA | 17 | 212 | WY | Cheyenne Transit | 29 |

## Table A-3 Rail Transit Systems Considered

| Rail | ST | Transit Agency | Total Vehicles Max. Service |
|---|---|---|---|
| **Heavy Rail** | | | |
| 1 | NY | NY-MTA-NYCTA | 4,954 |
| 2 | IL | Chicago-RTA-CTA | 856 |
| 3 | DC | Washington-WMATA | 534 |
| 4 | CA | San Francisco-BART | 406 |
| 5 | MA | Boston-MBTA | 378 |
| 6 | PA | Philadelphia-SEPTA | 304 |
| 7 | NY | Port Authority-PATH | 282 |
| 8 | GA | Atlanta-MARTA | 160 |
| 9 | NJ | Philadelphia-PATCO | 102 |
| 10 | FL | Miami-MDTA | 76 |
| 11 | MD | Baltimore-Maryland-MTA | 48 |
| 12 | NY | NY-MTA-Staten Island | 36 |
| 13 | OH | Cleveland-RTA | 35 |
| 14 | CA | LA-LACMTA/SCRTD | 16 |
| **Light Rail** | | | |
| 1 | MA | Boston-MBTA | 194 |
| 2 | PA | Philadelphia-SEPTA | 107 |
| 3 | CA | San Francisco-Muni | 101 |
| 4 | CA | San Diego- The Trolley | 59 |
| 5 | PA | Pittsburgh-PAT | 59 |
| 6 | CA | San Jose-SCCTD | 38 |
| 7 | CA | LA-LACMTA/SCRTD | 36 |
| 8 | CA | Sacramento-RT | 32 |
| 9 | MD | Baltimore-Maryland-MTA | 30 |
| 10 | OH | Cleveland-RTA | 24 |
| 11 | OR | Portland-Tri-Met | 23 |
| 12 | NY | Buffalo-NFTA | 23 |
| 13 | LA | New Orleans-RTA | 21 |
| 14 | NJ | New Jersey Transit | 16 |
| 15 | TN | Memphis-MATA | 4 |
| 16 | WA | Seattle-Metro | 3 |

# Appendix B

## Section 15 Transit Reporting Data **Used** in Analysis

**Table B-l Section 15 Transit Reporting Data**

**Transit Operating Expenses**
- Vehicle Operations
- Vehicle Maintenance
- Non-Vehicle Maintenance
- General and Administrative
- Purchased Transportation

**Transit Service Characteristics**
- Feet size - total
- Vehicles operated - base period
- Vehicles operated - peak period
- Vehicles operated - maximum service
- Vehicles available - maximum service
- Route miles
- Number employees
- Employee work-hours
- Number roadcalls
- Number of service interruptions

**Transit Safety**
- Number of incidents (collision, non-collision, station)
- Number of fatalities (patron, non patron, total)
- Number of injuries (patron, non patron, total)

**Transit Service Supplied**
- Scheduled annual vehicle revenue miles
- Actual annual vehicle miles
- Actual annual vehicle hours
- Actual annual vehicle revenue miles
- Actual annual vehicle revenue hours

**Transit Service Consumed**
- Annual unlinked passenger trips
- Annual passenger miles

# Appendix C

## APTS Deployments

### Table C-1 APTS Fleet Management System Deployments

| Operational | ST | Transit Agency | MB | DRT |
|---|---|---|---|---|
| 1 | CA | LA-Santa Monica | 106 | |
| 2 | CA | SF-SamTrans | 249 | |
| 3 | CA | San Francisco-Muni | 386 | |
| 4 | CA | LA-Gardena Bus Line | 38 | |
| 5 | CA | Napa-The V.I.N.E. | 13 | |
| 6 | CO | Denver-RTD | 663 | |
| 7 | FL | Tampa-Hartline | 133 | |
| 8 | IA | Des Moines-Metro | 79 | 24 |
| 9 | KY | Louisville-TARC | 248 | |
| 10 | NJ | New Jersey Transit | 1,656 | |
| 11 | NY | Albany-CDTA | 187 | |
| 12 | NY | NY-Westchester-Liberty | 241 | |
| 13 | OH | Columbus-COTA | 252 | |
| 14 | OR | Eugene-LTD | 65 | |
| 15 | PA | Scranton-Colts | 30 | |
| 16 | PA | Rochester - Beaver County | 13 | |
| 17 | TX | San Antonio-VIA | 498 | |
| 18 | VA | Norfolk-TRT | 124 | |
| 19 | WA | Seattle-Metro | 906 | |
| 20 | WI | Milwaukee-County | 460 | |
| 21 | WI | Sheboygan-ST | 29 | |

## Table C-1 APTS Fleet Management System Deployments (cont'd)

**Under Implementation**

| | ST | Transit Agency | MB | DRT |
|---|---|---|---|---|
| 1 | AZ | Tucson-Sun Tran | 157 | |
| 2 | CA | Santa Cruz-METRO | 66 | |
| 3 | CA | Stockton-SMART | 55 | |
| 4 | CA | San Jose-SCCTD | | 15 |
| 5 | CA | Oakland-AC Transit | 614 | |
| 6 | CA | LA-LACMTA/SCRTD | 1,912 | |
| 7 | FL | Ft. Lauderdale-Bct | 184 | |
| 8 | FL | Miami-MDTA | 617 | |
| 9 | GA | Atlanta-MARTA | 561 | |
| 10 | IA | Cedar Rapids-The Bus | 34 | |
| 11 | IL | Chicago-RTA-Pace | 584 | |
| 12 | IN | NW IN-Gary-GPTC | 29 | |
| 13 | LA | Shreveport-SparTran | 37 | |
| 14 | MA | Boston-CATA | 10 | |
| 15 | MD | Baltimore-Maryland-MTA | 722 | |
| 16 | MD | Maryland-Ride-On | 204 | |
| 17 | MI | Detroit-SMART | 233 | 126 |
| 18 | MI | Ann Arbor-AATA | 57 | |
| 19 | NC | Raleigh-CAT | | 7 |
| 20 | NY | Buffalo-NFTA | 307 | |
| 21 | NY | Rochester-RTS | 178 | |
| 22 | OH | Cincinnati-SORTA | 323 | |
| 23 | OR | Portland-Tri-Met | 468 | |
| 24 | TX | Corpus Christi | 54 | |
| 25 | TX | Dallas-DART | 530 | |
| 26 | WA | Bremerton-Kitsap Transit | 77 | 72 |

**Planned**

| | ST | Transit Agency | MB | DRT |
|---|---|---|---|---|
| 1 | AZ | Phoenix PTD | | 61 |
| 2 | AZ | Phoenix-Phoenix TS/ATC | 282 | |
| 3 | CA | LA-Torrance | 57 | |
| 4 | CA | Modesto-MAX | 25 | 10 |
| 5 | CA | San Bernardino-OMNITRANS | 86 | |
| 6 | IA | Sioux City-STC | 21 | 16 |
| 7 | IL | Chicago-RTA-CTA | 1,731 | |
| 8 | IL | Rock Island-Metro Link | 50 | |
| 9 | LA | New Orleans-RTA | 374 | |
| 10 | MA | Attleboro/Taunton-GATRA | | 28 |
| 11 | MN | Minneapolis-St. Paul-MTC | 855 | |
| 12 | MO | Kansas City-KCATA | 208 | |
| 13 | NC | Fayetteville-Fast | 12 | |
| 14 | NC | Winston-Salem-WSTA | | 12 |
| 15 | NM | Albuquerque-Sun Tran | | 44 |
| 16 | NY | NY-MTA-Long Island Bus | 265 | |
| 17 | NY | NY-MTA-NYCTA | 3,064 | |
| 18 | NY | Syracuse-RTA-Centro | 137 | |
| 19 | TX | El Paso-Sun Metro | 118 | |
| 20 | TX | Houston-Metro | 1,016 | |
| 21 | WI | Kenosha Transit | 35 | |

## Table C-2 APTS Transit Information System Deployments

| Operational | | | | | |
|---|---|---|---|---|---|
| | ST | Transit Agency | MB | DRT | RAIL |
| 1 | CA | LA-LACMTA/SCRTD | 1,912 | | |
| 2 | CA | LA-LACMTA/SCRTD | | | 16 |
| 3 | CA | LA-Long Beach Transit | 152 | | |
| 4 | CA | Napa-The V.I.N.E. | 13 | | |
| 5 | CA | Riverside - Special Transportation | | 19 | |
| 6 | CA | San Francisco-BART | | | 406 |
| 7 | CA | Santa Barbara-MTD | 59 | | |
| 8 | CA | SF-SamTrans | 249 | | |
| 9 | CA | Stockton-SMART | 55 | | |
| 10 | CO | Denver-RTD | 663 | | |
| 11 | CO | Greeley-The Bus | 10 | | |
| 12 | CT | Hartford-CT Transit | 193 | | |
| 13 | DC | Washington-WMATA | 1,339 | | |
| 14 | FL | Daytona Beach-VOTRAN | 34 | | |
| 15 | FL | Miami-MDTA | 617 | | |
| 16 | FL | Tampa-Hartline | 133 | | |
| 17 | HI | Honolulu-DTS | 424 | | |
| 18 | IA | Des Moines-Metro | 79 | | |
| 19 | IL | Chicago-RTA-Pace | 584 | | |
| 20 | KS | Wichita-MTA | 43 | | |
| 21 | LA | New Orleans-RTA | 374 | | |
| 22 | MA | Boston-MBTA | | | 378 |
| 23 | MN | Minneapolis-St. Paul-MTC | 855 | | |
| 24 | MO | Columbia-CATS | 10 | | |
| 25 | NC | Charlotte-CTS | 135 | | |
| 26 | NC | Winston-Salem-WSTA | 41 | 12 | |
| 27 | NV | Las Vegas - Citizens | 218 | | |
| 28 | NY | Rochester-RTS | 178 | | |
| 29 | OH | Columbus-COTA | 252 | | |
| 30 | OR | Portland-Tri-Met | 468 | | 23 |
| 31 | PA | Beaver County-BCTA | 13 | | |
| 32 | PA | Scranton-Colts | 30 | | |
| 33 | PA | State College-Centre Line | 26 | | |
| 34 | PA | Williamsport-City Bus | 14 | | |
| 35 | VA | Newport News-Pentran | 98 | | |
| 36 | WA | Seattle-Metro | 906 | | |
| 37 | WI | Kenosha-KTC | 35 | | |
| 38 | WI | Milwaukee-Waukesha Metro | 15 | | |

## Table C-2 APTS Transit Information System Deployments (cont'd)

**Under Implementation**

| | ST | Transit Agency | MB | DRT | RAIL |
|---|---|---|---|---|---|
| 1 | AZ | Tucson-Sun Tran | 157 | | |
| 2 | CA | Oakland-AC Transit | 614 | | |
| 3 | CA | Santa Cruz-METRO | 66 | | |
| 4 | GA | Atlanta-MARTA | 561 | | 160 |
| 5 | IL | Chicago-RTA-CTA | 1,731 | | |
| 6 | IL | Rock Island-Metro Link | 50 | | |
| 7 | MA | Boston-CATA | 10 | | |
| 8 | MD | Baltimore-Maryland-MTA | 722 | | |
| 9 | MD | Maryland-Ride-On | 204 | | |
| 10 | ME | Portland-METRO | 17 | | |
| 11 | MI | Ann Arbor-AATA | 57 | | |
| 12 | NC | Raleigh-CAT | 44 | | |
| 13 | NY | Buffalo-NFTA | 307 | | |
| 14 | OH | Cincinnati-SORTA | 323 | | |
| 15 | TX | Corpus Christi | 54 | | |
| 16 | TX | Houston-Metro | 1,016 | | |
| 17 | TX | Laredo-El Metro | 26 | | |
| 18 | WA | Bremerton-Kitsap Transit | 77 | | |
| 19 | WA | Spokane-STA | 115 | | |

**Planned**

| | ST | Transit Agency | MB | DRT | RAIL |
|---|---|---|---|---|---|
| 1 | CA | LA-Torrance | 57 | | |
| 2 | CA | San Francisco-Muni | 386 | | |
| 3 | ID | Boise Urban Stages | 23 | | |
| 4 | MI | Detroit-SMART | 233 | | |
| 5 | ND | Grand Forks-City Bus | 12 | | |
| 6 | NJ | New Jersey Transit | 1,656 | | |
| 7 | NY | NY-MTA-Long Island Bus | 265 | | |
| 8 | NY | NY-MTA-NYCTA | 3,064 | | |
| 9 | NY | Syracuse-RTA-Centro | 137 | | |
| 10 | NY | NY-Westchester-Liberty | 241 | | |
| 11 | WA | Tacoma-Pierce Transit | 147 | | |
| 12 | WI | Madison-MMT | | 158 | |

## Table C-3 APTS Automated Fare System Deployments

**Operational**

| | ST | Transit Agency | MB | DRT | RAIL |
|---|---|---|---|---|---|
| 1 | AZ | Phoenix-Mesa SunRunner | 9 | | |
| 2 | AZ | Phoenix-Phoenix TS/ATC | 282 | | |
| 3 | CA | LA-Culver City | 24 | | |
| 4 | CA | LA-Foothill Transit | 162 | | |
| 5 | CA | LA-LACMTA/SCRTD (HR/LR) | | | 52 |
| 6 | CA | LA-Montebello | 36 | | |
| 7 | CA | San Francisco-BART | | | 406 |
| 8 | CT | Hartford-CT Transit | 193 | | |

**Implementation**

| | ST | Transit Agency | MB | DRT | RAIL |
|---|---|---|---|---|---|
| 1 | CA | Lompoc Transit | | 9 | |
| 2 | GA | Atlanta-MARTA | 561 | | 160 |
| 3 | IL | Chicago-RTA-CTA | 1,731 | | |
| 4 | MA | Boston-CATA | 10 | | |
| 5 | NY | New York City DOT | 91 | | |
| 6 | NY | NY-MTA-NYCTA | 3,064 | | |
| 7 | NY | NY-Westchester-Liberty | 241 | | |
| 8 | NY | NYCDOT-Bus Tours | 100 | | |
| 9 | NY | NYCDOT-Command Bus | 106 | | |
| 10 | NY | NYCDOT-Green Bus | 148 | | |
| 11 | NY | NYCDOT-Queens | 226 | | |

**Planned**

| | ST | Transit Agency | MB | DRT | RAIL |
|---|---|---|---|---|---|
| 1 | CA | LA-Gardena Bus Line | | 7 | |
| 2 | CA | LA-Torrance | 57 | | |
| 3 | CA | Santa Cruz-METRO | 66 | | |
| 4 | CA | Simi Valley Transit | 6 | | |
| 5 | DC | Washington-WMATA | 1,339 | | 534 |
| 6 | DE | Wilmington-DART | 96 | | |
| 7 | FL | Tallahassee-TALTRAN | 41 | | |
| 8 | MA | Boston-MBTA | 841 | | 378 |
| 9 | MI | Ann Arbor-AATA | 57 | | |
| 10 | NC | Winston-Salem-WSTA | | 12 | |
| 11 | NV | Reno-Citifare | 53 | | |
| 12 | NY | NY-MTA-NYCTA | | | 4,954 |
| 13 | NY | Port Authority-PATH | | | 282 |
| 14 | PA | Pittsburgh-Westmoreland | 12 | | |
| 15 | TN | Chattanooga-CARTA | 48 | | |
| 16 | TX | Dallas-Grand Prairie | | 5 | |
| 17 | TX | San Antonio-VIA | 498 | | |
| 18 | WA | Seattle-Metro | 906 | | |
| 19 | WA | Seattle-Snohomish-Commun. | 150 | | |
| 20 | WA | Tacoma-Pierce Transit | 147 | | |
| 21 | WV | Huntington-TTA | 20 | | |

## Table C-3 APTS Demand Responsive CAD System Deployments

**Operational**

| | ST | Transit Agency | DRT |
|---|---|---|---|
| 1 | AL | Huntsville | 31 |
| 2 | AR | Fayetteville-Springdale | 2 |
| 3 | AZ | Phoenix-Glendale | 12 |
| 4 | CA | San Jose-SCCTD | 15 |
| 5 | CA | Santa Maria Area Transit | 5 |
| 6 | CT | Danbury-HART | 13 |
| 7 | FL | Daytona Beach-VOTRAN | 4 |
| 8 | FL | Miami-MDTA | 27 |
| 9 | FL | Miami-MDTA/Comprehensive | 283 |
| 10 | FL | Okaloosa County | 30 |
| 11 | FL | Panama City-Bay Council | 29 |
| 12 | HI | Honolulu-HDOT-Mayflower | 135 |
| 13 | IA | Watreloo MTA of Hawk County | 30 |
| 14 | IN | Lafayette-GLPTC | 3 |
| 15 | IN | South Bend-Transpo | 5 |
| 16 | KS | Wichita-MTA | 7 |
| 17 | MA | Lowell-LRTA | 22 |
| 18 | MA | Springfield-PVTA | 54 |
| 19 | MA | Fitchburg-MART | 158 |
| 20 | MA | Providence-GATRA | 60 |
| 21 | ME | Portland-RTP | 14 |
| 22 | ME | Lewiston-Western Maine | 15 |
| 23 | MI | Jackson-JTA | 17 |
| 24 | MI | Lansing-CATA | 50 |
| 25 | MO | St. Louis-Bi-State | 46 |
| 26 | MT | Billings-MET | 10 |
| 27 | NC | Charlotte-CTS | 37 |
| 28 | NC | Winston-Salem-WSTA | 12 |
| 29 | NC | Durham-DATA | 22 |
| 30 | ND | Grand Forks-City Bus | 9 |
| 31 | NV | Reno-Citifare | 29 |
| 32 | NV | Las Vegas-EOB | 23 |
| 33 | NY | Poughkeepsie-LOOP | 21 |
| 34 | NY | Utica-UTA | 5 |
| 35 | NY | NY-Westchester-BEE-LINE | 36 |
| 36 | OH | Youngstown-WRTA | 4 |
| 37 | PA | York-YCTA | 8 |
| 38 | SC | Greenville-GTA | 15 |
| 39 | TN | Clarksville-CTS | 3 |
| 40 | TX | Amarillo-ACT | 3 |
| 41 | TX | Laredo-El Metro | 7 |
| 42 | TX | San Antonio-VIA | 168 |
| 43 | TX | Brownsville-BUS | 5 |
| 44 | VT | Burlington-CT | 8 |
| 45 | WA | Tacoma-Pierce Transit | 106 |
| 46 | WA | Seattle-Snohomish-Senior | 24 |
| 47 | WV | Charleston-KRT | 8 |
| 48 | WY | City of Casper | 9 |

**Under Implementation**

| | ST | Transit Agency | DRT |
|---|---|---|---|
| 1 | CA | Stockton-SMART | 21 |
| 2 | LA | Shreveport-SparTran | 7 |
| 3 | MI | Detroit-SMART | 126 |
| 4 | MO | St. Joseph Express | 20 |
| 5 | NC | Raleigh-CAT | 7 |
| 6 | NC | Durham-Chapel Hill | 6 |
| 7 | NH | Nashua-City Bus | 9 |
| 8 | NY | Ithaca-TOMTRAN | 9 |
| 9 | OH | Hamilton City Lines | 8 |
| 10 | SC | Sumter-Santee Wateree | 45 |
| 11 | TX | Dallas - Handitran | 10 |
| 12 | TX | Corpus Christi-The B | 22 |
| 13 | WA | Bremerton-Kitsap Transit | 72 |
| 14 | WI | Madison-MMT | 158 |

**Planned**

| | ST | Transit Agency | DRT |
|---|---|---|---|
| 1 | AZ | Phoenix PTD | 61 |
| 2 | AZ | Phoenix-Maricopa STS | 47 |
| 3 | AZ | Peoria Transit | 4 |
| 4 | CA | Modesto-MAX | 10 |
| 5 | CA | Yuba-Sutter | 13 |
| 6 | CA | Lancaster-AV Transit | 13 |
| 7 | CA | Victorville-VVTSA | 8 |
| 8 | CT | New Haven-Gr. New Haven | 11 |
| 9 | CT | Greater Bridgeport TD | 14 |
| 10 | IA | Cedar Rapids-The Bus | 4 |
| 11 | IA | Sioux City-STC | 16 |
| 12 | IN | NW IN-Trade Winds Rehab | 22 |
| 13 | MI | Bay City-Metro Transit | 14 |
| 14 | OR | Medford-RVTD | 5 |
| 15 | WI | Milwaukee-Waukesha Metro | 4 |

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